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Via Email and US Mail

January 29, 2010

Brian Ellrott
National Marine Fisheries Service
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814

Re: **Public Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distict Population Segment of Central Valley Steelhead**

Dear Mr. Ellrott;

Thank you for the opportunity to submit the comments of the Merced River Conservation Committee, the California Sportfishing Protection Alliance, Trout Unlimited, Friends of the River, Golden West Women Flyfishers, and American Rivers regarding the Central Valley Salmon and Steelhead Draft Recovery Plan (Draft Recovery Plan), released on October 7, 2009. We appreciate NMFS's efforts to develop a comprehensive Recovery Plan for Central Valley Steelhead Distinct Population Segment (DPS) and Central Valley Spring-run Chinook Salmon Evolutionarily Significant Unit (ESU). Implementation of this Recovery Plan for threatened Central Valley Steelhead DPS and the threatened Central Valley Spring-run Chinook salmon ESU is necessary to improve the viability of these species so that they can be removed from federal protection under the Endangered Species Act.

NMFS is to be commended for its comprehensive, detailed, and thorough evaluation of Central Valley Salmon and Steelhead and their currently severely threatened status. The document reflects the hard work and analyses performed by NMFS staff, along with your Technical Recovery Teams. In our opinion, the document reflects the best current scientific and technical knowledge available on the subject of Central Valley anadromous fish species. When implemented, the actions will contribute to the recovery of these highly threatened Central Valley anadromous species. We thank all of the authors and consultants for their contributions to the development of this document!

Our organizations support the General Near-term Strategic Approach to Recovery of the Identified Populations.[1] We suggest that the general order of priorities should be: 1) secure all extant populations; 2) conduct critical research on fish passage above rim dams, reintroductions, and climate change (passage around limiting dams in the lower rivers); and 3) collect distribution and abundance data for *O. mykiss* in habitats accessible to anadromous fish. For the second and third elements, we suggest that it is equally important to conduct habitat and refugia evaluations (not only passage assessments) in priority upper rivers areas that are not currently accessible to anadromous fish. Also, it is fundamentally important to conduct population surveys of resident *O. mykiss* in currently disconnected areas to evaluate existing use, possible competition, and the likelihood of successful reintroduction of anadromous salmonids. Habitat evaluations in upper watershed areas should include flow requirements and, where applicable, opportunities for flow augmentation. Habitat evaluations should also include temperature conditions and presence or absence of suitable thermal conditions, along with passage assessments. We suggest that the executive summary and appropriate sections of the Final Recovery Plan be modified to capture these critical elements.

Because of the extreme precariousness of steelhead populations, and the apparent decreasing viability of fall-run Chinook salmon, in the Southern Sierra Diversity Group, actions in all five of its major rivers (Calaveras, Stanislaus, Tuolumne, Merced, and lower San Joaquin) should be given equal and urgent priority. Fish passage actions on the Merced River should be included as Priority 1 Recovery Actions to complement those already contemplated for the Stanislaus and the Tuolumne.[2]

In order to recover Central Valley steelhead and spring-run Chinook salmon, populations of these species need to be re-established above rim dams in every major Diversity Group. This includes re-introduction of spring-run Chinook in many of the watersheds from which they have been extirpated.

Our organizations believe that volitional passage past Central Valley rim dams (and elsewhere) should be established wherever it is feasible. However, we believe that trap and haul options will be necessary in many cases to avoid extinction.

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[1] NMFS Draft Recovery Plan, Executive Summary, Page 7 (pdf pagination).

[2] Because of our direct knowledge and regulatory experience, and the fact that its populations and those of the San Joaquin watershed as a whole are so depressed, we have chosen to analyze the Merced River in more detail, and comment more explicitly on it in Appendix A of this letter.

Additionally, we recommend that the following issues and principles be considered and incorporated into the Final Recovery Plan:

1. Equal priority should be given to projects and activities that seek to re-establish population connectivity around or over rim dams that is given to projects and activities that attempt to improve remnant "below-dam" populations and habitat.

2. In many watersheds, timing of studies may be crucial to implementing successful recovery actions. We are concerned that the species being considered for recovery have, or may become, extirpated before the NMFS (and other resource agencies) take(s) action. As written, the draft Recovery Plan appears to emphasize selecting optimal actions over getting things done "on the fast track." The final Plan should consider the trade-offs between certainty and the need for speedy action.

3. The Final Plan should consider procedural flexibility to incorporate on-going processes (e.g., water rights changes, FERC relicensing, resource agencies' adaptive management plans, or local watershed management activities) into the NMFS recovery actions and activities.

4. The Recovery Plan should systematically describe relevant studies that have been identified, proposed, or completed, as well as data gaps that need to be filled by future studies. These should include studies in ongoing regulatory processes (e.g. FERC relicensing, State Water Resources Control Board proceedings), studies undertaken or under consideration by other agencies, and studies undertaken by water users. This description should include discussion of studies or data that are scientifically controversial, the parties to the controversy, and the nature of the controversy. An example might be the discredited temperature modeling for the South Yuba River in the Upper Yuba River Studies Program.

5. NMFS should assure that the prioritization process does not de-emphasize watersheds where there is a lack of data, or where habitats have been more heavily impacted than in other watersheds (previous historical activities, such as mining, hydroelectric, agricultural diversion, or industrial and municipal diversions).

6. We are concerned that the prioritization process may presume that there will be a lack of will or of financial resources to do the recovery job right. The Recovery Plan should identify various landscape level courses of action based on a wide range of scenarios related to funding availability.

7. Outreach activities are focused upon State and Federal fisheries agencies.[3] Other agencies have jurisdictional authorities and responsibilities in many watersheds and could

[3] NOAA Press Release, October 7, 2009. "NOAA Seeks Public Comment on Draft Plan to Recover Salmon and Steelhead Trout in California's Central Valley", Page 1.

be public partners in the process (e.g. Bureau of Land Management, United States Forest Service, National Park Service, and the Federal Energy Regulatory Commission). NMFS should seek methods and modify ways to more actively include those agencies in the Recovery Plan Process. As part of the outreach activities, NMFS should inform local hydroelectric and irrigation projects of its analysis of climate change and its affect upon salmon and steelhead populations in California (Chapter 7).[4] NMFS should also conduct outreach to Indian Tribes and non-governmental organizations.

8. NMFS needs to approach the FERC relicensing process in the Central Valley with a unified and consistent effort, in order to have full participation of NMFS Staff in all ongoing FERC proceedings that may affect recovery of anadromous salmonids. Full recovery means the re-establishment of significant populations of salmon and steelhead into most Sacramento-San Joaquin tributary rivers. Time is of the essence in FERC relicensing because of the nature of the process (fast-tracked over a relatively short period of time) and the dire plight of Central Valley Steelhead DPS and Central Valley spring-run Chinook salmon ESU. FERC relicensing provides a defined process in which NMFS can advance recovery goals. Other stakeholders look to NMFS for guidance and leadership in these proceedings as they related to recovery of listed salmonids. The appendices to the Recovery Plan should provide up-to-date and accurate descriptions of NMFS actions and proposed actions within these FERC relicensing proceedings.

9. As quickly as possible, NMFS should develop and complete the Recovery Plan. As quickly as possible after its completion, NMFS should submit the final completed plan to FERC for implementation in the FERC relicensing process and for recognition as a formal FERC Comprehensive Plan under Section 10(a)(2)(A) of the Federal Power Act. Because of the 2-year FERC regulations for developing information and data to inform the Commission, NMFS should forward the Draft Recovery Plan to FERC, immediately, with an explanatory cover letter, under each of the dockets for which there is intersection with the Draft Plan.

10. In those cases where NMFS (and other resource trustees and non-governmental organizations) have recommended study requests to support NMFS' efforts for recovery of listed salmonids, and FERC has rejected those recommendations, NMFS should implement those studies independently, and should fast-track seeking alternative funding sources, such as omnibus funding from Congress. NMFS should also work with other interested parties to seek ways of developing the necessary data and studies to inform the FERC licensing process. NMFS should also conduct follow-up studies where previous or ongoing studies are poorly designed, inconclusive or equivocal. Appendix B lists the 7 critical studies that Resource Agencies and we believe that information is needed for anadromous fish recovery in the Merced River.

11. The North Fork and Middle Fork of the Feather River should be added as part of the spring-run Chinook and Central Valley steelhead recovery footprint.

[4] NMFS Draft Recovery Plan, Page 164-181.

12. Enforcement of the Endangered Species Act, as well as water rights proceedings, should be a very high priority for NMFS and other resources agencies. NMFS must hold parties accountable for take violations in light of almost extinct populations of threatened species in the Central Valley. NMFS should work with other resource agencies for the enforcement of State-Federal laws governing streambed alteration, water quality, water quantity, and facilities operations.

Simultaneous to the completion of the Final Recovery Plan, NMFS should plan a strategy for funding both the immediate and longer-term actions that the Plan recommends. This will necessarily include a concerted campaign to secure federal funding. To support this strategy, the Final Plan should contain an up-to-date analysis of the economic (as well as societal) benefits of robust Central Valley salmon and steelhead fisheries, as well as a thorough analysis of the financial losses (to the commercial and sport fishing industries, and also the regulatory costs) that have resulted from the severe depletion of Central Valley salmon and steelhead populations. Such an addition to the document is as important and appropriate as the section on climate change.

Thank you for considering our comments on the Draft Central Valley Salmon and Steelhead Recovery Plan.

Respectfully submitted,

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APPENDIX A – MERCED RIVER COMMENTS

SPECIFIC RECOVERY PLAN COMMENTS

2.3.7 Reasons for Listing/Threats Assessment. Crocker Huffman Diversion Dam, Merced Falls Dam, McSwain Dam, and New Exchequer Dam should all be identified as "stressors" (Page 49).

3.4 Core Populations

We support the intent of NMFS to define a recovery strategy based upon existing information on Core 1 and 2 watersheds as the foundation for recovery of the Central Valley Recovery Domain[5]. Core 2 population areas also form part of the recovery strategy by contributing to geographically diverse populations. Core 2 populations must have the potential to reach the biological recovery criteria for moderate risk of extinction as set out in Table 4-1. The lower Merced River is identified as a Core 2 steelhead population as priority for recovery focus (Table 3-1) and as a secondary reintroduction priority (Table 3-2). We believe that the Merced River should be included in the Core 1 category for recovery actions, along with all other major San Joaquin River tributaries,

3.5 Reintroduction Priorities

The Draft Recovery Plan correctly identifies that addressing the primary threats and risk factors for each of the ESUs and DPS will require reintroducing anadromous populations to historic, and currently unoccupied, habitats. NMFS prioritized waters above rim dams that are presently inaccessible to anadromous salmonids as primary or secondary areas (Table 3-2). The secondary priority watersheds included areas that historically supported large populations, but where there is little existing information on habitat suitability and where further evaluation is thus needed to understand the reintroduction potential. The upper Merced River was classified for steelhead as a secondary "focus for recovery". The attached Study Request details a study which would inform NMFS of the status for reintroduction potential, described in the Study Request, 3.1a Upper River Fish Populations and Habitat.[6]

4.4 Threat Abatement Criteria

In the analysis and discussion of steelhead threats, the Draft Recovery Plan indicates that there are similar threats to Chinook salmon and steelhead.[7] While there may be overlapping threats to the two species, the Recovery Plan should recognize that both species have unique life histories

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[5] NMFS Draft Recovery Plan, Page 64.

[6] Secondary priorities are characterized as having moderate to unknown habitat suitability. For the Merced River, several resources agencies including NMFS and the signatories to this letter have prepared Study Plans to develop information on anadromous fish habitats (and anadromous fish passage). Study Plans are found in Appendix B of this letter.

[7] NMFS Draft Recovery Plan, Page 76.

that will require different flow regimes and patterns. In the Merced River, management of flows for Chinook salmon has probably favored a trend to have more resident than anadromous *O. mykiss*. Flow conditions (i.e., low flows, especially spring) associated with attraction, migratory cues, flood flows and the attraction of non-natal fish into the Merced River affect adult immigration and holding. Changes in hydrology (i.e., low flows during summer) affect juvenile rearing and outmigration.

5.4 Recovery Scenarios

5.4.5 Spring-run Chinook Salmon

The Merced River is identified as one of 18 historical independent populations of Central Valley Chinook salmon.[8] The Merced River is identified as a candidate area for reintroduction of spring-run Chinook salmon in the conceptual recovery scenario.[9] The spring-run Chinook salmon conceptual recovery scenario for the Southern Sierra Nevada Diversity Group includesreintroduction of spring-run Chinook salmon to candidate areas, including the Merced River above New Exchequer Dam.[10] For these candidate areas, NMFS indicates that "passage feasibility studies, habitat suitability assessments and other related investigations. . .will be undertaken in separate processes (e.g., FERC relicensings, San Joaquin River Restoration Program), some of which are described in Appendix A (watershed profiles)." **In spite of best efforts in the FERC and San Joaquin Restoration processes,** we **are concerned that these other processes may not incorporate NMFS' plans for assessing and implementing reintroduction of spring-run Chinook salmon to the Merced River.**

5.4.6 Steelhead

The Merced River is identified as one of 81 historical independent populations in 48 watersheds of Central Valley Steelhead.[11] For the Recovery Plan, NMFS has identified 26 individual rivers/watersheds that historically and currently support populations of steelhead, identified by using literature and best professional knowledge regarding current distribution. The Merced River population was included in this latter list, and we strongly support this NMFS determination on the presence of steelhead in the lower Merced River[12]. NMFS recovery scenarios require that each Diversity Group within the Central Valley steelhead DPS be represented and that population redundancy within the groups be established to achieve Diversity Group recovery.[13] Therefore, the recovery scenarios include the objectives of a minimum of two viable populations of steelhead within each of the four extant steelhead Diversity Groups. Because of the extreme depletion (precariously depressed populations) among the Southern Sierra Nevada Diversity Group, we recommend that NMFS increase the minimum to **all viable populations of steelhead** in the Southern Sierra Nevada Diversity Group, and **include the**

[8] NMFS Draft Recovery Plan, Page 98.
[9] NMFS Draft Recovery Plan, Page 100.
[10] NMFS Draft Recovery Plan, Page 116
[11] NMFS Draft Recovery Plan, Page 122. The list of watersheds with historic populations of steelhead has omitted several Southern Sierra Nevada Diversity Group rivers, such as the Stanislaus, Tuolumne, and San Joaquin Rivers. It looks as if a column has been omitted in the Recovery Plan after the letter "P".
[12] NMFS Draft Recovery Plan, Page 123.
[13] Ibid.

Merced River in that designation. Long-term climate change is an additional consideration regarding the viability of the steelhead DPS and specific populations in the long-term.[14] NMFS included the Merced River as a candidate area for reintroduction of steelhead in the conceptual recovery scenario.[15] In the discussion of "Recovery Opportunities by Diversity Group" for the Merced River[16], the lower river is characterized as having low to moderate potential to support a viable population of steelhead. The major constraints are flows, lack of floodplain habitat, lack of coarse sediment supply, lack of channel migration, bedload impedance in identified reaches, and disruption of riparian habitat.[17] Although NMFS did not identify the process(es) that it would use to investigate reintroduction of steelhead to the upper Merced River, we are concerned that NMFS may be counting on FERC and San Joaquin Restoration studies and plans as part of its steelhead recovery planning for the upper Merced River. At this time, these two processes are not addressing NMFS's information needs and recommended studies.

The NMFS recovery scenario further describes the actions that NMFS recommends for recovery in the Merced River watershed:

> "The conceptual recovery scenario for the Merced River includes the maintenance of a steelhead spawning population in the upper reach of the lower Merced River extending from approximately the Highway 59 bridge (RM 42) upstream to the Crocker Huffman Dam (RM 52). Suitable *O. mykiss* spawning and juvenile rearing habitat is restricted to this reach. The conceptual recovery scenario also includes the reintroduction of steelhead above New Exchequer Reservoir on the mainstem Merced River and on the South Fork Merced River. Aquatic habitat above the New Exchequer and Crocker Huffman dams historically was likely suitable for steelhead spawning and juvenile rearing. In addition, the upper Merced River and South Fork Merced River are designated as National Wild and Scenic Rivers (National Park Service 2005)."[18]

We **support this recovery scenario plan** for the Merced River, and believe that it is essential for restoring the Merced River steelhead population in the Southern Sierra Nevada Diversity Group.

6.1.1 Recovery Action Narratives

Because the Merced River was placed in Priority 2,[19] it was not further evaluated for "Recovery Actions". We recommend that the final plan include placing the Merced River in Priority 1 for

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[14] NMFS Draft Recovery Plan, Page 124.
[15] Ibid.
[16] NMFS Draft Recovery Plan, Page 151-152
[17] Ibid.
[18] Ibid.
[19] NMFS Draft Restoration Plan, Page 162. We recommend that the Merced River be reclassified to Priority 1 because of its potential for extinction, because of possible modifications of cold water pool in New Exchequer Dam (Lake McClure), because of modifications in anadromous fish passage (lower Merced River), and because of upper river habitats in the South Fork and mainstem Merced River, above Lake McClure have completely natural hydrograpy with no limiting dams and no river flow controls for whitewater rafting or irrigation, for example.

"Recovery Actions" for the reasons stated previously in **General Plan Comments** (Page 2 of this letter):

8.2 Implementation Table

Two threat categories[20] for Spring-run Chinook salmon and steelhead are habitat loss[21] and water temperature[22] for the Tuolumne River. We suggest that they are equally applicable to the Merced River. Similar recovery actions for species, duration, involved parties, and 5 year cost estimates should be applied to the Merced River. Appendix B of this letter lists the approximate costs of 7 studies that would allow NMFS to ascertain the feasibility of a fish passage program and stream flow requirements for tailwater and upstream temperatures for all life stages.

Appendix B (Threats Assessment, 4.4.11) Flows and Regimes below Dams in the Southern Sierra Nevada Diversity Group

The threats assessment for steelhead in the Southern Sierra Nevada Diversity Group points out that: "different water management practices [are] used in the San Joaquin drainage than in the Sacramento River drainage". Post-dam mean annual discharges are 42 to 62 percent of pre-dam mean annual discharges in the San Joaquin River drainage; mean annual discharges declined in most months, especially during spring. In contrast, the Sacramento River drainage post-dam discharges are about 10 percent lower than pre-dam discharges. Not only do the San Joaquin watershed's changes in annual and seasonal water flows directly affect steelhead (and Chinook salmon), but they also indirectly favor invasive species (Page 4-106). In the Merced River, the flow conditions and habitat for steelhead trout have been significantly altered by the New Exchequer dam and agricultural diversions:

> "The magnitude, duration, and frequency of elevated spring flows in the Merced River has been altered by operations of Crocker-Huffman Dam which may negatively impact migrating juvenile steelhead. A strong correlation has been established between annual spring flow magnitude and the production of salmon smolt outmigrants from the tributary, survival of smolts in the Delta and the production of adults in the escapement and ocean harvest (Mesick 2008, Mesick and Marston 2007)."[23]

These findings should be thoroughly discussed in main body of the Recovery Plan (e.g., Section 4.4, Threat Abatement Criteria). The Recovery Plan should present actions and plans to improve flow, temperature and water quality in the Merced River.

SPECIFIC COMMENTS - MERCED RIVER

[20] NMFS Draft Recovery Plan, Appendix B, Page 4-134; We believe threat categories of the Merced River are similar or identical to those of the Tuolumne River and the Stanislaus River.
[21] NMFS Draft Recovery Plan, Page 203.
[22] NMFS Draft Recovery Plan, Page 204.
[23] NMFS Draft Recovery Plan, Appendix B, Page 4-126.

Background of Listed Species in the Merced River

In summary, the current status of the Central Valley Steelhead trout in the Merced River is that of an extremely depleted population[24] with very few living survivors of a once-large population, as is also the case for the Stanislaus and Tuolumne Rivers. Spring-run Chinook have fared less well, as they are extinct in the Merced River and elsewhere in the San Joaquin River watershed.

We are extremely disappointed that the Merced River is not included in the Priority 1 category in the Recovery Plan[25]. For recovery of steelhead and spring-run Chinook salmon, we believe that all of the San Joaquin River tributaries are critical to achieve the Recovery Plan's goals. The lower river habitat conditions of the Merced River are better than, for example, the San Joaquin River between Friant Dam and its confluence with the Merced River. The Merced River shares similarities with the Tuolumne River in having suitable and extensive above-rim-dam salmonid habitats. Their research and informational needs are comparable. The upper Merced River basin habitat conditions may be of some of the highest quality, and least developed, of any of the San Joaquin River tributaries. The upper Merced River has a virtually unimpaired hydrology with no limiting dams or river flow controls, unlike the Tuolumne, Stanislaus, and San Joaquin rivers. The upper basin has long-term, in-place habitat protections that are not found in most other basins. If re-introduced, these in-place protections should insure the preservation of the upper Merced River anadromous fish habitats in perpetuity. These protections include Wild and Scenic River designation and Yosemite National Park. The major problem with the upper Merced River is that anadromous fish simply can't get there because of fish passage issues. Because of these factors and conditions, we **recommend that the Merced River be considered in the Priority 1 recovery plan grouping**, and evaluated as such.

Summary of Specific Issues and Actions on the Merced River for Recovery

1. **Priority should be given to recovery actions in the Merced River,** where local interests may accelerate recovery actions.

2. Past mitigation for losses of populations of Central Valley Steelhead, fall- and late-fall run Chinook salmon, and spring-run Chinook salmon in the Merced River though adaptive management actions of the State[26] and Federal Resources Agencies, in conjunction with local agencies operating hydroelectric and agricultural diversions, has completely failed and is totally inadequate. In 2009, populations of steelhead and salmon in the Merced River are **at their lowest recorded historical numbers**.

[24] Zimmerman CE, Edwards GW, Perry K. 2009. Maternal origin and migratory history of steelhead and rainbow trout captured in rivers of the Central Valley. Trans. Amer. Fish. Soc. **138**:280-291

[25] NMFS Draft Recovery Plan Chapter 6, § 1.11 Southern Sierra Nevada Diversity Group, Pages 162 -163.

[26] This has now been recognized by the California Department of Fish and Game in a letter to Merced ID of November 16, 2009, which directs Merced ID to evaluate fish passage at the Crocker-Huffman Diversion Dam and to develop a plan for fish passage at that location (see Appendix C of this letter).

3. For the Merced River, recovery scenarios are **somewhat disconnected** from on-going regulatory process(es)[27,28]. We are concerned that further consideration for recovery of Merced River anadromous species will "fall through the regulatory cracks" because of lack of cooperation among Federal and State agencies. The Recovery Plan should acknowledge and cite the two important FERC relicensing actions for hydroelectric projects in the Merced River which may affect listed species: a) Section 18 Fishway Prescription, b) Compliance with the Endangered Species Act, and 3) Compliance with the National Environmental Policy Act.

4. With respect to Central Valley Steelhead and Spring-run Chinook Salmon, We **believe seven critical studies are needed to evaluate habitat, passage, and environmental conditions** on the Merced River[29] to evaluate alternatives and feasibility of recovery actions: Upper River Fish Populations and Habitat; Anadromous Steelhead Habitat; Fish Entrainment; Anadromous Fish Passage; Salmonid Flood Plain Rearing; Chinook Salmon Egg Viability; and Instream Flow.

[27] For spring-run Chinook salmon on the Merced River, the Recovery Plan (Page 116) states that "these candidate areas for reintroduction, passage feasibility studies, habitat suitability assessments and other related investigations are or will be undertaken in separate processes (e.g. FERC relicensing and San Joaquin River Restoration Program)." Evaluation of the Merced River for anadromous species recovery is not currently being considered under these other programs.

[28] The Plan (Page 151) states: "the conceptual recovery scenario also includes the reintroduction of steelhead above New Exchequer Reservoir on the mainstem Merced River and on the South Fork Merced River. Aquatic habitat above the New Exchequer and Crocker Huffman dams historically was likely suitable for steelhead spawning and juvenile rearing. In addition, the upper Merced River and South Fork Merced River are designated as National Wild and Scenic Rivers (National Park Service 2005)."

[29] Study Plans are found in Appendix B of this letter.

