COMMENTS
ON LICENSEE PROPOSED STUDY PLAN
MERCED RIVER HYDROELECTRIC PROJECT NO. 2179-042

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E-Filing

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

Dear Ms. Bose:

Thank you for the opportunity to submit comments on behalf of the Merced River Conservation Committee, Trout Unlimited, the California Sportfishing Protection Alliance, Friends of the River, Golden West Women Flyfishers, Northern California Council of Federation of Fly Fishers, and American Rivers (collectively, "Conservation Groups") regarding the Licensee Proposed Study Plan for the relicensing of the Merced Irrigation District's Merced River Hydroelectric Project.

The Federal Energy Regulatory Commission ("the Commission" or "FERC") is currently reviewing the Proposed Study Plan submitted by Merced Irrigation District (MID) for the relicensing of the Merced River Hydroelectric Project (Project) (FERC No. 2179). The Project is located on the Merced River in Mariposa County, California.

FERC has invited participation in the relicensing process and has circulated a Proposed Study Plan (April 17, 2009; MID, 2009) to provide agencies and the public with the applicant's proposed study plan for the Merced River Hydroelectric Project. FERC regulations (18 CFR § 5.12) allow comments on the applicant's proposed study plan, including any revised information or study requests that must be filed within 90 days after the proposed study plan is filed. This filing must include an explanation of any study plan concerns and any accommodations reached with the potential applicant regarding those concerns. Any proposed modifications to the potential applicant's proposed study plan must address the criteria in § 5.9 (b).

EXECUTIVE SUMMARY

As described below, Conservation Groups—in conjunction with resource agencies—support 8 modifications to study plans proposed by licensee, generally seeking to expand the geographic scope of licensee's proposed study plans, and 10 revised study requests for studies not proposed by licensee, which were developed and endorsed collectively by NMFS, CDFG, BLM and SWRCB. In addition, Conservation Groups support 14 study plans that MID and BLM resolved. For a list of all proposed study plans, see Table 1 (modifications to licensee proposed study plans), Table 2 (revised study requests), and Table 3 (agreed-to studies) in Section II below.

Our requests are supported by the Federal Power Act (FPA) regulations, and the information will be necessary to inform license conditions and analysis needed by FERC for National Environmental Policy Act (NEPA) analysis, and for Endangered Species Act (ESA) consultation, and for Clean Water Act (CWA) section 401 water quality certification.

Conservation Groups and resource agencies have a fundamental disagreement with the licensee MID over the purpose and scope of the proposed studies, including all of the studies most important to protection of water quantity, water quality and fisheries. MID would limit the geographic and subject matter scope of the studies in a way that is inconsistent with Scoping Document 2 (FERC, 2009a) and incompatible with the requirements of the FPA, NEPA, CWA section 401, and ESA section 7.

The minimum study needs for a comprehensive evaluation extend beyond the political borders of the FERC-designated boundaries. If confined to this restricted geographic scope, studies will be completely insufficient to reasonably inform the Commission for development of potential license conditions, as well as protection, mitigation and enhancement of fish and wildlife (including related spawning grounds and habitat). The broader geographic scope, recommended in part by Staff in the SD-2 for MID's Merced River Hydroelectric Project would better inform the Commission for licensing development, but FERC will need to ensure that the study plans developed now are sufficient to accomplish the relicensing tasks at hand.

Conservation Groups' comments are divided generally into two sections. Section I addresses comments that pertain to all of the proposed study plans, and in particular addresses the

necessary geographic scope of the analysis. Section II provides our comments on individual study plans, and their specific conformance with the Integrated Licensing Process Study Criteria.

COMMENTS ON PROPOSED STUDY PLAN

I. COMMENTS PERTAINING TO LICENSEE PROPOSED STUDY PLAN AS A WHOLE

a. MID Proposes an Inadequate Geographic Scope

MID's proposed study approach (MID, 2009) suffers from a fundamental flaw. MID proposes an exceptionally narrow geographic scope for all studies having to do with water quantity, water quality, and fisheries resources. Specifically, MID would limit its analysis of downstream effects to its Crocker-Huffman diversion dam, which lies less than 3 miles below the Merced Falls Powerhouse (P-2467) and 52 miles above the confluence of the Merced River and the San Joaquin River, and would limit its upstream geographic boundary to the upstream extent of Lake McClure, the uppermost project reservoir. Notably, the area does not even extend to the compliance point for instream flows established by the initial license, which is at Shaffer Bridge, located 20 miles below Crocker-Huffman. See License Articles 40, 41.

MID attempts to justify its constricted scope by stating that there is no "nexus" between project operations and resource effects, and no information from the studies that could be used to inform licensed conditions because the Project is not "the essential cause" of the resource effect. See Licensee Proposed Study Plan section 3.2.11. That is not the standard. The question is whether there is a "direct, indirect, or cumulative" nexus, or connection, between the Project and the resource effect to be studied, and whether the information could be used to inform license conditions. As explained below, our requested studies meet that test, and the other requirements of the law.

MID's proposed study plans are inconsistent with Scoping Document 2, the regulations for studies conducted for an ILP, the requirements for disclosure contained in NEPA, the information needed for Section 7 consultation under the ESA, and the information needed for certification under Clean Water Act section 401 and the California Environmental Quality Act (CEQA).

The geographic scope of the studies must cover requirements for NEPA and the FPA, CEQA and Section 401, and Section 7 consultation, whichever is broadest. In Section II below and the study requests, we set forth the geographic scope for each study. Generally speaking, the geographic scope for fisheries resources should extend to the confluence of San Joaquin and Sacramento Rivers and the geographic scope for water quality and other water-related resources should extend to the confluence of the Merced and San Joaquin Rivers.

b. Legal Requirements for Study Plans

i. Scoping Document 2

Scoping Document 2 states FERC's tentative view that the entire upper and lower Merced River down to the confluence of the San Joaquin and Sacramento Rivers should be included in studies relevant to federally listed species. See § 4.1.1. SD2 also states that the lower Merced River down to Snelling Road Bridge should be covered by water quality studies (id.) and that the studies themselves may develop more information as to the scope of project effects. See § 2.2.

MID's proposed studies are clearly contrary to SD2. Moreover, Conservation Groups conclude that Scoping Document 2 actually understates the effect of project operations, as explained below**.**

ii. Federal Power Act Regulations

The Federal Power Act regulations, 18 CFR § 5.9(b), set forth the requirements for a valid study plan in an ILP. In rejecting a number of study requests by Conservation Groups, the National Marine Fisheries Service, and others, MID cites especially the fifth criterion, which states that any study request must:

> Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements;

FERC's guidance document, *Understanding the Study Criteria: Integrated Licensing Process*, 2005, further explains the "nexus" requirement. With respect to nexus, the guidance states:

> This discussion should clearly draw the connection between project operations and the effects (direct, indirect, and/or cumulative) on the applicable resource.

Dictionaries also commonly define "nexus" to mean "connection" or "link." See dictionaries cited at http://dictionary.reference.com/browse/nexus.

The same FERC guidance also elaborates on the requirement that studies be intended to inform the development of license requirements:

> Just as important, this discussion should explain how the requester will use the information to develop protection, mitigation, and enhancement measures, including those related to an agency's mandatory conditioning authority under 401 of the Clean Water Act or sections 4(e) and 18 of the Federal Power Act.

Where there is a connection, or nexus, between project operations and resource effects, and the project could be modified to mitigate or enhance those resource effects, then this prong of the regulations is satisfied.

iii. National Environmental Policy Act

Study plans for the ILP are intended to develop information for the environmental review under NEPA, which requires consideration of all direct, indirect, and cumulative effects of a proposed project, including all existing and reasonably foreseeable actions in the area. See generally 40 CFR Parts 1500-1508.

The Merced River Hydroelectric Project PAD (MID, 2008) Section 8 (Issues, Activities, and Effects) discusses anadromous fish species in several sections, including Section 8.2.1, 8.2.2, and 8.2.3. The licensee states that these populations of anadromous fish species are not affected by the project because they do not occur within the designated FERC Project Boundary or upstream of the project. Licensee states that it therefore believes there is no nexus between anadromous fish and the project. MID's statement that anadromous fish do not appear to occur in the project area at present is incorrect as described below; even if it were true it would not mean that there could be no effects of the project, which currently modifies downstream habitat and instream flows, and presents a barrier to anadromous fish migration.

MID's assertion, along with a lack of analysis of existing information, essentially presents as conclusion that which the NEPA process is designed to determine. If anything, the geographic scope for NEPA analyses must err on the side of being overly broad, as the studies themselves should be used to develop information about the breadth of the project's effects. See SD2, p.4: "We note that relicensing studies may provide additional new information of the downstream extent of project effects."

The geographic scope of what is studied in relicensing must be sufficiently broad to quantify and evaluate beyond the applicant's project boundary, and be sufficient to provide information to determine where project effects occur and do not occur. If the relicensing studies do nothing outside the immediate project boundary, they can underestimate or overlook project effects, and, thus, would not inform the Commission for development of potential license conditions, as well as protection, mitigation and enhancement of fish and wildlife (including related spawning grounds and habitat). See U.S. Environmental Protection Agency, Office of Federal Activities (2252A), Consideration Of Cumulative Impacts In EPA Review of NEPA Documents, EPA 315-R-99-002/May 1999 ("Agencies tend to limit the scope of their analyses to those areas over which they have direct authority or to the boundary of the relevant management area or project area. This is often inadequate because it may not cover the extent of the effects to the area or resources of concern.").

iv. Endangered Species Act Section 7

Information, data, and analysis are needed to understand project effects on listed species and their essential fish habitats in order to fulfill the requirements of the National Marine

Fisheries Service and its Section 7 consultation. To comply with the applicable regulations (see 50 CFR § 402.14(c)) developed under ESA section 7, the consultation initiation package must include, among other information, a description of the manner in which the action may affect any listed species or critical habitat, and an analysis of any cumulative effects.

In conducting its own analysis, NMFS will need to understand the total effects of all past activities, including effects of the past operation of the project, current non-federal activities, and Federal projects with completed section 7 consultations, in addition to future direct and indirect impacts of the operation over the new license or contract period, including effects of any interrelated and interdependent activities, and any reasonably certain future non-Federal activities (cumulative effects). In addition, 18 CFR § 5.9 (Integrated Licensing Process procedures) states that study requests should include information and studies need for consultation under section 7 of the Endangered Species Act.

The ESA regulations, 50 CFR § 402.02, define "Action area" to mean "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." Guidance issued for the ESA makes clear that the Services are the ultimate judge of the geographic scope of an analysis under the law:

> If the Services determine that the action area differs from that described by the agency or applicant, the Services should discuss their rationale for the change with the agency or applicant. Occasionally, an action agency or an applicant disagrees with the Services' delineation of the action area. This generally occurs when impacts to the species/habitat result from indirect or interrelated/ interdependent effects. Reaching agreement on the description of the action area is desirable, *but ultimately the Services are responsible for this biological determination*. (US Fish and Wildlife Service and National Marine Fisheries Service, Endangered Species Consultation Handbook, 1998; Emphasis Added)

NMFS (2009c) has indicated to FERC and to the licensees that it needs to have available information and data on the Merced River projects and their direct, indirect, and cumulative effects on various anadromous and resident fish species that are found in the Merced and San Joaquin Rivers downstream of the projects to the Delta (i.e., the confluence with the San Joaquin and Sacramento Rivers) and in the Merced River upstream of the projects. NMFS (2009b) restated to the Commission the licensee's failure to view the broader geographic scope of the project that extends far beyond the distance that MID (2008, 2009) proposed in its Study Plan.

NMFS has specific authority over fishes in the Merced and San Joaquin Rivers that are listed under the Endangered Species Act (ESA), over critical habitat designated under the ESA, and over Essential Fish Habitat designated under the Magnuson-Stevens Fishery Conservation Management Act (MSA). Steelhead trout (*Oncorhynchus mykiss*) are present in the Merced and San Joaquin rivers, and the Central Valley steelhead Distinct Population Segment is currently listed as threatened under the ESA (January 5, 2006, 71 FR 834). Critical habitat has been designated for Central Valley steelhead in the Merced River

downstream of the Crocker-Huffman Diversion Dam, in the San Joaquin River, and in the San Joaquin-Sacramento River Delta (September 2, 2005, 70 FR 52488). Spring-run Chinook salmon (*Oncorhynchus tshawytscha*) historically occurred in the watershed. The Central Valley spring-run Chinook salmon Evolutionary Significant Unit is currently listed as threatened under the ESA (September 16, 1999, 64 FR 50394), and the San Joaquin fall-run Chinook salmon is currently a considered a Species of Concern by NMFS and Candidate Species under Federal and State Endangered Species Acts. (See http:www.nmfs.noaa.gov/pr/pdfs/species/chinooksalmon_highlights.pdf).

