United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In reply refer to:

NOV 5 2009

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Subject: Don Pedro Project, FERC # 2299, Tuolumne River, California, U.S. Fish and Wildlife Service Comments on Instream Flow and Water Temperature Study Plans

Dear Secretary Bose:

In its July 16, 2009 Order on Rehearing, Amending License, Denying Later Intervention, Denying Petition, and Directing Appointment of a Presiding Judge for a Proceeding on Interim Conditions (Order), the Federal Energy Regulatory Commission (Commission or FERC) directed the Turlock and Modesto Irrigation Districts (Districts) to develop and implement an instream flow study for, and a water temperature model of, the Tuolumne River below La Grange Dam. Specifically, paragraph F of the Commission Order states:

> *The Turlock and Modesto Irrigation Districts (Districts) shall develop and implement an IFIM/PHABSIM study plan to determine instream flows necessary to maximize fall-run Chinook salmon and O. mykiss production and survival throughout their various life stages. The PHABSIM flow models under the IFIM should evaluate base flows, to include, but not be limited to, 150 cubic feet per second (cfs), 200 cfs, 250 cfs, 300 cfs, and at least 400 cfs. The instream flow study shall also evaluate spring pulse flows of 1,000 to 5,000 cfs and fall pulse flows of up to 1,500 cfs from La Grange Dam. In general, the instream flow study shall include the following steps, unless agreed upon otherwise in consultation with the resource agencies: (1) selection of target species or guild, selection or development of appropriate micro- and/or macro-habitat suitability criteria, (2) study area segmentation and study site selection; (3) cross section placement and field data collection; (4) hydraulic modeling; (5) habitat modeling; (6) derivation of total habitat time series, micro- and macro-habitat; (7) determination of habitat bottlenecks; and (8) evaluation of management alternatives and problem resolution. In connection with the IFIM study, the Districts shall also develop a water temperature model to determine the downstream extent of thermally suitable habitat to protect summer juvenile O. mykiss rearing under various flow conditions and to determine flows necessary to maintain water temperatures at or below 68 degrees Fahrenheit from La Grange Dam to Roberts Ferry Bridge.*

By letter dated September 3, 2009, the Districts distributed draft instream flow and water temperature modeling study plans for review by the resource agencies. The U.S. Fish and Wildlife Service (Service) provided comments on those Instream Flow and Water Temperature Study Plans by letter dated October 5, 2009. By letter dated October 14, 2009, the Districts submitted final instream flow and water temperature modeling study plans to the Commission along with responses to Service comments, stating that:

> *The Districts shall implement the study plans following Commission approval, including any changes that may be required by the Commission.*

As discussed below, the Service finds that the responses provided by the Districts to the Service's October 5, 2009, comments are inaccurate or misleading, and requests that the Commission require the changes to the study plans included in the Service's October 5, 2009 letter. The Service's October 5, 2009, letter is enclosed herein and incorporated by this reference.

The Service also wishes to comment on the Order with regards to the development of instream flow and water temperature models. The Order lacks clarity about the need for the instream flow study, how the study results will be used in decision making, or how other flow-related studies will complement the modeling. The Order is unclear about why an instream flow model is appropriate, and why the Physical Habitat Simulation System (PHABSIM) was chosen as the model to be applied. In this regard, the Service requests the Commission to reconsider or clarify its order with regard to use of PHABSIM; the Districts assumed that the order's mention of PHABSIM and of transect placement meant that the one-dimensional (1-D) PHABSIM model should be used, while the Service recommends the use of two-dimensional (2-D) hydraulic and habitat models, such as River2D, since 2-D models represent the current state of the art for hydraulic and habitat modeling. The Service also requests the Commission to reconsider the range of flows given in its order; the Service recommends that habitat be simulated up to 8,400 cfs for all life stages of Chinook salmon and Central Valley steelhead (*O. mykiss*.) We suggest the Commission review the regulations required of the agencies when requesting information or studies in the relicensing process, and apply these standards to its determination of the appropriate methodology to be used here.

As discussed in our October 5, 2009 letter to the Districts, the Service has two overarching issues with the proposed plans. First, a PHABSIM flow model does not address all of the essential habitat needs of the migratory phases of anadromous species, such as Central Valley fall-run Chinook salmon and (*O. mykiss*. Further, the PHABSIM flow model does not address the effects of flow on potential biotic limiting factors (e.g., predation, food, contaminants, disease, etc.) or abiotic factors (e.g., unscreened diversions) within or outside of the Tuolumne River. Habitat needs and potential limiting factors are critical to the Commission's ultimate determination here, as to what measures may be necessary to protect the salmonid species. Accordingly, the PHABSIM flow model should not be used by itself to develop an instream flow schedule for the Don Pedro Project that will sustain and protect the Central Valley steelhead and Central Valley fall-run Chinook salmon populations in the Tuolumne River. The Instream Flow Incremental Methodology (IFIM) study plan should be revised to specifically state that the objectives of the study are to determine the instream flows necessary to maximize Chinook salmon and *O. mykiss* production and survival only for the resident phases of these species, particularly for adult *O. mykiss*. The study plan should be revised to indicate that other methods will be needed to assess the flows for the migratory phases of these species. The studies for the migratory phases are to be determined based on the Agencies' recommended interim measure elements, which include fish health assessments, temperature monitoring, tissue (genetic) sampling, paired rotary screw trap studies, escapement surveys, and adult age composition. Although the Order requires an instream flow study of the spring and fall pulse flows intended for the migratory phases of these species, typical habitat suitability criteria and weighted usable area estimates cannot be used to evaluate the benefits of these flows. Therefore, the study plan should be revised to state that the sole objective of the late winter and spring pulse flow studies is to demonstrate the relationship between pulse flows and the area of inundated floodplain habitats throughout the Tuolumne River. Other data will be used to assess the importance of inundated floodplain habitat and the duration and timing needed for floodplain inundation, whereas the instream flow studies will determine the flow that optimizes the amount of inundated habitat.

Second, the HEC-5Q water temperature model that was developed for the Tuolumne River and other tributaries of the San Joaquin River by AD Consultants and RMA was thoroughly reviewed by all the San Joaquin River Basin Stakeholders from 2005 through 2008 and should not be revised by the Districts or their consultants without the approval of the Service and other agencies. There is no reason why the existing model should not be used to determine the flows needed to maintain the specified water temperature targets under a range of climatic conditions and reservoir storage levels as well as manage the reservoir storage to prevent the release of unsuitably warm water. In addition, the Service believes that water temperature is highly important to the survival of salmon and *O. mykiss* and so the results of the water temperature analysis should not combined with weighted usable area estimates into a single habitat based index to provide the sole assessment of the instream flow needs of the fish.