APPENDIX B

Critical Merced River FERC Study Requests 2009[1]

ATTACHED STUDY PLANS

R 3.1a Upper River Fish Populations and Habitat Study
R 3.1b Anadromy Salmonid Habitat Study
R 3.2 Fish Entrainment Study
R 3.4 Anadromous Fish Passage Study
R 3.6 Salmonid Flood Plain Rearing Study
R 3.7 Chinook Salmon Egg Viability Study
R 3.8 Instream Flow Study

[1] Not ordered for relicensing in FERC Projects P-2179 (Merced ID) and P-2467 (PG&E).

Revised CG Study Request 3.1a
(3.1a CG rev)

UPPER RIVER FISH POPULATIONS & HABITAT

December 18, 2009

1.0 Project Nexus and Issue

A federally listed fish species, California Central Valley Steelhead trout DPS (FT), *Oncorhynchus mykiss*, and its designated critical habitat, along with the Central Valley fall/late-run Chinook salmon (*Oncorhynchus tshawytscha*), a listed Species of Concern, occur in the Merced River downstream of the Merced Falls Project.

Current conditions in the Merced River for the 3-mile reach between the PG&E's Merced Falls Reservoir and Merced Irrigation District's (Merced ID) Crocker-Huffman diversion dam and the 19.5 miles downstream of Crocker-Huffman diversion dam to Shaffer Bridge (RM 32.5) are directly affected by current project operations (Study Dispute Panel, 2009a).

The Project dam at Merced Falls blocks volitional passage of anadromous fishes, which are able to ascend the Merced River past Crocker-Huffman diversion dam during very limited river conditions (largely depending on flow). This issue was evaluated by the Dispute Resolution Panel for the Merced River Hydroelectric Project studies (Study Dispute Panel, 2009a, b). The Panel reported that there was evidence in the record that anadromous fish may ascend the Merced River to the Merced Falls Project dam.[2] This evidence includes: 1) some fall chinook salmon may surmount the dam during high flows (M. Cozart, pers. comm., 2000; cited in Stillwater Sciences, 2001); 2) presence of anadromous Pacific lamprey above Crocker Huffman dam and "assumed that the partially removed fish ladder at Crocker-Huffman provided limited passage for the lamprey observed above the dam" (Stillwater Sciences, 2007; 2008); 3) *O. mykiss* are known to be present upstream of Crocker-Huffman Dam, but were considered by Stillwater Sciences (2008) as "resident" since Crocker-Huffman Dam is a migration barrier to most fish species.

The California Department of Fish and Game CDFG (2009) notified Merced ID that the Department has determined that fish passage at the Crocker-Huffman Diversion Dam must be restored. CDFG directed Merced ID to consult with CDFG to evaluate fish passage at Crocker-Huffman Diversion dam and to develop a Crocker-Huffman fish passage plan.

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[2] "The above presents a dilemma for the Panel as some information in the record affirms that anadromous fish make it to the lowermost Commission licensed facility on the Merced River but not to the base of McSwain dam. The Panel's logic in addressing the following studies is: 1) flows measured at Shaffer Bridge originate in Lake McClure and pass through McSwain dam, Merced Falls dam and Crocker-Huffman diversion dam; and 2) information in the record suggests that anadromous fish do occur upstream of Crocker-Huffman diversion dam."

Prior to the construction of McSwain Dam (licensed under the current FERC Project License 2179), project works at PG&E's Merced Falls Dam included a fish ladder, now not operating. (FERC Project License 2467)[3].

Lindley *et al*. (2006) estimated there are 193 miles of salmonid habitat (primarily suitable for steelhead) upstream of Lake McClure, including an estimated 39 miles of historic spring-run Chinook salmon habitat.

In order to make informed decisions regarding restoration of anadromous species (Chinook salmon and *O. mykiss*) to the upper Merced River (upstream of Lake McClure) information and data is needed to determine: 1) presence of usable habitat for anadromous species; 2) suitable water quality conditions (temperature) for juveniles during summer seasons; 3) use of habitat over the life cycle of anadromous species; 4) characterization of available habitat by location; 5) presence of Merced River native *O. mykiss* populations; and 6) potential for predation on introduced anadromous species.

During the Technical Conference in the Merced ID Study Dispute Panel (Study Dispute Panel, 2009b), a representative from NMFS stated that NMFS "had brought to the Commission's attention a draft recovery plan that would be a proposal to put anadromous fish within the project and above the project. NMFS' intention is to explore these upper [Merced River] habitats, both their historical and current potential for the purpose of trying to decide whether or not to invoke a section 18 prescription at the appropriate point in the process. The information from the study would be used to inform any FPA section 18 prescription for the project, and its measures would need to be incorporated as conditions in the new license. NMFS commented that to do a proven job in making a section 18 decision, we (NMFS) need(s) to do further investigation of that habitat potential upstream."[4] No previous studies collected this information that is needed to inform the Commission.

PG&E (2009b) has proposed a Fish Population Study in its Merced Falls Project reservoir. It has a limited geographic scope, and does not address the geographic scope, stated by FERC staff in SD-2 (FERC, 2009), including the upper Merced River.

This Study Request addresses the following issues as identified in Section 8 of the Applicant's Pre-Application Document (PG&E, 2009a):

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[3] Until 1971, the fish ladder on Merced Falls Dam was operated to allow upstream access for anadromous species; however, operation of this ladder was discontinued in 1971 after the construction of Merced ID's McSwain Dam eliminated upstream spawning resources and CDFG requested that Merced ID's Crocker-Huffman Irrigation Diversion Dam ladder operation also be discontinued (letter to A.O. Clark, PG&E from A.E. Naylor, CDFG dated March 26 1971; letter to J.F. Roberts Jr., PG&E from K. Plumb, Federal Power Commission dated August 5, 1971)" (PG&E (2001a @ page 5-21)".

[4] Study Dispute Panel (2009b) @ Page 39

- Issue AR-4. Effect of the Project on special-status fishes anadromous fishes, including spring- and fall-run Chinook salmon and steelhead in the Merced River, due to blockage of passage
- Issue TE-3. Effect of the Project on special status fish species.

2.0 Resource Agency and Tribal Management Goals

The Applicant should confer with Resource Agencies and American Indian Tribes that participated in development of this study proposal; Resource Agencies (NMFS and California Department of Fish and Game) have identified specific management goals relevant to this Study Request (i.e. re-establishment of ESA listed anadromous species in the upper Merced River and re-opening the Crocker-Huffman Diversion Dam fish ladder to improve anadromous fish passage). In particular, NMFS has identified an ESA restoration plan for anadromous *O. mykiss* that will put fish in and above the project boundaries, including anadromous species habitat in the upper Merced River (NMFS 2009a). General management and restoration goals for Steelhead trout, fall-run Chinook salmon, and spring-run Chinook salmon have been published (see Martin, 2007 for a summary).

3.0 Relevant Public Interest Consideration and Potential License Conditions

The requester is not a resource agency and states the public interest considerations in regard to the proposed study.

- Information and data is lacking on the potential for restoration of anadromous species in the upper Merced River. Limited information regarding the critical factors necessary for anadromous species' migration and maintenance in the upper Merced River exists in a single study, conducted over limited space and seasons (Stillwater Sciences, 2008). Additional information is needed to make an informed decision and develop informed FERC license articles, as well as to describe project effects in the NEPA analysis for relicensing the Merced River FERC projects.

- Study is needed to provide data, information, and alternatives to prescription of fishways as deemed necessary to protect threatened populations of fish, under the ESA and Federal Power Act, § 18. The public interest served by providing this study is that sufficient information and data will be provided to the Secretaries of Commerce and Interior (acting on behalf of the public and protecting public fisheries interests) to evaluate the need/justification and alternatives to protect species of concern or threatened species and make recommendations, for the public benefit of anadromous fisheries and their recreational benefits of the Merced River.

- Southern Sierra Miwuk Nation tribal leaders have indicated that reconnection and restoration of anadromous fish species are important Tribal goals for the Merced River (Brochini, pers. comm.). The Tribal interests include fish and aquatic resources. Prehistoric and historic use of salmon and aquatic life by the indigenous tribes of the Merced River included 1) ceremonial purposes for salmon; 2) Salmon as a cultural wealth elevating factor in historic and prehistoric use; 3) Seasonal significance in the oral traditional calendar-signifying time; 4) essential trade item; 5) Salmon elevation of spawning as an indicator of elevation of village locations; and 6) Mythology of spawning introduction at higher elevations (indigenous planting). Study is needed to establish the feasibility of upper Merced River anadromous fish restoration for tribal purposes.

The applicant's proposed alternative studies are not sufficient to meet these stated information needs, which are necessary to evaluate the feasibility of restoring anadromous species to the upper Merced River:

- The applicant proposed a "fish population survey" in Merced Falls Dam impoundment and did not propose studies to evaluate anadromous fish in the broader "geographic scope" (PG&E, 2009b), outlined in the FERC Scoping Document 2 for the Merced Falls Hydroelectric Project (FERC, 2009). The applicant erroneously stated that anadromous fish do not occur in the Merced River upstream of the Crocker-Huffman Diversion Dam, and thus concuded that the Merced Falls Hydroelectric Project has no effect on the upstream migration of special-status fishes. Above Merced Falls Dam, all anadromous species have been extirpated, including historically present spring- and fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*Oncorhynchus mykiss*) (Natural Resources Scientists, Inc. 2007; Martin, 2008; PG&E, 2009a). There are efforts in the San Joaquin River basin to re-introduce these fishes, and the Merced River may be re-populated and important to the re-establishment of this species. The San Joaquin River Restoration Plan includes the reintroduction of spring-run Chinook salmon by 2012.

The results of this Study Request will inform the Commission by providing information for the development of protection, mitigation and enhancement (PM&E) measures relating to the effects of project structures, operations and maintenance. Potential measures include restoration of anadromous salmonids to the Merced River and tributaries upstream of Lake McClure. Development of PM&E measures is not part of the study.

4.0 Study Goals and Objectives

A known effect of the Merced Falls project is that, in conjunction with facilities owned by the Merced Irrigation District, the project blocks passage to fish habitat in the Merced River upstream of Lake McClure. This study will allow relicensing participants to

evaluate the effects of the blockage by characterizing and quantifying the habitat to which passage is blocked. The significance of the project effect in blocking fish passage cannot be evaluated absent understanding of the restoration potential of upstream habitat. A project effect that blocks fish passage to habitat that is usable by anadromous salmonids needs to be mitigated, whereas a project effect that blocks passage to unsuitable habitat might not need to be mitigated.

The objective of the Study Request is to characterize and quantify fish habitat in the upper Merced River, including the South Fork Merced River and tributaries that are likely to provide spawning and/or juvenile rearing habitat for anadromous salmonids. Study elements will evaluate:

- Presence of suitable habitat for anadromous species;
- Availability of suitable water quality conditions (temperature) for juveniles during summer seasons;
- Use of habitat by existing species including resident *O. mykiss* for use in comparison with the life-cycle needs of anadromous species;
- Presence of upper Merced River native *O. mykiss* populations based upon genetic characteristics; and
- Potential for predation on introduced anadromous species.

5.0 Existing Information and Need for Additional Information

There are three historical references or studies of fishes in the upper Merced River. Fish observations were made by Kisanuki and Shaw (1992), prior to a series of river restoration efforts in Yosemite National Park. Stillwater Sciences (2007, 2008) conducted qualitative fishery surveys in the upper Merced River in October 2006 and October 2007. None of these studies address the objectives of the present proposed study, including a) presence of usable habitat for anadromous species; b) suitable water quality conditions (temperature) for juveniles during summer seasons, including presence of temperature refugia; c) use of habitat over the life cycle of anadromous species; d) characterization of available habitat by location; e) presence of Merced River native *O. mykiss* populations; and f) potential for predation on introduced anadromous species.

The current baseline conditions for anadromous fish (Chinook salmon and *O. mykiss*) cannot be determined from the three cited studies. The studies were conducted in only one season (Fall), which is not a critical time period for thermal stress and refugia analyses for *O. mykiss* (Stillwater Sciences, 2008). The 1992 study did not use comparable modern sampling techniques or statistics to be compared with current study methodology, so that only general qualitative comparisons can be made (Kisanuki and Shaw, 1992, after Stillwater Sciences, 2008). Previous sampling was limited to the autumn, so that evaluation of the presence of usable habitat or use of habitat over time is not possible based on existing information. The studies have only evaluated the mainstem

of the Merced River, and ignored a large amount of potentially available salmonid habitats in the South Fork, and tributary streams and creeks, tentatively identified as "historical habitat for spring-run Chinook and steelhead", but not evaluated, by Lindley *et al*. (2006). Previous studies did not determine whether or not the *O. mykiss* in the upper Merced River were native or introduced strains, leaving a data gap as to whether the downstream projects have led to the extirpation of native Merced River genetic strains upstream.

In sum, while this information provided by the earlier studies is useful, it does not address all study reaches, focus of study (basin or reach), seasonal habitat use and availability, or many data needs to evaluate an anadromous fish restoration plan.

Potential historic fisheries habitat for *O. mykiss* has been modeled and evaluated by Lindley *et al*. (2006). This was a GIS-modeling study, using readily available environmental data, to estimate the historic population distributions of *O. mykiss*. Lindley *et al*. (2006) noted that numerous populations of *O. mykiss* above reservoirs in the Central Valley, but it is not at all clear "whether these populations are the residualized descendants of native anadromous populations, or are the descendants of rainbow trout that have been widely planted throughout California to enhance recreational trout fisheries." The compelling argument for evaluating habitat for steelhead trout lies with a threat of extinction. Lindley *et al*. (2006) concludes that the extensive loss of habitat historically available to anadromous *O. mykiss* supports the status of *O. mykiss* as a species threatened with extinction. An important next step is to identify and secure the sources of current natural production of genetically appropriate *O. mykiss*, limited as they may be.

To provide sufficient information to meet the goals and objectives of the study proposal both qualitative and quantitative data will be collected. The study methods and analyses of either sampling regime are described in Section 6.

Data will be collected along three reaches along the mainstem Merced River in the same manner as in sampling sites along four reaches on the South Fork of the Merced River. Refugia sampling will also be conducted in tributaries of both the mainstem and South Fork of the Merced River. The mainstem Merced River sampling sites will be selected prior to selecting equivalent sampling sites on the South Fork of the Merced River. The sites in the mainstem are for the purposes of being able to compare study results, and changes in populations and other fish metrics to the previous Stillwater Sciences (2008) study.

Sampling will also be conducted in South Fork of the Merced, where no fisheries population or habitat studies have been previously conducted along with several, accessible creek or stream tributaries. Streams identified in Lindley *et al*. (2006) modeling efforts may or may not currently be suitable habitat, as conditions in the upper

Merced Basin may have changed.[5] Tributaries may be temperature refugia for over-summering *O. mykiss*. There may be isolated native strains of *O. mykiss* in genetically separated populations in small streams of the upper Merced River. Finally, stream passage conditions (physical barriers, flows, and temperatures) may limit access to *O. mykiss* in previously GIS-modeled habitat locations.

6.0 Study Methods and Analysis

6.1 Study Area

The study area includes the mainstem Merced River upstream of Lake McClure, the South Fork of Merced River, and selected tributaries. A list of all stream reaches to be studied is included in Attachment 1 located at the end of this study proposal. Specifically excluded from the study area are locations where access is unsafe (very steep terrain) and locations on private property for which the Applicant has not received specific approval from the landowner to enter the property to perform the study. This latter constraint will be minimal in the Upper Merced River Watershed, as a majority of the land holdings are in public ownership.

6.2 Study Methods – Study Elements

A. Presence of usable habitat for anadromous species

B. Use of habitat over the life cycle of anadromous species

C. Characterization of available habitat by location

These three elements of the Study Request will be evaluated with species occurrence, distributions, habitat distribution, and location information and data. These data will be collected and analyzed with study methods, protocols, data forms and techniques as described in Section 6.3 and in Appendices 2 and 3. The purpose of the Representative Sampling is to describe the fish community inhabiting the sampled stream or reach (Meador, *et al*. 1993). Representative Sampling methods are divided into two levels: qualitative and quantitative (see Table 1). Qualitative sampling (referred to as Level I in this study proposal) is used to broadly characterize fish population composition. Quantitative sampling (Level II) is used to develop statistical metrics of fish populations. The purpose of "focused" sampling is a site-specific and detailed investigation regarding a specific information need. Focus sampling is described in Section 6.3.4.

[5] In Yosemite National Park, differences in species abundance and year class distributions apparently occurred between the 1992 study (Kisanuki and Shaw, 1992) and the 2008 study (Stillwater Sciences, 2008). It is logical to presume that such changes might occur in other non-studied Merced River tributaries: the South Fork, and smaller tributary streams.

Representative methods and analyses follow or are adapted from methods described in Zippin 1958; Van Deventer and Platts 1989; Rexstad and Burnham 1992; Moulton *et al*. 2002; Meador *et al.* 1993; Reynolds 1996; Jones and Stockwell, 1995; Temple and Pearsons 2007; and O'Neal 2007. All sampling methods will follow a detailed protocol to ensure both clarity and repeatability. Representative Sampling is described in detail below.

Fish sampling is predicated on the Applicant obtaining necessary federal and State of California permits for sampling. Required permits include a CDFG scientific collecting permit for streams that do not contain ESA listed species and permits for scientific collecting in Yosemite National Park and U.S. National Forests. Applicant should allow 135 days in the schedule for processing the scientific collecting permit. Currently, the Upper Merced River has no ESA listed species, because of historical conditions and historical anadromous fish blockage(s).

Two consecutive years of data will be collected with the first year being 2010 at all Level II sites unless CDFG, BLM, NOAA, SWRCB, and other interested relicensing participants (*e.g.*, Tribes, NGOs, and Private Citizens) and the applicant reach consensus that there are sites where a second year of data collection is not necessary .

After year 1, Level I site data will be reviewed by CDFG, BLM, NOAA, SWRCB, and other interested relicensing participants (*e.g.*, Tribes, NGOs, and Private Citizens) in consultation with the applicant. One year of Level II data will be collected on up to five Level I sites if these participants reach consensus on the need for additional data based on relative composition.

Licensee will consult with CDFG, BLM, NOAA, SWRCB, and other interested relicensing participants on technical issues that arise in carrying out the study.

6.3.1 Representative Sampling

As described above, Representative Sampling can be qualitative (referred to as Level I in this study proposal) or quantitative (Level II). Stream reaches with special-status species, more complex communities, or potential issues receive Level II sampling. Level I sampling is applied to all other reaches. A mixture of both sampling levels is implemented in larger streams that do not require numerous Level II sites. A description of site selection for either Level I or II sampling, and specific methods for each level are described below.

6.3.2 Representative Reach Sample Site Selection

Site selection for either Level I or Level II sampling is based upon several factors. These factors include spatial location, available habitat, habitat complexity, stream access, stream geomorphology and safety. Streams with greater homogeneity receive fewer number of sample sites. Those stream reaches with more complex communities or potential issues receive a higher number of sites. A breakdown of the number of sites by

reach is presented in Attachment 1 to this study proposal. Applicant will identify in the field the specific locations for sampling and, prior to sampling, invite interested relicensing participants into the field to comment on the selected sites. Prior to field reconnaissance, effort will be made to identify as many of the sites as possible by existing video and habitat mapping photos.

6.3.3 Representative Sample Collection Methods

A detailed description of each sampling level is provided below. A summary with the rationale and comments on the method to be used in each reach is provided in Attachment 1.

Conduct Field Work – General Methods Overview

Representative Sampling will be performed using a combination of backpack electrofishing equipment and/or snorkeling methods. Backpack electrofishing will be conducted in water sufficiently shallow (less than 1.5 m maximum depth) to safely permit wading and to allow efficient fish capture. Applicant may choose to use barge electrofishing in large stream reaches where backpacking electrofishing or snorkeling would not be effective. Snorkeling will supplement electrofishing and be conducted in depths greater than 1.5 m. Where statistically-supported analyses are prescribed, multiple-pass depletion sampling (Moran 1951, Zippin 1958, and Reynolds 1996) using backpack electrofishing equipment will be utilized with a population estimate goal of less than a 10 percent error. Fish sampling will be scheduled during mid-summer through mid- to late-fall when flows are typically lower, turbidity is low, and water temperatures are most suitable. Applicant may sample at other times in smaller streams if Applicant determines it is unlikely that sufficient flow for sampling would occur from mid-summer through late fall. Depending on elevation and flow control by Applicant, some streams may be suitable for sampling in mid-summer while others may not be suitable until mid- to late-fall. In some cases, releases may need to be regulated to facilitate safety and efficiency during electrofishing surveys.

In general, electrofishing field methods will be conducted following procedures identified by Meador *et al.* (1993), Reynolds (1996), Stangl (2001), and Temple and Pearsons (2007).

Table 1. Description of Representative Sampling methods, purpose, and information obtained by sample level.

Sample Level	Representative Sampling Method	Purpose & Information Obtained
II	*Quantitative Assessment* • Closed sample unit – fine mesh block nets spanning both top and bottom of unit (not proposing to block between mesohabitat types). • Multiple Pass Depletion Methodology. • Length of the sample site will be sufficient enough to include usable habitat represented in the reach. River sampling sites will generally be 100 meters long. Some of the larger river sites may require reaches up to 300 meters. The specific locations of the sampling sites will be determined in the field in coordination with a Technical Working Group. • Sample Processing – All fish will be identified to species and counted. Measured length/weight will be collected on up to 50 individuals per species per site. • Habitat/channel metrics will be collected at each site. • Supplemental snorkeling – deepwater mesohabitats may be snorkeled as a supplement to electrofishing. Techniques: snorkeling of individual pool with 2-3 divers, each with a lane, snorkel 3 times in the same direction; wait one hour between passes). • Collect and analyze a subsample of scales on larger, less abundant trout for error-checking length-age indices. • Collect and analyze samples of *O. mykiss* for SNP genetics.	• Sample site relative abundance • Species composition • Species distribution • Sample site fish density, length frequency, and age structure (from existing length/age indices) by species • Error-check length-age indices with scale analysis • Condition factor (from up to 50 individuals per species) • Channel/habitat metrics (for purpose of post-stratification or extrapolation relative to the specific site; see text detail)

Sample Level	Representative Sampling Method	Purpose & Information Obtained
I	*Qualitative Assessment* • Open sample unit – block nets will not be employed. • Spot sampling units distributed over several selected mesohabitat types and several locations within the reach. Number of spots will depend on mesohabitat complexity and length of reach. • Sampling effort will not be random, but rather habitat selective	• Species composition • Species distribution
	• Catch Per Unit Effort (CPUE) – will be determined from electrofishing time. • Sample Processing – All fish will be identified to species and counted. Measured length will be collected on up to 50 individuals per species per site.	• CPUE – Based on selective sampling of habitat • Sample site fish density, length frequency, and age structure (from existing length/age indices) by species
	• Channel and mesohabitats will be generally characterized. • Supplemental snorkeling – deepwater mesohabitats may be snorkeled as a supplement to electrofishing.	• Channel/habitat generally characterized (e.g., mesohabitat, avg. depth, avg. width, substrate, max pool depth)

6.3.3.1 Level II Sampling

Level II quantitative sampling is applied where a quantitative, closed-population assessment of the fish community is considered most important. These will predominantly be used in the mainstem and South Fork (not tributaries) of the Merced River.

Level II Backpack Electrofishing

At least three passes will be made at each site using backpack electrofishing units. Sample sites vary in length, but typically range between 100m and 300m. Upstream and downstream ends will be blocked with fine mesh nets. Applicant's goal in determining site length is to have adequate length to include sufficient usable fluvial habitat represented in that reach (e.g. riffle, pool, glide). Exact site length will be determined in the field by the Applicant.

Block nets will span the full width and depth of the stream except where an upstream fish passage barrier obviates the need for head-end blocking or where only edge or stream

margin habitat is to be sampled. If necessary, salt blocks will be placed in the stream immediately above the electrofishing station to increase conductivity. Salt blocks will be used when fish are observed escaping the direct path of the electric field generated by the electrofishing unit at elevated settings.

For Level II electrofishing, crews will consist of at least two netters for each shocker. Applicant will follow Temple and Pearsons (2007), who recommend one backpack electroshock crew for streams less than 7.5 m wide and two backpack electrofish crews for streams 7.5 – 15 m wide. In wadeable streams wider than 15 m the number of electroshocking crews will be expanded as necessary to assure effective and accurate sampling.