NMFS's preliminary recovery planning efforts involve the establishment of spring-run Chinook salmon populations in the San Joaquin Basin. During the development of these relicensing activities, recovery planning efforts may develop greater significance to the Project consultation. The Central Valley fall/late fall-run Chinook salmon (*Oncorhynchus tshawytscha*) Evolutionary Significant Unit, currently present in the Merced and San Joaquin River basins, is listed as a Species of Concern (April 15, 2004, 69 FR 19975). The area downstream of Crocker-Huffman Diversion Dam has been identified as essential fish habitat for Central Valley fall/late fall-run Chinook salmon pursuant to the MSA.

The geographic scope requested by Conservation Groups and resource agencies is fully consistent with usual practice; if anything, it is narrower. For example, the Klamath Hydroelectric Project DEIS (§ 3.2.1) defined the geographic scope for impacts to anadromous fish as extending from their range in the 200 mile offshore Klamath Management Zone in the Pacific Ocean upstream more than 250 miles through the project to all of the species' historic habitat.

v. Clean Water Act Section 401 and California Environmental Quality Act

The federal Clean Water Act (33 U.S.C. §§ 1251-1387) was enacted "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." (33 U.S.C. § 1251(a).) Section 401 of the Clean Water Act (33 U.S.C. §1341) requires every applicant for a federal license or permit which may result in a discharge into navigable waters to provide the licensing or permitting federal agency with certification that the project will be in compliance with the CWA. The State Water Resources Control Board has Section 401 responsibility in California.

Under these authorities, the certification shall include "any effluent limitations and other limitations, and monitoring requirements necessary to assure [compliance with water quality standards] ... and with any other appropriate requirement of State law set forth in such certification ...." A certification thus regulates "... the activity as a whole once the threshold condition, the existence of a discharge, is satisfied." *PUD No. 1 of Jefferson County v. Washington Department of Ecology*, 511 U.S. 700, 712 (1994). A certification may require capital improvements as well as changes in operational rules to attain water quality standards or comply with related requirements of State law. See *S.D. Warren Company v. Maine Board of Environmental Protection*, 547 U.S. 370, 385-386 (2006) (affirming that a certification condition

may require licensee to mitigate impacts on fish passage). Coldwater fisheries are among the designated beneficial uses of the Merced River.

In its comments for this proceeding, SWRCB (2009b) has stated that the geographic scope for project effects must extend to a far greater distance than MID has proposed. SWRCB has an independent obligation to develop information sufficient to make decisions consistent with CEQA and Section 401. Accordingly, the question whether information developed during a hydropower relicensing proceeding is adequate for the agency to evaluate impacts to affected resources is one that ultimately resides with the SWRCB. See SWRCB, Notice Of Preparation And Of Scoping Meetings For An Environmental Impact Report For 401 Water Quality Certification Of The Klamath Hydroelectric Project (Sept. 30, 2008 [stating that SWRCB cannot rely fully on information developed for DEIS for CEQA and CWA section 401 purposes, and initiating proceeding to develop additional data]).

FERC and SWRCB must also consider and identify how they will integrate the upcoming flow standards to replace the Vernalis Adaptive Management Plan (VAMP) flows at Vernalis, under a reopening of State Water Resources Control Board Water Right Decision 1641 or whatever succeeds it, into the FERC Merced River project licenses. VAMP flows have been shown to be grossly deficient and to directly adversely affect Merced River steelhead and fall-run Chinook salmon. Water to meet new standards must come from the San Joaquin River basin tributaries. Until the San Joaquin River, above the Merced River confluence, once again flows on a regular basis, there are only three sources of water to meet the new standards: the Stanislaus, the Tuolumne and the Merced. NMFS's (2009a) *Biological and Conference Opinion* has developed minimum instream flow standards to protect the Central Valley steelhead DPS. The Merced and the Tuolumne Rivers both contain FERC-jurisdictional rim dams, which essentially control all instream flows; New Don Pedro Project on the Tuolumne River is on a relicensing timeline two years behind the Merced River Projects. FERC EIS's for the Merced and Tuolumne relicensings must consider the effects of each proposed action on the other, and how the combined actions can best address flow requirements in the lower San Joaquin River and the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. Unless the geographic scope of the FERC studies extends downstream to the geographic scope of the VAMP proceeding (currently the confluence of the Merced and San Joaquin Rivers), it will be impossible for either FERC or SWRCB to ensure that the two decisions are compatible and comply with the law.

Again, SWRCB's relatively broad view of the appropriate geographic scope for water quantity and quality related resources is fully consistent with common practice. The geographic scope for water quantity, water quality, and geomorphic impacts in the Klamath DEIS, for example, extends 190 miles downstream of the FERC project boundary to the Pacific Ocean. In the Klamath River, of course, there are an exceptionally large number of other factors that also affect stream flows downstream of the project, including the Shasta River, Scott River, Salmon River, and Trinity River, and the numerous dams and diversions on those tributaries that affect stream flow timing and magnitude. Moreover, daily flow levels below the Klamath Project are largely controlled by the Bureau of Reclamation irrigation project upstream of the Klamath Project.

Although the geographic scope of CEQA is at least as broad as NEPA, there are a few differences between the two statutes. For example, the CEQA "no project" alternative is denial of the water quality certification, not continuation of current conditions. See SWRCB comments on Klamath DEIS (Nov. 30, 2006).

c. The MID Proposed Study Plan Would Study The Effects of Project Operations Only Where They Are The "Essential Cause" of a Resource Issue

Requests for study modifications or new studies related to anadromous salmonids in the Merced River were previously filed by agencies and non-governmental organizations, including a) hydrology of the Merced River; b) hydrologic modeling of the movement of water from the headwaters in Yosemite National Park to McClure Reservoir to the lower Merced River; c) water temperature modeling d) assessment of anadromous fish populations and habitats, upstream, within and downstream of the project; e) evaluation of potential fish passage; f) assessment of need and feasibility of an "anadromous conservation hatchery"; and g) assessment of sediment and gravel transport upstream, within, and down stream of the project for benefit to anadromous salmonid habitat. These requests have been updated, modified, and added to in the present filing.

Licensee has refused to consider inclusion of these NGO- and agency-proposed study requests for water resources and anadromous fish in its Licensee Proposed Study Plan. Its arguments against inclusion are set forth in section 3.2.11 of the Proposed Study Plan, and purport to explain why project effects on resources downstream of Crocker-Huffman or upstream of Lake McClure do not warrant study under ILP study criterion 5.9(b)(5).

First, licensee claims that requesters have not adequately addressed the nexus between Project operations and the object of the requested study (= nexus issue). Second, licensee claims that requesters have not shown how the information developed by the study would inform license requirements (= issue of how the study will inform license conditions). See p. 3-22. MID asserts that there is no nexus and the studies could not inform license requirements because the Project is not the "essential cause" of any of those effects:

> In summary, Merced ID does not believe that the Project is an essential cause of any of the adverse flow-related effects downstream of Crocker Huffman Diversion Dam or upstream of Lake McClure (p. 3-22).
>
> Merced ID believes that the Merced River below the Crocker-Huffman Diversion Dam is cumulatively affected by multiple entities and projects described above. Consequently, Merced ID does not believe that the Merced River Hydroelectric Project has a direct/indirect on controllable effects [sic] in the Merced River downstream of the Crocker-Huffman Diversion Dam. Furthermore, Merced ID believes that studies in the Merced River below the Crocker-Huffman Diversion Dam would not inform requirements in the new license (p. 3-24).

By "essential cause," MID apparently means "*only* cause," because it also rules out studies where it admits that the project is one of the causes of the effect wherever there are other factors that might also contribute to the effect. See pp. 3-23 to 3-24 (agreeing that project releases affect flows in the Lower Merced River but noting that other factors also affect flows in the River, so it is not "*the* essential cause").

MID's argument fails for a number of reasons. First, the "essential cause" limitation does not exist in the Federal Power Act or the FERC regulations. Rather, the regulations require that there be a nexus, which can be "direct, indirect, or cumulative," between project operations and effects on the resource to be studied.

Second, the notion of direct, indirect, or cumulative effects assumes that there will often be other factors that also contribute to the effects on a resource in addition to the project. That does not mean that license conditions cannot be designed to mitigate those effects that are connected to or controlled by the project. Indeed, for aquatic resources, it is almost impossible to envision any circumstances where there would not be multiple factors that influence a resource condition. FERC recognized that diversions (including MID's diversion) affect streamflows in the Lower Merced River in 1964 when it issued the original license for this project and included an instream flow requirement with a compliance point downstream of those diversions.

Using MID's strange current logic, set forth in its Proposed Study Plan, there was no nexus for the 1964 requirement, there was no basis for imposing that license condition, and it would have been impossible for MID to comply with it for all these years. In effect, the current license would have been contrary to law. Moreover, licensee has operated for over forty years in a practical and regulatory context in which the jurisdiction of the Commission over streamflows has been assumed and accepted as appropriate. Based on this assumption and acceptance, licensee has made numerous legal representations about its conduct and proposed future conduct; we address a number of such instances below.

Third, the "essential cause" phrase was apparently taken from a recently abandoned effort to rewrite the regulations governing ESA Section 7 consultation. (See *Federal Register volume 73, No 242, December 16***,** 2008, pp. 76272 ff**)**. This revision, and with it the "essential cause" language, was eliminated from the regulations by the Secretary of the Interior before it ever took force. Even had those rules remained in place, they would be no basis for restricting the studies here, since FERC study plans are not limited to those project effects that could result in a "jeopardy" finding under section 7. In other words, even if that rulemaking had remained in place, study plans would not be limited to effects where the project was an "essential cause."

d. Merced Project Operations Have Direct, Indirect, and Cumulative Effects on Stream Flow Timing and Magnitude, Water Quality, and Fish Habitat Downstream of the Power Facilities

Even a short rendition of the relevant facts makes it obvious that project operations have a direct, indirect, and cumulative connection to effects on flow, water quality, fish habitat, and

fish populations throughout the entire river basin. Indeed, the project is the dominant actor on the river.

New Exchequer Dam, which at full pool creates the twenty and one half mile long Lake McClure, is located at RM 62.4. Lake McClure has a storage capacity of just over one million af. There are no other facilities with meaningful storage in the basin. McClure is capable of capturing over 99% of the mean annual flow of the river upstream of its dam. (see http://www.water.ca.gov/floodmgmt/hafoo/csc/docs/Runoff_Table.pdf).

There is only one major tributary between the project and Merced River – San Joaquin River confluence; that tributary is ephemeral. New Exchequer Dam, since its construction, has never spilled. Flows on the river are, in the first instance, a function of what MID releases through the project.

As FERC notes, there are diversions for consumptive use downstream from the reservoir, and there are return flows from irrigation. To understand how the river operates, it is important to understand the relationship between these diversions and MID's releases. With few if any exceptions, the downstream diversions have senior water rights to MID's storage rights, or are operated by MID. Many are operated on basis of a "riparian right." See PAD, Section 7.2. The largest non-MID block of diversions are controlled by what is known as the "Cowell Diverters," who divert up to 250 cfs at any given time and are acknowledged as senior to MID. The Cowell Diverters have an operating agreement with MID to ensure their supply. The agreement was first established on January 17, 1926 pursuant to a Merced Superior Court Order, and stipulates a scheduled quantity of flow rates, measured at Crocker-Huffman Dam, to be maintained by MID. See SWRCB Water Right Order 2004-0041-DWR, In The Matter Of License 2685 (Application 1224), Merced Irrigation District. The largest diversion downstream of the powerhouses is owned by MID itself.

The second thing to understand about the downstream diversions is that they have essentially no storage. That means that their diversions operate, generally speaking, when they need the water. This is overwhelmingly for irrigation, during the dry months. Return flows, if they exist, are a function of irrigation schedules. Neither Crocker-Huffman nor any of the other diversions on the River have storage that enables them to re-regulate the River's flows.

As a result, for about five months out of each year, the diversions at Crocker-Huffman and elsewhere are not operating. *At these times, stream flows are a function of only one thing: what MID is required to release from the project.*

Even when the downstream diversions are operating, the diversions are senior to MID, so MID must release water to satisfy these diversions. It is also MID's job (assuming that it does not want to release water above and beyond what it is required to release) to coordinate with the diverters, and to understand and be able to predict the effect of return flows. In other words, MID controls flows in the Merced with its releases through the project.[1]

[1] Although we reject the "essential cause" standard as irrelevant, it would be met here.

The question for this relicensing is whether there will be any water in the river that is not diverted by downstream users. The timing and magnitude of flows beyond what downstream diverters require is determined by only one thing: the instream flow requirement imposed on the Project. If MID is required to maintain instream flows at particular points in the Lower Merced River below the water diversions, as is currently required, it will release more water than is required for the diversions. If there is no instream flow requirement for MID in the lower Merced River (as MID proposes on PAD page 9-9, proposed license measure 37 with its suggestion to move the compliance point to McSwain Dam) then there is no reason to believe there will be water left in the river.

In short, streamflow in the Merced River is a function of MID's releases, and MID's releases are a function of what it is required to release for senior diverters, plus what it is required to release for instream flow purposes.