SPECIFIC RESPONSES

We provide the following specific responses to the Districts' October 14 response to the Service's comments. The Districts' responses are found in Attachment 6 of the October 14 filing.

Instream Flow Study Plan

Mesohabitat Mapping (page 6-2) – The Service requested that the mesohabitat for the Tuolumne River be delineated using 12-mesohabitat types (Service's October 5, 2009, letter at 3). The Districts decline to adopt this approach. However, the Districts provide no evidence supporting their view that the Tuolumne River lacks the mesohabitat complexity that the Service's proposed mapping system assumes. The Service has found, based on past studies on the American, Sacramento and Yuba Rivers, that the Service's proposed mapping system is essential to capture the mesohabitat complexity of Central Valley rivers, and thus is applicable to the Tuolumne River.

Habitat Modeling (page 6-3) – The Service suggested that habitat modeling be conducted using a two-dimensional model rather than one-dimensional PHABSIM (Service at 4). The Districts' responses ignore the advantages of 2-D hydraulic and habitat modeling and inaccurately state advantages of 1-D models. The foremost advantage of 2-D hydraulic and habitat modeling is that virtually all areas of a low-gradient stream such as the lower Tuolumne River can be modeled. In contrast, in our experience at least half of the length of streams cannot be modeled by 1-D models such as PHABSIM due to hydraulic complexities such as transverse flow and across-channel variation in water surface elevations. The relevant question for selecting 1-D versus 2-D models is what model is the state of the art, not what model is a standard approach; in our opinion, the scientific literature is clear that 2-D models are the current state of the art for evaluation of habitat and flow relationships for rivers affected by hydroelectric projects. In our experience, the same number of habitat units are typically modeled for both 1-D and 2-D models due to the desire to consolidate as many transects as possible into an individual site. Thus, the Districts' argument on this supposed advantage of 1-D models is erroneous. Further, the Districts are incorrect that 2-D modeling is a representative reach approach – our 2-D studies have consistently used a mesohabitat mapping-based approach to extrapolate to the entire river from the 2-D sites. The Districts suggest that 1-D models are more accurate than 2-D models because they are based on measured velocities. While PHABSIM will typically do a good job in predicting velocities at flows close to those at which velocity data were collected, it generally does not do as well at flows farther from those at which velocity data were collected, particularly when extrapolating up to higher flows. Thus, the Districts' argument on this supposed advantage of 1-D models is misleading. An advantage of 2-D models is that a large number of velocity measurements are not needed to calibrate the model, since they take into account local bed topography and roughness, and explicitly use mechanistic processes (conservation of mass and momentum), rather than the reduced Manning's formulation and an empirical velocity adjustment factor. The Districts' argument regarding the similarity of flow-habitat relationships from 1-D and 2-D studies is flawed because comparisons can only be made for areas which can be modeled with both 1-D and 2-D. If flow-habitat relationships for areas that cannot be modeled with PHABSIM are significantly different from areas which can be modeled with PHABSIM, the choice of model would have an effect on instream flow prescriptions.

Habitat Suitability Criteria (HSC) (page 6-4) – The Service suggested that the Districts utilize a depth modification procedure in developing HSC (Service at 11). The Districts' comments on the depth modification procedure are inaccurate. Specifically, the method does not result in the highest suitability for conditions where few or no empirical observations are recorded, nor does it result in maximum suitability for very rare or theoretical conditions, since it just determines the depth at which suitability reaches zero. The Districts' comments on logistic regression are also inaccurate. As noted in our October 5, 2009 letter to the Districts, logistic regression is now considered the standard best approach in the scientific literature for developing habitat suitability criteria (Service at 12). Thus, the method complies with generally accepted practice in the scientific community. It should be noted that the citation provided by the Districts (PG&E 2007) to claim that the method has received unfavorable peer review is in fact not a peer review of the methodology but rather a stakeholder review of logistic regression. In contrast, a peer review of the same document that was the subject of the citation found most of the criteria curves to be appropriate and supported the use of logistic regression. The citation provided by the Districts with regards to the predictions of areas of habitat use from logistic regression does not provide an accurate depiction of the results of logistic regression. Specifically, the logistic regression results in this citation did not include substrate and were calculated using a geometric mean, rather than the product of the suitabilities, to calculate combined suitability. These procedures (exclusion of substrate and geometric mean) resulted in most of the site being predicted as having high suitability. In contrast, the Service's results from the Yuba River, using substrate and the product of the suitabilities, found a much better relationship between redd locations and combined suitability than shown for logistic regression in the Districts' citation, and showed a substantial portion of the site with low suitability. A direct comparison of the Service's results from the Yuba River and the other techniques for salmon spawning in the District's citation cannot be made because this citation used a much finer resolution topography to generate depths and velocities than that used by the Service.

Biological Verification (page 6-5) – The Service requested that biological verification data be collected (Service at 13). The Districts' comments in response to this request are misleading in suggesting that biological verification relates only to the Service's 2-D model. The Service considers biological verification to be important for both 1-D and 2-D models. However, unless 1-D models are applied in a spatially explicit manner, which is rarely done, it is impossible to conduct biological verification of 1-D models. The Service thus views the ability to conduct biological verification as an important advantage of 2-D models.

GENERAL RESPONSES

The Districts' response that "there are relatively few sections of the lower Tuolumne River that have significant areas of natural floodplain that are inundated at anything below the highest flood magnitudes" is misleading. The Service's 2008 flow-overbank inundation report established that there are 513 acres of floodplain inundated at 3,100 cfs in the upper 30.5 miles (almost three-fifths of the Tuolumne River below La Grange Dam). The question of whether this floodplain is natural or is not is irrelevant to the biological function of the floodplain. The Districts' claim that it would be enormously costly to model the entire river using River2D to evaluate floodplain inundation is simply false. The only data that needs to be collected to accomplish this task is bathymetry data from upstream of Modesto (at least River Mile (RM) 17) to the 7/11 Bridge (at RM 36.5), or at most 19.5 miles. An order of magnitude estimate of the cost of this can be made from Turlock Irrigation District's November 19, 2004 CALFED monitoring grant proposal, which gives an estimate of $105,000 to collect bathymetry data from La Grange Dam (RM 52) to at least RM 34.2 (Task 7E), or a total of at least 17.8 miles. Accordingly, data collection costs would be on the order of $100,000. The Service estimates that the modeling, apart from the data collection, would likely also cost on the order of $100,000. We would not consider a cost of $200,000 to be enormously costly.

The Service requests that the Commission consider the Service's recommendations as it reviews the Districts' proposed analyses. If f you have any questions regarding this letter, please contact Dr. Mark Gard of my office at (916) 414-6589.