Captured fish will be retained in aerated buckets and/or live cars until each pass is completed. As described above, fish will be sedated as necessary and with appropriate approvals. All fish will be identified to species and counted. Up to 50 individuals of each species will be measured to the nearest millimeter (fork length) and weighed by digital scale to the nearest gram. Effort will be made to evenly represent all size classes collected within the subsample of the measured species. The actual number of measured species will be determined through professional judgment based upon the size class homogeneity of the sample (i.e., number of size classes represented). Scale samples will be taken on a subsample of larger, less abundant game fish and special status fishes for validating length-age indices. Fin clip samples for *O. mykiss* will be taken according to the SNP sampling protocols. Captured fish will be released proximally below the sampling area following completion of each electrofishing pass. Mortalities and fish condition (spinal trauma, burning) will be noted and recorded prior to release. All data will be recorded on a standardized electrofishing form (see Attachment 2). All effort will be made to ensure sampling activities in the field will minimize potential injury or mortality to aquatic species.

General information and habitat/channel metrics will be collected at each sample site. General information will include site identification, crew members, number of shockers, date and time, air and water temperature, conductivity, weather conditions, and GPS location. Metrics collected at each meso-habitat unit within the sample site will include meso-habitat type, estimated average and maximum depth, estimated average wetted and bankfull width, dominant cover type, dominant and subdominant substrate. Habitat data collected will be consistent with that collected in habitat mapping studies (see Attachment 2).

D. Suitable water quality conditions (temperature) for juveniles during summer season

Temperature Monitoring

Data on annual temperature and profiles are an essential component of determining if adequate thermal refuge is present in the upper Merced River. Although historical records of the use of the upper Merced River strongly suggest that it was suitable habitat for anadromous species (see Martin, 2008), conditions of the watershed may have changed with its development and use. Dunham *et al* (2005) provide guidance and recommendations on the use of digital temperature recording loggers (thermographs), suitable for continuous, inexpensive stream temperature monitoring. Deployment of thermographs at 19 locations will give a complete watershed profile for temperature conditions for a selected water year.

Focused Sampling – Upper Merced River Watershed Thermal Refugia Assessment

The purpose of this study element is to determine trout and other native species microscale habitat use of mainstem Merced River, between Yosemite Valley to the park boundary (El Portal), and the lower South Fork Merced River (Hites Cover) as thermal refugia from the mainstem and South Fork of the Merced River. To achieve this goal, two snorkel surveys will be conducted. The first survey will be conducted in mid- to late-June when water temperatures are less than 17°C, depending upon water year runoff. The second survey will be conducted when water temperatures in the same location greater than 20°C (likely late July or early August). Effort will be made to minimize the time elapsed between each survey to reduce the potential influence of external variables (e.g., fishing pressure). In general, snorkeling survey field methods will be conducted following procedures identified by Cannon and Kennedy (2003), Dolloff *et al*. (2005), O'Neal (2007), Hankin and Reeves (1988), and Slaney and Martin (1987).

The snorkel survey will involve two closed population snorkel assessments occurring in near-Yosemite Valley reach and the lower reach (Park kiosk-El Portal reach) and the South Fork Hite's cove site. Block nets will be setup at the top and bottom of each sample site during midday. Study site size will have adequate length to include multiple habitat types that have a high probability of fish use (e.g. undercut banks, pools, areas of velocity refuge). Exact site length will be determined in the field.

Two to three divers (as determined by the wetted stream channel width at each site) will snorkel the sample site and record species composition and abundance. Fish will be identified, counted, and visually categorized into pre-defined length-classes (0-2 in., >2-4 in., >4-6 in., >6-8 in., >8-10 in., >10-12 in., >12-14 in., etc.). Visual estimates of length will be made in English units and later converted to metric units to avoid error. Maximum sight distance for accurate determination of fish species will be recorded on the field data form. Two to three replicate snorkel surveys will be performed using the same diving team to assess efficiency, obtain an estimate of survey variance, and determine a level of confidence for use in abundance estimation (Slaney and Martin 1987; Hankin and Reeves 1988). Data will be recorded and analyzed as previously recommended in CG's Requested Study (CG, 2009). In addition to data collected on snorkel data sheet, observations of fish habitat use during the snorkel survey will be included. Site information and habitat metrics will be collected prior to snorkeling.

The goal of data analysis will be to describe notable differences in relative population abundance and habitat use between the two surveys. The description will include an assessment of changes in stream temperature between surveys. Description and results from the study will be included within the Fish Population report as an appendix.

Microscale water temperature profiles will be collected in large pool habitats to evaluate thermal refugia potential of mainstem and South Fork habitats, during these surveys.

The applicant will review the sampling design and protocols from previous Merced River fish studies incorporate, and report all methods and evaluations into the current study effort

E. Presence of Merced River native *O. mykiss* populations

Assess the condition genetic origin (i.e, native or introduced) of resident rainbow trout (*O. mykis*s) at 3 mainstem sites, 1 South Fork Site, and 3 isolated tributary creeks. The condition of genetic origins will be determined genetic markers (Single Nucleotide Polymorphism or SNP) from DNA extracted from fin clips (Aguilar and Garza, 2008) to determine genetic status (origin) of *O. mykiss*. Genetic analyses protocols will follow Aguilar and Garza (2008), which require fin clip specimens from 25 individual fish at each location, and dry storage in clean paper envelopes. DNA is extracted from fin clips with a commercially available kit (DNeasy, QIAGEN), and 20–60 ng of DNA is used as a template in subsequent polymerase chain reaction (PCR) amplifications

F. Potential for predation on introduced anadromous species.

Using species composition and density information, evaluate relative presence of known aggressive predatory fish species, such as introduced black bass, smallmouth bass, and brown trout. Assess the potential for predation on potentially introduced native anadromous species. Compare peak linear densities of potential predators and potential introduced native anadromous species, using relative densities, and CPUE distributional data. The techniques and methods for field work and evaluation is described in Section 6.2 A-C, above.

6.4 Consultation and Communication

Applicant will engage in the following consultation:

- As soon as possible, advise FERC and relicensing participants via email if potential changes in approach to perform the study might be needed and discuss alternatives.
- Consultation with CDFG and NOAA Fisheries regarding scientific collection permits, as appropriate.
- Prior to sampling, invite interested relicensing participants into the field to comment on the selected sampling sites.

Applicant will also file with FERC and post on its Relicensing Website quarterly progress reports (first report due three months after FERC's Study Plan Determination). Each report will summarize work performed in the last quarter and key findings, and will study data that have been organized, compiled, and subject to QA/QC procedures. The final report will adhere to reporting standards according to the PAD Communication Guidelines.

The Applicant will consult with interested relicensing participants if the Applicant believes a modification to the study proposal is needed. In addition, the Applicant will invite interested relicensing participants in the field to comment on study sites.

6.5 Schedule

Applicant anticipates the schedule to complete the study is as follows in two consecutive years, with the first year being in 2010:

Planning & Site Selection……..…..Winter-Early Spring of Each Year
Field Work ……May-June & November of Each Year
Data QA/QC & Analysis……..….November & December of Each Year
Report Preparation……..…..January – February of Each Year

The justification and rationale for requesting a two-year study is based upon the following factors. Generally, variability in physical, chemical, and biological conditions in the aquatic environment, as well as fish population responses, has been shown to consist of seasonal variability and annual variability. With regard to annual sampling, the Stillwater Sciences study (2008) of the upper Merced River showed annual trends between the two annual Fall samplings, as this was the only season sampled (lower flows had very different distributional patterns). In contrast, in the lower Merced River where seasonal and annual sampling occurred, the study showed number of individual fish observed in each survey varied from season-to-season and year-to-year. Overall, more fish were observed during the fall seasons than summer and spring seasons combined. However, this was highly variable between the two survey years; during the 2006 (high-flow year) fall surveys, the lowest number of individual fish were observed (559), while during fall 2007 (low-flow year), the greatest number of individual fish were observed (13,823). This latter observation could just be an artifact of sampling, i.e. it is easier to count fish under lower (compressed habitat) flow conditions. Fish population monitoring studies (such as being proposed) tend to be multiple-year studies to document long-term trends or environmental conditions, and should be designed to document both seasonal and annual trend information and data. Finally the FERC ILP schedule will only allow a two-year time period to collect data, so that is a limiting constraint on collection of annual cyclic data.

6.6 Consistency of Methodology with Generally Accepted Scientific Practices

Electrofishing and snorkeling are widely accepted methods for sampling fish populations in stream habitats. The other study methods, condition of genetic origin, assessment of predator potential, and temperature monitoring are: 1) used by Resource Agencies in the evaluation of *O. mykiss* management in California, 2) scientific technique used in previous environmental study in the upper Merced River (Stillwater Sciences, 2009), or 3) the most widespread method for monitoring water temperatures (Dunham *et al*., 2005), respectively. The methods discussed above are consistent with the study methods followed in several other relicensings in, and outside of, California.

7.0 Products

After data are collected, tabulated, and quality checked the data will be made available to the relicensing participants in an Excel format or other format as appropriate.

Products will include but not be limited to the following:

1) Known distribution map (not continuous) for each species in the sampled stream reaches;
2) Detailed description of each sample site location and summary of habitat;
3) Length frequency or size class histograms of sampled fish;
4) Summation of data collection for each Study Element A- F;
5) Analysis and Report of each Study Element A – F;
6) Incidental observations of other species;
7) Copies of field data sheets upon request.

Presented products will include maps of study areas and tables and graphics of study results. Both written and presented products will be consistent with and include the analyses outlined in Section 6.0, above.

Applicant should make study results available for collaborative development of possible PM&E measures.

The final stream fish population study report will be prepared in a format that can easily be incorporated into the Applicant's application for a new license.

8.0 Level of Effort and Cost

A preliminary estimate for the study cost in 2010 dollars is as follows:

2010 Cost Estimate Based upon 55 Level II and 278 Level I evaluations

Planning & Site Selection	$ 37,000

Field Work	$240,000
Genetic Analysis	$ 20,000
Data QA/QC & Analysis	$ 65,000
Report Preparation	$ 37,000
TOTAL	**$399,000**

9.0 References Cited

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ATTACHMENT 1

Fish Population Sampling Level by Reach for the Merced River Hydroelectric Project

Fish population sampling-level by project-affected reach for the Merced River Hydroelectric Project.

Stream	River Reaches:	Level II	# of Sites	Level I	Target Spot # Per Site	Comment or Rationale
Mainstem Merced River (below South Fork to below El Portal)	*Below South Fork Junction (UF2-F1 to UF2-F3) (Between RM 92 to RM 97.5)*			●	20	Current study should re-occupy study sites from Stillwater Sciences (2008), sampling the same habitat types and distributions (see Stillwater Sciences, 2008 for station nomenclature and locations). Snorkel spot-check if Level I does not completely represent habitats.
	From South Fork Junction to Near Redbud Picnic(RM 99.7 to RM 102 (UF1-F1 to UF1-F3)	●	2	●	40-60	Current study should re-occupy study sites from Stillwater Sciences (2008), sampling the same habitat types and distributions (see Stillwater Sciences, 2008 for station nomenclature and locations). Two sites should have expanded Level II evaluations.

Mainstem Merced River (El Portal to Yosemite Valley	*From Near Redbud Picnic (RM102.5 to RM 126)*	●	3	●	60	Stillwater Sciences (2008) had 9 sites with Fall 2006 & Fall 2007. These should be re-sampled for comparisons, and expanded for seasonality for Level 1. Three sites should have expanded Level II evaluations.
Moss Creek	*Rancheria Flat, below El Portal*			●	20-30	Level I at two to three geographically separated locations. Sites may be different lengths depending on homogeneity of reach. Sample near confluence with Merced River, and then two or three locations MC Canyon below Twin Bridges. Snorkel spot-check if Level I does not completely represent habitats.
Indian Creek	*El Portal*			●	20-30	Level I at two to three geographically separated locations. Sites may be different lengths depending on homogeneity of reach. Sample near confluence with Merced River, and then two or three locations above and below Chinquapin Falls.
Crane Creek	*El Portal*			●	20-30	Level I at two to three geographically separated locations. Sites may be different lengths depending on homogeneity of reach. Sample near confluence with Merced River, and then two or three locations above and below Foresta Falls.
Avalanche Creek	*Above NPS Park Kiosk*			●	20-30	Level I at two to three geographically separated locations. Sites may be different lengths depending on homogeneity of reach. Sample near confluence with Merced River, and then between Highway 41 and Merced River

Grouse Creek	*Above NPS Park Kiosk*			•	20-30	Level I at two to three geographically separated locations. Sites may be different lengths depending on homogeneity of reach. Sample near confluence with Merced River, and then between Highway 41 and Merced River

Stream	River Reaches:	Level II	# of Sites	Level I	Target Spot # Per Site	Comment or Rationale
South Fork, Merced River	Savage's Trading Post to Hite's Cove	●	2	●	60	Level 1 is reconnaissance survey, using approach of Stillwater Sciences (2008), followed by Level II
	Hite's Cove to Devil Creek Junction	●	2	●	60	Level 1 is reconnaissance survey, using approach of Stillwater Sciences (2008), followed by Level II
	Devil Creek Junction to Peach Tree Bar	●	2	●	60	Level 1 is reconnaissance survey, using approach of Stillwater Sciences (2008), followed by Level II
	Peach Tree Bar to Granite or Zip Creek	●	2	●	60	Level 1 is reconnaissance survey, using approach of Stillwater Sciences (2008), followed by Level II. Upper limit of sampling stations determined by "currently limiting barriers".

Stream	River Reaches:	Level II	# of Sites	Level I	Target Spot # Per Site	Comment or Rationale
Devil Creek	*Devil Creek to Peachtree Bar*			●	20-30	Level I at two to three geographically separated locations. Sites may be different lengths depending on homogeneity of reach. Sample near confluence with South Fork, and then two or three locations upstream, limited by depth of canyon.
Granite Creek	*Above Peachtree Bar*			●	20-30	Level I at two to three geographically separated locations. Sites may be different lengths depending on homogeneity of reach. Sample near confluence with South Fork, and then two or three locations upstream, limited by depth of canyon.
Iron Creek	*Along FS Road 4S17*			●	20-30	Level I at two to three geographically separated locations. Sites may be different lengths depending on homogeneity of reach.
Alder Creek	*Below Highway 41*			●	20-30	Level I at two to three geographically separated locations. Sites may be different lengths depending on homogeneity of reach.

Stream	River Reaches:	Level II	# of Sites	Level I	Target Spot # Per Site	Comment or Rationale
Bishop Creek	*At South Fork Trail crossing*			●	20-30	Level I at two to three geographically separated locations. Sites may be different lengths depending on homogeneity of reach.
Rush Creek	*At FS Road 4S17*			●	20-30	Level I at two to three geographically separated locations. Sites may be different lengths depending on homogeneity of reach.
Big Creek	*Near Wawona*			●	20-30	Level I at two to three geographically separated locations. Sites may be different lengths depending on homogeneity of reach.

ATTACHMENT 2

Level II Representative Sampling
Field Data Form

Page A

LEVEL II - Electroshocking

Date: ____________ **Page** ______ of ______
mm/dd/yyyy (ie. 03/21/2008)

Project: ______________________________ **Time Start:** ________ **Time End:** ________
24 hr clock (ie 14:15) 24 hr clock (ie 15:25)

Site #: ______ of ______ **Prepared by:** ____________________
First initial, Last name

Location Description: ______________________ [redacted]

Site Length: ________ Feet **Avg Site Width:** ________ Feet **Avg Site Depth:** ________ Feet

	Pass 1		Pass 2		Pass 3	
Shocking Timer:	____ Beg (secs)	____ End (secs)	____ Beg (secs)	____ End (secs)	____ Beg (secs)	____ End (secs)
Shocker Settings:	____ Volts	____ Amps	____ Volts	____ Amps	____ Volts	____ Amps

Weather: ____________________
Cloudy, raining, sunny

Shocker Model: ____________________
Model: LR-24, LR-20, Type 12

Species Information

Pass	Species	Length (mm)	Weight (g)	Pass	Species	Length (mm)	Weight (g)	Pass	Species	Length (mm)	Weight (g)

Comments (Note all incidental observations of sculpin, turtles or amphibians):

Depletion: $(1-[(N_2*E_1)/(N_1*E_2)]*100=$ _______ $(1-[(N_3*E_2)/(N_2*E_3)]*100=$ _______

Species Codes: Black Bullhead=BKB; Black Crappie=BLC; Bluegill=BLG; Brook trout=BKT; Brown bullhead=BRB; Brown trout=BRT; California roach=CAR; Channel catfish=CCF; Common carp=CAP; Goldfish=GOS; Green sunfish=GSF; Hardhead=HDH; Lahontan cutthroat trout=LCT; Lahontan redside=LRS; Largemouth bass=LMB; Mosquitofish=MOF; Rainbow trout=RBT; Sacramento pikeminnow=SPW; Sacramento sucker=SSK; Speckled dace=SPD; Smallmouth bass=SMB; Unknown=UNK; Unknown centrarchid=UCD; Unknown minnow=UMW; Unknown salmonid=USD; White crappie=WHC; Riffle Sculpin=RFS; Prickly Sculpin=PSC; Unknown Sculpin=SCL; Sierra Nevada Yellow-Legged Frog=SNYLF; Foothill Yelow-Legged Frog=FYLF; Unknown Amphibian=AMP; Western Pond Turtle=WPT; Unknown Turtle=TRT

Page A

LEVEL II - Snorkeling

Date: _____ (mm/dd/yyyy (ie. 03/21/2008)) **Page** _____ of _____

Project: _____ **Time Start:** _____ (24 hr clock (ie 14:15)) **Time End:** _____ (24 hr clock (ie 15:25))

Site #: _____ of _____ **Prepared by:** _____ (First initial, Last name)

Location Description: _____

Site Length: _____ (Feet) **# of Spots:** _____ **Avg Site Width:** _____ (Feet) **Avg Site Depth:** _____ (Feet)

GPS Coord: _____ º (Lat deg. (39º)) _____ (Lat mins (49.510)) N _____ º (Long deg. (121º)) _____ (Long mins (34.051)) W Weather: _____ (Cloudy, raining, sunny)

Air Temp: _____ (Degrees F.) **H2O Temp:** _____ (Degrees F.) **Dissolved Oxygen:** _____ (MG/L) **Conductivity:** _____ µmhos

Observer 1: _____ (First initial, Last name) **Observer 2:** _____ (First initial, Last name) **Observer 3:** _____ (First initial, Last name) **Observer 4:** _____ (First initial, Last name) **Visibility:** _____ (Feet)

Species Information

Pass	Obs #	Species	Length Class (inches) 0-2	2-4	4-6	6-8	8-10	10-12	12-14	14+

Comments (Note all incidental observations of sculpin, turtles or amphibians):

Species Codes: Black Bullhead=BKB; Black Crappie=BLC; Bluegill=BLG; Brook trout=BKT; Brown bullhead=BRB; Brown trout=BRT; California roach=CAR; Channel catfish=CCF; Common carp=CAP; Goldfish=GOS; Green sunfish=GSF; Hardhead=HDH; Lahontan cutthroat trout=LCT; Lahontan redside=LRS; Largemouth bass=LMB; Mosquitofish=MOF; Rainbow trout=RBT; Sacramento pikeminnow=SPW; Sacramento sucker=SSK; Speckled dace=SPD; Smallmouth bass=SMB; Unknown=UNK; Unknown centrarchid=UCD; Unknown minnow=UMW; Unknown salmonid=USD; White crappie=WHC; Riffle Sculpin=RFS; Prickly Sculpin=PSC; Unknown Sculpin=SCL; Sierra Nevada Yellow-Legged Frog=SNYLF; Foothill Yelow-Legged Frog=FYLF; Unknown Amphibian=AMP; Western Pond Turtle=WPT; Unknown Turtle=TRT

ATTACHMENT 3

Level I Representative Sampling
Field Data Form

Page A

LEVEL I - Electroshocking

Date: _____ (mm/dd/yyyy (ie. 03/21/2008)) **Page** 1 of _____

Project: _____ **Time Start:** _____ (24 hr clock (ie 14:15)) **Time End:** _____ (24 hr clock (ie 15:25))

Site #: _____ of _____ **Prepared by:** _____ (First initial, Last name)

Location Description: _____

Site Length: _____ (Feet) **# of Spots:** _____ **Avg Site Width:** _____ (Feet) **Avg Site Depth:** _____ (Feet)

GPS Coord: _____ º _____ N (Lat deg. (39º) / Lat mins (49.510)) _____ º _____ W (Long deg. (121º) / Long mins (34.051)) Weather: _____ (Cloudy, raining, sunny)

Sample Method: _____

Shocking Timer: _____ (Beg (secs)) _____ (End (secs)) **Shocker Settings:** _____ (Model: LR-24, LR-20, Type 12) _____ (Volts) _____ (Amps)

Air Temp: _____ (Degrees F.) **H2O Temp:** _____ (Degrees F.) **Dissolved Oxygen:** _____ (MG/L) **Conductivity:** _____ (µmhos)

Habitat Information Over Length of the Site

% Substrate (nearest 5%)

_____ (Clay) + _____ (Silt) + _____ (Sand) + _____ (Gravel) + _____ (Cobble) + _____ (Boulder) + _____ (Bedrock) =100% (up to 3 classes)

% Habitat Characterization (nearest 5%) **% Cover (nearest 5%)**

_____ (Riffle) + _____ (Pool) + _____ (Glide) =100% _____ (Surface Turbulence) _____ (Object) _____ (Undercut Bank) _____ (Overhanging Veg)

% Canopy: _____ **% Gradient:** _____ **Estimated Flow:** _____ (cfs)

Species Information

Species	Length (mm)	Species	Length (mm)	Species	Length (mm)	Species	Length (mm)	Species	Length (mm)

Comments (Note all incidental observations of sculpin, turtles or amphibians):

Species Codes: Black Bullhead=BKB; Black Crappie=BLC; Bluegill=BLG; Brook trout=BKT; Brown bullhead=BRB; Brown trout=BRT; California roach=CAR; Channel catfish=CCF; Common carp=CAP; Goldfish=GOS; Green sunfish=GSF; Hardhead=HDH; Lahontan cutthroat trout=LCT; Lahontan redside=LRS; Largemouth bass=LMB; Mosquitofish=MOF; Rainbow trout=RBT; Sacramento pikeminnow=SPW; Sacramento sucker=SSK; Speckled dace=SPD; Smallmouth bass=SMB; Unknown=UNK; Unknown centrarchid=UCD; Unknown minnow=UMW; Unknown salmonid=USD; White crappie=WHC; Riffle Sculpin=RFS; Prickly Sculpin=PSC; Unknown Sculpin=SCL; Sierra Nevada Yellow-Legged Frog=SNYLF; Foothill Yelow-Legged Frog=FYLF; Unknown Amphibian=AMP; Western Pond Turtle=WPT; Unknown Turtle=TRT

Page B

LEVEL I - Snorkeling

Date: ____________________ **Page** ______ of ______
mm/dd/yyyy (ie. 03/21/2008)

Project: ____ **Time Start:** __________ **Time End:** __________
24 hr clock (ie 14:15) 24 hr clock (ie 15:25)

Site #: ______ of ______ **Prepared by:** ____________________
First initial, Last name

Location Description: ______________________________

[redacted]

Snorkeling Fields Only

Observer 1: __________ **Observer 2:** __________ **Observer 3:** __________ **Observer 4:** __________ **Visibility:** __________
First initial, Last name First initial, Last name First initial, Last name First initial, Last name Feet

Species Information

Snorkel Observer #	Species	Length Class (inches) >0-2	>2-4	>4-6	>6-8	>8-10	>10-12	>12-14	>14+

Comments (Note all incidental observations of sculpin, turtles or amphibians):

Species Codes: Black Bullhead=BKB; Black Crappie=BLC; Bluegill=BLG; Brook trout=BKT; Brown bullhead=BRB; Brown trout=BRT; California roach=CAR; Channel catfish=CCF; Common carp=CAP; Goldfish=GOS; Green sunfish=GSF; Hardhead=HDH; Lahontan cutthroat trout=LCT; Lahontan redside=LRS; Largemouth bass=LMB; Mosquitofish=MOF; Rainbow trout=RBT; Sacramento pikeminnow=SPW; Sacramento sucker=SSK; Speckled dace=SPD; Smallmouth bass=SMB; Unknown=UNK; Unknown centrarchid=UCD; Unknown minnow=UMW; Unknown salmonid=USD; White crappie=WHC; Riffle Sculpin=RFS; Prickly Sculpin=PSC; Unknown Sculpin=SCL; Sierra Nevada Yellow-Legged Frog=SNYLF; Foothill Yelow-Legged Frog=FYLF; Unknown Amphibian=AMP; Western Pond Turtle=WPT; Unknown Turtle=TRT

CG Study Request 3.1b

ANADROMY SALMONID HABITAT

Baseline Juvenile *O. Mykiss* Abundance and Distribution

August 30, 2009

1.0 Project Nexus and Issue

A federally listed fish species, California Central Valley Steelhead trout DPS (FT), *Oncorhynchus mykiss*, and its designated critical habitat, occurs in the Project Area.