For these reasons, releases from the project have a direct connection, or nexus, with the timing and quantity of water in the Lower Merced River. Such releases are also directly, indirectly, and cumulatively connected with resource effects that depend on streamflows, such as fish habitat and habitat for other aquatic life, water temperature, dissolved oxygen and other water quality parameters, sediment transport, and entrainment.

It is equally clear that studies that address these resource effects can inform future license conditions, by altering the timing and quantity of MID's releases. The existing license for the Project recognizes this reality. Specifically, license articles 40, 41, and 42, require PM&E measures downstream of MID's diversion:

> **FERC No 2179**
> **"Article 40.** The Licensee shall provide minimum streamflow in the *Merced River downstream from the project reservoirs in accordance with the following schedule:….(b) At Shaffer Bridge* (RM 32.5) *downstream from Exchequer Afterbay Dam, a minimum streamflow shall be maintained as follows:….*"
>
> "**Article 41.** The Licensee shall, insofar as possible during the period November 1 through December 31, regulate the *Marced* [sic] *River* streamflow downstream from the Exchequer afterbay development between. . . . .*Streamflow shall be measured at Shaffer Bridge* (RM 32.5)
>
> "**Article 42**. The Licensee shall operate the powerplants so as to avoid rapid fluctuation of the Merced River. *At Crocker-Huffman diversion* (RM 52) *, the Licensee shall, insofar as possible, restrict the rate of change of release during any one-hour period* to not more than double nor less than one-half the amount of release as the start of the change. …."
>
> [emphasis added]

Additionally, the FERC license for Pacific Gas & Electric Company's Merced Falls Project (FERC No. 2467) require PM&E measures downstream:

FERC No 2467

"Article 38. Licensee, *for the protection, propagation, and preservation of the fish and wildlife resources of the Merced River* shall coordinate project operations with the project operations of the Merced Irrigation District's Project No. 2179 and shall, insofar as releases from Merced Irrigation District's Project No. 2179 permit, *release past Merced Falls dam* (RM 55) such minimum flows as have been designated in Articles 40, 41 and 42 of the license for Project No. 2179." [emphasis added]

Notwithstanding the diversions downstream, MID has never argued that it is unable to comply with these requirements, or that they are unlawful.

Indeed, in other contexts, MID freely acknowledges that its project affects streamflow and fish habitat throughout the river. MID's Proposed Study Plan makes reference to an MOU signed by MID with the Department of Fish and Game in 2002, and some scientific work that it asserts is being done pursuant to the MOU, "outside the relicensing." In the MOU, the District states why these studies are necessary:

> Through its operation, MERCED's Merced River Development Project, ("Project") as licensed by the Federal Energy Regulatory Commission ("FERC") can materially affect the amount, quality and timing of instream flows downstream of Crocker-Huffman Diversion Dam (lower Merced River), thereby potentially affecting the welfare and success of salmon stocks and other fishery resources in that stretch of the Merced and San Joaquin Rivers. (Recital paragraph B, pp.2-3.)

Conservation Groups agree.

e. MID Operations Are a Direct, Indirect and Cumulative Cause of Lack of Fish Passage

MID states that its hydropower project has no direct, indirect or cumulative connection to salmon or steelhead fish passage or recovery because its Crocker-Huffman Diversion Dam, which is operated jointly with its hydropower operations, blocks anadromous fish passage three miles below the lowermost power plant. MID's characterization is factually and legally incorrect.

First, the evidence suggests that even under recent flow conditions, project configurations, and project operations, a few anadromous fish can attain the Merced River upstream of Crocker-Huffman. (Stillwater Sciences, 2001, page 9). Passage is difficult, but not impossible, for anadromous fish to ascend to the Merced Falls Dam, where they are blocked by the current projects' operational configurations. This establishes a direct connection between

project operations and anadromous fish impacts, and an obvious potential for license conditions to address those impacts.[2]

Second, project operations currently limit fish passage to the base of Merced Falls Dam. Fish passage past Crocker-Huffman is possible only under high flow conditions. See *id.* MID radically limits the frequency, magnitude and timing of high flow conditions through its diversions to storage at New Exchequer, and therefore directly impairs the ability of salmon and steelhead to gain access to the habitat immediately below the projects.

Third, project operations as currently licensed by FERC led directly to changes in management by PG&E and MID that further limit fish passage. The history of fish passage issues around dams in the Merced River prior to 1897 is summarized by Bopp (2008) (Appendix B). By 1928, there were three obstructions to migrating salmon and steelhead in the Merced River: a) Crocker-Huffman Diversion Dam (with a fish ladder) near Snelling; b) Merced Falls Dam (with a fish ladder) about 3 miles upriver of Crocker-Huffman, where there was a natural fall with a deficient fishway; and c) the impassible Exchequer Dam (constructed in 1926), "20 (sic. 7.5) miles above Merced Falls" (Clark, 1929). A decade later, Hatton (1940) considered the spawning areas (for fall run Chinook) to occur between "a point half a mile downstream from a line due south of Balico [Highway 99 bridge, Merced County] and Exchequer Dam". Prior to 1964, when the New Exchequer and McSwain Dams were constructed, anadromous fish could pass to the Exchequer Dam, where they were then blocked by the MID project.

Thus, MID's current project (FERC No. 2179) stopped fish passage above McSwain Dam in 1964, because McSwain Dam did not have fish passage facilities, and because it restricted the amounts of water released downstream that previously facilitated fish passage past Crocker-Huffman Diversion Dam and Merced Falls Dam during high spring and summer snowmelt runoff.

The original Exchequer Dam could only store about 280 taf per year and had to spill the rest (on average, about 750 taf per year). Since its construction in 1964, the New Exchequer Dam is able to store the entire average annual production of the watershed, and significantly and dramatically alters flows on the Merced River downstream.

There were also dam operational measures (in addition to fish ladders) that aided fish passage through the Project to the Exchequer Dam prior to 1964. Prior to construction of the New Exchequer Dam, MID generally took out engineer-designed "removable flashboards" during periods of higher instream flows at the Crocker-Huffman Diversion Dam. This effectively lowered the height required to ascend the dam during high flow periods (3,000 –5,000 cfs), and fish were able to ascend to and pass Merced Falls Dam via the fish ladder or via opened gates (in a high flow mode).

[2] Licensee apparently disputes the fact that some fish may be able to pass Crocker-Huffman during high flows, but it should not be allowed to use a dispute over evidence to establish that no more evidence should be collected.

It was only because project operations for New Exchequer limited further migration of salmon and steelhead that PG&E and MID abandoned these operational mechanisms to facilitate fish passage, and then blocked the fishways at Crocker-Huffman and Merced Falls.

In 1971, the California Department of Fish and Game sent a letter to PG&E (CDFG 1971) which states, in part:

> There is no reason that Pacific Gas and Electric Company should continue passing water over the fish ladder on the Merced Falls Dam …. Requirement for fish water in the ladder at Merced Falls Dam had a value before McSwain Reservoir was constructed; now there is no spawning area available above Merced Falls. The Department of Fish and Game has also requested the Merced Irrigation District to make the fish ladder on their Crocker-Huffman Dam inoperable, so that salmon would not pass this ladder but turn into a spawning channel which has been constructed.

Later that year, the Federal Power Commission sent a letter to PG&E (FPC 1971), which recounts

> . . . your plans to make the fish ladder inoperable at Merced Falls Project No. 2467. You report that the Merced Irrigation District's (MID) McSwain Project No. 2179 has eliminated upstream spawning areas for anadromous fish and that a fish spawning channel has been constructed by MID below its Crocker-Huffman Dam. The California Department of Fish and Game has requested MID to make the Crocker-Huffman fish ladder inoperable, thereby eliminating the need for the operation of the fishway at Merced Falls dam.[3]

Therefore, PG&E's and MID's actions to abandon their efforts at fish passage at Crocker-Huffman and Merced Falls are themselves effects of project operations, which can be mitigated as part of the new license.

It is also worth noting that California state law requires MID to maintain a fishway at Crocker-Huffman (see Fish and Game Code section 5931), and it is likely that the currently abandoned fishway there will soon be restored to operability and improved.

In short, the current partial fish passage condition at Crocker-Huffman Diversion Dam is caused by project operational decisions for instream flows from the New Exchequer Dam, and is also contributed to by current operations at the McSwain, Merced Falls and Crocker-Huffman Diversion Dams, which now are seldom operated in a high flow mode (gates opened) because of the highly impaired and regulated releases from the New Exchequer

[3] Conservation Groups believe there is significantly suitable habitat for anadromous fish between Merced Falls and Crocker-Huffman that can be utilized. In particular, we have observed a small but robust population of O. mykiss that are likely descended from steelhead in that section of the river. This habitat and fish population should be evaluated in this proceeding.

Dam and its storage capacity. *The lack of fish access to historic habitat therefore has a direct and indirect, as well as cumulative, nexus to project operations, and could be mitigated and enhanced with new license terms.*[4]

The current situation can be summarized as follows: MID and PG&E relied on current project operations at New Exchequer to justify shutting the fishways at Crocker-Huffman and Merced Falls. Now the licensees seek to rely on their success in shutting the fishway at Crocker-Huffman to justify rejection of requests to study the impacts of project operations and opportunities for improvement. FERC should not allow the District and the Company to succeed.

Spring- and Fall-run Chinook salmon once thrived in the Merced River up to El Portal on the mainstem and to Peach Tree Bar on the South Fork. Steelhead were among the many visitors to Yosemite National Park, and are reported to have reached Yosemite Valley and, on the South Fork, to have reached Wawona (Yoshiyama *et al.* 2001, Clark 1929). With changes in project operations, it could be so again. Our requested studies are necessary to determine whether that outcome is in the public interest.

e. Crashing Fish Populations Demand Immediate and Forceful Attention on a Watershed-Wide Basis

Conservation Groups have an overriding interest in the conservation and protection of the Merced River, and are seriously concerned with the current status of its anadromous salmonids. Recent numbers of returning fall-run Chinook salmon in the entire San Joaquin watershed, including the Merced River have been precariously low, to the point where fisheries agencies have stated that these fall-run populations are in danger of extinction (Mesick *et al.* 2007).

Returns of fall Chinook salmon (escapement) to the Merced River in 2007 and 2008 are among the lowest on record for two consecutive years, numbering about 450 adult fish last year (combined hatchery and in-river spawners; H. Steve Tsao CDFG Merced River Biologist, pers. communication). This population level is an order of magnitude lower than the numbers that existed when current project operations were established, and it places the Merced River's fall and late fall run Chinook salmon in danger of immediate extinction.

Steelhead populations in the Merced River are currently unknown, but catch statistics and study observations estimate very low numbers in the past several years. All of the applicant's proposed study plans have failed to substantively address the project's potential effects on these federally ESA listed anadromous fish resources of the Merced River.

NMFS (2009a) states: "Assessing the current status of the Central Valley steelhead population indicated that the current populations are severely depressed within the east side tributaries, and an important aspect of the RPA [Reasonable and Prudent Alternative)] analysis for steelhead concerns the status of the Southern Sierra Diversity Group, which is

[4] If "essential cause" were the test, this test would be met here.

critical to preserving spatial structure of the DPS. This diversity group, consisting of extant populations in the Calaveras, Stanislaus, Tuolumne, Merced and Mainstem San Joaquin rivers, *is very unstable due to the* poor status of each population."

The dire conditions and urgent status of Merced River anadromous fish populations emphasize the need for a watershed approach to aquatic habitat management because of the complexities of the environment, along with the large numbers of overlapping, and possibly conflicting, jurisdictions. The Commission, resources agencies, State Water Resources Control Board, licensees, and participants in these licensing proceedings will have to grapple with these fundamental problems, both in the context of this relicensing and of other proceedings undertaken under the respective authorities and responsibilities of the governmental agencies.

A comprehensive planning mission is explicitly contemplated in section 10(a)(1) of the Federal Power Act:

> That the project adopted, including the maps, plans, and specifications, shall be such as in the judgment of the Commission will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for the use or benefit of interstate or foreign commerce, for the improvement and utilization of water-power development, for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat), and for other beneficial public uses, including irrigation, flood control, water supply, and recreational and other purposes… .