Sincerely,

M. Kathleen Wood
Assistant Field Supervisor

Enclosure (October 5, 2009, letter)

cc:
FERC Service List, Project No. 2299

BEFORE THE
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

CERTIFICATE OF SERVICE

I hereby certify that Don Pedro Hydroelectric Project, FERC #2299, Tuolumne River, California, U.S. Fish and Wildlife Service Comments on Instream Flow and Water Temperature Study Plans has this day been electronically filed with the Federal Energy Regulatory Commission and electronically served on Parties indicating a willingness to receive electronic service and served, via deposit in U.S. mail, first-class postage paid, upon each other person designated on the service list for Project #2299 compied by the Commission Secretary.

Dated at Sacramento, California, this 5th of November, 2009.

Name: Heeja Seto
Office Assistant
US Fish and Wildlife Service
2800 Cottage Way, Rm.W-2605
Sacramento, CA 95825
(916) 414-6600

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
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Sacramento, California 95825-1846

In reply refer to:

Tim Ford, Aquatic Biologist
Turlock Irrigation District
333 East Canal Drive
Post Office Box 494
Turlock, California 95381

OCT 5 2009

Subject: Don Pedro Hydroelectric Project, FERC # 2299, Tuolumne River, California – Service Comments on Instream Flow and Water Temperature Study Plans

Dear Mr. Ford:

In its July 16, 2009 Order on Rehearing, Amending License, Denying Later Intervention, Denying Petition, and Directing Appointment of a Presiding Judge for a Proceeding on Interim Conditions (Order), the Federal Energy Regulatory Commission (Commission or FERC) directed the Turlock and Modesto Irrigation Districts (Districts) to develop and implement an instream flow study for, and a water temperature model of, the Tuolumne River below La Grange Dam. Specifically, paragraph F of the Commission Order states:

> *The Turlock and Modesto Irrigation Districts (Districts) shall develop and implement an IFIM/PHABSIM study plan to determine instream flows necessary to maximize fall-run Chinook salmon and O. mykiss production and survival throughout their various life stages. The PHABSIM flow models under the IFIM should evaluate base flows, to include, but not be limited to, 150 cubic feet per second (cfs), 200 cfs, 250 cfs, 300 cfs, and at least 400 cfs. The instream flow study shall also evaluate spring pulse flows of 1,000 to 5,000 cfs and fall pulse flows of up to 1,500 cfs from La Grange Dam. In general, the instream flow study shall include the following steps, unless agreed upon otherwise in consultation with the resource agencies: (1) selection of target species or guild, selection or development of appropriate micro- and/or macro-habitat suitability criteria; (2) study area segmentation and study site selection; (3) cross section placement and field data collection; (4) hydraulic modeling; (5) habitat modeling; (6) derivation of total habitat time series, micro- and macro-habitat; (7) determination of habitat bottlenecks; and (8) evaluation of management alternatives and problem resolution. In connection with the IFIM study, the Districts shall also develop a water temperature model to determine the downstream extent of thermally suitable habitat to protect summer juvenile O. mykiss rearing under various flow conditions and to determine flows necessary to maintain water temperatures at or below 68 degrees Fahrenheit from La Grange Dam to Roberts Ferry Bridge.*

By letter dated September 3, 2009, the Districts distributed draft instream flow and water temperature modeling study plans for review by the resource agencies. The Fish and Wildlife Service (Service) is providing the following comments on those Instream Flow and Water Temperature Study Plans.

The Districts' plans raise a number of concerns, as outlined specifically below. In addition, the Service has two overarching issues with the Districts' proposed plans. First, a Physical Habitat Simulation System (PHABSIM) flow model does not address all of the essential habitat needs of the migratory phases of anadromous species, such as Central Valley fall-run Chinook salmon and Central Valley steelhead (*O. mykiss*). Further, the PHABSIM flow model does not address the effects of flow on potential biotic limiting factors (e.g., predation, food, contaminants, disease, etc.) or abiotic factors (e.g., unscreened diversions) within or outside of the Tuolumne River. Habitat needs and potential limiting factors are critical to the Commission's ultimate determination here, as to what measures may be necessary to protect the salmonid species. Accordingly, the PHABSIM flow model should not be used by itself to develop an instream flow schedule for the Don Pedro Project that will sustain and protect the Central Valley steelhead and Central Valley fall-run Chinook salmon populations in the Tuolumne River. The District's Instream Flow Incremental Methodology (IFIM) study plan should specifically state that the objectives of the study are to determine the instream flows necessary to maximize Chinook salmon and *O. mykiss* production and survival only for the resident phases of these species, particularly for adult Central Valley steelhead. The District's study plan should indicate that other methods will be needed to assess the flows for the migratory phases of these species. The studies for the migratory phases are to be determined based on the Agencies' recommended interim measure elements, which include fish health assessments, temperature monitoring, tissue (genetic) sampling, paired rotary screw trap studies, escapement surveys, and adult age composition. Although the Order requires an instream flow study of the spring and fall pulse flows intended for the migratory phases of these species, typical habitat suitability criteria and weighted usable area estimates cannot be used to evaluate the benefits of these flows. Therefore, the Districts should state that the sole objective of the late winter and spring pulse flow studies is to demonstrate the relationship between pulse flows and the area of inundated floodplain habitats throughout the Tuolumne River. Other data will be used to assess the importance of inundated floodplain habitat and the duration and timing needed for floodplain inundation, whereas the instream flow studies will determine the flow that optimizes the amount of inundated habitat.

Second, the HEC-5Q water temperature model that was developed for the Tuolumne River and other tributaries of the San Joaquin River by AD Consultants and RMA was thoroughly reviewed by all the San Joaquin River Basin Stakeholders from 2005 through 2008 and should not be revised by the Districts or their consultants without the approval of the Service and other agencies. There is no reason why the existing model should not be used to determine the flows needed to maintain the specified water temperature targets under a range of climatic conditions and reservoir storage levels as well as manage the reservoir storage to prevent the release of unsuitably warm water. In addition, the Service believes that water temperature is highly important to the survival of salmon and *O. mykiss* and so the results of the water temperature analysis should not combined with weighted usable area estimates into a single habitat based index to provide the sole assessment of the instream flow needs of the fish.

SPECIFIC COMMENTS

We provide the following specific comments on the District's September 3 letter.

Instream Flow Study Plan

1. Study Segment Delineation - Study segments should be delineated based on differences in flow. Bovee (1995) recommends that the cumulative change in flow within a segment be less than ten percent.