Merced Irrigation District's (MID or applicant) continued operation and maintenance (O&M) of, and new development in, the Merced River Hydroelectric Project (Project) directly affects volitional anadromous fish passage. Because aquatic and riparian habitats below these facilities in the Merced River can be negatively affected, those habitats may be modified in a different manner than if the project was not operated. Since inception of the project from the early1900's, project dams (in 1967) have partially or totally blocked volitional anadromous fish passage, as they were constructed without fish bypass capabilities, or those with fish bypass structures were blocked in the early 1970's (Vogel, 2007). Since the completion of Exchequer Dam in 1926, the direct and cumulative effect of these dams is that access to greater than 96% of the original historically available spawning and rearing habitat on the Merced River for *O. mykiss* (Steelhead trout) and other anadromous fishes (spring-run, fall-run and late fall-run Chinook salmon, lamprey) has been eliminated by impassable barriers and/or inundation. (Martin 2008, Schick *et al* 2005)

Suitable *O. mykiss* spawning and juvenile rearing habitat is now restricted to the Merced River reach between Crocker-Huffman Diversion Dam (RM 52) and the Shaffer Bridge (RM 32.5). Reduction and modification of seasonal flow from the operation of the Project dams has adversely impacted the restricted *O. mykiss* accessible spawning and rearing habitat in this reach through interference with spawning gravel replenishment and armoring of gravel beds and instream flow regimes. The habitat is partially maintained by spawning gravel restoration (for Fall run Chinook salmon, but not for Steelhead trout) and temperature dependent flow releases from the Project.

In addition to other concerns, this Study Request addresses the following preliminary issues, which have been identified in Section 6 of the applicant's Pre-Application Document (MID, 2008):

- Issue AR-1. Effect of the Project on special-status coldwater fishes in the Merced River watershed
- Issue AR-3: Effect of the Project on fishes due to entrainment into Project intakes

- Issue AR-7. Effect of the Project on trout and salmon upstream of Lake McClure, including the populations and fishing
- Issue AR-8. Effect of the Project on special-status fishes, especially fall- and late fall-Run Chinook salmon (NMFS Species of Concern), due to blockage of passage.
- Issue T&E-1. Effect of the Project on the federal Endangered Species Act (ESA)- and the California Endangered Species Act (CESA)-Listed anadromous fishes due to water temperature.
- Issue T&E-2. Effect of the Project on ESA- and CESA-Listed anadromous fishes due to attraction flows.
- Issue T&E-3. Effect of the Project on ESA-and CESA-Listed anadromous fishes adult holding habitat, juvenile holding habitat, and spawning habitat.
- Issue T&E-5. Effect of the Project (*e.g.*, physical barriers) on upstream and downstream migration of ESA- and CESA-Listed anadromous fishes, including Spring-run Chinook salmon (FT and CT) and Central Valley steelhead (FT).
- Numerous Issues Described by Relicensing Participants as "Potential Studies Requested by Relicensing Participants" (MID, 2008, § 10.3, Page 10-5)

2.0 Resource Agency and Tribal Management Goals

The applicant must confer with Resource Agencies and American Indian Tribes that participate in development of this study proposal. At this time, Resource Agencies have not yet identified specific management goals relevant to this study proposal. General management and restoration goals for Steelhead trout have been published by the agencies (see Martin, 2007 for a summary). Potential management goals should be considered:

- Improve production of native Steelhead trout by improving adequate temperature and flow regimes, especially for juvenile rearing (CDFG, 1996)
- Improve project operations, outlet modifications, and establishment of minimum pools for reservoirs so that cool water temperatures could be provided in late-summer and fall (CDFG, 1996)
- Install fishways on presently unladdered dams to allow access to tailwater habitat (CDFG, 1996)
- Improve stock production through hatchery facility supplementation to native Steelhead trout populations (CDFG, 1996)
- Maintain, enhance, and restore populations of Steelhead trout in tailwater aquatic habitats caused by project dams and lack of volitional fish bypass
- Maintain, recover, and restore streamflow regimes sufficient to sustain desired conditions for populations of Steelhead trout, defined as keeping the tailwater fishery in 'good condition' *sensu* California Fish and Game Code 5937
- Maintain, enhance, or restore populations of native aquatic biota, including fish, benthic macroinvertebrates, and riparian species to be viable with adequate habitat consistent with species' needs

- Maintain, enhance, or restore all life stages of native aquatic species by ensuring connectivity between project-affected stream reaches, between reaches of mainstem river and their tributaries, and between reservoirs and reaches of mainstem river
- Maintain, recover, and restore streamflow regime sufficient to sustain desired conditions of native riparian, aquatic, wetland, and meadow habitats
- Protect and enhance river fishing opportunities consistent with overall watershed recreation
- Protect aquatic systems to which species are uniquely adapted
- Reestablish, maintain, and enhance traditional cultural properties and anadromous salmonid species to provide for tribal retrieval of fish for ceremonial and spiritual purposes

3.0 Relevant Public Interest Consideration and Potential License Condition

The requester is not a resource agency and states the public interest consideration in regard to the proposed study:

Study is needed to provide data, information, and alternatives to protect and enhance the beneficial uses of the lower Merced River, including coldwater habitat, fisheries, water contact recreation, Migration of Aquatic Organisms, & Spawning Habitat to establish data and information to be used in National Environmental Policy Act (NEPA) environmental impact assessment(s), potential Endangered Species Act consultations, Water Quality Certification, Section 401, Clean Water Act, and development of potential conditions of a new license for the purpose of protected, mitigating, or enhancing the Steelhead trout for public benefit in the public interest.

Study is needed to provide data, information, and alternatives to assess conditions of the Merced River with regard to compliance with California Fish and Game Code. The public has an interest in fishing, in the use and utilization of anadromous fisheries resources, and in the maintenance of the Merced River by allowing sufficient water at all times to pass through a fishway, or in the absence of a fishway, allowing sufficient water to pass over, around or through the dam, to keep in good condition any fish that may be planted or exist below the dam.

The applicant's proposed alternative studies are not sufficient to meet these information needs.

The results of this Study Request will inform the Commission with information, useful in development of protection, mitigation and enhancement (PM&E) measures relating to the effects project structures, operations and maintenance, which may include:

- Modifications of Project Operations
- Modification of Project Facilities
- Development of protection measures relative to Project O & M
- Development of protection measures relative to Project recreation activities
- Development of site-specific management plans, if needed
- Instream flow releases.
- Seasonal reservoir elevation constraints for coldwater temperature management

Development of PM&E measures is not part of the study.

4.0 Study Goals and Objectives

The goal of this Study Request is to provide information to the Relicensing Participants concerning California Central Valley Steelhead trout DPS, *O. mykiss* associated with Merced River reaches affected by the Merced River Hydroelectric Project. This will be achieved through the evaluation of the juvenile life stage of *O. mykiss* present in the lower Merced River. It is recognized that not all of the juvenile *O. mykiss* studied will exhibit an anadromous life history. The objectives of the study are to:

- Assess baseline juvenile *O. mykiss* abundance and distribution
- Assess the population structure
- Assess habitat type utilization
- Develop a monitoring protocol to evaluate juvenile population structure and habitat type utilization
- Investigate the relationship between physical features within habitat types and location of *O. mykiss*, including aggregate mining pools and restoration plans
- Develop a baseline with which to compare available habitat and fish populations under different flow regimes
- Confirm *O. mykiss* anadromy lineage and population distributions of the Merced River.

5.0 Existing Information and Need for Additional Information

No directed baseline abundance and distribution surveys have been conducted to assess ESA threatened *O. mykiss* populations in the Lower Merced River. Due to this lack of information, it is impossible to make informed instream flow, management and habitat restoration decisions necessary to sustain or recover these threatened populations. This is

of particular importance because anadromous Central Valley *O. mykiss* (steelhead) are listed as threatened under the ESA.

The decline of *O. mykiss* populations throughout the San Joaquin River basin has been well documented, principally due to loss of spawning and rearing habitat above impassable dams and associated water diversions (McEwan 2001). Similarly, Merced River *O. mykiss* populations likely have been reduced to a fraction of their historic numbers primarily due to the construction of the Exchequer Dam in 1926, with some restrictions by the Merced Falls Dam in 1913 and Crocker-Huffman Diversion Dam in 1907. The construction of Crocker-Huffman Dam, with a poorly functional fish ladder, resulted in partial loss of access of almost all anadromous fish spawning/rearing habitat. The concomitant drastic reductions in stream flows below the Crocker-Huffman Diversion Dam had negative effects on the remaining limited downstream anadromous habitat. Both the historic and current status of Merced River salmonid populations has been controversial in the regulatory arena. While there is little scientific controversy over the presence of *O. mykiss* in the Merced River, scientific knowledge of *O.myiss*t juvenile populations in the Lower Merced River is based upon very limited study.

Most, if not all, of the previous research on the Lower Merced River has focused upon fall- and late fall-run Chinook salmon management issues, with only cursory or ancillary observations on *O. mykiss*. It is known that an *O. mykiss* population exists in the Lower Merced River. Observations of the population status have been obtained through incidental capture during the course of ongoing fall- and late fall-run Chinook salmon research. The following observations, data, and information is evidence of an anadromous *O. mykiss* presence in the Lower Merced River:

- Incidental catch of spawning *O. mykiss* in Merced River Hatchery (CDFG, 1996)
- Captures of young of year specimens during seining and electro-fishing surveys, as well as observations during snorkeling surveys (Stillwater Sciences, 2008)
- Observation of large adult *O. mykiss* in the lower river, in reaches inhabited by anadromous Chinook salmon (Stillwater Sciences, 2008).
- Kodiak trawl captures of smolts in the San Joaquin River at Mossdale (San Joaquin River Group Authority, 2008)
- Sportfishing catch statistics report large *O. mykiss*, greater than 18 inches in the Lower Merced River (Jackson, 2007)
- In a limited samples of *O. mykiss* otoliths (Sr:Ca ratios), a steelhead progeny in Lower Merced River was verified (Zimmerman *et al*., 2008, 2009).

6.0 Study Methods and Analysis

6.1 Study Area

The study area includes aquatic habitats within the normal high water line of Project-affected stream reaches, including the section of the Merced River from Merced ID's Crocker Huffman Diversion Dam to RM 32.5 at the Shaffer Bridge, Merced County.

6.2 General Concepts

The following general concepts apply to the study:

- Personal safety is an important consideration of each fieldwork team. If applicant determines the information cannot be collected in a safe manner, applicant will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.
- Applicant shall make a good faith effort to obtain permission to access private property where needed well in advance of performance of the study. If access is not granted or river access is not feasible or safe, applicant will notify FERC and Relicensing Participants as soon as possible via email to determine if Relicensing Participants can assist in gaining access or to discuss alternative approaches to perform the study.
- The schedule for each proposed study is reasonably flexible to accommodate unforeseen problems that may affect the schedule. If a schedule changes, applicant will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.
- Field crews may make minor modifications to the study proposal in the field to accommodate actual field conditions and unforeseen problems. When modifications are made, applicant's field crew will follow the protocols in this study proposal. If minor modifications are made, applicant will provide a detailed description of the conditions that led to the decision to modify the study to FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.
- Applicant's performance of the study does not presume applicant is responsible in whole or in part for resource management measures that may arise from that study.
- The estimated level of effort and cost is not a firm commitment by applicant to expend all the funds. If the study costs more, applicant is committed to completing the study. If the study costs less, applicant is not committed to expending the remaining funds on other Relicensing studies or resource management measures.
- Field crews will be trained as appropriate to identify all special-status amphibians, reptiles, and fish that may be encountered coincidentally. Training will include instruction in diagnostic features and habitat associations of special-status species. Field crews will also be provided with laminated identification sheets showing special-status species, compared to other common species.
- All special-status species observations will be submitted to the California Natural Diversity Database.

- Field crews will include a list of native and non-native species that may be encountered using the sampling methods described in the plan and their State and Federal (if any) status. Crews will make sure there are codes for all these species on the data forms.

6.3 Study Methods

The proposed scope of work will take place in the Lower Merced River from the upstream anadromous migration barrier, Crocker-Huffman Diversion Dam at river mile 52 downstream to the Shaffer Bridge at river mile 32.5 (Figure 1)

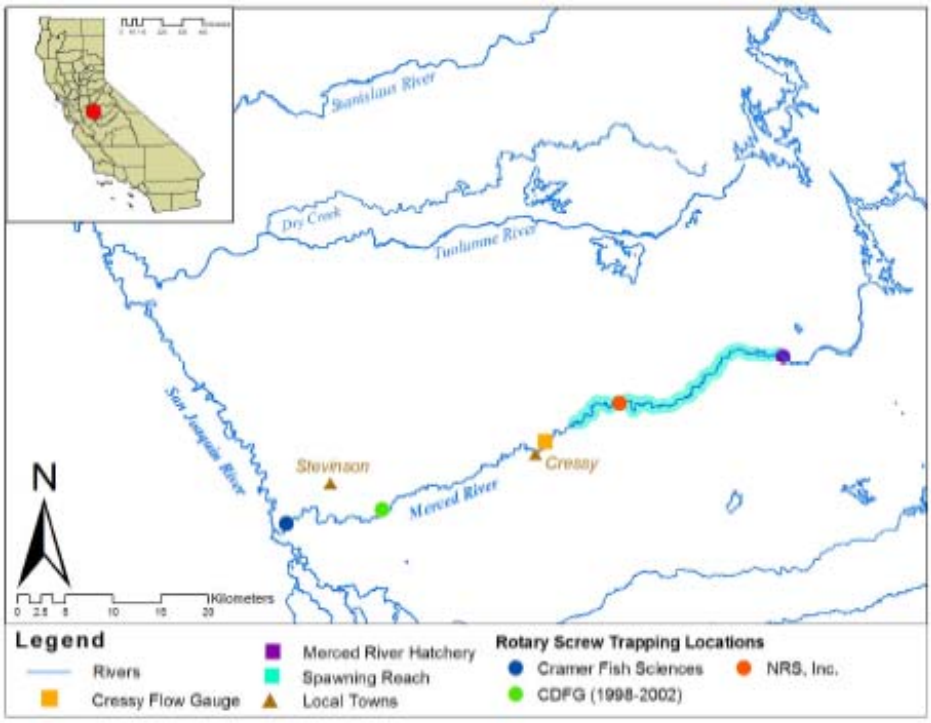

Figure 1. Location of river study area for electroshocking and snorkeling surveys. The upper boundary of the study site is at the Crocker-Huffman diversion dam (=Merced River Hatchery @ RM 52) and the lower boundary is at RM 32.5, approximately 5.5 RM above the Cressy Flow Gauge (RM 27).

The survey locations will be selected based on habitat characteristics most suitable for *O. mykiss* (i.e. riffle, run, and pool). Ten survey locations will be selected within the 20.5 river miles below Crocker-Huffman Dam. The study will provide information and data compatible for analyses and comparisons with adjoining rivers of the San Joaquin River basin.

Step 1 – Document baseline (current year of study, 2010-2011) juvenile and (and incidentally captured adult) *O. mykiss* abundance and distribution in the Lower Merced River.

The study goals will be addressed with a simple stratified random sampling design in which the most appropriate methodology is used to estimate population within strata. The Lower Merced River is a typical medium/large low gradient valley stream characterized by deep pool habitat, interspersed with wide low gradient riffles, side channel, and margin habitat. Total population estimates on large Central Valley rivers are difficult because researchers tend to rely on a single methodology to collect fish specimens or focus on one habitat type. Because of the diversity in habitat types, no single sampling methodology is adequate. For example, visual estimation (snorkeling) is effective in deep pool habitat but is not effective in shallow side channels with complex instream habitat diversity. Similarly, side channels can be electro-fished effectively but large deep pools may or may not be electro-fished adequately dependent on allowable electro-fishing equipment and pool morphology. By utilizing different sampling methodologies within a stratified sampling design, a more complete resource assessment will be attained. A total juvenile rearing population estimate for the river reach study will be calculated for *O. mykiss*. Total population estimation requires data from two factors, which have not been accounted for in the limited studies conducted to date:

- Assessment of the range/distribution of *O. mykiss*;
- Assessment of the abundance of *O. mykiss*

For estimates of juvenile *O. mykiss* and abundance and distribution, the following methodology will be employed. Capture method will include angling and/or backpack electro-fishing depending on survey locations and numbers of fish caught. All fish captured will have their biological data recorded (included but not limited to length, weight, and life stage). Scale samples will be taken from all fish. Scales will be analyzed for age structure purposes. Fish that meet the minimum requirement for marking will be marked with T-bar anchor tag (Floy tag). Floy tags will be used as identification of a surveyed fish if repeated sampling is required. A sub-sample of 25 fish will have acoustic tags surgically implanted, and marked with different color Floy tag at each location. The total number in the acoustic tagged sample will be 150 for each year. Marked fish will be held in a recovery container until full equilibrium is restored. All fish will be release to slow water habitat near the capture location. All acoustic tagged samples will be digitally photographed, and tag information (acoustic tag and Floy tag) will be attached to its photo.

Snorkel surveys will be used as the recapture method by visibly detecting the presence of Floy tags. All *O. mykiss* (fin clipped or unclipped) will be enumerated, along with size and life stage estimated. All other observed fish species will be enumerated and recorded. A mobile acoustic tag detector will be used to detect the presence of acoustic-tagged fish prior to snorkel surveys. The data from the acoustic tagging will be used as a control group (known number of fish in water). Stationary acoustic detectors will be deployed in all survey locations. Two detectors will be installed for each survey locations at its upper and lower end. A total of 20 stationary detectors will be installed in the Merced River study reach. Acoustic tags will provide more extensive information such as survival, movement, and migration patterns. Floy tags provide information about relative

population abundance and distribution. Any mortality resulting from angling or electrofishing survey will be kept and recorded on datasheet.

Scales samples and fin clips will be collected for age determination and genetic analysis. Any mortality observed from snorkel survey will be collected, and recorded. Scales will be collected for age determination and fin clips for genetic analysis.

All field survey will occur during June, July, and August for two years. Fish sampling for mark-recapture study will be conducted in June. Intensity of fish sampling will depend on number of acoustic tagged fish released. July and August will be recapture survey and habitat survey.

Step 2 - Assess the age structure.

The population age class structure will be determined through fork length histograms and confirmed through reading scales. Assessment of population structure within the instream life history stage is vital to understanding the limiting factors on overall *O. mykiss* population. Each life history stage requires different environmental and habitat conditions. For example, age 0+ may utilize different habitats and have different flow requirements than age 1+ and older specimens. Lack of suitable habitat for age 0+ fish may limit the overall *O. mykiss* population even if the requirements for age 1+ and older fish are sufficient.

All scale samples will be cleaned and mounted on microscope slides. Digital images of scale samples will be taken. Age-reading technicians will then identify age of a sample by use of a digital image on a personal computer.

Step 3 – Assess the condition of anadromy and verify genetic origin.

The condition of anadromy will be determined by performing Sr:Ca ratio analyses of otolith samples to determine resident or anadromous life history of *O. mykiss* (Zimmerman *et al.* 2008, 2009). 150 specimens will be sampled; an incidental take permit from the National Marine Fisheries Service shall be obtained prior to collection of fish for otolith samples.

Genetic origin will be examined by analyzing genetic markers (Single Nucleotide Polymorphism or SNP) from DNA extracted from fin clips from thirty of the fish sampled for otiliths(Aguilar and Garza, 2007; Donohoe *et al*., 2008). Compare these with samples from thirty individual *O. mykiss* specimens taken upstream of Lake McClure in the course of performing the Upper River Fish Populations and Habitat study. In such case as the latter study is not performed, licensee will collect samples from the upper Merced River following a protocol determined by CDFG, SWRCB, and NMFS.

Step 4 - Assess habitat utilization.

The nature of the survey design necessitates assessment of population density and age class structure within habitat strata. Because minimum requirements for summer flows are highly variable (50 to 1000 cfs, *e.g.* CDEC flows MSN station, yr. 2000 versus 2005), available habitat is likewise highly variable. Some habitat strata, particularly side channels, are not present during the lowest minimum flow conditions. It is vital to assess habitat strata utilization in order to evaluate the potential effects of varied summer flow regimes.

This task will be carried out when mark-recapture snorkel survey is conducted. Environmental data will include air and river temperature, river flow, turbidity, snorkel visibility, and habitat typing. Survey area will be marked by using Trimble GPS units to show boundaries and sampling areas. Water velocities will be measured with either a Price AA flow meter or an Acoustic Doppler Current Profiler (ADCP) over a range of low to high flows to characterize water velocities in juvenile *O. mykiss* habitats at the 10 sites. Habitat typing will be surveyed by varieties of methods included direct observation from a drift boat or kayak, and underwater observation by snorkel or underwater surveillance equipment.

Habitat will be characterized into pool, riffle, run/glide, and side channel. Substrate will be categorized into silt, sand, gravel, cobble, boulder, and bedrock. Cover will be categorized into none, overhanging, instream, and both overhanging and instream.

Step 5 - Investigate the relationship between physical features within habitat types and location of *O. mykiss*

During the course of population assessment within habitat units, physical habitat features, such as current speed and structural complexity, will be related to fish position within the habitat units. Fundamental understanding of the locations fish prefer will assist in the planning of habitat enhancement/restoration efforts. This assessment will be carried out qualitatively, with extensive use of GIS to allow geographical representation of observations and captures within habitat units.

Step 6 - Data Analysis

Data will be entered into MS Access database by data management personnel. Quality control will be performed to ensure the accuracy and integrity of the data entered by using existing database and data management procedures of the research group. QA/QC procedures and process will be reported to and agreed upon by the Relicensing Participants.

Data collected from acoustic telemetry and habitat typing will be analyzed by using ArcView GIS database to form range/distribution map. *O. mykiss* abundance can be formulated from both telemetry and mark-recapture data at the selected survey locations.

O. mykiss and abundance at each location will be calculated by using this formula:

$$N = \left(\frac{A_M \bullet T_S}{A_S} \right) + M$$

N = Number of *O. mykiss* at a survey location
A_M = Observed acoustic tagged fish via a mobile detector
A_S = Observed acoustic tagged fish via snorkel survey
T_S = Total number of *O. mykiss* observed (marked and unmarked) via snorkel survey
M = Observed mortality from both sampling and snorkel surveys
By using this formula we assume the following to be true:

- 100% tag retention
- marked fish is distributed evenly at each survey location
- marked fish is mixed with unmarked fish at each survey location

Step 7 – Prepare Report. –

Applicant will prepare a report that includes the following sections: 1) Study Goals and Objectives; 2) Methods and Analysis; 3) Discussion; and 4) Description of Variances from the FERC-approved study proposal, if any. Data will be provided on CD in Microsoft Excel spreadsheets. Applicant plans to make the report available to Relicensing Participants when completed. The report will be included in the License Applications as appropriate. Besides the reports described above, the study results will be displayed in Geographic Information System (GIS) maps that show the habitat utilization and range of distributions of juvenile Steelhead trout in the Merced River, below Crocker Huffman Diversion Dam.

6.4 Consultation and Communication

This study proposal includes 6 study-specific Agency, Tribe, and Relicensing Participant consultations regarding final details of study plans, locations, protocols, and field reconnaissance activities:

- Consult on Step 1 Document Baseline of juvenile and adult *O. mykiss*
- Consult on Step 2 Assess Age Structure
- Consult on Step 3 Assess Anadromy
- Consult on Step 4 Assess Habitat Utilization
- Consult on Step 5 Investigate Physical Features/Habitat Types and Location
- Consult on Step 6 Data Analyses

A quarterly report on overall study progress, with any notations of change from agree-to protocols or timelines, will be filed with FERC and posted on its Relicensing Website periodic reports as required by the FERC in the Study Plan Determination.