Without prejudicing or predicting what might in fact be done in the context of other jurisdictions, a simple and obvious first step towards a watershed-based planning effort that the Commission can take under its own authority is to consider a joint NEPA document for the relicensing applications for the Merced River Hydroelectric Project (FERC No. 2179)-042) and Merced Falls Hydroelectric Project (FERC No. 2467-019) collectively, as FERC (2009b, page 4) has suggested in Scoping Document 1 for the Merced Falls Hydroelectric Project. Should the Commission or the respective licensees decline to conduct a joint proceeding, the Commission should at least order joint conduct of certain studies where the projects work in combination to have resource impacts. Examples of such studies would be *Fish Entrainment, Anadromous Fish Passage,* and *Gravel Sediment Budget and Mobility.*

f. Fourteen Years Without Habitat Improvements for Anadromous Fish

i. The Commission Should Give No Consideration to Studies Proposed by Licensee for Use in Other Venues as Irrelevant and Non-compliant

In section 3.2.11 of the Licensee Proposed Study Plan, MID provides a long list of studies that it is proposing "*outside of the Merced River Hydroelectric Project Relicensing"* for use in several proceedings in California: the successor to the Vernalis Adaptive Management Plan

(VAMP), the San Joaquin River restoration, the Bay-Delta Strategic Plan, water rights hearings, and TMDL processes. Licensee states that:

> As part of the above proceedings, Merced ID, *outside of the Merced River Hydroelectric Project Relicensing*, is presently conducting a number of studies concerning the salmon and steelhead resources of the Merced River pursuant to a Memorandum of Understanding between Merced ID and CDFG. These studies are needed to inform Merced ID and others about the status and condition of the anadromous fish resources in the Merced River downstream of the Crocker-Huffman Diversion Dam, and flows that might be established under the above proceedings. (p. 3-28)
>
> Merced ID is committed to performing these fish studies to help inform Merced ID and others involved in the above proceedings. (p. 3-29).

The clear implication, since the "above proceedings" do not include relicensing, is that licensee maintains that the Commission has no authority to set flows downstream of Crocker-Huffman, in spite of the fact that FERC set flows in that reach of the Merced since the Project was licensed in 1964.

The Commission should clearly rule, first of all, on the extent of its authority to set flows downstream of Crocker-Huffman Diversion Dam, flows that it has set since 1964.

The Commission should give no consideration to these studies (collectively, MOU studies) proposed by licensee for processes "outside the relicensing," because they are irrelevant and more specifically are non-compliant with 18 CFR § 5.9(b). These studies do not conform to *any* of FERC's study criteria. They are not subject to the ILP comment process by agencies and the public. They will not meet Commission deadlines for study plan submittals. There is no certainty that they will be performed at all, let alone on time. There will be no oversight by the Commission on the adequacy and scientific integrity of their performance. There is no specified cost or funding source.

Some of the MOU studies are follow-ons to studies that were conceived and begun by the California Department of Fish and Game as early as 1992, but remain without useful result. Most have gone unperformed; three quarters do not even have study plans completed. Relicensing participants have been promised review copies of studies that heretofore lacked plans. One day before comments are due on licensee-proposed study plans under the ILP, not one new study plan for any of these studies has been produced by licensee.

We note that MID, and others in the San Joaquin River Group Authority, are at present proposing before the State Water Resources Control Board a six year extension of the VAMP at a time when San Joaquin River salmon and steelhead have shown direly low numbers for three years, when pelagic fisheries in the Delta have crashed to a point that many face imminent extinction. This is also a moment when the National Marine Fisheries Service has published a Biological Opinion for salmon and steelhead that explicitly requires greatly increased releases from New Melones Reservoir on the Stanislaus River, and suggests

that as much as a million acre feet a year must pass from the San Joaquin River through the Delta to restore salmon and steelhead in the San Joaquin watershed. (see NMFS 2009a, Appendix 5).

The most unintentionally revealing of the proposed MOU studies are those relating to steelhead: "Steelhead information compilation" and "Steelhead presence." Efforts made by licensee in other venues clearly suggest that the purpose of these studies is to show that steelhead do not exist in the Merced River, and that a Section 7 consultation for steelhead should therefore not be required for this relicensing.

In 2002, the same year that the MID-CDFG MOU was signed, Licensee became a plaintiff in Case 1:06-cv-00308-OWW-DLB, in the Eastern District Court of California, which unsuccessfully sought to delist San Joaquin River system steelhead under the Endangered Species Act for several reasons, including the failure to include hatchery fish in considering listing. Licensee personnel to this day dispute the existence of steelhead in the Merced River, and refer to *O. mykiss* in the lower Merced River exclusively as "rainbow trout," apparently as a matter of District policy. This is in spite of 2008 study results that demonstrated anadromous life history in the maternal origin of a Merced River *O. mykiss* (Zimmerman *et al.* 2008).

ii. CSPA 1995 Complaint, and MID's Unfulfilled Study Promises in Response

On April 14, 1995, the California Sportfishing Protection Alliance filed a complaint with the Commission over the decline of anadromous fisheries in the Merced River. This complaint alleged, among other things, inadequate instream flow requirements. It also documented numerous alleged violations by licensee of those inadequate instream flow requirements over the period 1971 through 1992, amounting to a total of 912 days when licensee was in violation with a cumulative release deficiency of over 54,000 acre-feet. CSPA requested relief from the Commission, including that the Commission: re-open the license and adjust minimum flows; penalize licensee for past streamflow deficiencies and carefully monitor flow compliance; and compel licensee to fund a Merced River ecosystem restoration.

FERC asked MID to comment on this complaint on May 10, 1995. MID responded to this complaint, and that response was summarized by FERC in a February 20, 1998 issuance as follows:

> Your response, filed on June 9, 1995, stated, inter alia, that such a proceeding would be untimely, in light of negotiations currently underway with the California Department of Fish and Game (CDFG) regarding measures to enhance the Merced River salmon and also comprehensive regional negotiations concerning water quality standards for the Bay-Delta.
>
> At this time we are requesting that you provide us with an update concerning the status of these negotiations, any agreements that that may affect water release or anadromous salmonids at the project, and any additional

> comments you may have concerning CSPA's request. By copy of this letter we are also inviting comments of CSPA and CDFG (page 1).

On March 30, 1998, CSPA responded, asking FERC to re-open the license for P-2179, increase minimum flows, provide migration and attraction flows for salmonids, maintain adequate water temperatures, require fish screens, cease flow fluctuations, replenish gravel, reintroduce Spring-run Chinook, provide and protect adequate water quality, consult with federal agencies under the ESA, and comply with applicable laws and requirements for environmental review. In that same letter, CSPA also requested that it be allowed to attend negotiations between MID and CDFG, and that CSPA be provided a copy of any draft agreement between the parties.

On April 21, 1998, MID filed with the Commission a letter heralding "significant recent developments." It announced the imminent presentation of VAMP to the State Water Resources Control Board, and stated that "Merced believes that it is very close to reaching final agreement with CDFG on fishery enhancement and study measures." MID concluded:

> Meanwhile, Merced continues to maintain that CSPA's request to reopen the license is wholly without legal or factual merit. Any action by the Commission to reopen the license at this time would have a most unfortunate effect on the voluntary, good-faith efforts of the District and other stakeholders to address Bay-Delta water quality concerns and to improve the status of salmonid species in the San Joaquin River system.

On June 19, 1998, MID informed the commission that approval of the VAMP by the SWRCB was imminent, that a "San Joaquin River Agreement" had allocated responsibility for meeting VAMP flows, that these flows largely met the flow request of CDFG for the Merced, and that "Merced has made a substantial contribution toward funding the cost of conducting significant studies on the Merced River … . While the source of additional funding to meet the total cost of studies remains an unresolved issue, Merced and CDFG have committed to cooperate in seeking additional funding sources to insure completion of the studies."

The MID letter of June 19, 1998 is particularly notable for its conclusions on page 5:

> 1. CSPA has no standing to seek a license reopener.
>
> 2. CSPA has presented no creditable [sic] scientific evidence that reopening of license terms is warranted. Indeed, all of the parties to the VAMP Implementation Agreement have acknowledged that there currently is a lack of scientific evidence concerning the relative impacts of flow conditions and Delta operations on salmonid populations. This is precisely why the 12-year VAMP study will be undertaken. By the time the studies are completed, Merced will be commencing the process of relicensing the project (the initial license expires in 2014). ***The relicensing process will be the appropriate time and forum for the Commission to assess the need for any***

> ***modifications to the existing license terms concerning minimum flows.*** [emphasis added]
>
> 3. Any action by the Commission to reopen the District's license at this time would be counterproductive in view of the fruitful, voluntary efforts that have taken place to resolve Bay-Delta water quality and Merced River fishery concerns.

On November 16, 2000, the Commission issued an Order requiring another update from MID within sixty days.

On January 11, 2001, MID responded to the Commission. MID noted the conclusion of the San Joaquin River Agreement [organizing responsibility for VAMP], the issuance by the SWRCB of Decision 1641, and appended to its filing a "Scope of Work for Merced River Chinook Salmon Investigations." MID requested that the Commission dismiss CSPA's complaint, and opined that "the type of scientific evidence that would be needed to support any permanent amendment of the New Exchequer Project license will not be available until after two separate studies of at least ten years' duration are completed. Those studies include the ten-year Merced River salmon study described in Ross Rogers' accompanying correspondence, and the VAMP … ." In its January 11, 2001 letter, MID again concluded:

> By the time those studies are completed and adequate data exists to assess the relative impact of freshwater flows and other factors on salmon production and survival, the District will be approaching the end of it current license for Project 2179 (the license expires in 2014). ***The relicensing process will be the appropriate forum to address the needs for any permanent modification to the project's minimum flow requirements or other terms and conditions.*** [page 3, emphasis added].

Of particular import in this presentation of the situation by MID is the fact that ***the District explicitly asked FERC to address flows in the future relicensing proceeding, and drew an explicit line between the flows and the condition of salmon***. In other words, MID advocated the relicensing process as the appropriate forum to address the condition of salmon in the lower Merced River.

On March 5, 2001, FERC issued an order dismissing CSPA's complaint and declining to re-open the license for Project 2179. The order stated that MID has "agreed to conduct a series of studies over the next 10 - 12 years designed to assess the benefits of the augmented flows and to determine factors that may limit salmon production in the Merced River."

iii. The Pattern of Delay Must End

Since CSPA and others raised this issue in the mid-1990s, MID has been citing ongoing studies as the basis for delaying action, but these studies have never been completed. Of the 20 studies that were specifically proposed in the 2002 MOU, study plans have not even been produced for 15. A water temperature model for the lower San Joaquin River watershed was

completed under the auspices of CalFed, but licensee proposes to use only part of it in relicensing. A watershed assessment was completed; however it lacks the specificity needed to inform PM&E measures. A reconnaissance study of possible facility modifications (including to Crocker-Huffman Dam) was completed, but it also lacks the specificity needed to inform PM&E's.

Licensee Merced Irrigation District has actively delayed and deferred consideration of compulsory and effective improvements for anadromous fisheries in the Merced River for fourteen years.[5]

Now that the promised moment has arrived when there is a defined process for redress, MID denies nexus, and thus denies responsibility (see Licensee Proposed Study Plan, page 3-22) to follow through on what it has been promising since 1995, slamming the door once and for all. In doing so, MID directly challenges FERC's authority, something that MID had never done in any of its previous filings. Eight years ago, MID told FERC that the time for the Commission to address these issues was the upcoming relicensing. Today, MID argues that FERC has no authority to address the issues—ever. We hope the Commission rejects this effort.

If the Study Criteria of the Integrated Licensing Process are to mean anything, they must be applied to licensees as surely and fairly as they are to resource agencies or spokespersons for the public interest. They were designed in part to provide certain and timely completion of studies conducted according to accepted scientific practice. They were not designed to be voluntary, or free from the input of relicensing participants, as MID believes all studies relating to anadromous fish should be.

One of the repeated claims made by MID is that it wants ten years to complete the necessary studies. More than ten years after MID first made this claim, many of the proposed studies have not yet been started. Much of the alleged need for long study duration stems from the fact that licensee assumes that significant amounts of water will not be needed to perform the studies over and above water that is released into the lower Merced River in the course of normal operations. It is not accepted scientific practice to wait fourteen years, let alone twenty-four years, to complete studies until Mother Nature provides sufficient water to make those studies convenient. Had outmigrant trapping studies in the lower Merced River been provided with sufficient water to calibrate the percent of outmigrants that are captured in rotary screw traps, DFG and MID might have another MOU study in usable form completed today.

The Commission should order studies of anadromous fish in the lower Merced according to its normal two year time period under the ILP, and make the best use of the information available from those studies and existing information to set PM&E's. Licensee has

[5] This is not the only example of MID using delay as a favored tactic. See Merced Irrigation District, Project No. 2179-019, 63 FERC ¶61,032, (Apr. 06, 1993) (ordering MID to comply with 1964 license term requiring water for wildlife refuges).

consistently abused the effusive deference shown to it by the Commission since 1995 regarding "voluntary" studies of anadromous fish in the Merced River.

There must be finality to process: this principle was a cornerstone of the creation of the Integrated Licensing Process. And indulgence must have limits.

II. CONSERVATION GROUPS' REQUESTS FOR STUDY MODIFICATIONS AND REVISED STUDY REQUESTS FOR STUDIES NOT PROPOSED BY LICENSEE

a. Overview

Merced River Conservation Committee's two March 2, 2009 letters (MRCC, 2009b; 2009c) provided documents to FERC, and filed three new study requests for which detailed study plans were not provided: assessment of environmentally limiting factors for anadromous fish; assessment of risks of extinction of anadromous fish; and documentation of degree of anadromy. As one of the Conservation Groups, MRCC is not providing revised study requests, and hereby withdraws its requests, for these three studies as they were previously described.