2. Mesohabitat Mapping – Mesohabitats for alluvial channels, such as the Tuolumne River, should be delineated using the following geomorphically-based habitat mapping system. This habitat mapping system uses 12 mesohabitat types: bar complex glides, bar complex pools, bar complex riffles, bar complex runs, flatwater glides, flatwater pools, flatwater riffles, flatwater runs, side channel glides, side channel pools, side channel riffles, and side channel runs (Snider et al 1992). Definitions of the habitat types are given in Table 1. Aerial photos should be used in conjunction with direct observations to determine the aerial extent of each habitat unit. The location of the upstream and downstream end of each habitat unit should be recorded with a Global Positioning System (GPS) unit. The habitat units should be also delineated on the aerial photos. Following the completion of the mesohabitat mapping, the mesohabitat types and number of each habitat type in each segment should be enumerated, and shapefiles of the mesohabitat units should be created in a Geographic Information System (GIS) using the GPS data and the aerial photos. The area of each mesohabitat unit should be computed in GIS from the above shapefiles.

3. Field Reconnaissance and Study Site Selection – Study sites for modeling spawning should be placed in high spawning use areas and study sites for rearing should be selected to adequately represent the mesohabitat types present in each segment. Using a mesohabitat-based approach for modeling spawning habitat fails to take into account salmonids' preference for spawning in areas with high gravel permeability (Vyverberg et al 1996), while having sites only in high-use spawning areas indirectly takes into account characteristics of spawning habitat, such as permeability and upwelling, which are key characteristics of spawning habitat and are not captured by depth, velocity and substrate (Gallagher and Gard 1999). The assumption is that high-use spawning areas have high gravel permeability since salmonids are selecting these areas for spawning. For spawning, the study reach should be surveyed, with the location of the upstream and downstream ends of spawning areas recorded with a GPS unit and the numbers of redds in each spawning area recorded. The spawning study sites selected should be those with the highest number of redds observed during the above survey. The upstream and downstream end of each spawning study site should be selected to correspond to the upstream and downstream ends of spawning areas recorded with the GPS unit. There should be at least five spawning study sites per study segment.

Table 1 Habitat type definitions.

Habitat Type	Definition
Bar Complex	Submerged and emergent bars are the primary feature, sloping cross-sectional channel profile.
Flatwater	Primary channel is uniform, simple and without gravel bars or channel controls, fairly uniform depth across channel.
Side Channel	Less than 20% of total flow.
Pool	Primary determinant is downstream control - thalweg gets deeper as go upstream from bottom of pool. Fine and uniform substrate, below average water velocity, above average depth, tranquil water surface.
Glide	Primary determinants are no turbulence (surface smooth, slow and laminar) and no downstream control. Low gradient, substrate uniform across channel width and composed of small gravel and/or sand/silt, depth below average and similar across channel width (but depth not similar across channel width for Bar Complex Glide), below average water velocities, generally associated with tails of pools or heads of riffles, width of channel tends to spread out, thalweg has relatively uniform slope going downstream.
Run	Primary determinants are moderately turbulent and average depth. Moderate gradient, substrate a mix of particle sizes and composed of small cobble and gravel, with some large cobble and boulders, above average water velocities, usually slight gradient change from top to bottom, generally associated with downstream extent of riffles, thalweg has relatively uniform slope going downstream.
Riffle	Primary determinants are high gradient and turbulence. Below average depth, above average velocity, thalweg has relatively uniform slope going downstream, substrate of uniform size and composed of large gravel and/or cobble, change in gradient noticeable.

Study sites for rearing should be randomly selected to ensure unbiased selection of the study sites. The upstream and downstream end of each rearing study site should be selected to correspond to the upstream and downstream ends of the mesohabitat units selected. The rearing study sites should have a total length of two miles of river. The rearing study sites should include, in total, at least three mesohabitat units of each of the following mesohabitat types: pool, run, riffle, and glide. The proportion of habitat types in the rearing sites should roughly correspond to the proportion of habitat types in each study segment.

4. Habitat Modeling – Habitat modeling should be conducted using a two-dimensional (2-D) model rather than 1-D PHABSIM. 2-D model inputs include the bed topography and bed roughness, and the water surface elevation at the downstream end of the site. The amount of habitat present in the site is computed using the depths and velocities predicted by the 2-D model, and the substrate and cover present in the site. The 2-D model avoids problems of transect placement, since data is collected uniformly across the entire site. The 2-D model also has the potential to model depths and velocities over a range of flows more accurately than 1-D PHABSIM because it takes into account upstream and downstream bed topography and bed roughness, and explicitly uses mechanistic processes (conservation of mass and momentum), rather than Manning's Equation and a velocity adjustment factor (Leclerc et al. 1995). Other advantages of 2-D modeling are that it can explicitly handle complex hydraulics, including transverse flows, across-channel variation in water surface elevations, and flow contractions/expansions (Ghanem et al. 1996, Crowder and Diplas 2000, Pasternack et al. 2004). With appropriate bathymetry data, the model scale is small enough to correspond to the scale of microhabitat use data with depths and velocities produced on a continuous basis, rather than in discrete cells. The 2-D model, with compact cells, should be more accurate than 1-D PHABSIM, with long rectangular cells, in capturing longitudinal variation in depth, velocity and substrate. The 2-D model should do a better job of representing patchy microhabitat features, such as gravel patches. The data can be collected with a stratified sampling scheme, with higher intensity sampling in areas with more complex or more quickly varying microhabitat features, and lower intensity sampling in areas with uniformly varying bed topography and uniform substrate. Bed topography and substrate mapping data can be collected at a very low flow, with the only data needed at high flow being water surface elevations at the up- and downstream ends of the site and flow, and edge velocities for validation purposes. In addition, alternative habitat suitability criteria, such as measures of habitat diversity, can be used.

A. 2-D Model Quality Assurance/Quality Control (QA/QC)

A PHABSIM transect should be placed at the upstream and downstream end of each site. See PHABSIM section for standards for developing stage/discharge relationships for upstream and downstream end of sites.

Data collected between the upstream and downstream transects should include: 1) bed elevation; 2) northing and easting (horizontal location); 3) substrate; and 4) cover. These parameters should be collected at enough points to characterize the bed topography, substrate and cover of the sites. Bed topography points need to be collected at a minimum density of 40 points/100m^2 in all areas of the selected study sites. Data should be collected at least up to the location of the water's edge at the highest flow to be simulated. Bed topography data should be collected at a higher density of points in areas with rapidly varying topography and patchy substrate and cover, and lower densities of points in areas with more uniform topography, substrate and cover. The accuracy of the bed elevations should be 0.1 foot, while the accuracy of the northings and eastings should be at least 1.0 foot[1] The bed topography data can be collected with a total station, a survey-grade Real-time Kinematic (RTK) GPS, or for deeper areas, a combination of Acoustic Doppler Current Profiler (ADCP) traverses across the channel and total station to record the initial and final northing and easting of each traverse, or a combination of depth sounder and RTK GPS.