Applicant will coordinate with FERC and other Relicensing Participants as described in this section.

6.5 Schedule

The schedule to complete the proposed study is:

- Step 1. Baseline of juvenile *O. mykiss*……...June-Sept 2010; June-Sept 2011
- Step 2 Assess Age Structure…….…..Oct-Nov 2011
- Step 3 Assess Anadromy……Oct-Nov 2011
- Step 4 Assess Habitat Utilization ……..June-Sept 2010; June-Sept 2011
- Step 5 Investigate Physical Features/Habitat Types and Location……. ……....June-Sept 2010; June-Sept 2011
- Step 6 Data Analyses.…….Nov-Dec 2011
- Step 7 Report Preparation……...Nov-Dec 2011

It is anticipated that the study will be completed in 2011.

6.6 Consistency of Methodology with Generally Accepted Scientific Practices

This study is consistent with the goals, objectives, and methods outlined for recent FERC hydroelectric relicensing studies in California, and uses well recognized scientific methodologies and protocols from US Fish & Wildlife Service, California Department of Fish and Game, and National Marine Fisheries Service.

7.0 Products

After data are collected, tabulated, and quality checked the data will be made available to the Relicensing Participants in an Excel format or other format as appropriate.

Products will include but not be limited to the following:

An overall Project Report will be prepared. Data will be provided on CD in Microsoft Excel spreadsheets. Besides the report, the study results will be displayed in Geographic Information System (GIS) maps that show locations of any identified potential barriers to upstream or downstream anadromous fish species movement.

8.0 Level of Effort and Cost

Step in Study	**Study Task**	**Estimate person time**	**Cost**
Step 1	**Baseline Abundance Distribution**	**12 person-months & Supplies**	**$110,000**
Step 2	**Assess Age Structure**	**2 person-months**	**$ 15,000**
Step 3	**Assess Anadromy with SNAP DNA analysis and Sr:Ca ratios**	**400 fin punch samples @ $45; 100 otolith samples @ $90**	**$ 18,000** **$ 9,000**
Step 4	**Assess Habitat Utilization**	**12 person-months**	**$90,000**
Step 5	**Physical Features Habitat types & Locations**	**4 person- months**	**$30,000**
Step 6	**Data Analyses**	**4 person-months**	**$30,000**
Step 7	**Report Preparation**	**6 person-months**	**$45,000**
	TOTAL STUDY COST		**$347,000**

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Revised Study 3.2

FISH ENTRAINMENT

20 October 2009

1.0 Projects Nexus and Issue

Merced Irrigation District's (Merced ID or Licensee) continued operation and maintenance (O&M) of the Merced River (P-2179) and Merced Falls (P-2467) Hydroelectric Projects (Projects), operation of the non-FERC Crocker-Huffman Dam, and operation of the two MID water diversion canals (Northside Canal at Merced Falls Reservoir and Main Canal at Crocker-Huffman Dam) affect aquatic resources in the Merced River watershed, including populations of current resident fish such as rainbow trout (*Oncorhynchus mykiss*) and potential future anadromous fish such as steelhead (*O. mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*). In addition, there are two additional private canal diversions off of Merced Falls Reservoir that could also entrain fish. The Study Area for both Projects includes Lake McClure, McSwain Reservoir, Merced Falls Reservoir, and Crocker-Huffman Reservoir (including the river reach between Merced Falls Dam and Crocker-Huffman Dam). Fish could be affected due to entrainment into and passage through the P-2179 and P-2467 powerhouses, MID's water diversion canals, and the two private canal diversions. Since MID operates the P-2467 Project, owned by Pacific Gas and Electric Company (PG&E), coordination and cost-sharing between MID, PG&E, and other private parties will be necessary to conduct this study.

Resident rainbow trout and anadromous steelhead are the same species (*Oncorhynchus mykiss*) and have been shown to exhibit both fresh water and marine life histories. NMFS believes that juvenile or adult rainbow trout within the study area could become entrained into the above facilities. Therefore, a percentage of steelhead (smolts and perhaps kelts) from the *O. mykiss* population passing downstream through the study area may become entrained into the intakes of the powerhouses or water canals, and fish from that population could exhibit a marine life history. It is conceivable that rainbow trout could successfully travel downstream through the study area into the lower Merced River, smolt, and continue on as potential steelhead. Although some juveniles may survive passage through these facilities, we consider that most are seeking habitats downstream of the Projects, are susceptible to such entrainment, and a high proportion would be killed. These *O. mykiss* may be important for the recovery of the Central Valley steelhead Distinct Population Segment (DPS), which is listed as Threatened under the Endangered Species Act (ESA). In addition, it is also conceivable that other anadromous salmonids designated under the ESA, such as the Central Valley spring-run and fall- /late fall-run Chinook salmon (designated under the ESA as Threatened and as a Species of Concern, respectively) could range into the study area if fish passage facilities are restored or as a result of future potential recovery actions for listed salmonids. Finally, NMFS believes that if this fish entrainment study is not implemented with our proposed modifications, then it is likely that recommendations for fish screens on the intakes to the powerhouses and water diversion canals would be made to protect potential *O. mykiss* that may be important for future steelhead recovery actions and to protect anadromous salmonids should they gain passage in the future.

This study addresses the following preliminary issue as identified in the P-2179 and P-2467
Pre-Application Documents (PAD) filed by MID and PG&E (MID 2008; PG&E 2009a):

- Issue AR-3 (P-2179) and Issue AR-2/7 (P-2467): Effect of the Projects on fishes due to entrainment into the Projects' powerhouse intakes and water diversion canals.

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

Licensees believe that four agencies have jurisdiction over populations of current resident fish and potential future anadromous fish within the P-2179 and P-2467 Projects and downstream to the Crocker-Huffman Dam: (1) United States Department of Commerce, National Oceanic and Atmospheric Administration, Marine Fisheries (NMFS) with regards to anadromous fishes; (2) United States Department of Interior (USDOI), Bureau of Land Management (BLM) on United States-owned land administered by BLM; (3) USDOI, Fish and Wildlife Service (USFWS); and (4) California Department of Fish and Game (CDFG).

3.0 Potential License Condition

Study results may be used in the development of Projects' facilities and/or activities Licensee will undertake, in coordination with PG&E and others as needed, as a condition of the new licenses for the purpose of protecting or mitigating impacts to fish in the reservoirs affected by the P-2179 and P-2467 Projects. These facilities, operations and management activities, which are referred to as protection, mitigation and enhancement (PM&E) measures, could include:

- Fish stocking
- Installation of fish screens
- Placement of spawning gravels
- Other PM&E measures

Development of PM&E measures is not part of this study.

4.0 Study Goals and Objectives

The goal of the study is to determine the likelihood that entrainment into the various powerhouses and water canal intakes within the study area occurs and, if so, is it likely that this entrainment would have significant affect on fish populations. If the results of the study suggest additional information is needed, Licensee will consult with CDFG, USFWS, BLM, NMFS and other Relicensing Participants regarding the design of the study, and will file the study proposal with the Federal Energy Regulatory Commission (FERC).

5.0 Existing Information and Need for Additional Information

Section 7.3.3.2 of the P-2179 PAD describes the known fish populations in Lake McClure and McSwain Reservoirs, and Section 8.2.3.3 describes P-2179 power intakes in the reservoirs and powerhouse conditions. Information regarding Lake McClure and McSwain Reservoirs in provided in Table 5.0-1. PG&E described their dam, reservoir, and powerhouse information as well as fish occurring in the vicinity of P-2467 in Sections 4.0 and 5.3, respectively, of their PAD (MID 2008; PG&E 2009a)

Table 5.0-1. Morphometric information regarding Merced ID's Merced River Hydroelectric Project's reservoirs.

Project Reservoir	Upstream Drainage Area	Usable Storage Capacity	Normal Max. Water Surface Elevation	Surface Area	Shoreline Length	Maximum Length	Estimated Maximum Depth
	(sq mi)	(ac-ft)	(ft)	(ac)	(mi)	(mi)	(ft)
Lake McClure[1]	1,035 sq mi	1,024,600 ac-ft	867 ft	7,110 ac	82 mi	19 mi	400
McSwain Reservoir	1,054 sq mi	9,730 ac-ft	400 ft	310 ac	12.5 mi	4.8 mi	80

[1] Lake McClure inundated Exchequer Reservoir which was constructed in 1926-27.

Information regarding the power intakes and powerhouses associated with Lake McClure and McSwain Reservoir is presented in Table 5.0-2 and 5.0-3.

Table 5.0-2. Characteristics of the New Exchequer and McSwain power intakes.

Intake Structure	Outlet Size	Control Valve/Gate	Depth of Intake At Full Pool	Estimated Maximum Capacity
	(in)	(type)	(ft)	(cfs)
THROUGH POWERHOUSE				
New Exchequer Intake[1]	12 ft wide	See Table 8.2.3-2	382 ft	3,200 cfs
McSwain Intake[2]	10 ft wide	See Table 8.3.2-2	40 ft	2,700 cfs
THROUGH POWERHOUSE BYPASS				
New Exchequer Intake[1]	Same as for Powerhouse	108 in Diameter Howell-Bunger Valve	Same as for Powerhouse	9,000 cfs
McSwain Intake[2]	Same as for Powerhouse	96 in Diameter Howell-Bunger Valve	Same as for Powerhouse	2,580 cfs

[1] New Exchequer Powerhouse and Bypass discharge directly into McSwain Reservoir
[2] McSwain Powerhouse and Bypass discharge directly into Pacific Gas and Electric Company's (PG&E) Merced Falls Reservoir

Table 5.0-3. Characteristics of the Francis (Reaction) and Kaplan (Impulse) turbine runners at New Exchequer and McSwain powerhouses.

Powerhouse	Turbines	Revolutions per Minute	Head	Runner Blades	Diameter	Type of Turbine
	(number)	(number)	(ft)	(number)	(in)	(Francis/Kaplan)
New Exchequer	1	180 rpm	397 ft	17	138 in	Francis (Reaction)
McSwain	1	180 rpm	54 ft	5	84 in	Kaplan (Impulse)

As a summary of fishes in the two P-2179 reservoirs, Lake McClure supports the following game fish: largemouth bass, spotted bass, bluegill, crappie, catfish, rainbow trout, Kokanee salmon and Chinook salmon. In comparison, a sport fishery for rainbow trout and spotted bass occurs in McSwain Reservoir. CDFG annually stocks rainbow trout and Chinook salmon in Lake McClure and rainbow trout in McSwain Reservoir. CDFG manages Lake McClure as a Put-and-Take fishery for trout and salmon and

McSwain Reservoir as a Put-and-Take trout fishery. CDFG manages Lake McClure as a bass fishery.

PG&E referenced fish information from MID's PAD for Merced Falls Reservoir and the downstream reach and reservoir on the Merced River between Merced Falls Dam and Crocker-Huffman Dam. Fish found is these areas are largely stocked by the Calaveras Trout Farm and CDFG and include rainbow, Eagle Lake, brown, and brook trout and spotted bass. However, there is a self-sustaining population of rainbow trout within the river reach and reservoir downstream of Merced Falls Dam (NRS 2007).

MID and PG&E proposed fish population studies in their reservoirs and MID proposed to asses the fish population in the river reach between Merced Falls Dam and Crocker-Huffman Dam (MID 2009; PG&E 2009b). Additional information regarding the movements of fishes in the reservoirs and river reach within the study area and the associated intakes would be useful to meet the study goal.

6.0 Study Methods and Analysis

6.1 Study Area

The study area includes the intakes, powerhouses, and water diversion canals associated with Lake McClure and McSwain Reservoir (P-2179), Merced Falls Reservoir (P-2467), and the river reach between Merced Falls Dam and Crocker-Huffman Dam. The associated P-2179 intakes and powerhouses are described in Tables 5.0-2 and 5.0-3.

If additional Projects' facilities or features are identified during the Relicensing, the study area will be expanded, if necessary, to include these areas. If, at a later time, Licensees proposes activities that are outside of the study area that may affect resources addressed by this study proposal, the study area will be expanded, if necessary, to include these areas.

6.2 General Concepts

The following general concepts apply to the study:

Personal safety is an important consideration of each fieldwork team. If Licensee determines the information cannot be collected in a safe manner, Licensee will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.

Licensee will make a good faith effort to obtain permission to access private property where needed well in advance of performance of the study. If access is not granted or river access is not feasible or safe, Licensee will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.

The schedule for each proposed study is reasonably flexible to accommodate unforeseen problems that may affect the schedule. If a schedule changes, Licensee will notify FERC

and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.

Field crews may make minor modifications to the study proposal in the field to accommodate actual field conditions and unforeseen problems. When modifications are made, Licensee's field crew will follow the protocols in this study proposal. If minor modifications are made, Licensee will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.

Licensee's performance of the study does not presume Licensee is responsible in whole or in part for PM&E measures that may arise from that study.

The estimated level of effort and cost is not a firm commitment by Licensee to expend all the funds. If the study costs more, Licensee is committed to completing the study. If the study costs less, Licensee is not committed to expending the remaining funds on other Relicensing studies or PM&E measures.

Global Positioning System (GPS) data will be collected in a manner that meets or exceeds the federal government's "National Map Accuracy Standards" for published maps. All GPS data will be in the Universal Transverse Mercator (UTM) Coordinate System, using the North American Datum 1983 and stored in Environmental Science Research Institute (ESRI) Shapefile format. After a Shapefile has undergone a quality assurance/quality control (QA/QC) review to Licensee's satisfaction and after all metadata have been documented, Licensee will provide the Shapefile to resource and land management agencies upon request.

6.3 Study Methods

The study methods will consist of the following steps in phases :

Phase I

Step 1 - Review Scientific Literature and Information from Other Relicensing Studies. Relevant entrainment and other studies from the literature, including any relevant studies solicited from Relicensing Participants will be reviewed to determine how fish species in the study area likely utilize the reservoirs and river reach (*e.g.*, movement and habitat preference). Information from Licensee's proposed Water Quality and Reservoir Fish Survey studies will also be considered in the assessment. Additional information regarding CDFG's and Calaveras Trout Farm's fish stocking practices and policies in the study area will also be gathered.

Step 2 - Determine Likelihood of Entrainment. The location of intakes for powerhouses and water diversion canals in the study area, including elevation and flow at different times of the year; will be described. In combination with results of Step 1, the timing of when fish are likely to be in the vicinity of the powerhouse and canal intakes will be determined. In addition, the relationship of approach velocity at the intake to the fishes' ability to avoid entrainment (*i.e.*, swim speed) and other fish habits will be evaluated.

Step 3 – Prepare Report. Licensee will prepare a report that includes the following sections: Study Goals and Objectives; Methods and Analysis; Results; Discussion; and

Description of Variances from the FERC-approved Study Proposal, if any. Licensee plans to make the report available to Relicensing Participants when completed, and ideally in time to be included in the Initial Study Report. The report will be included in Licensee's License Application.

Phase II

Step 1 – Consult with Relicensing Participants. Licensee will review the results of Phase I with Relicensing Participants. If Licensee and Relicensing Participants collaboratively agree that a high likelihood of significant levels of entrainment into one or more powerhouses and/or water canals might occur in the study area, Licensee will conduct entrainment sampling and monitoring at the intakes to the specified powerhouses and/or water canals. The entrainment sampling and monitoring study will utilize hydroacoustics so as to ascertain where the fish go in relation to the various intakes. This would provide more quantitative data as to potential numbers and sizes of fish entrained relative to those that would not become entrained. The hydroacoustic sampling methods are described in Step 2 below, and are similar to the methods identified in the P-2266/P-2310 Fish Entrainment Study 2.3.5 (PG&E and NID 2009).

Step 2 – Conduct the entrainment sampling as described below; analyze results; and do QA/QC of study results. Licensee will install a split-beam sonar device at the diversion or in the intake facility to the diversion from April 15, or as soon as weather permits, through August 15 to monitor the direction fish move (e.g., upstream or downstream in the conduit) and size of fish. Licensee will read and analyze the resulting split-beam sonar record on each sixth day (20 readings) of the recording, and will discuss the results with Relicensing Participants. The entire record will be retained and provided to Relicensing Participants in its raw form upon request. If Licensee and Relicensing Participants collaboratively agree (e.g., if a substantial change in fish movement occurs between adjacent readings) additional portions of the record will be read up to a total of 60 days. License will invite interested Relicensing Participants to one 1-day long meeting prior to commencing work to provide information such as installation configuration and location and data reading protocols. If the hydro-acoustic monitoring system does not cover the entire crosssection of the intake, the data from the area covered will be extrapolated using an appropriate method to estimate fish movement for the entire cross-section of the intake. Based on the data, for each intake Licensee will calculate total number of fish entrained for each reading, and over the 120-day period that entrainment is monitored.

Step 3 – Prepare Report. Licensee will prepare a report that includes the following sections: Study Goals and Objectives; Methods and Analysis; Results; Discussion; and Description of Variances from the FERC-approved Study Proposal, if any. Licensee plans to make the report available to Relicensing Participants when completed, and ideally in time to be included in the Initial Study Report. The report will be included in Licensee's License Application.

6.4 Study Proposal Consultation

The study proposal includes the following study-specific consultation:

Licensee will consult with Relicensing Participants regarding fish stocking programs within the study area.

Licensee and PG&E will consult with Relicensing Participants regarding an entrainment sampling and monitoring study proposal as described in Phase II.

6.5 Schedule

Licensee anticipates the schedule to complete the study proposal is as follows assuming FERC's Study Plan Determination is deemed final on October 20, 2009:

Phase I

Compile/Review Information (Step 1).....January 2010 – June 2010
Assess Potential for Entrainment (Step 2) .....July 2010 – September 2010
Report Preparation (Step 3) .....September 2010 – October 2010

Phase II

Consultation and Phase II Study development (Step 1).....October 2010 – April 2011
Fieldwork (Steps 2) ..... …….April 2011 – September 2011
QA/QC Review (Step 2) ..... October 2011 – November 2011
Report Preparation (Step 3) .....,..... November 2011 – December 2011

6.6 Consistency of Methodology with Generally Accepted Scientific Practices

This study is consistent with the methods used in other FERC hydroelectric relicensing efforts in California, including the Middle Fork Project (FERC Project No. 2079), the Drum-Spaulding Project (FERC Project No. 2310), and the Yuba-Bear Project (FERC Project No. 2266).

7.0 Products

The products from the study will be the study reports described above.

8.0 Level of Effort and Cost

NMFS and CDFG estimate that the cost to complete Phase I of this study in 2009 dollars is between $45,000 and $65,000, based on MID's and PG&E's original study plans (MID 2009; PG&E 2009a; 2009b; PG&E aand NID 2009). NMFS and CDFG estimate that the cost to complete Phase II of this study in 2009 dollars is up to between $350,000 and $875,000, depending on the number and site characteristics of intakes to be sampled. The total cost estimate in 2009 dollars is up to between $395,000 and $940,000,

9.0 References Cited

Merced Irrigation District (MID). 2008. Preliminary Application Document (PAD) for Relicensing of the Merced River Hydroelectric Project, FERC Project No. 2179. November 3, 2008. Available at www.ferc.gov.

MID. 2009. Proposed Study Plan (PSP) for Relicensing of the Merced River Hydroelectric Project, FERC Project No. 2179. April 17, 2009. Available at www.ferc.gov.

Natural Resource Scientists, Inc (NRS). 2007. A Feasibility Investigation of Reintroduction of Anadromous Salmonids above Crocker-Huffman Dam on the Merced River: A Report prepared for the U.S. Fish and Wildlife Service Anadromous Fish Restoration Program.

Pacific Gas and Electric Company (PG&E). 2009a. Preliminary Application Document (PAD) for Relicensing of the Merced Falls Hydroelectric Project, FERC Project No. 2467. February 23, 2009. Available at www.ferc.gov.

PG&E. 2009b. Preliminary Proposed Study Plan (PPSP) for Relicensing of the Merced Falls Hydroelectric Project, FERC Project No. 2467. April 10, 2009. Available at www.ferc.gov.

PG&E and Nevada Irrigation District (NID). 2009. Revised Study Plan No. 2.3.5: Fish Entrainment. PG&E and NID Study Plan for the Yuba-Bear (P-2266)/Drum-Spaulding (P-2310) Relicensing Proceeding. January 2009, Available at: http://www.eurekasw.com/NID/default.aspx.

Revised Study Request 3.4
(3.4 CG rev)

ANADROMOUS FISH PASSAGE

20 December 2009

1.0 Project Nexus and Issue

A federally listed fish species, California Central Valley Steelhead trout DPS (FT), *Oncorhynchus mykiss*, and its designated critical habitat, along with the Central Valley fall/late-run Chinook salmon (*Oncorhynchus tshawytscha*), a listed Species of Concern, occur in the Merced River downstream of the Merced Falls Project.

Current conditions of the fishery in the Merced River for the 3-mile reach between the PG&E's Merced Falls Reservoir and Crocker-Huffman diversion dam and the 19.5 miles downstream of Crocker-Huffman diversion dam to Shaffer Bridge (RM 32.5) are directly affected by project operations (Study Dispute Panel, 2009 a, b)

The Project dam at Merced Falls blocks volitional passage of anadromous fishes, which are able to ascend the Merced River past Crocker-Huffman diversion dam during very limited river conditions (depending largely on flow). This issue was evaluated by the Dispute Resolution Panel for the Merced River Hydroelectric Project studies (Study Dispute Panel, 2009a). The Panel reported that there was evidence in the record that anadromous fish may ascend the Merced River to the Merced Falls Project dam.[6] This evidence includes: 1) some fall chinook salmon may surmount Crocker-Huffman dam during high flows (M. Cozart, pers. comm., 2000; cited in Stillwater Sciences, 2001); 2) presence of anadromous Pacific lamprey above Crocker-Huffman dam; Stillwater Sciences (2008) "assumed that the partially removed fish ladder at Crocker-Huffman provided limited passage for the lamprey observed above the dam"; 3) *O. mykiss* are know to be present upstream of Crocker-Huffman Dam, but were considered by Stillwater Sciences (2008) as "resident" since Crocker-Huffman Dam was presumed to be a migration barrier to most fish species.

Prior to the construction of McSwain Dam (licensed under the current FERC Project License 2179), project works at PG&E's Merced Falls Dam included a fish ladder (FERC

[6] "The above presents a dilemma for the Panel as some information in the record affirms that anadromous fish make it to the lowermost Commission licensed facility on the Merced River but not to the base of McSwain dam. The Panel's logic in addressing the following studies is: 1) flows measured at Shaffer Bridge originate in Lake McClure and pass through McSwain dam, Merced Falls dam and Crocker-Huffman diversion dam; and 2) information in the record suggests that anadromous fish do occur upstream of Crocker-Huffman diversion dam."

Project License 2467)[7].

On November 17, 2009, the California Department of Fish and Game (CDFG, 2009) notified Merced Irrigation District that fish passage at the Crocker-Huffman Diversion Dam must be restored. CDFG directed Merced ID to consult with CDFG to evaluate fish passage at Crocker-Huffman Diversion dam and develop a Crocker-Huffman fish passage plan.[8]

Today, the fish ladder at Merced Falls Dam is non-functional.

Since 1966, Merced Irrigation District's McSwain and New Exchequer dams have totally blocked volitional fish passage since they were constructed without fish bypass facilities

Cumulatively, the dams on the Merced River have eliminated and blocked access to approximately 99% of the river's original spawning and rearing habitats for steelhead trout (*O. mykiss*) (Martin, 2008). Schick *et al.* 2005 estimate that about 92% of fall- and late fall-run Chinook salmon spawning habitat has been eliminated in the Merced River.

The Anadromous Fish Passage study will provide the Resource Agencies with a qualitative and quantitative assessment of potential upstream and downstream anadromous fish migration barriers, including natural barriers and man-made barriers that are not specific to dams.