Merced River Conservation Committee's March 1, 2009 letter (2009a) commented on four "straw man" study proposals included in MID's (2008) PAD: *Hydrologic Alteration*, *Water Balance/Operations Model*, *Water Quality*, and *Water Temperature Model*. In the same letter, MRCC included detailed study proposals for four studies: *Upper River Fish Populations*, *Anadromous Conservation Hatchery*, *Anadromous Fish Passage*, and *Juvenile Steelhead Habitat*.

In its March 3, 2009 comments on the PAD, the California Sportfishing Protection Alliance requested modifications to the study plans for the *Water Balance/Operations Model* and the *Water Temperature Model* .

In addition, Friends of the River and Golden West Women Flyfishers filed comments on the PAD, but did not explicitly propose study modifications or new study requests.

Conservation Groups, continue to request modifications of the following four studies included in MID's Proposed Study Plan: *Hydrologic Alteration* (PSP Study 2.1), *Water Balance/Operations Model* (PSP Study 2.2), *Water Quality Monitoring* (PSP Study 2.3), and *Water Temperature Model* (PSP Study 2.4). These requests for modification are now made in conjunction with those being made by the Resource Agencies (NMFS, CDFG, BLM, and SWRCB).

In addition, Conservation Groups, in conjunction with the Resource Agencies, request modifications of the following additional studies proposed by licensee: *Bioaccumulation* (PSP Study 2.5); *Reservoir Fish Populations* (PSP Study 3.1); *Fish Entrainment* (PSP Study 3.2); and *Riparian Habitat and Wetlands* (PSP Study 6.1).

Conservation Groups, in conjunction with the Resource Agencies, now also submit revised study requests for ten studies not recommended by licensee. For convenience, we have adopted a numeration system similar to that used by licensee; this system is consistent with that adopted by the Resource Agencies.

Conservation Groups continue to request the following four studies that were previously requested by Merced River Conservation Committee: *Upper River Fish Populations and Habitat* (CG Study 3.1a); *Anadromy Salmonid Habitat* (CG Study 3.1b); *Anadromous Conservation Hatchery* (CG Study 3.3); and *Anadromous Fish Passage* (Resource Agencies'/CG Study 3.4). These studies have been revised since they were originally submitted by MRCC, and the names of two have been slightly changed to more accurately reflect their intent.

Conservation Groups and NMFS, have jointly developed a revised study request for a new study previously proposed by NMFS. This proposed new study is entitled *Gravel Sediment Budget and Mobility* (Resource Agencies'/CG Study G1).

Finally, Conservation Groups support the following revised study requests being proposed by the Resource Agencies. Conservation Groups remind the Commission and licensee that all of these revised study requests were suggested in some form in comments on the PAD by one or more of the commenting parties, many in the Merced River Conservation Committee studies that are now being withdrawn. The revised study requests that are being filed by the Resource Agencies are: *Reservoir Management Temperature Feasibility* (Resource Agencies' Study 2.6); *Anadromous Fish Passage Facilities* (Resource Agencies' Study 3.5); *Flood Plain Habitat Availability* (Resource Agencies' Study 3.6); *Anadromous Salmonid Egg Survival* (Resource Agencies' Study 3.7); and *Instream Flow Study (PHABSIM)* (Resource Agencies' Study 3.8).

b. Description of How Study Modifications and Revised Study Requests are Presented in this Document

Immediately following this description are three tables. The first table shows the name and number of each licensee-proposed study for which modifications are being proposed, briefly describes the proposed modifications, and states which relicensing participants will be filing the modified study plan. The second table shows the name and number of each revised study request, briefly describes the purpose of each revised study request, and states which relicensing participant will be filing the revised study request. The third table is a list of studies that have been agreed to by Conservation Groups, Resource Agencies and licensee; the third table is not discussed further in this document.

Immediately thereafter, using the format of the respective tables as a header for each proposed study modification or revised study request, is a narrative that discusses each study. This narrative may discuss licensee's response to a particular study or to previous comments made by Conservation Groups or Resource Agencies regarding the study, particularly if that response referenced the ILP study criteria. It may also affirmatively discuss the study in relation to the study criteria, or otherwise provide context and clarification of the need for the study.

The proposed study modifications have been filed, as indicated in the table, by the Resource Agencies as redline revisions of the respective study plans proposed by the licensee. The revised study requests for studies not proposed by licensee that have been authored or co-authored by Conservation Groups are provided in numeric order in Appendix A of this

document. The revised study requests for studies not proposed by licensee that were authored or co-authored by the Resource Agencies will be filed by the Resource Agencies.

Conservation Groups have collaborated with the National Marine Fisheries Service, the Bureau of Land Management, the California Department of Fish and Game, and the State Water Resources Control Board in the preparation of the requests for study modifications and the revised study proposals. Conservation Groups support all of the proposed study modifications and revised study requests for studies not proposed by licensee that are listed in Section II of this document.

Table 1: Proposed Modifications to Licensee Proposed Study Plan, Developed and Endorsed Collectively by Conservation Groups, NMFS, CDFG, BLM and SWRCB

1) PSP Study: ***2.1 Hydrologic Alteration***
Modification: *Expand scope at least to current License compliance point, Shaffer Bridge, RM 32.*
[to be filed by Resource Agencies]

2) PSP Study: ***2.2 Water Balance/Operations Model***
Modification: *Expand scope at least to current License compliance point, Shaffer Bridge, RM 32.*
[to be filed by Resource Agencies]

3) PSP Study: ***2.3 Water Quality Monitoring***
Modification: *Expand scope at least to current License compliance point, Shaffer Bridge, RM 32. Sample locations determined by Resource Agencies.*
[to be filed by Resource Agencies]

4) PSP Study: ***2.4 Water Temperature Model***
Modification: *Expand scope at least from Lake McClure Reservoir downstream to the San Joaquin River. Study must include thermodynamic model of Lake McClure Reservoir, McSwain Reservoir and Crocker-Huffman Diversion Pool.*
[to be filed by Resource Agencies]

5) PSP Study: ***2.5 Bioaccumulation***
Modification: *Expand scope at least to current License compliance point, Shaffer Bridge, RM 32..Study must include sediment and fish sampling as determined by Resource Agencies.*
[to be filed by Resource Agencies]

6) PSP Study: ***3.1 Reservoir Fish Populations***
Modification: *Night electrofishing should also be used.*
[to be filed by Resource Agencies]

7) PSP Study: ***3.2 Fish Entrainment (P-2179 Powerhouses)***
Modification: *Expand scope to include MID Canals (Northside Canal at Merced Falls Reservoir and Main Canal at Crocker-Huffman Reservoir) and two private canals at Merced Falls Reservoir. Study methods must include hydroacoustic entrainment sampling (similar to what is in FERC's Study Plan for the P-2266 and P-2310 projects). Study should be coordinated with PG&E.*
[to be filed by Resource Agencies]

8) PSP Study: ***6.1 Riparian Habitat and Wetlands***
Modification: *Expand scope at least to San Joaquin River confluence.*
[to be filed by Resource Agencies]

Table 2: Revised Study Requests For Studies Not Proposed by Licensee, Developed and Endorsed Collectively by Conservation Groups, NMFS, CDFG, BLM and SWRCB

1) Resource Agencies' Study: ***2.6 Reservoir Water Temperature Management Feasibility***
Purpose: An evaluation of engineering alternatives and approximate costs for water temperature management facilities at New Exchequer Dam and Lake McClure, McSwain Dam and Reservoir, Merced Falls Dam and Reservoir, and Crocker-Huffman Dam Diversion Pool (coordinating with PG&E).
[to be filed by Resource Agencies]

2) Resource Agencies'/CG Study: ***G1 Gravel Sediment Budget and Mobility***
Purpose: An assessment of the Merced River's sediment capture in reservoirs, transport, recruitment, and quality related to anadromous salmonid habitat.
[to be filed by Resource Agencies and also filed by Conservation Groups in Appendix A of this document]

3) CG Study: ***3.1a Upper River Fish Populations and Habitat***
Purpose: An assessment of fish populations and habitat upstream of the Project in the upper Merced River.
[filed by Conservation Groups in Appendix A of this document]

4) CG Study: ***3.1b Anadromy Salmonid Habitat***
Purpose: An assessment of anadromous fish population and habitat within and downstream of the Project in the lower Merced River.
[filed by Conservation Groups in Appendix A of this document]

5) CG Study: ***3.3 Anadromous Conservation Hatchery***
Purpose: An assessment of the potential to use a conservation hatchery to restore anadromous fish in the Merced River, and a feasibility study of possible facilities.

[filed by Conservation Groups in Appendix A of this document]

6) Resource Agencies'/CG Study: ***3.4 Anadromous Fish Passage***
Purpose: An assessment/evaluation of potential anadromous fish passage scenarios. Includes the use of SHIRAZ, DHSVM, and RIPPLE habitat and fish population models.
[to be filed by Resource Agencies and also filed by Conservation Groups in Appendix A of this document]

7) Resource Agencies' Study: ***3.5 Anadromous Fish Passage Facilities***
Purpose: An evaluation of engineering alternatives and approximate costs for upstream and downstream fish passage facilities at New Exchequer Dam and Lake McClure, McSwain Dam and Reservoir, Merced Falls Dam and Reservoir, and Crocker-Huffman Dam and Diversion Pool (coordinating with PG&E).
[to be filed by Resource Agencies]

8) Resource Agencies' Study: ***3.6 Flood Plain Habitat Availability***
Purpose: An assessment of flood plain habitat availability in the Merced River between Crocker-Huffman Diversion Dam and the confluence with the San Joaquin River.
[to be filed by Resource Agencies]

9) Resource Agencies' Study: ***3.7 Anadromous Salmonid Egg Survival***
Purpose: An assessment of anadromous salmonid egg survival in the spawning reach from Crocker-Huffman Dam to the current License compliance point, Shaffer Bridge, RM 32.
[to be filed by Resource Agencies]

10) Resource Agencies' Study: ***3.8 Instream Flow Study (PHABSIM)***
Purpose: An assessment of flow versus habitat relationships using 1-D PHABSIM for steelhead and fall-run Chinook salmon. Specific lifestages include: Adult, juvenile, fry, and spawning.
[to be filed by Resource Agencies]

Table 3: Studies Agreed to by Conservation Groups, Resource Agencies and Licensee

1. 4.1 Special Status Bats
2. 5.1 Special Status Plants
3. 5.2 Noxious Weeds
4. 7.1 ESA-listed Amphibians
5 7.4 ESA listed Wildlife
6. 7.5 ESA listed Plants
7. 7.6 CESA listed Amphibians- Limestone Salamander
8. 7.7 CESA Listed Wildlife -Bald Eagle

9. 7.8 CESA listed Plants
10. 8.1 Recreation Use and Visitor Survey
11. 8.2 Recreation River Boating
12. 11.1 Visual Quality
13. 12.1 Historic Property
14. 13.1 Traditional Cultural Properties

c. Description and Discussion of Conservation Groups' and Resource Agencies' Proposed Modifications to MID's Proposed Study Plan (PSP)

1) PSP Study: ***2.1 Hydrologic Alteration***
Modification: *Expand scope at least to current License compliance point, Shaffer Bridge, RM 32.*

Conservation Groups believe that they have addressed the nexus issue and the issue of how the study will inform license conditions in a programmatic manner in Section I above. Section I of this document contains an extensive rebuttal to the programmatic refusal by licensee in Proposed Study Plan Section 3.2.11 to consider project effects downstream of Crocker-Huffman Diversion, and upstream of Lake McClure insofar as upstream conditions relate to fish passage for anadromous salmonids that is blocked as a direct effect of the project.

2) PSP Study: ***2.2 Water Balance/Operations Model***
Modification: *Expand scope at least to current License compliance point, Shaffer Bridge, RM 32.*

In its comments on the PAD, CSPA requested that licensee provide variable input capability for flows required at Vernalis and for agricultural diversions. MID replied that the model contains this capability for Vernalis, Crocker-Huffman Diversion, and the diversion to the Northside Canal. Conservation Groups consider these precise aspects of CSPA's request to be resolved.

In its comments on the PAD, CSPA also requested that MID modify its water balance/operations model to incorporate the consumptive diversions between Crocker-Huffman Diversion Dam and the compliance point at Shaffer Bridge. In its response to CSPA, licensee maintained that CSPA was requesting a new study by asking for nodes between these two points to reflect these diversions, in particular the development of a database to inform the model.

Conservation Groups disagree. First, Conservation Groups believe that they have addressed the nexus issue and the issue of how the study will inform license conditions in a programmatic manner in Section I above. Section I of this document contains an extensive rebuttal to the programmatic refusal by licensee in Proposed Study Plan Section 3.2.11 to

consider project effects downstream of Crocker-Huffman Diversion, and upstream of Lake McClure insofar as upstream conditions relate to fish passage for anadromous salmonids that is blocked as a direct effect of the project.