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[1] All bed topography points will need to be accurate to within 0.1 foot. An accuracy level of 0.1 foot is the scientific standard for modeling salmonid habitat. While Light Detection and Ranging (LiDAR) and other methods may have their uses for coarse scale hydraulic modeling, we believe that the amount of vertical error involved with LiDAR makes it unacceptable for use in juvenile salmonid habitat modeling.

Substrate and cover data should be collected using the categories in Tables 2 and 3. The northings and eastings of the transect headpins and tailpins should be determined with the total station or RTK GPS so that the topography for the transects can be incorporated into the bed topography of the sites. Additional topography data should be collected for one channel width upstream of the upstream transect to improve the accuracy of the flow distribution at the upstream end of the sites.

At least 50 velocity measurements, with the northing and easting of each velocity measurement determined with the total station or RTK GPS, should be collected (in addition to the velocities measured at the upstream and downstream transects and measured by the ADCP, if used) to validate the hydraulic predictions of the 2-D model. The locations of these velocity measurements should be distributed throughout the site. Velocities should be measured to the nearest 0.01 ft/s at 0.6 of the depth for 20 seconds using either a Price AA or Marsh-McBirney velocity meter. The flow present during validation velocity data collection should be detemined from gauge readings, if available. If gauge data is not available, the flow present during validation velocity data collection should be measured.

The topographic data described above should be combined with the bed topography from the upstream and downstream transects to create the initial bed file. The bed file contains the horizontal location (northing and easting), bed elevation and initial bed roughness value for each point. The initial bed roughness values should be determined from the substrate and cover data using the values in Table 4. If the topography data collected upstream of the upstream transect does not extend at least one channel width upstream of the top of the site, a one-channel-width artificial extension should be added upstream of the measured topography data to enable the flow to be distributed by the model when it reaches the study area, thus minimizing boundary conditions influencing the flow distribution at the upstream transect and within the study site. A utility program, R2D_BED (Steffler 2002), should be used to define the study area boundary and to refine the raw topographical data triangulated irregular network (TIN) by defining breaklines[2] going up the channel along features such as thalwegs, tops of bars and bottoms of banks. Breaklines should also be added along lines of constant elevation. An additional utility program, R2D_MESH (Waddle and Steffler 2002), should be used to define the inflow and outflow boundaries and create the finite element computational mesh for the RIVER2D model.

[2] Breaklines are a feature of the R2D_Bed program which force the TIN of the bed nodes to linearly interpolate bed elevation and bed roughness values between the nodes on each breakline and force the TIN to fall on the breaklines (Steffler 2002).

Table 2. Substrate codes, descriptors and particle sizes.

Code	Type	Particle Size (inches)
0.1	Sand/Silt	< 0.1
1	Small Gravel	0.1 – 1
1.2	Medium Gravel	1 – 2
1.3	Medium/Large Gravel	1 – 3
2.3	Large Gravel	2 – 3
2.4	Gravel/Cobble	2 – 4
3.4	Small Cobble	3 – 4
3.5	Small Cobble	3 – 5
4.6	Medium Cobble	4 – 6
6.8	Large Cobble	6 – 8
8	Large Cobble	8 – 10
9	Boulder/Bedrock	> 12
10	Large Cobble	10 – 12

R2D_MESH uses the final bed file as an input. Mesh breaklines[3] should be defined which coincide with the final bed file breaklines. Additional mesh breaklines should then be added between the initial mesh breaklines, and then additional nodes should be added as needed to improve the fit between the mesh and the final bed file and to improve the quality of the mesh, as measured by the Quality Index (QI) value. A QI value of at least 0.2 is considered acceptable (Waddle and Steffler 2002).

The computational mesh should be run to steady state at the highest flow to be simulated, and the water surface elevations (WSELs) predicted by RIVER2D at the upstream end of the site should be compared to the WSELs predicted by PHABSIM at the upstream transect. A stable solution will generally have a solution change (Sol Δ) of less than 0.00001 and a net flow (Net Q) of less

[3] Mesh breaklines are a feature of the R2D_MESH program which force edges of the computation mesh elements to fall on the mesh breaklines and force the TIN of the computational mesh to linearly interpolate the bed elevation and bed roughness values of mesh nodes between the nodes at the end of each breakline segment (Waddle and Steffler 2002). A better fit between the bed and mesh TINs is achieved by having the mesh and bed breaklines coincide.

Table 3. Cover coding system.

Cover Category	Cover Code
No cover	0
Cobble	1
Boulder	2
Fine woody vegetation (< 1" diameter)	3
Fine woody vegetation + overhead	3.7
Branches	4
Branches + overhead	4.7
Log (> 1' diameter)	5
Log + overhead	5.7
Overhead cover (> 2' above substrate)	7
Undercut bank	8
Aquatic vegetation	9
Aquatic vegetation + overhead	9.7
Rip-rap	10

than one percent (Steffler and Blackburn 2002). In addition, solutions for low gradient streams should usually have a maximum Froude Number (Max F) of less than one. Calibration is considered to have been achieved when the WSELs predicted by RIVER2D at the upstream transect is within 0.1 foot of the WSEL predicted by PHABSIM. In cases where the simulated WSELs at the highest simulation flow varies across the channel by more than 0.1 foot, the highest measured flow within the range of simulated flows should be used for RIVER2D calibration. The bed roughnesses of the computational mesh elements should then be modified by multiplying them by a constant bed roughness multiplier (BR Mult) until the WSELs predicted by RIVER2D at the upstream end of the site matched the WSELs predicted by PHABSIM at the top transect. BR Mult values should lie within the range of 0.3 to 3.0. The minimum groundwater depth should be adjusted to a value of 0.05 to increase the stability of the model. The values of all other RIVER2D hydraulic parameters should be left at their default values (upwinding coefficient = 0.5, groundwater transmissivity = 0.1, groundwater storativity = 1, and eddy viscosity parameters $\varepsilon_1 = 0.01$, $\varepsilon_2 = 0.5$ and $\varepsilon_3 = 0.1$).

Table 4. Initial bed roughness values. For substrate code 9, use bed roughnesses of 0.71 and 1.95, respectively, for cover codes 1 and 2. Bed roughnesses of zero should be used for cover codes 1 and 2 for all other substrate codes, since the roughness associated with the cover is included in the substrate roughness.