The Upper River Fish Populations and Habitat study seeks to evaluate habitat for anadromous salmonids upstream of Lake McClure. The Anadromous Fish Passage study seeks to evaluate the accessibility of habitat for anadromous salmonids once they have reached the Merced River upstream of the Lake McClure reservoir pool, recognizing that if they are transported there rather than arriving volitionally, options for the location of their initial release into the upper river may exist. For this element of the present study, it will be assumed that anadromous salmonids are able to reach the upper Merced River upstream of the Lake McClure reservoir pool.

The Anadromous Fish Passage study will develop a fish passage assessment and provide estimates of potential fish passage production utilizing two independent modern salmonid population and habitat models (SHIRAZ-DHSVM and RIPPLE).

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[7] Until 1971, the fish ladder on Merced Falls Dam was operated to allow upstream access for anadromous species; however, operation of this ladder was discontinued in 1971 after the construction of Merced ID's McSwain Dam eliminated upstream spawning upstream spawning habitat and CDFG requested that Merced ID's Crocker-Huffman Irrigation Diversion Dam ladder operation also be discontinued (letter to A.O. Clark, PG&E from A.E. Naylor, CDFG dated March 26 1971; letter to J.F. Roberts Jr., PG&E from K. Plumb, Federal Power Commission dated August 5, 1971)" PG&E (2001a @ page 5-21)". CDFG (2009) notified Merced ID that the Department has determined that fish passage at the Crocker-Huffman Diversion Dam must be restored. CDFG directed Merced ID to consult with CDFG to evaluate fish passage at Crocker-Huffman Diversion dam and develop a Crocker-Huffman fish passage plan.

[8] CDFG (2009)

Finally, this study will evaluate the potential for a trap-and-haul program to move upmigrating anadromous fish from downstream of the Merced Falls project (and perhaps downstream of Merced Irrigation District's Crocker-Huffman diversion dam) to an appropriate location upstream of the Lake McClure reservoir pool, and to move downstream migrants to the lower Merced River.

This study will inform the Resources Agencies and the Commission on the availability of fish passage feasibility options, and provide scientific evidence to demonstrate how the Agencies (and FERC) exercise (and support) the Agencies' Section 18 authority. The data and study will be used to inform the Commission of ESA and MSA consultation and restoration alternative needs for the Merced River projects. The information obtained from this study will be used by PG&E and resource agencies to evaluate the potential effects of the Project on migratory anadromous fish, and will be used to evaluate various management options when balancing resource uses.

This Study Request addresses the following preliminary issues as identified in Section 6 of the Applicant's Pre-Application Document (PAD) (PG&E, 2009a):

- Issue AR-4: Effects of the Project on special status anadromous fishes, including spring- and fall-run Chinook salmon, and steelhead in the Merced River, due to blockage of passage.
- Issue TE-3: Effect of the project on special status fish species.

2.0 Resource Agency and Tribal Management Goals

The Applicant should confer with NMFS, USFWS, SWRCB, CDFG, Tribes, and NGO organizations that participated in development of this revised study request. At this time, the NMFS has identified specific resource management goals and objectives relevant to this revised study proposal (NMFS 2009a; 2009b; 2009c; 2009d, 2009e). CDFG filed a letter with FERC which states the Department's intent to restore fish passage at the Crocker-Huffman Diversion Dam (CDFG, 2009). Southern Sierra Miwuk Nation tribal leaders have indicated that reconnection and restoration of anadromous fish species throughout the Merced River are important Tribal goals for the Merced River (Brochini, pers. comm.). In addition, general management and restoration goals for steelhead trout, fall-run Chinook salmon, and spring-run Chinook salmon have been published (see Martin, 2007 for a summary)[9].

NMFS' (2009e) current steelhead recovery plan for the Merced River states: "a recovery scenario for the Merced River includes the maintenance of a steelhead spawning population in the upper reach of the lower Merced River (and) ... includes the reintroduction of steelhead within Project boundaries and upstream of New Exchequer reservoir on the mainstem Merced River and on the South Fork Merced River."

[9] These plans are also identified in the PG&E PAD (PG&E, 2009a) @ Table 6.4-1 & 6.4.2.

NMFS (2009e) is also concerned with the status and condition of fall- and late fall-run Chinook salmon, whose Merced River population has steeply declined in the last four years. NMFS anticipates that consultation will be necessary under the Endangered Species Act and MSA for the effects of the Merced Falls and Merced River projects on listed steelhead.

3.0 Relevant Public Interest Consideration and Potential License Conditions

The requester is not a resource agency and states the public interest considerations in regard to the proposed study:

Study and analysis is needed to provide data, information, and alternatives to protect and enhance the beneficial uses of the upper Merced River, including coldwater habitat, fisheries, water contact recreation, migration of aquatic organisms, & spawning habitat. Data collected will be used in National Environmental Policy Act (NEPA) environmental impact assessment(s), Water Quality Certification, §401, Clean Water Act, and Federal Power Act § 18 consultation or prescription in the public interest.

Study and analysis is needed to provide data, information, and alternatives to prescription of fishways as deemed necessary to protect threatened populations of fish, under the ESA and Federal Power Act, § 18. The study will serve the public interest by providing information and data to the Secretaries of Commerce and Interior to evaluate alternatives to protect species of concern and threatened anadromous fish species. The study will add to the record that will form the basis for the secretaries to make fisheries management recommendations for the public benefit, enhancing ecosystems that are part of the public trust and recreation in the Merced River and the Pacific Ocean.

The applicant's proposed alternative studies are not sufficient to meet these stated information and data needs, and they are inconsistent with the geographic scope of the Project for anadromous fish issues (FERC, 2009). The applicant is proposing no studies to address anadromous fish passage PG&E, 2009b). The study will be used to inform the Commission and relicensing participants on the feasibility of restoring anadromous fish to the Upper Merced River.

4.0 Study Goals and Objectives

A known effect of the Merced Falls project is that, in conjunction with facilities owned by the Merced Irrigation District, the project blocks passage to fish habitat in the Merced River upstream of Lake McClure. This study will allow relicensing participants to evaluate the effects of the blockage by characterizing and quantifying the potential accessibility by restored salmonids to habitat to which passage is blocked. This significance of the project effect in blocking fish passage cannot be evaluated absent

understanding of the potential accessibility of upstream habitat. A project effect that blocks fish passage to accessible habitat that is usable by anadromous salmonids needs to be mitigated, whereas a project effect that blocks passage to unsuitable or inaccessible habitat might not need to be mitigated.

The objectives of the Study Request are to characterize and quantify the potential accessibility of fish habitat to anadromous fish in the upper Merced River, including the South Fork Merced River and tributaries that are likely to provide spawning and/or juvenile rearing habitat for anadromous salmonids. Study elements will:

- Document the location, nature, and characteristics of natural and man-made barriers to anadromous fish migration in the upper Merced River and its tributaries
- Develop a fish passage assessment model to evaluate various combinations of alternative fish passage program elements and goals for the Merced River.
- Evaluate The feasibility of a "trap and haul" fish bypass alternative to restore Merced River connectivity and to increase dangerously restricted spawning and rearing habitats for Central Valley steelhead trout and for Central Valley Chinook salmon.

5.0 Existing Information and Need for Additional Information

Crocker-Huffman Diversion Dam and Merced Falls Dam have non-functional or partially functional fish ladders, whose use was discontinued with apparent approval by CDFG in the early 1970's. At that time, an artificial spawning channel was constructed by Merced Irrigation District near Crocker-Huffman dam with the intention of benefitting fall- and late fall-run Chinook salmon. (McSwain, 1977). Unfortunately, the spawning channel proved to be non-functional as well, and a mitigation hatchery was constructed during the 1980's (Merced River Hatchery) for fall- and late fall-run Chinook salmon.

The Anadromous Fish Restoration Program (USF&WS, 2002) commissioned a study of the feasibility of reintroduction of anadromous salmonids above the Crocker-Huffman Diversion Dam. The primary objective for this feasibility study was to examine the biological and physical issues associated with re-establishing migratory passage and fish protection at Crocker-Huffman Dam, as well as to investigate the biological production potential of the habitat between Crocker-Huffman and Merced Falls dams for anadromous salmonids. An additional objective was to assess the implications for, and interactions of, such a reintroduction action in conjunction with ongoing and future planned operations of the California Department of Fish and Game's (CDFG) Merced River Hatchery and a private hatchery (Calaveras Trout Farm). The investigation examined the opportunities and constraints of anadromous salmonid reintroduction upstream of Crocker-Huffman Dam. Vogel (2007) found that there were benefits and constraints on providing fish passage above Crocker-Huffman Diversion Dam to improve spawning and rearing habitats for anadromous salmonids.

The opportunities for suitable habitat and conditions in the reach between Merced Falls Dam and Lake McSwain Dam, as well as the reach between Lake McSwain and the New Exchequer Dam, are probably more limited than the reach evaluated in Vogel (2007). At the present time, there are clearly four barriers to volitional anadromous fish migration in the Merced River: a) Crocker-Huffman Diversion Dam (partially operable fish ladder at RM 52), b) Merced Falls Dam (inoperable fish ladder at RM 55), c) McSwain Dam (no fish ladder at RM 56.1), and d) New Exchequer Dam (no fish ladder at RM 62.4). One historic fish blockage, the Cascade Diversion Dam on the mainstem of the Merced River near Yosemite Valley, was removed in 2003 by the National Park Service.

Although the reach between Merced Falls Dam and Crocker-Huffman Diversion Dam may have limited opportunities to create "tailwater" *O. mykiss* habitat for spawning and rearing, fish passage past Crocker-Huffman Diversion Dam and Merced Falls Dam is technically relatively simple, while passage past McSwain Dam (and reservoir) and New Exchequer Dam (and reservoir) are serious and formidable challenges. However, without the Merced River Hydroelectric Projects in place, anadromous fish passage could be achieved with relative simplicity by simply making existing fish ladders at Crocker-Huffman and Merced Falls dams operational (short term) or reconstructing them if necessary (long term) to modern standards. Further, but for the Merced River Hydroelectric Projects, there would be less available water to divert (only by the Crocker-Huffman Diversion Dam, which was the historic condition prior to 1925), and the Merced River would return to a more natural "run-of-the-river" hydrology, which would improve connectivity and habitat quantity/quality for steelhead trout.

There is a 25-ft water waterfall/cascade on the mainstem near the North Fork at RM 86 (Stanley and Holbek 1984) that is a mandatory portage for small watercraft, but based on historical accounts it was probably not enough of a barrier to have posed a meaningful obstacle to migration of anadromous salmonids. Further evaluation of the degree to which this waterfall would or could prevent upstream passage of anadromous salmonids is needed. Evaluation of other, less formidable natural barriers in the Merced River and its tributaries upstream of Lake McClure is needed to quantify the amount of habitat that would be available to anadromous fish once they reached the current of upper Merced River and its tributaries, and to inform decisions relating to location of possible release and capture facilities in a trap-and-haul program, which may rely, in part, on the availability of road access to areas with river flow.

Information and data is lacking on the potential for restoration of anadromous species in the upper Merced River. There is no known study of fish passage past natural or man-made barriers in the upper Merced River, and there has been no study of the feasibility of a trap-and-haul program to restore anadromous salmonids to the upper Merced River.

6.0 Study Methods and Analysis

6.1 Study Area

An investigation of natural and man-made barriers will be made in the mainstem of the Merced River upstream of Lake McClure and selected tributaries, from the Highway 49 Bridge crossing of the upper end of Lake McClure at Bagby to Yosemite Valley, and in the South Fork of the Merced River and selected tributaries from the mouth to four miles downstream of Wawona. The SHIRAZ or Ripple Model will encompass the same geographic area. The analysis of trap-and-haul options will include consideration of this same geographic area upstream of Bagby, but will additionally include the Merced River, and all reservoirs that are located on the river, from upstream-most end of Lake McClure at full pool downstream to Snelling at RM 49.

The study area is consistent with the Commission's SD2 determination of geographic scope (FERC, 2009) for threatened and endangered species.

6.2 General Concepts

The following general concepts apply to the study:

- Personal safety is an important consideration of each fieldwork team. If Applicant determines the information cannot be collected in a safe manner, Applicant will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.
- Applicant shall make a good faith effort to obtain permission to access private property where needed well in advance of performance of the study. If access is not granted or river access is not feasible or safe, Applicant will notify FERC and Relicensing Participants as soon as possible via email to determine if Relicensing Participants can assist in gaining access or to discuss alternative approaches to perform the study.
- The schedule for each proposed study is reasonably flexible to accommodate unforeseen problems that may affect the schedule. If a schedule changes, Applicant will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.
- Field crews may make minor modifications to the study proposal in the field to accommodate actual field conditions and unforeseen problems. When modifications are made, Applicant's field crew will follow the protocols in this study proposal. If minor modifications are made, Applicant will provide a detailed description of the conditions that led to the decision to modify the study to FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.
- Applicant's performance of the study does not presume Applicant is responsible in whole or in part for resource management measures that may arise from that study.
- The estimated level of effort and cost is not a firm commitment by Applicant to expend all the funds. If the study costs more, Applicant is committed to completing

the study. If the study costs less, Applicant is not committed to expending the remaining funds on other Relicensing studies or resource management measures.

- Field crews will be trained as appropriate to identify all special-status amphibians, reptiles, and fish that may be encountered coincidentally. Training will include instruction in diagnostic features and habitat associations of special-status species. Field crews will also be provided with laminated identification sheets showing special-status species, compared to other common species.
- All special-status species observations will be submitted to the California Natural Diversity Database.
- Field crews will include a list of native and non-native species that may be encountered using the sampling methods described in the plan and their State and Federal (if any) status. Crews will make sure there are codes for all these species on the data forms.

6.3 Study Methods

Step 1 – Identify and Qualitatively Assess Potential Upstream and Downstream Anadromous Fish Species' Migration Barriers. This investigation will be made in the mainstem of the Merced River upstream of the Highway 49 Bridge crossing of Lake McClure and selected tributaries, and in the South Fork of the Merced River and selected tributaries. In this step, Applicant will identify potential barriers (e.g., natural falls, tributary junctions, road crossings, shallow riffles, and diversions or dam structures) for steelhead trout and Chinook salmon.

From early and late winter flow conditions (coincidental with steelhead trout and spring-run Chinook salmon spawning migration) and spring/early summer conditions (smolt passage and spring-run Chinook salmon), the areas of the streams tributary will be examined for all adult anadromous fish barriers or to 0.5 mile upstream from the confluence with the the Merced River or its South Fork, whichever is less. To perform the work, Applicant will determine if fish barriers in the study area have already been assessed. If so, the assessment will be summarized (*e.g.*, barrier type, fall height, plunge pool depth, photographs, field biologist observations). If not, Applicant will use existing field mapping, aerial photographs and the Projects' helicopter video to examine the tributaries. If these sources provide adequate coverage, the potential for barriers will be summarized including pertinent photographs. If existing material is not adequate, Applicant will visit the tributary to perform the assessment. Appropriate photographs and descriptions, including GIS location, will be made for all sites visited (*e.g.*, description of the confluence; and location, fall height, plunge pool depth, and description and photographs of any potential fish barriers). In this step, Applicant will use best professional judgment in identifying a potential barrier to upstream and downstream migrations of anadromous fish species.

Step 2 – Consult with relicensing participants. In this step, Applicant will consult with relicensing participants regarding the results of Step 1, and in particular identify any potential barriers to upstream or downstream movements of anadromous fish species,

along with a summary of the recommendations and opinions of agencies and tribe consultations found in

Step 3 – Quantitative Fish Barrier Study. If there are substantive qualitatively identified potential barriers to anadromous fish migration, quantitative assessments will be done, including the following:

- Determination of jump heights and plunge pool depth at barriers;
- Development of a simple hydraulic model to assess stage discharge relationships in mainstem rivers at tributary confluences.•

The following additional information will be employed as method(s) in which to conduct the quantitative assessment:

- Leaping and swimming capabilities of the fish based on the literature (Powers and Orsborn 1985; Hoar and Randall 1978; and Bell 1991) and fish size and water temperature information from the Fish Population Technical Study Plan and the Water Temperature Modeling Study Plan;
- Physical and hydraulic characterization of potential barriers based on measurements from the field;
- Fish passage assessment methodology outlined in Powers and Orsborn (1985) and Thompson (1972) modified, where necessary, for the specific species (e.g., trout, salmon).

Seasonal and annual flow monitoring will be included in the assessment to characterize the seasonality, magnitude, and frequency of flows at the barrier over a range of the two water years.

Step 4 – Develop a fish passage assessment model that incorporates variables to represent fish passage program conditions and interactions. The model will provide a prediction or estimate of the abilities of Chinook salmon or steelhead trout to ascend reaches of the upper Merced River that may have full, partial, or no impediment to spawning migration, if those species are introduced into the upper Merced River.

Two Salmonid population and habitat models have been proven useful in evaulating fish passage suitability: a) "Salmon Habitat Integrated Resource Analysis model (SHIRAZ; Scheuerell *et al*., 2006) in combination with the Distributed Hydrology Soil Vegetated Model (DHSVM; Bartz *et al*, 2006) and b) the RIPPLE Population Model (Stillwater Sciences, 2006).

The SHIRAZ model is a mechanistic model that uses: 1) user-defined stock(s) and associated life-history trajectories; 2) a network of user-defined spatial units (e.g. reaches or sub-watersheds); 3) the initial and final time step (i.e., year) for the simulation; 4) a set of habitat indicators represented in functional relationships that affect fish survival; 5) the initial number of individuals alive at each life stage for each stock and the proportion of each life stage occupying each spatial unit; 6) a matrix of movement probabilities to realistically represent downstream migration patterns (the SHIRAZ model structure

allows the user to specify these constants or rely on ideal free distribution theory); 7) stray rates to non-natal reaches/sub-watersheds; 8) age-specific maturation rates; 9) and a harvest strategy that can be either a constant escapement goal or constant exploitation rate (Bartz, *et al*., 2006; Scheuerell, *et al*., 2006).

The RIPPLE Population Model (Stillwater Sciences, 2006) is a GIS-based model that initiates with a with geology model, upon which a habitat module including aquatic features relating to fisheries habitat. A fish population model is then placed over the previous model features, which then produces the number of fish that would be supported under the prescribed conditions. In this approach, a carrying capacity and density-independent mortality for each life stage, estimated from field data or literature, are used to develop life-stage-specific stock-production relationships. The model identifies critical life-stages, and compares relative changes in population size between alternative management scenarios (e.g., various instream flows, fish passage, potential enhancements). The model also serves as a framework for integrating available data and can either be used predicatively or as a means of identifying critical data gaps.

The SHIRAZ model is being used extensively by NMFS in the northwestern states, including Washington and Oregon. The RIPPLE model has been employed in Rock Creek, Umpqua Basin Oregon. Either model can be used to inform the Commission and relicensing participants of potential changes in existing populations under alternative management scenarios (habitat enhancements, fish passage) or environmental condition (instream flows). The models integrate environmental conditions (instream flows, passage, life-histories) to assess fish population success, under different environmental scenarios.

The choice of models shall be made in consultation with Resource Agencies and relicensing participants. Criteria for model selection should include a) assessment of suitable data inputs from upper Merced River; b) acceptance by relicensing participants; and c) applicability of model outputs to inform the Commission and relicensing participants. The information and results of the model simulations can be used by Resources Agencies to plan and evaluate restoration actions in ESA recovery plans, in environmental assessments under NEPA, and under Section 18 of the Federal Power Act.

Step 5– Evaluate the feasibility of a "trap and haul" program on the Merced River, Identify possible locations and conceptual design for facilities and operations to provide upstream and downstream migration of steelhead trout and Chinook salmon. Evaluate upstream spawning adult capture and release, and downstream juvenile smolt migrant capture and release.

Step 6 – Consult with Relicensing Participants Regarding Quantitative Fish Barrier, Fish Passage Assessment Model, and "Trap and Haul" or other alternatives. Applicant will consult with Relicensing Participants regarding Steps 3 through 5. The Agencies and Tribe will judge the adequacy of the study information and recommendations; where indicated, the participants will evaluate the adequacy of data and data collection, data presentation, and QA/QC,

Step 7 – Prepare Report. - Applicant will prepare a report that includes the following sections: 1) Study Goals and Objectives; 2) Methods and Analysis; 3) Discussion; and 4) Description of Variances from the FERC-approved study proposal, if any. Data will be provided on CD in Microsoft Excel spreadsheets. Applicant will make the report available to relicensing participants when completed. The report will be included in the License Application as appropriate. Besides the reports described above, the study results will be displayed in Geographic Information System (GIS) maps that show locations of any identified potential barriers to upstream or downstream anadromous fish species movement.

6.4 Consultation and Communication

This study proposal includes two study-specific agency and tribe consultations:

- Consult with Agencies and Tribe regarding potential upstream and downstream migration barriers in the mainstem and South Fork, Merced River (Step 2).
- Consult with Agencies and Tribe regarding Quantitative Fish Barrier Study (Step 3); Fish Passage Assessment Model (Step 4), and "Trap and Haul" or other alternatives (Step 6).

Applicant will file with FERC and post on its Relicensing Website periodic reports as required by the FERC in the Study Plan Determination. Applicant will coordinate with FERC and other relicensing participants as described in Steps 2 and 6.

6.5 Schedule

The schedule to complete the study proposal is:

Mainstem Migration Barrier Assessment (Step 1).....April-May & November 2010
Consultation (Step2).....……. October 2010 – December, 2010
Quantitative Fish Barrier Study (Step 3)…….….April-May & November 2011
Fish Passage Assessment Model (Step 4)……..…..April through September 2010
Trap and Haul feasibility (Step 5).…….……....….April through September 2010
Consult with relicensing participants on steps 3 thru 6 (Step 6)…….September 2011
Report Preparation (Step7).....……...September – December 2011

It is anticipated that the study will be completed in December 2011.

6.6 Consistency of Methodology with Generally Accepted Scientific Practices

Mainstem Migration Barrier Assessment (Step 1) & Quantitative Fish Barrier Study (Step 3) are consistent with those used in recent relicensings in California (e.g., Yuba Bear Fish Passage Study 2.3.4 http://www.eurekasw.com/NID/default.aspx). Fish Passage Assessment Model (Step 4) to develop feasibility of restoration alternatives under changing environmental scenarios has been used by Resource Agencies in development of recovery strategies for depleted anadromous fish (Bartz *et al*, 2006). Trap and Haul (Step 5) study is an assessment of options, constraints, and feasibility of restoration of fish passage in the upper Merced River; trap and haul is used in the Pacific Northwest to provide passage for anadromous salmonids to otherwise inaccessible habitat upstream of dams.

This study is consistent with the goals, objectives, and methods outlined for recent FERC hydroelectric relicensing studies in California, and uses well-recognized scientific methodologies and protocols from US Fish & Wildlife Service, California Department of Fish and Game, and National Marine Fisheries Service.

7.0 Products

After data are collected, tabulated, and quality checked the data will be made available to the Relicensing Participants in an Excel format or other format as appropriate.

Products will include but not be limited to the following:

An overall Projects Report will be prepared. Data will be provided on CD in Microsoft Excel spreadsheets. Besides the report, the study results will be displayed in Geographic Information System (GIS) maps that show locations of any identified potential barriers to upstream or downstream anadromous fish species movement.

8.0 Level of Effort and Cost

A preliminary estimate for the study cost in 2010 dollars is as follows:

2010 Cost Estimate Based upon Efforts and Costs of study elements

Step in Study	**Study Task**	**Estimate person time**	**Cost**
Step 1	**Field Survey of Barriers in River**	**6 person-months**	**$45,000**
Step 2	**Consultation process**	**1/2 person-months**	**$ 4,000**
Step 3	**Quantitative fish barrier study (collaboratively determined)**	**18 person- months**	**$135,000**
Step 4	**Fish passage assessment model**	**14 person-months**	**$105,000**

Step 5	**Trap and Haul / Alternatives / Facilities Operation**	**12 person-months**	**$85,000**
Step 6	**Consult with relicensing participants**	**½ person month**	**$5,000**
Step 7	**Report Preparation**	**6 person-months**	**$45,000**
	TOTAL STUDY COST		**$424,000**

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Study 3.6

SALMONID FLOODPLAIN REARING

July 16, 2009

1.0 Project Nexus

Operation of the Merced River Project includes the impoundment of the Merced River into Lake McClure Reservoir (approx. 1 million acre-feet), and the subsequent controlled release of impounded waters through the New Exchequer Powerhouse to downstream power and diversion facilities. This operation results in direct, indirect, and cumulative impacts to the aquatic resources of the lower Merced River, including native anadromous salmonid fishes and their habitat.