Conservation Groups maintain that the water balance/operations model as proposed by licensee fails to meet criterion 5.9(b)(6), in that it does not conform to accepted scientific practice. It is not accepted scientific practice to construct a water balance model that only includes selected or convenient hydrologic features of a hydrologic system. It is also not accepted scientific practice to construct a water balance model that does not include essential hydrologic features that affect the resources for which management measures are most critical. The request made by CSPA is a request for a study modification, not a request for a new study.

Moreover, the required data should be readily available to licensee because of licensee's need to meet the requirements of senior diverters, as discussed in section I(d) above. Licensee was not forthcoming in the PAD with information about consumptive diversions in the river reach between river miles 32.5 and 52; so it is difficult to determine what data may be lacking to develop the data needed to support a model. However, based on what is known and on Resource Agency experience, Resource Agencies have revised the study plan to incorporate CSPA's proposed modification and estimate the cost in conformity with criterion 7.

3) PSP Study: ***2.3 Water Quality Monitoring***
Modification: *Expand scope at least to current License compliance point, Shaffer Bridge, RM 32.*

Conservation Groups believe that they have addressed the nexus issue and the issue of how the study will inform license conditions in a programmatic manner in Section I above. Section I of this document contains an extensive rebuttal to the programmatic refusal by licensee in Proposed Study Plan Section 3.2.11 to consider project effects downstream of Crocker-Huffman Diversion, and upstream of Lake McClure insofar as upstream conditions relate to fish passage for anadromous salmonids that is blocked as a direct effect of the project.

Conservation Groups point out that the since the streamflow in the Merced River is a function of MID's releases through the project (see Section I above), MID has a direct effect on the amount of water available to dilute constituent contaminants in the Merced River downstream of the project. Indeed, MID is the only party that is capable of using dilution to mitigate such contaminants in the Merced River. Dilution is a widely recognized means of mitigating or partially mitigating the effects of degraded water quality, as is readily understood by considering the salinity requirements set by the State Water Resources Control Board for the San Joaquin River at Vernalis and at points further downstream.

4) PSP Study: ***2.4 Water Temperature Model***
Modification: *Expand scope at least from Lake McClure Reservoir downstream to the San Joaquin River. Study must include thermodynamic models of Lake McClure, McSwain Reservoir, and Crocker-Huffman Diversion Pool.*

In its comments on the PAD, CSPA requested several modifications to the Water Temperature Model, and questioned certain aspects of how it had been calibrated. MRCC commented on the accuracy of the HEC-5Q model and questioned whether it was best suited to model Lake McClure in particular. Conservation Groups are satisfied that the model and model output as proposed by licensee will be satisfactory for purposes of developing PM&E measures, with the following exceptions:

It is unclear whether licensee proposes to include a thermodynamic model of Lake McClure, and Lake McSwain as part of its study. Resource Agencies have revised the study plan to assure that thermodynamic models of Lake McClure, McSwain Reservoir, and Crocker-Huffman Diversion Pool are part of the study.

Licensee proposed to include output from the model only as far downstream as Crocker-Huffman Diversion Dam. Conservation Groups believe that they have addressed the nexus issue and the issue of how the study will inform license conditions in a programmatic manner in Section I above. Section I of this document contains an extensive rebuttal to the programmatic refusal by licensee in Proposed Study Plan Section 3.2.11 to consider project effects downstream of Crocker-Huffman Diversion, and upstream of Lake McClure insofar as upstream conditions relate to fish passage for anadromous salmonids that is blocked as a direct effect of the project.

Resource Agencies have revised the study plan so that model output reflects conditions in the Merced River from the top of Lake McClure to confluence with the San Joaquin River.

Since these aspects of the model are already available as part of the CalFed water temperature model of which the licensee proposed temperature model is a part, Conservation Groups believe that the only cost added by these requests will be in processing additional model output. Resource Agencies have estimated the cost of this processing and added it to the projected cost of the licensee-proposed study.

5) PSP Study: ***2.5 Bioaccumulation***
Modification: *Expand scope at least to current License compliance point, Shaffer Bridge, RM 32. Study must include sediment and fish sampling as determined by Resource Agencies.*

Conservation Groups believe that they have addressed the nexus issue and the issue of how the study will inform license conditions in a programmatic manner in Section I above. Section I of this document contains an extensive rebuttal to the programmatic refusal by licensee in Proposed Study Plan Section 3.2.11 to consider project effects downstream of Crocker-Huffman Diversion, and upstream of Lake McClure insofar as upstream conditions

relate to fish passage for anadromous salmonids that is blocked as a direct effect of the project.

Conservation Groups point out that the since the streamflow in the Merced River is a function of MID's releases through the project (see Section I above), MID has a direct effect on the amount of water available to dilute mercury contamination in the Merced River downstream of the project. Indeed, MID is the only party that is capable of using dilution to mitigate such contaminants in the Merced River. The Merced River is listed under CWA section 303(d) for mercury impairment. The presence of mercury in fish presents obvious and serious health concerns.

Flows released through the project affect bioaccumulation due to varying velocities, the movement or lack of movement of sediment, and the migration and composition of fish in the River.

Licensee has agreed to measure mercury bioaccumulation in fish present in project reservoirs. Licensee should also be required to measure bioaccumulation in the Merced River downstream that is directly affected by the operation of the project.

6) PSP Study: ***3.1 Reservoir Fish Populations***
Modification: *Night electrofishing should also be used.*

Daytime electrofishing in reservoirs has been shown to be ineffective. At a fish rescue in August, 2008 on Caples Lake (part of FERC Project 184), CDFG and volunteers captured less then thirty fish in eight hours of daytime electrofishing. During the following three nights, over 6000 fish were captured by electrofishing. The study as proposed by licensee fails to meet criterion 5.9(b)(6), in that it does not conform to accepted scientific practice.

Licensee's consultant has raised safety concerns for night electrofishing. CDFG was able to address those concerns, and safely conduct night electrofishing not only with trained personnel, but also with inexperienced volunteers, at Caples Lake, in 2008. The order of magnitude of difference in results when compared to day electrofishing is worth the extra effort needed to safely conduct night electrofishing.

7) PSP Study: ***3.2 Fish Entrainment (P-2179 Powerhouses)***
Modification: *Expand scope to include MID Canals (Northside Canal at Merced Falls Reservoir and Main Canal at Crocker-Huffman Reservoir) and two private canals at Merced Falls Reservoir. Study methods must include hydroacoustic entrainment sampling (similar to what is in FERC's Study Plan for the P-2266 and P-2310 projects). Study should be coordinated with PG&E.*

In Scoping Document 2, FERC has given the Upper and Lower Merced River as the geographic scope of analysis for federally listed Species (p. 10). One of the concerns of Resource Agencies and Conservation Groups in expanding the Fish Entrainment study is to

understand the potential for entrainment of listed species should they be restored to project reservoirs. As given within SD-2, the geographic scope for listed species, some of which may already be present upstream of Crocker-Huffman Diversion Dam, includes the Merced River from upstream of Lake McClure to confluence with the San Joaquin.

Resource Agencies and Conservation Groups have recommended that this study be jointly conducted with licensee of the Merced Falls Project (P-2467); Merced Falls is also currently undergoing relicensing.

8) PSP Study: ***6.1 Riparian Habitat and Wetlands***
Modification: *Expand scope at least to San Joaquin River confluence.*

The issue with this study is simply one of geographic scope. Licensee proposes only to study riparian vegetation in the immediate area of project reservoirs and downstream as far as Crocker-Huffman Diversion Dam. Riparian vegetation can play an important function for anadromous salmonids in the lower Merced River, and is directly, indirectly and cumulatively affected by the operation of the project. Under the geographic scope given for ESA listed species in Scoping Document 2 alone, the scope of this study should be extended to the mouth of the San Joaquin River.

In any case, Conservation Groups believe that they have addressed the nexus issue and the issue of how the study will inform license conditions in a programmatic manner in Section I above. Section I of this document contains an extensive rebuttal to the programmatic refusal by licensee in Proposed Study Plan Section 3.2.11 to consider project effects downstream of Crocker-Huffman Diversion, and upstream of Lake McClure insofar as upstream conditions relate to fish passage for anadromous salmonids that is blocked as a direct effect of the project.

d. Description and Discussion of Conservation Groups' and Resource Agencies' Revised Study Requests For Studies Not Proposed by Licensee, Developed and Endorsed Collectively by NMFS, CDFG, BLM and SWRCB

i. General Comments Applicable to All Conservation Group and Resource Agency Revised Study Requests for Studies Not Proposed by Licensee

Merced River Conservation Committee, in its March, 2009 comments on the PAD, submitted study plans for four proposed studies. These are now being re-submitted by Conservation Groups in revised form. The current iterations of these studies are now entitled: CG Study 3.1a *Upper River Fish Populations and Habitat*; CG Study 3.1b *Anadromy Salmonid Habitat*; CG Study_3.3 *Anadromous Conservation Hatchery*; and NMFS/CG Study 3.4 *Anadromous Fish Passage.*

Conservation Groups emphasize that licensee had little *specific* complaints with any of these four study requests in their original form.

In its March 4, 2009 comments on the PAD, the National Marine Fisheries Service requested two studies: Sediment Budget Estimate and Anadromous Fish Ecosystem Analysis. The first of these two study requests is being submitted in revised form, in conjunction with Conservation Groups as *Study G1 Gravel Sediment Budget and Mobility*. Parts of NMFS's second March study request submittal have been reinvested into separate revised study requests, including Resource Agencies' proposed *Study 3.8 Instream Flow Study (PHABSIM)*, Resource Agencies'/Conservation Groups' joint proposed *Study 3.4 Anadromous Fish Passage,* and Resource Agencies' proposed *Study 3.5 Anadromous Fish Passage Facilities*.

Licensee also took no *specific* exception to either of the NMFS study requests that were filed in March.

In response to MRCC and to NMFS, licensee made a programmatic denial of proposed studies relating to anadromous salmonids in Section 3.2.11 of the Licensee Proposed Study Plan. This denial was based on Study Criterion 5.9(b)(5): In general, Merced ID believes the commenters did not meet the requirements of 18 CFR §5.9(b)(5) regarding Project nexus and how the information for the requested study would be used to inform license requirements.

Conservation Groups believe that they have addressed the nexus issue and the issue of how the study will inform license conditions in a programmatic manner in Section I above. Section I of this document contains an extensive rebuttal to the programmatic refusal by licensee in Proposed Study Plan Section 3.2.11 to consider project effects downstream of Crocker-Huffman Diversion, and upstream of Lake McClure insofar as upstream conditions relate to fish passage for anadromous salmonids that is blocked as a direct effect of the project.

Conservation Groups wish to point out that MID did not comment on these proposed studies with respect to any of the following FERC Study Plan Criteria 18 CFR §5.9(b): Goals-Objectives and Information obtained, 5.9(b)(1); b) Resource Management Goals, 5.9(b)(2); Relevant Public Interest, 5.9(b)(3); Study Methodology consistent with acceptable scientific practice, 5.9(b)(6), and Level of Effort & Cost, 5.9(b)(7).

Licensee did object to MRCC's March request for an Upper River Fish Populations study on the basis of 5.9(b)(4), suggesting that existing information was adequate to characterize fish populations upstream of Lake McClure. This response reflects either inadvertent or deliberate misunderstanding of the goal of the proposed study, which was not to characterize existing fish populations for their own sake, or to characterize existing anadromous fish upstream of Lake McClure, since they have been at least temporarily extirpated from that portion of the Merced River. Rather, the goal as explained below was to use an understanding of existing fish populations to understand the ecosystem conditions for the potential reintroduction of salmon and steelhead upstream of Lake McClure, including the

probable effects of existing non-native fishes on restored anadromous fishes. In discussing MRCC's March study requests entitled *Anadromous Fish Passage* and *Anadromous Conservation Hatchery*, licensee referenced its response to MRCC's requested Upper River Fish Populations study, but did not specify how 5.9(b)(4) applied to these other study requests.

Merced River Conservation Committee also requested three studies for which it did not provide study plans: *Environmentally Limiting Factors for Anadromous Fish, Assessment of Risks of Extinction of Anadromous Fish,* and *Documentation of Degree of Anadromy*. With this filing, MRCC has withdrawn these as topics for proposed studies. However, two additional studies presently proposed by Resource Agencies provide specificity to the intent of the MRCC's previously proposed *Environmentally Limiting Factors for Anadromous Fish*: these are Resource Agencies' Study 3.6 *Flood Plain Habitat Availability,* and Resource Agencies' Study 3.7 *Anadromous Salmonid Egg Survival.*

ii. Supplementary Comments on Specific Conservation Group and Resource Agency Revised Study Requests for Studies Not Proposed by Licensee

1) Resource Agencies' Study: ***2.6 Reservoir Water Temperature Management Feasibility***
Purpose: An evaluation of engineering alternatives and approximate costs for water temperature management facilities at New Exchequer Dam and Lake McClure, and McSwain Dam and Reservoir.