Substrate Code	Bed Roughness (m)	Cover Code	Bed Roughness (m)
0.1	0.05	0.1	0
1	0.1	1	0
1.2	0.2	2	0
1.3	0.25	3	0.11
2.3	0.3	3.7	0.2
2.4	0.4	4	0.62
3.4	0.45	4.7	0.96
3.5	0.5	5	1.93
4.6	0.65	5.7	2.59
6.8	0.9	7	0.28
8	1.25	8	2.97
9	0.05	9	0.29
10	1.4	9.7	0.57
		10	3.05

Velocities predicted by RIVER2D should be compared with measured velocities to determine the accuracy of the model's predictions of mean water column velocities. The criterion used to determine whether the model was validated was whether the correlation between measured and simulated velocities was greater than 0.6. The model would be in question if the simulated velocities deviated from the measured velocities to the extent that the correlation between measured and simulated velocities fell below 0.6.

After the RIVER2D model is calibrated, the flow and downstream WSEL in the calibrated cdg file should be changed to simulate the hydraulics of the site at the simulation flows. The cdg file for each flow contains the WSEL predicted by PHABSIM at the downstream transect at that flow. Each cdg file should be run in RIVER2D to steady state. Again, a stable solution will generally have a Sol Δ of less than 0.00001 and a Net Q of less than 1%. In addition, solutions should usually have a Max F of less than one.

B. 1-D PHABSIM QA/QC

Transects should be placed in locations where there is no more than a 0.1 foot difference in WSEL across the transect and where the velocity profile across the transect is entirely perpendicular to the transect. Transects generally cannot be placed in areas with transverse flows, across-channel variation in water surface elevations, or flow contractions/expansions. Vertical benchmarks should be established for each transect to serve as the reference elevations to which all elevations (streambed and water surface) are tied. Vertical benchmarks should consist of items that will not change elevation over time, such as lag bolts driven into trees or painted bedrock points. Vertical benchmarks should be tied together for the upstream and downstream transects, so that water surface elevations at these transects can be compared to ensure that water is not running uphill.

The data collected at each transect should include: 1) WSELs measured to the nearest 0.01 foot at a minimum of three significantly different stream discharges using standard surveying techniques (differential leveling); 2) at least 20 wetted streambed elevations per transect determined by subtracting the measured depth from the surveyed WSEL at a measured flow; 3) dry ground elevations to points above bankfull discharge surveyed to the nearest 0.1 foot; 4) mean water column velocities measured at the points where bed elevations are computed; and 5) substrate and cover classification at these same locations (Tables 2 and 3) and also where dry ground elevations were surveyed. When conditions allow, WSELs should be measured along both banks and in the middle of each transect. Otherwise, the WSELs should be measured along both banks. If the WSELs measured for a transect are within 0.1 foot of each other, the WSELs at each transect should be derived by averaging the two to three values. If the WSEL differ by greater than 0.1 foot, the WSEL for the transect should be selected based on which side of the transect was considered most representative of the flow conditions. If there is a hydraulic control downstream of a given transect, the stage of zero flow in the thalweg downstream of that transect should be surveyed in using differential leveling.

The range of flows to be simulated should go up to 8,400 cfs. Water surface elevations should be collected at a minimum of three relatively evenly spaced calibration flows, spanning approximately an order of magnitude. The calibration flows should be selected so that the lowest simulated flow is no less than 0.4 of the lowest calibration flow and the highest simulated flow is at most 2.5 times the highest calibration flow.

For the *IFG4* model to be considered to have worked well, the following standards must be met: 1) the beta value (a measure of the change in channel roughness with changes in streamflow) is between 2.0 and 4.5; 2) the mean error in calculated versus given discharges is less than ten percent; 3) there is no more than a 25% difference for any calculated versus given discharge; and 4) there is no more than a 0.1 foot difference between measured and simulated WSELs. A beta value greater than 4.5 generally indicates that a hydraulic control downstream of the transect was not surveyed in, resulting in an erroneously low stage of zero flow value. *MANSQ* is considered to have worked well if the second through fourth of the above criteria are met, and if the beta value parameter used by *MANSQ* is within the range of 0 to 0.5. The first *IFG4* criterion is not applicable to *MANSQ*. *WSP* is considered to have worked well if the following criteria are met:

1) the Manning's n value used falls within the range of 0.04 - 0.07; 2) there is a negative log-log relationship between the reach multiplier and flow; and 3) there is no more than a 0.1 foot difference between measured and simulated WSELs. The first three *IFG4* criteria are not applicable to *WSP*. An additional QA/QC measure for *IFG4* or *MANSQ* is to check and see if water is flowing uphill at any of the simulated flows – if this is present, it usually indicates that the extrapolation of WSELs beyond the range of measured WSELs has broken down, and in such cases *WSP* should be used to develop the stage-discharge relationship for the upstream transect. The Froude numbers should be <1.0. The acceptable range of Velocity Adjustment Factor (VAF) values is 0.2 to 5.0 and the expected pattern for VAFs is a monotonic increase with an increase in flows.

5. Habitat Suitability Criteria (HSC) – The resident and anadromous forms of *Oncorhynchus mykiss*, including age classes 1+ and 2+, sub-adults, adult holding and summertime habitat conditions, need to be considered. Cover and adjacent velocity will be needed for all HSC observations, in addition to depth and mean water column velocity at the fish location (Service 2005). The Service measures average water column velocities when collecting HSC data. Average water column velocity data need to be collected for all HSC velocity and adjacent velocity measurements. There needs to be a minimum of 150 observations for each life stage and species (Bovee 1986).

The habitat suitability criteria in Service (1995) should not be used since they are likely biased towards low depths and velocities. The criteria used should use the recent advances in techniques for developing habitat suitability criteria for instream flow studies (adjustment of depth habitat suitability criteria for spawning to account for low availability of deep waters with suitable velocity and substrate, use of logistic regression to develop criteria, use of cover and adjacent velocity criteria for rearing) since 1995. Criteria should be developed on the Tuolumne River or the criteria in Service (2008a and b) should be used.

Most habitat utilization curves for salmonid spawning suggest that spawning salmonids, such as Chinook salmon and steelhead, prefer shallow conditions (typically depths of one to two feet). However, such curves may simply reflect that there is very little deeper areas present in streams which have suitable (good) velocities and substrates. Gard (1998) presents a method to adjust depth habitat utilization curves for spawning to account for low availability of deep waters with suitable velocity and substrate. To modify the depth curve to account for the low availability of deep water having suitable velocities and substrates, a sequence of linear regressions (Gard 1998) is used to determine the relative rate of decline of use versus availability with increasing depth. The depth correction methodology has been published in a peer-reviewed journal (Gard 1998) and has been applied on six streams (Merced River, American River, Sacramento River, Butte Creek, Yuba River and Clear Creek). The methodology has consistently shown that most of the decline in spawning habitat use with increasing depth is due to the low availability of deeper waters with suitable velocities and substrates, and not because salmonids will select only shallow depths for spawning.