Merced Irrigation District (Merced ID) listed in its Pre-Application Document (PAD) Section 6.3.2.2 several instream flow agreements below Crocker-Huffman Diversion Dam. All of these agreements will expired before or soon after the existing Merced ID FERC Project No. 2179 license expires in 2014. Most of these instream flow agreements are used to study various anadromous fish life stages below Crocker-Huffman Diversion Dam and are critical for understanding instream salmonid habitat usage at different life stages. Different salmonid life stages require different habitat and instream flow regimes and providing the scientific research flows is a necessary requirement of many of the on-going studies.

Anadromous salmonids in the Merced River below Crocker-Huffman Diversion Dam include steelhead (*Oncorhynchus mykiss)* and Chinook salmon (*Oncorhynchus tshawytscha).* Both adult and juvenile migrations of these species are being studied and continuation of these scientific studies (and the associated instream flow requirments below Crocker-Huffman Diversion Dam.), should be incorporated into the FERC relicensing process. It is important to note that critical salmonid life stages are not limited to the migration period. Other life stages, including egg fry and non-migratory juveniles have had no or very limited studies conducted on the Merced River to date. Rearing habitat for fry and juvenile is a critical factor to ensure survival of salmonid until they migrate to ocean. Scientific studies on salmonid floodplain rearing requirements must be conducted to provide federal and state resource agencies necessary information to ensure the survival of anadromous fish on Merced River.

2.0 Resource Agency Management Goals

The resource agency management goals for the Merced River Project include, but are not limited to, the following:

- Restoring disturbed or altered habitat for all life stages of native fish species including fish spawning and fish passage habitat.

- Protecting, conserving, enhancing and recovering native anadromous fishes and their habitats by providing access to suitable habitats and by restoring fully functioning habitat conditions.

- Maintaining, enhancing and restoring all life stages of native aquatic species by ensuring connectivity between Project-affected stream reaches and between Project reservoirs.

- Maintaining, recovering and restoring streamflow regimes sufficient to sustain desired conditions of native riparian and aquatic habitats in Project-affected stream reaches.

- Identifying and implementing measures to protect, mitigate or minimize direct, indirect and cumulative impacts to, and enhance native anadromous fish resources, including relate

- Maintaining, recovering, and restoring riparian resources, channel condition, and aquatic habitat.

- Maintaining, recovering, and restoring streamflow regime sufficient to sustain desired conditions of native riparian, aquatic, wetland, and meadow habitats.

- Protecting aquatic systems to which species are uniquely adapted.

3.0 Potential License Conditions

Water operation modifications to provide instream flow below Crocker-Huffman Dam to support scientific studies of salmonid rearing within the Merced River floodplain.

5.0 Study Goals and Objectives

Table 1 provides the target species and its life stage.

Table 1. Target species and life stages to be analyzed.

Species	Lifestage
Oncorhynchus mykiss (Steelhead Rainbow trout)	Juvenile Fry
Oncorhynchus tshawytscha (Fall-run Chinook salmon)	Juvenile Fry

The goals of the study are:

- To determine whether flows that inundate floodplains, thereby affecting fry rearing during February and/or March, are critical to the production of smolt-sized outmigrants from the Merced River.

- To identify differences in health, feeding and growth of juvenile salmonids that use the floodplain habitats versus those using main channel of the rivers.
- To determine whether a combination of stressors affects the survival of fry to a smolt size or if survival is primarily improved by managing instream flow.

6.0 Existing Information and Need for Additional Information

The existing information includes:

- Rotary Screw Trap (RST) data at both Hopeton and near confluence with San Joaquin River
- Adult salmon abundance monitoring (escapement survey)

The additional information needed includes but is not limited to:

- Steelhead abundance information both in adult and juvenile
- Floodplain usage by fry and juvenile
- Extension of RST survey period
- Analysis of RST data during February and March

6.0 Study Methods and Analysis

6.1 Study Area

The study area includes the lower Merced River between the Crocker-Huffman Diversion Dam (RM 52.0) and the confluence with San Joaquin River (RM 0).

6.2 General Concepts

The following general concepts apply to this study:

- Personal safety is an important consideration of each fieldwork team. If Licensees determine the information cannot be collected in a safe manner, Licensees will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.

- Licensees shall make a good faith effort to obtain permission to access private property where needed well in advance of performance of the study. If access is not granted or river access is not feasible or safe, Licensees will notify FERC and Relicensing Participants as soon as possible via email to determine if Relicensing Participants can assist in gaining access or to discuss alternative approaches to perform the study.

- The schedule for each proposed study is reasonably flexible to accommodate unforeseen problems that may affect the schedule. If a schedule changes, Licensees will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.

- Field crews may make minor modifications to the study proposal in the field to accommodate actual field conditions and unforeseen problems. When modifications are made, Licensees' field crew will follow the protocols in this study proposal. If minor modifications are made, Licensees will provide a detailed description of the conditions that led to the decision to modify the study to FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.

- Licensees' performance of the study does not presume Licensees are responsible in whole or in part for resource management measures that may arise from that study.

- The estimated level of effort and cost is not a firm commitment by Licensees to expend all the funds. If the study costs more, Licensees are committed to completing the study. If the study costs less, Licensees are not committed to expending the remaining funds on other Relicensing studies or resource management measures.

- All special-status species observations will be submitted to the California Natural Diversity Database.

6.3 Study Methods

The general study methods are included (not necessarily in the order shown):

- Implement an experimental flow schedule designed to test the relative importance of the magnitude and duration of February and March pulse flows in combination with elevated spring pulse flows (3 steps with both varying between 1,000 to 4,000 cfs). The actual flow schedules should be developed by MID in consultation with CDFG, USFWS and NOAA.

- Annually monitor the abundance juvenile salmonid with RST near the downstream boundary of the spawning reach from January 1 to June 15. Calibration tests should be conducted every 7 to 14 days depending on the availability of naturally produced juveniles or hatchery reared juveniles.

- Annually monitor the abundance of smolt outmigrants with RST near the confluence with San Joaquin River from January 1 to June 15. Calibration tests should be conducted every 7 to 14 days depending on the availability of naturally produced juveniles or hatchery reared juveniles.

- Monitor the abundance of adult salmon by continuing the California Department of Fish and Game (CDFG) carcass surveys.

- To estimate the importance of predation on fry parr and smolt, a combination of electrofishing, gill netting, and angling (lures that simulate the appropriately sized juvenile salmonid) should be utilitzed to determine (a) the fish species that prey on juvenile salmonid by examining their stomach contents and (b) the habitats where predation is occurring during February and March over a range of Critical, Dry, Below-Normal, Above-Normal, and Wet water year types.

- To evaluate the importance of food availability, contaminants, smoltification timing, and disease as potential mechanisms of smolt mortality, by collecting a total of 360 juvenile salmon on a weekly basis from March 1 through June 15 over the next four years with RST (main channel use) and seines (floodplain use) for physiological, histological, and disease analyses.

    - If this evaluation shows sign of toxic insult, then a bioassay lab should be established on the Merced River.
    - If this evaluation shows that food availability for juvenile fish may be a limiting factor, studies should be conducted to evaluate whether food resources are primarily aquatic or terrestrial and to compare allochthonous production, autochthonous production, and prodction from within McClure and McSwain reservoir (planktonic).

6.4 Products

- Salmonid floodplain usage reports
- Rotary Screw Trap reports
- Juvenile Chinook salmon migration health assessment reports

6.5 Consultation and Communication

Licensees will file with FERC and post on its Relicensing Website periodic reports (annual and semi annual reports) as required by the FERC in the Study Plan Determination.

Licensees will coordinate with FERC and other Relicensing Participants as described in Section 6.2.

The Licensees will collaborate with the Relicensing Participants on the following items:

- Detailed study methods
- Sites selection
- Obtain proper scientific collecting permits from federal and state agencies
- Analysis methods

6.6 Schedule

The salmonid floodplain rearing study should be conducted 2010 - 2014.

7.0 Consistency of Methodology with Generally Accepted Scientific Practices (18 CFR 5.9(b)(6))

The study methods discussed above are consistent with the general accepted scientific practices studying salmonid species in many other river systems within California and other states.

8.0 Considerations of Level of Effort and Cost (18 CFR 5.9(b)(7))

The preliminary cost estimate for the study is $500,000 annually.

9.0 References

Mesick, C., McLain, J., Marston, D. and T. Heyne, February 27, 2007, *DRAFT* Limiting Factor Analyses & Recommended Studies for Fall-run Chinook Salmon and Rainbow Trout in the Tuolumne River.

Study 3.7

CHINOOK SALMON EGG VIABILITY

July 16, 2009

1.0 Project Nexus

Operation of the Merced River Project includes the impoundment of the Merced River into Lake McClure Reservoir (approx. 1 million acre-feet), and the subsequent controlled release of impounded waters through the New Exchequer Powerhouse to downstream power and diversion facilities. This operation results in direct, indirect, and cumulative impacts to the aquatic resources of the lower Merced River, including native anadromous salmonid fishes and their habitat.

Merced Irrigation District (Merced ID) listed in its Pre-Application Document (PAD) Section 6.3.2.2 several instream flow agreements below Crocker-Huffman Diversion Dam. According to California Department of Fish and Game (CDFG)/Merced ID Memorandum of Understanding, the October flow is 12,500 ac-ft. This October flow is critical to attract Chinook salmon into Merced River.

Improving the viability of salmon egg will improve the survival of the Chinook salmon at the southern most tributaries within California Central Valley. However, very little is known about controllable factors which influence viability of salmon eggs on the Merced River. In order for state and federal resource agencies to make informed management decisions designed to improve survival of Chinook salmon, more information on egg viability must be gathered.

2.0 Resource Agency Management Goals

The resource agency management goals for the Merced River Project include, but are not limited to, the following:

- Restoring disturbed or altered habitat for all life stages of native fish species including fish spawning and fish passage habitat.

- Protecting, conserving, enhancing and recovering native anadromous fishes and their habitats by providing access to suitable habitats and by restoring fully functioning habitat conditions.

- Maintaining, enhancing and restoring all life stages of native aquatic species by ensuring connectivity between Project-affected stream reaches and between Project reservoirs.

- Maintaining, recovering and restoring streamflow regimes sufficient to sustain desired conditions of native riparian and aquatic habitats in Project-affected stream reaches.

- Identifying and implementing measures to protect, mitigate or minimize direct, indirect and cumulative impacts to, and enhance native anadromous fish resources, including relate

- Maintaining, recovering, and restoring riparian resources, channel condition, and aquatic habitat.

- Maintaining, recovering, and restoring streamflow regime sufficient to sustain desired conditions of native riparian, aquatic, wetland, and meadow habitats.

- Protecting aquatic systems to which species are uniquely adapted.

3.0 Potential License Conditions

Water operation modifications to provide fall pulse flows below Crocker-Huffman Dam.

7.0 Study Goals and Objectives

This study targets *Oncorhynchus tshawytscha* (Fall-run Chinook salmon) females with developing eggs as well as the egg stage itself.

The goals of the study are:

- To determine whether elevated fall pulse flows improve egg viability and minimize straying of early arriving adult salmon.

8.0 Existing Information and Need for Additional Information

The existing information includes:

- Coded Wire Tag (CWT) data collected on Merced River
- CDFG escapement survey data
- Bay Delta water quality and fall export rates

The additional information needed:

- Chinook salmon pre-spawned mortality
- Viability of eggs
- Temperatures on migration path in relevant time line.

6.0 Study Methods and Analysis

6.1 Study Area

The study area includes the lower Merced River between the Crocker-Huffman Diversion Dam (RM 52.0) and confluence with San Joaquin River (RM 0).

6.2 General Concepts

The following general concepts apply to this study:

- Personal safety is an important consideration of each fieldwork team. If Licensees determine the information cannot be collected in a safe manner, Licensees will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.

- Licensees shall make a good faith effort to obtain permission to access private property where needed well in advance of performance of the study. If access is not granted or river access is not feasible or safe, Licensees will notify FERC and Relicensing Participants as soon as possible via email to determine if Relicensing Participants can assist in gaining access or to discuss alternative approaches to perform the study.

- The schedule for each proposed study is reasonably flexible to accommodate unforeseen problems that may affect the schedule. If a schedule changes, Licensees will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.

- Field crews may make minor modifications to the study proposal in the field to accommodate actual field conditions and unforeseen problems. When modifications are made, Licensees' field crew will follow the protocols in this study proposal. If minor modifications are made, Licensees will provide a detailed description of the conditions that led to the decision to modify the study to FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.

- Licensees' performance of the study does not presume Licensees are responsible in whole or in part for resource management measures that may arise from that study.

- The estimated level of effort and cost is not a firm commitment by Licensees to expend all the funds. If the study costs more, Licensees are committed to completing the study. If the study costs less, Licensees are not committed to expending the remaining funds on other Relicensing studies or resource management measures.

- All special-status species observations will be submitted to the California Natural Diversity Database.

6.3 Study Methods

The general study methods are included (not necessarily in the order shown):

- Evaluate straying rates of CWT smolts that were released in the Merced River and recovered in Central Valley adult escapement surveys relative to pulse flow releases, Delta water quality, and fall export rates.
- Evaluate egg viability at the Merced River Hatchery relative to tributary and Delta water temperatures. The migration history of individual females will need to be evaluated to determine the temperature exposure.
- Evaluate pre-spawn mortality surveys in the Merced River relative to pulse flow releases. This would require the CDFG carcass survey crews to collect the eggs from a number of adult female carcasses and then count the eggs following the surveys. Relationships would be evaluated between the timing and occurrence of fall pulse flows and the number of eggs retained per female.

6.4 Product

Chinook salmon egg viability report on Merced River

6.5 Consultation and Communication

Licensees will file with FERC and post on its Relicensing Website periodic reports (annual and semi annual reports) as required by the FERC in the Study Plan Determination.

Licensees will coordinate with FERC and other Relicensing Participants as described in Section 6.2.

The Licensees will collaborate with the California Department of Fish and Game on obtaining escapement data, and provide detailed analysis methods to Relicensing Participants.

6.6 Schedule

The salmonid floodplain rearing study should be conducted 2010 - 2012.

7.0 Consistency of Methodology with Generally Accepted Scientific Practices (18 CFR 5.9(b)(6))

The study methods discussed above are consistent with the general accepted scientific practices studying salmonid species in many other river systems within California and other states.

8.0 Considerations of Level of Effort and Cost (18 CFR 5.9(b)(7))

The preliminary cost estimate for the study is $80,000 annually.

10.0 References

Mesick, C., McLain, J., Marston, D. and T. Heyne, February 27, 2007, *DRAFT* Limiting Factor Analyses & Recommended Studies for Fall-run Chinook Salmon and Rainbow Trout in the Tuolumne River.

Appendix A
Revised Study 3.8

INSTREAM FLOW STUDY[1]

15 December 2009

1.0 Projects Nexus

Operation of the Merced River (P-2179) and Merced Falls (P-2467) Projects (Projects) includes the impoundment of the Merced River into Lake McClure Reservoir (approx. 1 million acre-feet), and the subsequent controlled release of impounded waters through the New Exchequer Powerhouse to downstream power and diversion facilities. This operation results in direct, indirect, and cumulative impacts to the aquatic resources of the lower Merced River from Lake McClure downstream to the confluence with the San Joaquin River, including native anadromous salmonid fishes and their habitat.

Additionally, the licensee proposes to move the point of compliance for lower Merced River instream releases nearly 24 miles upstream from the existing compliance point. Articles 40 and 41 of the existing license establish minimum instream release requirements for the lower Merced River, and they specify that compliance is to be determined at the Shaffer Bridge (RM 32.5). However, in section 9.3.2 of the Pre-Application Document (PAD), the licensee proposes to eliminate license articles 40 and 41, and in section 9.2.2 of the PAD, the licensee proposes to set the flow measurement point of compliance at McSwain Dam (RM 56.1).

This instream flow study will estimate the habitat versus flow relationships in four subreaches in the lower Merced River between the Crocker-Huffman Dam (RM 52.0) and the confluence with the San Joaquin River using the Physical Habitat Simulation system (PHABSIM). The study results, along with other information, will be used to develop minimum instream flow requirements for the lower Merced River. The study results will also be used to evaluate the effect of changing the point of compliance from the Shaffer Bridge to McSwain Dam.

2.0 Resource Agency Management Goals

The resource agency management goals for the Merced River Projects include, but are not limited to, the following:

- Restoring disturbed or altered habitat for all life stages of native fish species including fish spawning, fish passage, and both adult immigration and juvenile (smolt size) outmigration corridor habitat.

- Protecting, conserving, enhancing and recovering native anadromous fishes and their habitats by providing access to suitable habitats and by restoring fully functioning habitat conditions.
- Maintaining, enhancing and restoring all life stages of native aquatic species by ensuring connectivity between Projects-affected stream reaches and between Projects reservoirs.

[1] NMFS has edited this Revised Study Plan, previously submitted under P-2179, to encompass both the P-2179 and P-2467 Projects, as MID operates both Projects as an integrated complex.

- Maintaining, recovering and restoring streamflow regimes sufficient to sustain desired conditions of native riparian and aquatic habitats in Projects-affected stream reaches.

- Identifying and implementing measures to protect, mitigate or minimize direct, indirect and cumulative impacts to, and enhance native anadromous fish resources, including relate

- Maintaining, recovering, and restoring riparian resources, channel condition, and aquatic habitat.

- Maintaining, recovering, and restoring streamflow regime sufficient to sustain desired conditions of native riparian, aquatic, wetland, and meadow habitats.

- Protecting aquatic systems to which species are uniquely adapted.

3.0 Potential License Conditions

The study results, along with other information, will be used to develop minimum stream flow requirements for the lower Merced River. Development of protection, mitigation and enhancement measures is not part of this study.

4.0 Study Goals and Objectives

The overall goal of the study is to evaluate the relationship between flow and fish habitat in the lower Merced River between the Crocker-Huffman Dam (RM 52.0) and the confluence with the San Joaquin River using PHABSIM modeling. The target species and lifestage for this study include the following:

Table 1. Target species and life stages to be analyzed.

Species	Lifestage
Oncorhynchus mykiss (Steelhead Rainbow trout)	Adult Juvenile (inc, smolt outmigration) Fry Spawning
Oncorhynchus tshawytscha (Fall-run Chinook salmon)	Adult Juvenile (inc. smolt outmigration) Fry Spawning
Mylopharodon conocephalus (Hardhead)	Adult Juvenile
Pogonichthys macrolepidotus (Sacrament splittail)	Adult Juvenile

The study results will also be used to evaluate the effect to fish and other aquatic resources of changing the flow measurement compliance point from the Shaffer Bridge to McSwain Dam.

5.0 Existing Information and Need for Additional Information

The PAD does not identify any previous instream flow studies conducted in the lower-Merced River. However, the resource agencies are aware of several previous instream flow studies, including a 1994 study of salmon spawning habitat conducted by CDFG, and a 2000-2002 study conducted by the US FWS of habitat restoration sites. However, it is unclear whether this information is sufficiently complete and/or suitable for use in this study effort.

To achieve the study goals, information that is needed includes but is not limited to:

- Preparation of habitat mapping of the lower-Merced River
- Selection of PHABSIM study sites and 1-D transect locations
- Development of site-specific habitat suitability criteria for target species and lifestages
- Field measurement of physical parameters required for PHABSIM modeling
- Calibration of PHABSIM hydraulic models
- Development of flow versus habitat relationships using PHABSIM modeling

6.0 Study Methods and Analysis

6.1 Study Area

The study area includes the lower Merced River between the Crocker-Huffman Dam (RM 52.0) and the confluence with the San Joaquin River. There are four PHABSIM subreaches within the study area, including:

- Crocker-Huffman to the Snelling Road Bridge;
- Snelling Road Bridge to the Highway 59 Bridge; and
- Highway 59 Bridge to Shaffer Bridge;
- Shaffer Bridge to confluence with San Joaquin River

6.2 General Concepts

The following general concepts apply to this study:

- Personal safety is an important consideration of each fieldwork team. If Licensees determine the information cannot be collected in a safe manner, Licensees will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.
- Licensees shall make a good faith effort to obtain permission to access private property where needed well in advance of performance of the study. If access is not granted or river access is not feasible or safe, Licensees will notify FERC and Relicensing Participants as soon as possible via email to determine if Relicensing Participants can assist in gaining access or to discuss alternative approaches to perform the study.
- The schedule for each proposed study is reasonably flexible to accommodate unforeseen problems that may affect the schedule. If a schedule changes, Licensees will notify FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.

- Field crews may make minor modifications to the study proposal in the field to accommodate actual field conditions and unforeseen problems. When modifications are made, Licensees' field crew will follow the protocols in this study proposal. If minor modifications are made, Licensees will provide a detailed description of the conditions that led to the decision to modify the study to FERC and Relicensing Participants as soon as possible via email to discuss alternative approaches to perform the study.
- Licensees' performance of the study does not presume Licensees are responsible in whole or in part for resource management measures that may arise from that study.
- The estimated level of effort and cost is not a firm commitment by Licensees to expend all the funds. If the study costs more, Licensees are committed to completing the study. If the study costs less, Licensees are not committed to expending the remaining funds on other Relicensing studies or resource management measures.
- All special-status species observations will be submitted to the California Natural Diversity Database.

6.3 Study Methods

For 1-D PHABSIM studies, the general steps include (not necessarily in the order shown):

- selection of target species and life stages
- stream reach identification, segmentation, and consolidation
- study site and transect selection including review and agreement with interested and available Relicensing Participants
- field data collection
- development of habitat suitability criteria
- hydraulic and habitat modeling

Selection of Target Species and Life Stages

The species and life stages that will be used for PHABSIM modeling are based on management importance and/or sensitivity to Projects operations. Target species and life stages are shown in Table 1.

Stream Reach Identification, Reach Segmentation, and Consolidation

Projects-affected reaches are stratified in three steps.

Step 1 is identification of the Projects-affected reaches and preparation of habitat mapping. Habitat mapping shall be conducted through field assessments made in accordance with the CDFG's Salmonid Habitat Restoration Manual (DFG Restoration Manual) to Level IV.

Step 2 is segmentation of Projects-affected reaches into homogeneous stream segments, where necessary, based on geomorphology, hydrology, and channel metrics. A series of very similar reaches having a common channel morphology and flow regime comprise a river segment (Bovee 1982). Data used in Step 2 includes the habitat mapping prepared in Step 1, topographic maps, and the hydrologic record.

Step 3 is consolidation of these river segments (or sub-reaches) into one or more PHABSIM study reaches, where appropriate. Bovee (1982) describes different strategies for river segment

consolidation from little or no consolidation (higher effort and higher cost) to more consolidation (lesser effort and lesser cost). Either sampling strategy can be employed in a particular study (Bovee 1982).

Study sites (transect or transect cluster locations) are selected within the consolidated reach to represent the range of channel and habitat types in the reach (Bovee 1982). The characteristic feature of a (PHABSIM) study reach is homogeneity of the channel structure and flow regime. In the upper foothill regions of the two Projects, channel characteristics are primarily formed by bedrock control rather than fluvial processes. Bedrock channels are generally insensitive to short-term changes in sediment supply or discharge. Only a persistent decrease in discharge and/or an increase in sediment supply sufficient to convert the channel to an alluvial morphology would significantly alter fluvial bedrock channels (Montgomery and Buffington 1993). For this reason, flow accretion is not used as a dominant factor in river segmentation.

Meso Habitat Stratification

Meso habitat stratification will be based on the habitat mapping prepared in Step 1. The mapping data will be used to develop a habitat unit frequency analysis for the instream flow studies. This cumulative frequency sampling approach is an extremely efficient way to inventory meso habitats over long distances (Bovee, 1997).