In its March 2, 2009 comments on Scoping Document 1, Friends of the River noted, regarding studies contemplated by licensee:

> But neither does there appear to be any project-element design studies on how to create better temperature-control capabilities of the project that affect downstream waters. Clearly adverse water temperatures from the project have created problems for anadromous fisheries of concern for resources agencies.
>
> One easy traditional approach to that [sic] managing temperatures better at many dams has been the construction of deeper multilevel inlet structures for power production inlets. Use of higher inlets during times of low temperature stress avoids unnecessary depletion of deeper, colder waters. Use of the lower inlet(s) draws on the lowest and, usually, coldest layers of a reservoir's temperature profile. The approach is, by itself, unlikely to be sufficient to solve the anadromous fishery downstream, but it is likely to be helpful. Relicensing is the time to make modifications to project facilities to address resource issues of concern.

This study seeks to address this issue.

Conservation Groups remind the Commission that in processes when studies of possible facility modifications for non-power purposes are not conducted on the front end, an identified benefit of such a modification generally becomes a contentious issue that can lead to impasse late in the proceeding. If nothing else, lack of timely study leads to delay, and tends to push the process over into the 401 proceeding. In the present instance, it could also delay the completion of the Section 7 consultation.

Licensees tend to suggest that any study of a non-power facility modification is premature, and is a request for a PM&E measure in and of itself. It has been our experience that, on the contrary, the absence of study is used to preclude consideration of new facilities for the improvement of beneficial uses other than power production. Licensees prefer to eliminate the pre-condition for a negotiation by saying that a pre-condition is already the negotiation itself, whereas in many cases a study demonstrates the lack of need for a negotiation.

Licensees are rarely known, however, to balk at study of facility modifications for power or water supply purposes. When studies of reasonable non-power modifications do not get the same consideration as studies of reasonable modifications for power purposes, it is fair to talk of a double standard. The equal consideration clause of Section 4(e) of the Federal Power Act should be applied evenly in considering studies.

2) Resource Agencies'/CG Study: ***G1 Gravel Sediment Budget and Mobility***
Purpose: An assessment of the Merced River's sediment capture in reservoirs, transport, recruitment, and quality related to anadromous salmonid habitat.

In its comments on the PAD, NMFS requested that MID perform a new Sediment Budget Evaluation Study. Specifically, NMFS requested that MID develop a sediment budget model for the Merced River, both upstream and downstream of the Project, focusing on spawning gravel requirements for steelhead and Chinook salmon. Deliverables from the study would include channel sediment storage, bedload flux, residence time, and particle size distribution. NMFS did not provide details regarding its study request, but opined that the information for the request could, in part, be obtained without field work, and estimated the study cost to be between $80,000 and $120,000.

Conservation Groups endorse and recommend the NMFS Sediment Budget Estimate study request, as modified and submitted by Resource Agencies and Conservation Groups. Conservation Groups disagree with the licensee that the Study Requests have not met the requirements of 18 CFR§5.9(b)(5), involving project nexus and how information would be used to inform license requirements.

In addition to the programmatic discussion of nexus in Section I of this filing above, Conservation Groups offer the following discussion of project nexus in the specific context of this study.

The direct effect of the project is to trap gravel and sediment in project reservoirs. This requires the licensee from time to time to remove this gravel and sediment when they interfere with project operations. The project contributes (along with the PG&E's Merced Falls Hydroelectric Project) to the modifications of downstream hydrologic conditions to affect gravel and sediment movements (scouring or deposition) that, in turn, may affect benthic macroinvertebrates, fish spawning habitat and behavior, and riparian vegetation.

There are three direct effects jointly caused by the Merced Falls Hydroelectric Project and the Merced River Hydroelectric Project. The first direct effect was initially caused, and then completely and uninterruptedly continued up to today, by the construction of the dams. Those events terminated all gravel and sediment replenishment from the upstream basins to the river below each of the dams. The second direct effect occurs during operations from flow releases of the Merced Falls Hydroelectric Project (and the two MID dams up-river). When flows exceed 3000 to 5000 cfs, benthic gravel and sediment may be displaced and re-deposited, but it is uncertain to what degree project flow causes movement of gravel and sediment (MID-NRS 2003, p. 24). The third direct effect of project operations is the release of relatively clear waters, which causes "armoring" of the riverbed. The project reservoirs trap the downstream movement of gravels and releases clear water, which causes the winnowing of smaller particles in reaches downstream of dams resulting in progressively coarser particles over time. This process of "armoring" occurs in the reach downstream of Merced Falls Dam (Vogel, 2007 p. 66).

Because of these adverse effects of gravel and sediments on the benthic substrates, Vogel (2007) suggested that hydraulic and physical habitat simulation modeling would be necessary to predict available spawning habit following the addition of good spawning substrate. He also recommended, in the event that the fish ladder at the Crocker Huffman Diversion Dam was unblocked and operated for fish passage, an analysis of coarse bedload transport through the Crocker-Huffman Diversion Pool to ensure that continual gravel additions do not result in filling it.

During project maintenance activities, periodic releases of highly turbid water (containing suspended and settleable solids) is also suspected to interfere with fisheries habitat, fishing, and water quality in downstream reaches of the Merced River below the Merced Falls Hydroelectric Project (Vogel, 2007. p. 64). The Merced River Hydroelectric Project contributes to these releases of highly turbid water downstream of its project facilities.

The information generated from this study would used to reasonably inform the Commission for development of potential license conditions and project operations and maintenance needs:

a) gravel additions downstream of Project dam;
b) operational changes to facilitate sediment transport and floodplain inundation;
c) anadromous fish passage into areas with suitable spawning gravels;
d) instream flow modifications to promote channel processes and optimize existing spawning and incubation gravels, and floodplain and riparian habitats.

3) CG Study: ***3.1a Upper River Fish Populations and Habitat***
Purpose: An assessment of fish populations and habitat upstream of the Project in the upper Merced River.

In Section I above, we have demonstrated how the project, in combination with the Merced Falls Project, directly affects fish passage of anadromous fish on the Merced River. We have shown that the project directly, indirectly and cumulatively affects fish passage, and how the project eliminates fish passage for anadromous fish.

Conservation Groups believe that they have addressed the nexus issue and the issue of how the study will inform license conditions in a programmatic manner in Section I above. Section I of this document contains an extensive rebuttal to the programmatic refusal by licensee in Proposed Study Plan Section 3.2.11 to consider project effects downstream of Crocker-Huffman Diversion, and upstream of Lake McClure insofar as upstream conditions relate to fish passage for anadromous salmonids that is blocked as a direct effect of the project.

Licensee objected to MRCC's March request for an Upper River Fish Populations study on the basis of 5.9(b)(4), suggesting that existing information was adequate to characterize fish populations upstream of Lake McClure. This response reflects either inadvertent or deliberate misunderstanding of the goal of the requested study, which was not to characterize existing fish populations for their own sake, or to characterize existing anadromous fish upstream of Lake McClure, since they have been at least temporarily extirpated from that portion of the Merced River. Rather, the goal is to use an understanding of existing fish populations to understand the ecosystem conditions for the potential reintroduction of salmon and steelhead upstream of Lake McClure, including the probable effects of existing non-native fishes on restored anadromous fishes

This study seeks to evaluate the habitat available in the Merced River upstream of Lake McClure in order to understand how best to mitigate the project's effects in blocking anadromous fish passage. Possible PM&E measures that could be developed from this study and inform license conditions include evaluation of which runs and lifestages of salmon and/or steelhead are most likely to thrive in the Merced River upstream of Lake McClure; evaluation of where to truck fish migrating upstream if a "trap and truck" alternative is implemented temporarily or permanently; and where a downstream capture facility might most effectively be located.

One of the means by which Conservation Groups propose to evaluate existing habitat and its suitability for anadromous salmonids is to analyze existing use by resident trout, on the theory that use by resident trout will be similar to that by anadromous trout (steelhead) or by salmon. Conversely, non-use by resident trout at certain times of year may indicate non-suitability in those times of year for anadromous fish. We remind the Commission and licensee that resident rainbow trout are of the same species as steelhead. It is also necessary to examine existing fish communities in order to understand what effect they may have on future populations of restored anadromous fish.

This study has been expanded from its first iteration to include temperature monitoring in the upper Merced River and South Fork Merced River, in order to further quantify the suitability of this watershed and specific parts of this watershed, over time, for restoration of anadromous salmonids.

Extensive further rationale for this study is provided within the study plan itself.

4) CG Study: ***3.1b Anadromy Salmonid Habitat***
Purpose: An assessment of anadromous fish population and habitat within and downstream of the Project in the lower Merced River.

This study proposes population sampling, study to examine success of outmigration, samples to determine anadromy and origin, and several other types of study to do a basic analysis of the condition of the salmon and steelhead fishery in the Lower Merced River. Many of these studies are studies similar to studies listed but neither designed nor completed in the DFG-MID MOU studies.

The only known objection that licensee has to this study is scope. Licensee agrees that a study such as this needs to be done, but does not believe FERC has the authority to order it or oversee it. Conservation Groups disagree, and have addressed the issues of nexus and how the study will inform license conditions programmatically in Section I above.

5) CG Study: ***3.3 Anadromous Conservation Hatchery***
Purpose: An assessment of the potential to use a conservation hatchery to restore anadromous fish in the Merced River, and a feasibility study of possible facilities.

This study proposes to examine whether a conservation hatchery might have a role in restoring anadromous fish in the Merced River, and, if so, how it might be located and operated. The study envisions using such a facility for no more than ten years. A similar approach is being used to restore salmon to the soon-to-be-rewatered portion of the San Joaquin River, and is referenced as an appendix in the study plan.

The only known objection that licensee has to this study is scope. Licensee does not believe FERC has the authority to order such a study or oversee it. Conservation Groups disagree, and have addressed the issues of nexus and how the study will inform license conditions programmatically in Section I above.

6) Resource Agencies'/CG Study: ***3.4 Anadromous Fish Passage***
Purpose: An assessment/evaluation of potential anadromous fish passage scenarios. Includes the use of SHIRAZ, DHSVM, and RIPPLE habitat and fish population models.

This study seeks to provide a framework and conceptual umbrella to fish passage, and seeks to examine different approaches to fish passage issues.

In response to MRCC's original version of this study request, licensee made only a programmatic denial in Section 3.2.11 of the Licensee Proposed Study Plan. This denial was based on Study Criterion 5.9(b)(5). Conservation Groups have addressed the issues of nexus and how the study will inform license conditions programmatically in Section I above.

7) Resource Agencies': ***3.5 Anadromous Fish Passage Facilities***
Purpose: An evaluation of engineering alternatives and approximate costs for upstream and downstream fish passage facilities at New Exchequer Dam and Lake McClure, McSwain Dam and reservoir, and ideally at Merced Falls Dam and reservoir, and Crocker-Huffman Dam and reservoir (coordinating with PG&E).

This study should appropriately be seen as a revision and elaboration of a portion of the Anadromous Fish Passage study requested on March 2, 2009 by MRCC. That previously requested study, and the revised study request 3.4 *Anadromous Fish Passage* as given above, provide a wider framework and conceptual umbrella to fish passage, and seek to examine different approaches to fish passage issues. Revised study request 3.5 will provide greater specificity and detail to the engineering aspects and potential physical structures that may be associated with the provision of fish passage for anadromous salmonids past project facilities and related facilities.

Conservation Groups have addressed the issues of nexus and how the study will inform license conditions programmatically in Section I above.

Conservation Groups and Resource Agencies recommend that this study be conducted by MID jointly with PG&E.

8) Resource Agencies' Study: ***3.6 Flood Plain Habitat Availability***
Purpose: An assessment of flood plain habitat availability in the Merced River between Crocker-Huffman Dam and the confluence with the San Joaquin River.

This revised study request gives specificity and shape to a defined portion of the Limiting Factors Analysis that was proposed by Merced River Conservation Committee in its March 2, 2009 comments on the PAD, but for which MRCC did not provide a formal study plan.

The only known objection that licensee has to this study is scope. Licensee does not believe FERC has the authority to order such a study or oversee it. Conservation Groups disagree, and have addressed the issues of nexus and how the study will inform license conditions programmatically in Section I above.

9) Resource Agencies' Study: ***3.7 Anadromous Salmonid Egg Survival***
Purpose: An assessment of anadromous salmonid egg survival in the Merced River from Crocker-Huffman Dam to the confluence of the San Joaquin River.

This revised study proposal also gives specificity and shape to a defined portion of the Limiting Factors Analysis that was proposed by Merced River Conservation Committee in its March 2, 2009 comments on the PAD, but for which MRCC did not provide a formal study plan.

The only known objection that licensee has to this study is scope. Licensee does not believe FERC has the authority to order such a study or oversee it. Conservation Groups disagree, and have addressed the issues of nexus and how the study will inform license conditions programmatically in Section I above.