Traditionally, habitat suitability criteria are created from observations of fish use by fitting a nonlinear function to the frequency of habitat use for each variable (depth, velocity, and substrate or cover). One concern with this technique is the effect of availability of habitat on the observed frequency of habitat use. For example, if a cover type is relatively rare in a stream, fish will be found primarily not using that cover type simply because of the rarity of that cover type, rather than because they are selecting areas without that cover type. Guay et al. (2000) proposed a modification of the above technique where depth, velocity, and cover data are collected both in locations where fish are present and in locations where fish are absent, and a logistic regression is used to develop the criteria. Logistic regressions tend to produce criteria that are shifted towards higher depths and velocities, as compared to criteria based solely on habitat use data, as a result of the limited availability of faster and deeper conditions (Service 2008a, b). Unoccupied observations need to be collected to be used for developing logistic regression criteria (Manly et al. 2002). There needs to be a minimum of 300 unoccupied observations for each life stage and species. The use of logistic regression in developing HSC is now considered the standard best approach in the scientific literature (Knapp and Preisler 1999, Parasiewicz 1999, Geist et al. 2000, Guay et al. 2000, Tiffan et al. 2002, McHugh and Budy 2004) for developing habitat suitability criteria. For example, McHugh and Budy (2004) state:

> "More recently, and based on the early recommendations of Thielke (1985), many researchers have adopted a multivariate logistic regression approach to habitat suitability modeling (Knapp and Preisler 1999; Geist et al. 2000; Guay et al. 2000)."

Adjacent velocity can be an important habitat variable as fish, particularly fry and juveniles, frequently reside in slow-water habitats adjacent to faster water where invertebrate drift is conveyed (Fausch and White 1981). Both the residence and adjacent velocity variables are important for fish to minimize the energy expenditure/food intake ratio and maintain growth. The concept of adjacent velocity criteria was included in the original PHABSIM software, through the Adjacent Velocity Habitat Analysis (HABTAV) program (Milhous et al. 1989, pages v.69-78), but has rarely been implemented, and has been envisioned as primarily applying to adult salmonids, where the fish reside in low-velocity areas, but briefly venture into adjacent fast-velocity areas to feed on invertebrate drift. In studies for both the Yuba and Sacramento Rivers, the adjacent velocity criteria has been developed based on an entirely different mechanism, namely the transport of invertebrate drift from fast-water areas to adjacent slow-water areas where fry and juvenile salmonids reside via turbulent mixing (U.S. Fish and Wildlife Service 2008b). Adjacent velocity is an important aspect of anadromous juvenile salmonid rearing habitat that has been overlooked in previous studies. Fry and juvenile anadromous salmonid rearing criteria show a consistent preference for composite cover (instream woody plus overhead) (U.S. Fish and Wildlife Service 2008b). Composite cover likely is an important aspect of juvenile salmonid habitat because it reduces the risk of both piscivorous and avian predation. While cover is frequently used for anadromous juvenile salmonid rearing, the simplicity of the cover categories (typically no cover, object cover, overhead cover and object plus overhead cover) misses the importance of woody composite cover for anadromous juvenile salmonid rearing.

6. Biological Verification – Biological verification data should be collected to test the hypothesis that the compound suitability predicted by the River2D model is higher at locations where redds, fry or juveniles were present than in locations where redds, fry or juveniles were absent. The collected biological verification data are the horizontal locations of redds, fry and juveniles. The horizontal locations of redds, fry and juveniles found during surveys should be recorded with a total station or RTK GPS. For redds, depth, velocity, and substrate should also be measured. For fry and juveniles, depth, velocity, adjacent velocity, and cover should also be measured. The horizontal locations of where redds, fry or juveniles were not present (unoccupied locations) should also be recorded with a total station or RTK GPS. The hypothesis that the compound suitability predicted by the River2D model is higher at locations where redds, fry and juveniles were present than in locations where redds, fry and juveniles were absent should be statistically tested with a Mann-Whitney U test (Zar 1984). The combined habitat suitability predicted by River2D should be determined at each fry and juvenile observation location in the sites where redds, fry and juvenile locations were recorded with a total station or RTK GPS. The River2D cdg files should be run at the flows present in the study sites for the dates that the biological verification data was collected. The horizontal location measured for each observation should be used to determine the location of each observation in the River2D sites. The horizontal locations recorded with a total station or RTK GPS where redds, fry or juveniles were not present should be used for the unoccupied points. Mann-Whitney U tests (Zar 1984) should be used to determine whether the combined suitability predicted by River2D was higher at locations where redds, fry or juveniles were present versus locations where redds, fry or juveniles were absent. Biological verification needs to be conducted at the microhabitat scale (1 ft^2 grid) to determine if the combined suitability of occupied locations is greater than the combined suitability of unoccupied locations. This data is needed to verify the accuracy of the model's predictions regarding habitat availability and use (Gard 2006).

6. Habitat Time Series – In section 3.4.7, Total Habitat Time Series, the Districts suggest that the habitat time series analysis will be developed based on monthly average flows. We disagree with the development of a habitat time series based on monthly average flows and strongly recommend that the Districts develop the habitat time series based on daily flows.

GENERAL COMMENTS

Non-migratory life history stages, primarily fry and parr juvenile salmon, utilize inundated floodplain habitats for rearing; the modeled range of flows less than 1,000 cfs will not assess the benefits of inundated floodplain habitats. Neither PHABSIM nor Riverine Habitat Simulation Model (RHABSIM) are designed to assess the effects of high flows flushing organic matter and terrestrial invertebrates into the river to augment the food base for juvenile salmon and trout. Instead, the Districts should determine the relationship between flow releases and the amount of floodplain habitat that becomes inundated throughout the entire river at flows of 1,000 cfs, 1,500 cfs, 2,000 cfs, 2,500 cfs, 3,000 cfs, 4,000 cfs and 5,000 cfs. Rotary screw trap estimates of the survival rates of fry (Waterford estimates) to a smolt-size at the Grayson sites along with fish health assessments should be used to evaluate the effectiveness of the amount, duration, and location of floodplain inundation.

While LIDAR data are not sufficiently accurate for microhabitat assessments, such data would be sufficiently accurate for a macrohabitat assessment, such as determining the relationship between flow and the amount of floodplain habitat. It is our understanding that there are 2005 LIDAR data for the entire river. Our recommendation would be to combine this data with bathymetry data to develop a River2D model of the entire river to determine the relationship between flow and the amount of floodplain habitat. Our understanding is that bathymetry data are available from McBain and Trush for the upper portion of the Tuolumne River (upstream of the 7/11 bridge) and from the U.S. Army Corps of Engineers for the lower portion of the Tuolumne River (from the San Joaquin River to just upstream of Modesto). The Districts would still need to collect bathymetry data from just upstream of Modesto to the 7/11 bridge. Existing GIS information on vegetation cover produced by the California Gap Analysis Project could be used to specify bed roughness values for the LIDAR data. In this regard, it should be noted that it would be important to use spatially varying bed roughness values for the River2D model to improve the hydraulic calibration of the River2D model. The rating tables for the U.S. Geological Survey gages on the Tuolumne River at Modesto (Gage Number 1129000) and Below La Grange Dam (Gage Number 11289650) could be used to provide the downstream boundary condition and upstream calibration information for a River2D model of the entire river.