The Level IV habitat types referenced in the DFG Restoration Manual have been aggregated to a lower level of detail for the purpose of transect placement, hydraulic data collection, and transect weighting consistent with river stratification for PHABSIM modeling. The aggregated meso habitat types will be split into two categories – modelable and non-modelable. These are listed below:

Modelable Habitat Types:
- High Gradient Riffle (where channel hydraulics permit – identified in the field during transect selection)
- Low Gradient Riffle
- Run/Step-run
- Glide
- Pocket Water (where channel hydraulics permit – identified in the field)
- Pools (Mid-Channel, Trench, Lateral, Plunge)

Non-modelable habitat types include:
- Falls
- Cascade
- Chute
- Sheet Flow
- High Gradient Riffle (where channel hydraulics do not permit – identified in the field during transect selection)

Study Site and Transect Selection Including Relicensing Participant Review

Meso habitat study site and transect selection within each reach will be coordinated and determined in collaboration with interested and available Relicensing Participants. The goal is to obtain a relatively accurate representation of the habitat index versus flow relationship for each PHABSIM reach. This goal will be achieved by distributing study sites (transects and transect clusters) throughout the PHABSIM study reach in such a way that all modelable habitat types are represented with at least two representative habitat units. For habitat types with a high diversity in a particular reach, such as pool meso habitat type, the habitat type may need to be represented by three or more representative units. Meso habitat unit and transect selection is made in conjunction with field review for two reasons. The first is that some PHABSIM reaches have greater (or lesser) importance in relation to the amount of habitat they provide (e.g., length of the reach or quality of the habitat) or the potential the Projects has to modify habitat; therefore, the sampling effort will be adjusted as appropriate. The second reason is because of the difficulty in determining *a priori* sampling effort (number and type of habitat units sampled) necessary to provide accurate habitat index versus flow relationships.

The specific locations and lengths of the study sites will be selected in the field as described below, in consultation with the interested and available Relicensing Participants. Prior to study site selection in the field, the Licensees will summarize the geomorphic and hydrological data and work with the Relicensing Participants to finalize the demarcation of PHABSIM reaches. The Licensees will also summarize the aquatic habitat characterization data and study site access data and work with the Relicensing Participants to make a preliminary recommendation of study site, meso habitat unit, and possibly transect locations. Licensees will offer a pre-field presentation and orientation meeting ahead of each field visit. The pre-field meeting will include a description of the study site, meso habitat units, and possibly selected transects. The basis for selection, still photos, aerial video (if available), and maps of these features will also be provided. Pre-field meetings and field site visits will be scheduled with a goal of 30 days advance notice to allow the Relicensing Participants the opportunity to participate in the selection of final study sites, specific habitat units, and transects. Less than 30 days advance notice may be necessary if a site visit needs to be rescheduled due to unforeseen circumstances such as weather, sudden and unavoidable changes in operations, or unavoidable late arising scheduling conflicts affecting key participants.

Meso Habitat Unit Sampling

In general, it is proposed that within a study reach, meso habitat types will be sampled approximately in proportion to their abundance. Adjustments to the proportional sampling may be made based on the importance or variability of particular meso habitat types. While the number of transects is dependent on the diversity of channel and habitat types in a study reach, the target number of transects per PHABSIM subreach will generally be in the range of 17-20, up to as many as 25. This provides enough sampling flexibility to replicate each of the 4-5 predominant (>5% frequency) modelable meso habitat types. Meso habitat types with complex hydraulics (e.g. cascades, falls, chutes, and sheet flow) that cannot be modeled using standard PHABSIM and do not contain significant habitat for the primary target species will not be sampled with transects.

Transect Selection and Placement

The study sites used for transect placement to represent the different geomorphic and hydraulic conditions will be selected using a stratified random sampling approach based on the least-available sampled meso habitat type (Payne 1992). Other more-available meso habitat types will be represented using transects placed in meso habitat units in close proximity to the least-available selector. This approach minimizes the effect of selection bias, results in transect clustering that limits travel time, and assures transect representation in proportion to habitat availability.

Actual transect selection and placement is typically accomplished with a combination of random selection and professional judgment through the following procedure:

1. All Projects-affected reaches that are accessible and open to study are identified and designated for random transect placement.

2. Within the accessible areas, the habitat type with the lowest percentage of abundance (from the habitat mapping data) is used as the basis for random selection (provided that the habitat type is ecologically significant and modelable). If the distribution of the initial least common selector is too limited to provide an adequate choice of representative habitats, the next least common selector will be used.

3. All habitat units of this type within the accessible distance and that are judged to be modelable during the habitat survey are sequentially numbered and a minimum of five units selected by random number.

4. In the field, the first selected unit is relocated and, if it was judged to be modelable and reasonably typical of that particular habitat type within the study reach, one or more transects is/are placed to best represent the habitat type.

5. At least one example of each remaining habitat type is then located in the immediate vicinity of the random transect (upstream or downstream) until transects are placed in all significant types.

6. This process is repeated with the second, third, fourth or higher random selector to place additional clusters until the different geomorphic and hydraulic conditions are adequately characterized (as determined in collaboration with interested and available Relicensing Participants) or the target total number of transects is reached.

Although the outlined steps are fairly rigorous, all decisions regarding transect placement are subject to revision through the exercise of professional judgment by study participants, including the specific inclusion of desirable study areas not randomly selected and the placement of transects across appropriate spawning gravels. The overall objective of the method is to assure stakeholders and reviewers that satisfactory representation of study reaches is achieved.

Final selection of the study sites and transects will be completed in the field in collaboration with the interested and available Relicensing Participants. To facilitate the field-based transect selection process, a field package including reach maps, proposed study site and possible transect locations, photos (aerial and on the ground), and habitat mapping data results will be distributed to Relicensing Participants providing the necessary information for decision making.

Field Data Collection

General Method
Physical habitat and hydraulic parameters will be measured using a combination of standard techniques of the USFWS methodology (Trihey and Wegner 1981; Bovee 1982; Bovee et al. 1998 USGS (Rantz 1982), and techniques outlined in this study plan. PHABSIM data collection methods may vary somewhat between study reaches, depending on hydraulic and channel variations.

Target Calibration Flow
Target calibration flows will be selected with the goal of achieving relatively even logarithmic spacing of flows and allow development of an adequate stage/discharge relationship in the PHABSIM models. In other words, the stage change between calibration flows must be sufficient to test for a linear relationship between the log of discharge and log of stage minus stage of zero flow (IFG-4), or through the use of hydraulic conveyance modeling (MANSQ). Preliminary target calibration flows are 37 cfs, 275 cfs, and 2,000 cfs.

Selection of final target calibration flows will depend on reach specific conditions and will be selected in consultation with the Relicensing Participants. If target calibration flows need to be modified in the field, the modification will be done in collaboration with interested and available Relicensing Participants. The following guidelines will be applied in selecting the target calibration flows.

- Target calibration flows must be within the range of Projects flow control
- Incremental differences between the three target calibration flows must be within the control capabilities of the flow control mechanism
- High calibration flow should be high enough to model up to 10% or greater on the unimpaired flow exceedance curve or highest flows anticipated in the reach (regulated flow exceedance curve)
- High calibration flow should be within the physical limits of field measurement options using manual meters or an acoustic Doppler current profiler (ADCP).
- An additional (fourth) stage/discharge measurement may be taken in certain circumstances
- Low calibration flow target should be low enough to model down to the current instream flow requirement and adequately capture low flows generated by Projects operation
- Middle calibration flow target will be the logarithmic midpoint between the high and low calibration flow targets thus providing the necessary spread to assess the relationship between stage and discharge

High flow calibration targets will be set based on the above guidelines and may be adjusted during field reconnaissance in spring or other high flow periods to confirm suitability.

Surveying and Controls
All elevations will be surveyed by standard differential survey techniques using an auto-level or total station instrument. Headpin and tailpin elevations, water surface elevations (WSE), hydraulic controls, and above-water bed and bank elevations will be referenced to a temporary benchmark serving a single transect or transect cluster. Where reasonable (line of sight or 1 turning point), benchmarks will be tied together. At a minimum, all transects surveyed in a

single mesohabitat unit will have a common datum. Transect locations will be fixed, to the accuracy level possible, using a handheld GPS instrument.

Water Surface Elevation-Discharge
Stage/discharge measurements will be obtained at no fewer than three discharges. Additional stage/discharge measurements may be collected at higher flows (possibly lower also) in order to model habitat over a greater range of the flow frequency curve. When only a stage/discharge measurement is taken, discharge through the study site will be measured using manual velocity meters or a combination of an ADCP (described below) and manual velocity meters at an appropriate cross section.

Calibration Velocity
One velocity calibration set will be collected at the high or middle flow[2] at each transect using manual velocity meters alone or in combination with an ADCP. At cross sections and flows where predominant depths are greater than 2.5 feet, velocity distributions will be measured using the ADCP mounted on a small inflatable cataraft or a rigid trimaran. According to an extensive evaluation conducted by the USGS (Morlock 1996), an ADCP can be used successfully for data collection under a variety of field conditions.

Because the ADCP will not measure velocities well in depths less than approximately 1.0-2.0 feet, shallower measurements will be taken manually using calibrated digital Swoffer® brand or Price AA, or pigmy velocity meters mounted on standard USGS top-set wading rods. To assure adequate characterization of micro habitat for all life stages (e.g. adult, fry, juvenile, and spawning), during manual velocity measurements, sample sites (verticals) along the transect will be purposefully placed to describe points where changes in substrate, bed elevation, and velocity occur. The number of verticals will be adjusted in the field to accomplish micro habitat stratification as dictated by site specific conditions, and will also be increased in stream margin areas where fry or juvenile fish habitat is present. The placement and number of verticals will also be designed to limit discharge in any one cell to no more than 10% of the total discharge.

Temporary staff gage levels and the time of day will be recorded at the beginning and end of each transect measurement to note potential changes in stage. Continuous recording level-loggers may be deployed in certain reaches to monitor changes in stage during the calibration measurements. A continuous record of stage is useful in modeling if flows do change during calibration measurements.

If Projects operations allow, all three calibration measurements in a PHABSIM reach may be collected within a 2-3 day period. In this case low flows would normally be collected first, then mid flow, and then high flow. In other cases several weeks may elapse between flow measurements. Discussions with operations managers will determine the most efficient and cost effective methods of obtaining the appropriate calibration discharge. If a reach is run-of-river and has little storage, hydraulic data for the target high calibration flow will be collected in the spring with subsequent measurements obtained on the descending limb of the hydrograph. Note that the target flows are those flows that will be ***released*** into the stream from the nearest

[2] The determination of the flow at which velocity calibration data will be collected will be made collaboratively with the Relicensing Participants.

upstream Projects facility. While accretion will be factored into the release on the day of measurement, flows at each transect may be higher than the target calibration flow.

Substrate
Substrate will be classified according to a standard procedure, and will be evaluated visually during low flow conditions.

Percent occurrence of all substrate sizes within the immediate vicinity of each vertical (1-2 feet radius from vertical) will be recorded. Particle size categories are described below:

Organic debris, permanent vegetation
Clay, silt ..... <0.1 inches
Sand ..... 0.1-0.2 inches
Small gravel ..... 0.2-1.0 inches
Medium gravel ..... 1-2 inches
Large gravel ..... 2-3 inches
Small cobble ..... 3-6 inches
Medium cobble ..... 6-9 inches
Large Cobble ..... 9-12 inches
Boulder ..... >12.0 inches
Bedrock

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

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

Development of Habitat Suitability Criteria
The following procedures shall be used to develop habitat suitability criteria. They are designed to ensure collection of usable field data and HSC development. They were derived to address the matter of habitat availability in HSC development. These procedures focus on development of site-specific criteria. However, the general concepts apply to development of regional criteria

as well. The licensees may apply these procedures in any appropriate tributary within the San Joaquin River watershed after consultation with the relicensing participants. The licensees should consult with interested relicensing participants during each of the following steps.

1. Identify and evaluate at least three river flows (e.g., low, medium, and high) to sample. Extremely low and high flows should be avoided during data collection. Sampling fewer than three flow levels very likely would result in biased criteria, and should be avoided. Flows sampled shall be based on the hydraulic and physical microhabitat variability present within mesohabitat types, and shall be made collaboratively. Regardless of the number of flows sampled, flows sampled and data obtained must allow for development of HSC applicable to PHABSIM models that facilitate extrapolation of WUA/discharge relationships to flows ranging between 90% and 10% unimpaired (i.e., natural) exceedance flows. If all parties cannot agree whether fewer or more than three flows should be sampled, three flows remains the default sample size.

2. Partition the river in question into generally homologous segments. If regional HSC are being developed, riverine systems should be partitioned by stream type, elevation, gradient, and/or other appropriate characteristics.

3. Delineate all mesohabitat types (e.g., run, riffle, pool, etc.) at an unimpaired, moderate river discharge throughout each segment. Extremely low and high flows should be avoided for mesohabitat delineation. Identify each mesohabitat type comprising at least 5% of the total linear distance of each homologous reach, and all biologically important mesohabitat types comprising less than 5% of the total linear distance.

4. Evaluate specific mesohabitat types and/or river flows that may be hazardous to sample. If all interested parties agree that specific mesohabitats and/or flows should be deleted from subsequent HSC data collection, determine how deletion of such data may affect HSC development and utility. Incorporate appropriate measures to reduce identified impacts. Document the decision making process, and conclusions.

5. Prepare a sample design for each homologous stream segment. Randomly select three units of each mesohabitat type comprising 5% or greater of the total linear distance of each homologous segment, and those biologically important mesohabitat types comprising less than 5% of the total linear distance. There are various procedures to introduce randomness into mesohabitat selection. The method selected shall be determined in a collaborative manner. If an acceptable approach cannot be agreed upon by all interested parties, then complete random selection is the default. Document the decision making process and random approach selection.

6. Ground truth selected mesohabitat units to determine whether the unit represents the target mesohabitat type. Randomly select and ground truth additional units as needed.

7. Collect data within each mesohabitat unit. Data may be collected through 100% sampling of each unit, or by a resource agency approved sub-sampling technique (e.g., transects, grids, etc.). Ground truth sub-sampling units selected within each mesohabitat

sample unit to determine whether they represent the mesohabitat unit, the hydraulic conditions, and the physical microhabitats available within the unit. Select additional sub-sampling units within the mesohabitat unit(s) needed, with ground truthing. This item does not apply to two dimensional data collection.

8. Partition data collection by riverine type, flow, and meso- and microhabitat type. Data should be partitioned diurnally and seasonally whenever possible. Data from different categories should be compared, and data for significant individual categories included, as appropriate, within PHABSIM analyses and water allocation decisions.

9. Sample all sample periods/conditions/components/flows/etc. equally. If not sampled equally, appropriate steps (e.g., mathematically adjust sample sizes to attain equality) should be taken to address and minimize potential biases. These steps should be developed collaboratively with interested relicensing participants. However, the resource agencies reserve the option of determining the acceptable technique.

10. The target sample size is at least 150 observations per species life stage per river flow, homologous reach, season, and diurnal period sampled. A single fish or group of fish in the same location is considered an observation. More than 150 observations may be needed to develop HSC. Actual sample sizes and partitioning components are dependent upon specific circumstances, and should be determined in a collaborative manner. Identify and account for influencing factors. Sampling should not be discontinued once 150 observations is reached if doing so would compromise equal sampling design needs (e.g., effort, area, etc.). Each condition is a specific requirement. For example, if 150 observations have been collected, but equal area sampling requirements have not been met, sampling must continue until the sample area requirements have also been met.

11. Address habitat availability for each river flow, mesohabitat, and/or representative reach, season, diurnal period, etc. sampled, and account for habitat availability in HSC development. Habitat availability may be accounted for in the basic fish observation sample design (e.g., sample a wide range of flows, hydraulic conditions, physical conditions, seasons, etc.), or in data compilation (e.g., proportional habitat use divided by proportional habitat availability). If habitat availability data are not included in HSC development, resultant HSC are suitable for habitat analyses only for the limited conditions existing during data collection.

12. Collect hydraulic and physical data. These data include:
    a. Total water depth and average velocity.
    b. Fish focal point velocity.
    c. Stream margin edge type.
    d. Cover type components.
    e. Substrate components.
    f. Vegetative components
    j. Distance to and type of nearest components described above.
    k. Other factors as appropriate.

13. Compile observation and habitat availability data in such a way that unequal sizes do not bias resultant HSC. For example, individual data sets may be normalized or equalized prior to data compilation. The procedures used should be developed collaboratively with interested relicensing participants. However, the resource agencies reserve the option of determining the acceptable technique.

14. Address anomalies in HSC distributions. Determine if additional data are required to address the anomalies, or if the effect of the anomalies should be minimized and/or included in analyses. An example of minimizing anomaly effects is by smoothing or curve fitting techniques, and/or professional judgment. Smoothing and curve fitting techniques are preferred. Procedures used should be developed collaboratively with interested relicensing participants. The resource agencies reserve the option of determining the acceptable technique.

15. Determined whether the above procedures provide sufficient sample sizes and/or do not account for habitat availability. Evaluate and select alternative procedures through a collaborative process with interested relicensing participants. The resource agencies reserve the option of approving appropriate methods.

1-D PHABSIM Modeling

Licensees may use any suitable software to model habitat index versus flow relationship, such as PHABSIM, PHABWin, or RHABSIM. The program will be made available to Relicensing Participants upon requested.

Hydraulic modeling procedures appropriate to the study site and level of data collection will be used for modeling water surface elevations and velocities across each cross-section. For water surface elevations, these procedures include: the development of stage-discharge rating curves using log-log regression (IFG4), Manning's formula (MANSQ), and/or step backwater models (WSP, HecRas); direct comparison of results; and selection of the most appropriate and accurate method. If, for example, rating curves using log-log and MANSQ are nearly identical, then log-log will be used to easily allow changes in simulated flows. But, if the two methods diverge and the transect is a riffle or run, then MANSQ will be selected for flow simulation. Water velocities will be simulated using the Manning's n method of velocity distribution across all transects, with calibrations generally consisting of correction of over- or under-simulated velocities at individual sample points (i.e. velocity adjustment factors or VAFs). Data file construction, calibration, simulation, reporting, review, and consultation will follow standard procedures and guidelines.

Habitat modeling will be conducted using an approach consistent with the Instream Flow Incremental Methodology (IFIM) approach (Bovee et al. 1998). Meso habitat types will be weighted and combined to develop a representation of hydraulic characteristics and fish habitat suitability for the PHABSIM reach or subreach. Meso habitat weighting will be based on the relative proportion of each of the modeled meso habitats within the PHABSIM reach or subreach, as described above.

Products

Instream flow study products will include: a) a study report that includes a summary of field methods, data analysis, and results for all elements of the study (including HSC development, hydraulic modeling, and habitat modeling); b) all PHABSIM digital data on CD formatted for input to PHABSIM, PHABWin, or RHABSIM, as appropriate; and c) spreadsheet based interactive analytical tools, as necessary.

Field Methods Summary

Field methods for each PHABSIM reach will be summarized to include but not be limited to the following:

- Maps showing study site and transect locations
- Photographs of transects at calibration flows
- Date and discharge of calibration flows
- Description of any deviations from the study plan

Data Analysis Summary

Data analysis for each PHABSIM reach will be summarized to include but not be limited to the following:

- Hydraulic calibration report (detailed modeling procedures and model performance);
- Habitat modeling report (target species, and HSC used)
- Description of any deviations from the study plan

Results Summary

Results for each PHABSIM reach will be summarized to include but not be limited to the following:

- Graphic and tabular results of Weighted Useable Area vs. flow
- Habitat modeling report (target species and HSC used)
- Description of any deviations from the study plan

6.4 Consultation and Communication

Licensees will file with FERC and post on its Relicensing Website periodic reports as required by the FERC in the Study Plan Determination.

Licensees will coordinate with FERC and other Relicensing Participants as described in Section 6.2.

The Licensees will collaborate with the Relicensing Participants on the following items:

- study site and transect selection
- development of habitat suitability criteria
- selection of target calibration flows
- hydraulic and habitat modeling (modeling procedures and model calibration)

6.5 Schedule

The Instream Flow Study should be conducted in 2009 and 2010.

7.0 Consistency of Methodology with Generally Accepted Scientific Practices (18 CFR 5.9(b)(6))

Instream flow studies conducted using PHABSIM are common in California hydropower relicensing. Similar studies are being, or have been, conducted on the Yuba-Bear Project (FERC Project No. 2266), the Drum-Spaulding Project (FERC Project No. 2310), and Middle Fork Project (FERC Project No. 2079), the Upper American River Project (FERC Project No. 2101), the DeSabla-Centerville Project (FERC Project No. 803), and the South Feather Project (FERC Project No. 2088), to name just a few examples.

8.0 Considerations of Level of Effort and Cost (18 CFR 5.9(b)(7))

The preliminary cost estimate for the study in 2009 dollars is $600,000.

9.0 References

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Document Content(s)

APPENDIX C

Letter from Jeffrey R. Single, Ph.D., California Department of Fish and Game to Hicham Eltal, Merced Irrigation District, November 16, 2009 regarding fish passage at the Crocker-Huffman Diversion Dam

California Natural Resources Agency
DEPARTMENT OF FISH AND GAME
Central Region
1234 East Shaw Avenue
Fresno, California 93710
www.dfg.ca.gov

***ARNOLD SCHWARZENEGGER**, Governor*
***DONALD KOCH,** Director*

November 16, 2009

Hicham Eltal
Deputy General Manager
Merced Irrigation District
744 West 20th Street
Merced, California 95340

Re: Legal Requirements of California Fish and Game Code for Fish Passage at the Crocker-Huffman Diversion Dam

Dear Mr. Eltal:

The Department of Fish and Game (Department) has reviewed our previous direction regarding the fish ladder at Merced Irrigation District's (Merced ID) Crocker-Huffman Diversion Dam, in the context of current condition of the anadromous fish populations in the Merced River, historic and ongoing efforts to manage those populations, and Fish and Game Code (FGC) § 5901, which provides that "it is unlawful to construct or maintain" any barrier "that prevents, impedes, or tends to prevent or impede, the passing of fish up and down stream," unless otherwise authorized by the FGC.

The Department and Merced ID have made several adaptive changes at the Crocker-Huffman Diversion Dam over the years to reduce the impact the diversion and dam have on fish resources. At one time, Merced ID operated a fishway at Crocker-Huffman. Then, in the early 1970s, the Department recommended closing the fish ladder in conjunction with construction of an experimental spawning channel adjacent to the diversion dam. At that time, the Department believed a spawning channel, along with minimum flow releases required by the Federal Energy Regulatory Commission from upstream hydropower projects (Nos. 2467 and 2179), would provide the best opportunity for restoring salmon on the Merced River. Unfortunately the spawning channel experiment failed and Merced ID may no longer rely on the Department's letter from the 1970s. Additional management actions are necessary to maintain and recover anadromous fish in the Merced River.

Today, the Crocker-Huffman diversion dam impedes the passage of resident and anadromous fish up and down stream except during rare high flow events. Meanwhile, the fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead rainbow trout (*O. mykiss*) anadromous fish populations in the Merced River have deteriorated to extremely low levels. Given this background and the current situation, the Department has determined that fish passage at the Crocker-Huffman

Diversion Dam must be restored. FGC §5935 states "the owner of any dam upon which a fishway has been provided shall keep the fishway in repair and open and free from obstructions to the passage of fish at all times". The Department directs Merced ID to consult with the Department to i) make a determination regarding anadromous fish passage adequacy of the existing (but closed) Crocker-Huffman Dam fishway and ii) assist the Merced ID in developing a Crocker-Huffman anadromous fish passage plan[1].

We do not expect nor desire that opening the existing fishway take place in an immediate and unplanned manner, but rather in a thoughtful and collaborative manner that leads to improved fish habitat and fish populations, as well as fitting with Merced ID's operational needs to the greatest extent possible.

My staff and I look forward to working with Merced ID to restore the passage of resident and anadromous fish over the Crocker Huffman Diversion Dam, as required by the Fish and Game Code. If you have any questions regarding this letter, please contact Mr. Dean Marston, Environmental Program Manager, of my staff at (559) 243-4014, extension 241.

Sincerely,

Original signed by Jeffrey R. Single, Ph.D.

Jeffrey R. Single, Ph.D.
Regional Manager

cc: Page Three

[1] This plan would include, but not be limited to, identifying the timeframes for fish passage implementation, restoration of anadromous fish habitat upstream of Crocker-Huffman in conjunction with passing fish upstream of Crocker-Huffman, and development of provisions to preclude further impacts to the Merced River anadromous fish populations as a result of operation of a fishway at Crocker-Huffman Dam.

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