The Districts plan to use effective Weighted Usable Area (WUA) to identify habitat bottlenecks (page 13). However, this analysis cannot incorporate many biological bottlenecks, such as food limitations or predation and so are inappropriate. This analysis should be dropped from the planned studies.

In section 3.5.3, High Flow Stage Discharge Relationships, the Districts indicate they will only release the high calibration flows during a wet water year type and when certain flow management criteria are met. The Districts also suggest that, if the criteria are not met during the first year of the study, the high flow calibration releases may be deferred for up to two years. We encourage the Districts to make every effort to deliver the high calibration flows as soon as possible so that the study can be completed sooner rather than later. We believe this is in the spirit of the Commission Order.

Water Temperature Study Plan

Issue 1. The Districts' study plan has the objective of answering the following two questions:

1. What flows are required to maintain maximum weekly average summer water temperatures (MWAT) of 68°F from La Grange Dam downstream to Roberts Ferry Bridge at river mile (RM) 39.5.
2. What is the relationship between flow and water temperature at various times during the summer in the upper reaches of the lower Tuolumne River?

The Service recommends that the study questions should be revised and expanded to reflect the Agencies recommended interim flow measures:

1 What flows are required to maintain maximum weekly average summer water temperatures (MWAT) of 18°C (64.4°F) from La Grange Dam downstream to Roberts Ferry Bridge at river mile (RM) 39.5.
2. What flows are required to maintain maximum weekly average water temperatures (MWAT) of 18°C (64.4°F) from La Grange Dam downstream to the confluence with the San Joaquin River (RM 0) from October 15 to December 1.
3. What flows are required to maintain maximum weekly average water temperatures (MWAT) of 18°C (64.4°F) from La Grange Dam downstream to the confluence with the San Joaquin River (RM 0) from October 15 to December 1.
4. What flows are required to maintain maximum weekly average water temperatures (MWAT) of 13°C (55.4°F) from La Grange Dam downstream to Roberts Ferry Bridge at river mile (RM) 39.5 from October 15 to February 15.
5. What flows are required to maintain maximum weekly average water temperatures (MWAT) of 15°C (59.0°F) from La Grange Dam downstream to the confluence with the San Joaquin River (RM 0) from March 20 to May 15.
6. What is the minimum pool for Don Pedro that is needed to achieve the above in-river temperature objectives?
7 Are there modifications to Don Pedro that would allow a smaller minimum pool and still meet the above in-river temperature objectives.

Issue 2, Validation, page 5. The Districts intend to validate the existing HEC5Q with data that they collected since 1986. If there are discrepancies between their observed data and the model's predictions that are greater than 2°F, the Districts indicate that they might modify the temperature model. The Service recommends that if substantial discrepancies are discovered, the Districts should be required to prove to the Agency oversight team that their temperature measurements are valid before modifications to the model are considered.

Issue 3, Initial Scenario, page 6. The Districts intend to model flows ranging from 100 cfs to 400 cfs in addition to the Article 37 flows and the actual flows released from 1996 to 2009. The Service recommends that the seven questions regarding the thermal requirements for the Agencies interim flow measures listed above should be fully addressed in the initial scenario development phase.

The District's suggestion that they only need to maintain maximum weekly average water temperatures of 68°F between La Grange Dam and the Roberts Ferry Bridge is inconsistent with the Commission Order. In addition, the District's suggestion that they only need to determine the relationship between flow and water temperature "at various times during the summer" is also inconsistent with the Order. In accordance with the Order, the Districts are required to determine the flows that are necessary to ensure that water temperatures between La Grange Dam and the Roberts Ferry Bridge do not exceed 68°F. This is an instantaneous standard based on the timestep of the selected model (which is six hours for the HEC-5Q model) and not a weekly average standard as suggested by the Districts.

Goodness of fit criteria

In section 4.1, Validate Existing Water Temperature Model, the Districts suggest that "unbiased goodness of fit statistics" will be developed. However, the Districts do not present specific goodness of fit criteria. We suggest using the following criteria that have been recommended by U.S. Geological Survey staff (Theurer et al. 1984) to assess "goodness-of-fit".

- Maximize the R^2 value. The maximum value possible for R^2 is 1.0. The closer the value is to 1.0, the better the goodness-of-fit.
- Absolute Mean Error of < 0.5°C
- No more ten percent of the simulated water temperatures should be more than 1°C from the observed water temperatures.
- No single water temperature should be more than 1.5°C from the observed water temperature.
- No obvious trend in the data error either spatially of temporally.

In section 4.2, Initial Scenario Development, the Districts suggest that, in addition to the current FERC (1996) flow schedules and the actual flow releases during the 1996 – 2009 period, flows of 100 – 400 cfs will be evaluated using the water temperature model. The Districts are again reminded that, in accordance with the Order, they are required to determine the flows that are necessary to ensure that water temperatures between La Grange Dam and the Roberts Ferry Bridge do not exceed 68°F. The Order does not include a 100 – 400 cfs limitation on the flows to be evaluated with the model.

In section 5, Schedule, the Districts suggest the model development schedule may be delayed if the Districts do not receive timely responses from the Fish and Wildlife Service and the model developer in providing calibration data and model documentation. While we will make every effort to provide the Districts with available calibration data, the Districts are reminded that the Order does not imply that the existing model cannot be used (without modification) to assess the flow releases needed to meeting the water temperature standards. We suggest that the District's should use the existing HEC-5Q model to provide the results as soon as possible.

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If you have any questions regarding this letter, please contact Dr. Mark Gard of my office at (916) 414-6589.

Sincerely,

M. Kathleen Wood

M. Kathleen Wood
Assistant Field Supervisor

cc:
FERC Service List, Project No. 2299

BEFORE THE
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

CERTIFICATE OF SERVICE

I hereby certify that Don Pedro Hydroelectric Project, FERC #2299, Tuolumne River, California-Service comments on Instream Flow and Water Temperature Study Plans has this day been sent by that service for filing with the Federal Energy Regulatory Commission and served, via deposit in U.S. mail, first-class postage paid, upon each person designated on the service list for Project #2299 complied by the Commission Secretary.

Dated at Sacramento, California, this 5th of October, 2009.

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