10) Resource Agencies' Study: ***3.8 Instream Flow Study (PHABSIM)***
Purpose: An assessment of flow versus habitat relationships using 1-D PHABSIM for steelhead and fall-run Chinook salmon. Specific lifestages include: Adult, juvenile, fry, and spawning.

Instream flow studies are performed in virtually every FERC relicensing process. The instream flow study proposed by CDFG is based on the FERC-approved study currently being carried out in the combined Yuba-Bear/Drum Spaulding proceeding, with adjustments made to model habitat for anadromous fish.

The only known objection that licensee has to this study is scope. Licensee agrees that a study such as this needs to be done, but does not believe FERC has the authority to order it or oversee it. Conservation Groups disagree, and have addressed the issues of nexus and how the study will inform license conditions programmatically in Section I above.

Respectfully submitted,

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APPENDICES A & B

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APPENDIX A

CG Study Request 3.1a

UPPER RIVER FISH POPULATIONS & HABITAT

July 15, 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 Project Area. Both species are considered valuable sport fishes in the State of California.

The Project and the four Merced River dams (New Exchequer, McSwain, Merced Falls, and Crocker-Huffmann Diversion Dams) totally block volitional passage of anadromous fishes. These four dams perpetuate and exacerbate human interference with the movement of migratory fishes in the Merced River, which began in the 1850s. 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).

Continued project operation and maintenance (O&M) of, or new construction for, the Merced River (and Falls) Hydroelectric Projects have the potential to affect environmental conditions for fish life in Lake McClure, along with the Upper Merced River and its tributaries. These potential environmental effects include: introduction of non-indigenous fish genetic lineages (*Oncorhynchus mykiss* or steelhead/rainbow trout), introduction of other indigenous fish species (*Oncorhynchus tshawytscha* or Chinook salmon), competition with existing fish populations, introduction of non-native fish species, water temperature, quantity, and quality; entrainment at diversions and intakes; and changes in physical habitat (e.g., lake elevation changes or extent of littoral zone). Through these effects, the project could affect fish populations in Upper Merced River stream reaches, including the South Fork, which is managed as a "Heritage and Wild Trout" river by California Department of Fish and Game.

The project originally blocked, and continues to block, volitional passage for anadromous salmonids, with the construction of New Exchequer Dam (along with partial migration blockage at Crocker-Huffman Diversion Dam). These barriers restrict available breeding and rearing habitats for these species throughout the entire Merced River. Upstream

conditions need to be evaluated to provide data/information in the process of determining alternatives, feasibility, and potential mitigation for the projects.

- Rainbow trout and Chinook salmon in the reservoir may migrate upstream and may affect the genetic composition of fish in the upper river
- Planted fish (rainbow trout) in the upper river may affect the genetic composition of fish in Lake McClure
- Existing fish populations could directly compete for habitat with newly introduced species
- If fish passage for anadromous salmonids is provided in the future through the two FERC licensed Merced River Projects and upstream, population condition and suitability of aquatic habitat need to be evaluated to provide an understanding of the feasibility, as well difficulties, costs, and constraints, with respect to such passage prescriptions.

Applicant (MID, 2008) has proposed a Fish Population Study in Project reservoirs and in the Merced River from Merced Falls Reservoir to Crocker-Huffman Diversion Dam-Study 3.1), which characterizes fish species composition, relative abundance, and size in Project impoundments and the reach between McSwain and Crocker-Huffman Diversion Dams. It does not address the issue of upper Merced River populations and the potential for Habitat Expansion for anadromous salmonids.

This Study Request addresses the following issues as identified in Section 8 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 should confer with Resource Agencies and American Indian Tribes that participated in development of this study proposal; at this time, Resource Agencies have not yet identified specific management goals relevant to this Study Request. 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). The following management goals should be considered:

- Maintain reservoir levels to protect beneficial uses.
- Protect and enhance stream and reservoir fishing opportunities consistent with overall fishing-based recreation.
- Maintain reservoir levels to enhance a sustainable rainbow trout (and Chinook salmon) fishery in Lake McClure and its upstream tributaries.
- Maintain reservoir levels and habitat availability for "assisted" anadromous salmonid species.
- Populations of native aquatic biota, including fish, benthic macroinvertebrates, and riparian species are viable with adequate habitat consistent with species' needs. Maintain, enhance, or restore all life stages of native aquatic species.
- 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.
- Provide fish bypass by construction, maintenance, or operation of any dam which impedes passage of fish *sensu* California Fish and Game Code 5901 and 5930 *et seq*
- Provide fish bypass alternatives for Endangered Species Act consultation.
- Develop feasible alternatives for fish passage prescription (FPA § 18 Fishway Presciption)

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 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 to establish data and information to be used in National Environmental Policy Act (NEPA) environmental impact assessment(s), Water Quality Certification, § 401, Clean Water Act, Endangered Species Act, and Federal Power Act § 18 consultation or prescription in the public interest. Study is needed to provide data, information, and alternatives to protect and enhance species of concern, threatened or extinct populations of California Central Valley Steelhead Trout, Central Valley spring-run Chinook salmon, and fall- and late fall-Chinook salmon in the Merced River watershed to establish data and information useful in developing protection, mitigation, and enhancement (PM&E), Section 7 consultation, ESA 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 interests of fishing, public's use and utilization of anadromous fisheries resources, 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, allow 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 dam and project operations should be examined for fish passage. The information and alternatives to fish passage may provide useful information in developing protection, mitigation, and enhancement (PM&E), consultation with California Department of Fish and Game public trustee responsibilities for the Merced River (CDFG, 2003).

- 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.

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

- The applicant received potential study recommendations and issues by Relicensing Participants in August 2008. Applicant chose to ignore or consider "information sufficient" and to not develop "Preliminary Proposed" studies to address Anadromous Fish bypass and restoration (MID, 2008).
- The applicant proposed a "fish population survey" in the McClure and McSwain impoundments and in the Merced River between Merced Falls and Crocker-Huffman Diversion Dams, but did not propose studies to evaluate anadromous fish in the broader "geographic scope", outlined in the FERC Scoping Document 2 for the Merced River Hydroelectric Project (FERC, 2009). The applicant stated that anadromous fish do not occur in the Merced River upstream of the Crocker-Huffman Diversion Dam, and thus, the Merced River Hydroelectric Project has no effect on the upstream migration of special-status fishes. Operations of the Project (in conjunction with the PGE Merced Falls Hydroelectric Project) have major modifying effects upon Merced River flows, which are significantly different that "run-of-the-river flows", and have a significant effect on "tailwater" habitats and conditions for anadromous fishes.
- The applicant stated that California Central Valley Steelhead Trout DPS were reported on USFWS species lists (MID, 2008); MRCC indicates in a recent query to USFWS, both the steelhead trout and Chinook salmon are reported from the USGS Merced Falls and Snelling Quad maps, and the MID information is not complete and accurate.
- The extirpated population of spring-run Chinook salmon historically occurred in the Merced River, but the MID-PAD (2008) did not further consider spring-run Chinook salmon (*Oncorhynchus tschawytscha*) because of their historical extirpation from the Merced River (MID PAD, pg. 8-25). There are efforts in the San Joaquin River basin to re-introduce this fish, 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, useful in development of protection, mitigation and enhancement (PM&E) measures relating to the effects project structures, operations and maintenance, which may include:

- Reservoir operations
- Reservoir fish stocking and management of recreational fisheries
- Alternative anadromous fish bypass options
- In-stream flow requirements to keep in good condition any fish that occurs below the project

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 Applicant and the Relicensing Participants concerning the Project effects on maintenance and enhancement of juvenile Steelhead trout abundance and distribution (*O. mykiss*) in the Merced River and other anadromous species. The objectives of the Study Request are to provide:

- Information on project-affected streams to allow for evaluation of the health of fish populations, especially special-status fishes;
- Information on project-affected streams to allow for evaluation of differences between fish populations in project-affected streams and unimpaired streams of similar size, streamflow and elevation; and
- Information on project-affected streams to allow for the evaluation of potential project-related effects on the health and size of fish populations.

Following is a list of study objectives that apply depending on the reach, sampling method, and purpose of sampling effort:

- Characterization of fish species composition and relative spatial distribution;
- Estimate of total or relative abundance;
- Analysis of population size-structure and age-class structure;
- Calculation of condition factor; and
- Establish a baseline genetic characterization of upper River rainbow trout populations.

5.0 Existing Information and Need for Additional Information

Stillwater Sciences (2008) provides the most recent summary of fish studies for the Merced River; they reported (2007) that very little is known regarding the composition, distribution, and relative abundance of fish in the Merced River outside of Yosemite National Park (AMFSTP 2002; Stillwater Sciences 2002, 2006, 2007, 2008). Although a number of studies have been conducted within the Park, many of the results are not readily available to the scientific community and the public. Prior to this recent study, resident fish data from the Upper Merced River is limited to Yosemite National Park.

Historically, the lakes and streams of Yosemite National Park were fishless above 1,800 m (6,000 ft). For the mainstem Merced River, this corresponds to roughly the Nevada Falls location (~RM 128), just downstream of Little Yosemite Valley where the river sits slightly above 1,800 m. In the mid 1800's, stocking by recreational groups began to introduce fish into formerly fishless lakes and streams in the Park. A predecessor to CDFG began stocking in the early 1900s and became the exclusive fish stocking organization by the 1940's. In 1972, the National Park Service banned artificial stocking within Park boundaries, however limited stocking by CDFG continued until 1991(Knapp 1996). Rainbow trout stocking continues on the upper Merced River below the designated wild trout section (Foresta Bridge). Overall, approximately 75% of Yosemite National Park's lakes and at least 60% of its streams were stocked with trout (Elliot and Loughlin 1992, Wallis 1952; cited from Knapp 1996). In stocked, formerly fishless lakes in Yosemite National Park, the trout community was dominated by rainbow trout, a species native to the park, which were present in about 75% of the stocked lakes (Botti 1977). Data was collected on species, reproductive status, number, and size of fish using creel census and snorkeling spawning habitat. Notes were also made on basic aquatic plants and food availability was examined using general BMI surveys. Brook trout, an introduced species, were present in approximately 35% of the lakes and golden and brown trout were present in less than five percent of the lakes. A 1977 survey, six years after stocking had stopped, showed that 40% of formerly fishless lakes could not support a fish population and returned to a fishless state. Presence of the native rainbow trout decreased most dramatically, declining to 30%. Brook, brown, and golden trout presence also decreased slightly (Botti 1977). These lakes continued to lose fish species, with over half of the formerly stocked lakes being fishless by 1992 (Elliot and Loughlin 1992, Wallis 1952; cited from Knapp 1996).

Fish populations in stocked streams were more stable; approximately 95% became self-sustaining (Elliot and Loughlin 1992, Wallis 1952; cited from Knapp 1996). Fish surveys in Yosemite Valley include a CDFG study in the early 1990's and a study by Brown and

Short (1999) designed to expand on the 1993–1995 USGS NAWQA studies in the upper Merced River. Results of both surveys indicated low fish species richness in Yosemite Valley. The CDFG study was carried out to inventory Valley fish populations and determine the impacts of altered instream and streamside habitat on those populations. Twelve sections of the Merced River, each 100 meters in length, were surveyed using boat and backpack electrofishing and snorkeling. Results indicated over 1,300 rainbow trout and 2,700 brown trout per mile. Rainbow trout densities were greatest in high and medium gradient boulder habitat with pocket water and runs, while brown trout were the most common in pooled cobble, moderate gradient gravel cobble boulder pocket water, and wide gravel sand runs and pools with woody debris. Both young-of-year and adult Sacramento sucker were found throughout the Valley reach.

Brown and Short (1999) reported that at Yosemite Valley sites, only three species of fish, brown trout, rainbow trout, and Sacramento sucker were observed. Low numbers of trout, particularly brown trout, were attributed to difficult snorkeling conditions, and perhaps differences in distribution between years. Many of the suckers seen were small young of-the-year, so despite large observed numbers, sucker biomass was relatively low. Additionally, the authors concluded that high discharge and low water temperatures in 1995 likely delayed spawning compared to 1993 and 1994 resulting in individuals too small to be detected by the surveying techniques used. These results, combined with the apparent importance of physical barriers (e.g., bridges) in determining species distributions, led the authors to conclude that fish community structure was not a useful indicator of habitat and water quality in Yosemite National Park.

Stillwater Sciences (2007, 2008) conducted qualitative fishery surveys in the Merced River. There are 40 fish species that are currently known to occur in the area or are likely to occur in downstream areas. Five of these species are or may be anadromous. Twelve of the fish species are native to the Merced River. Of the 38 species in the lower river, 12 are native species. Of the 19 species in the upper river, 8 are native species. In the most recent study, Stillwater Sciences recorded the presence of 13 species in the Upper Merced River, and 29 species in the lower Merced River. Martin (2008, Table 3) summarized known information on seasonal timing of migration, spawning, incubation, and rearing life stages for 3 important anadromous and resident fish species (*eg*. spring-run Chinook salmon have been extirpated from the Merced River, but are included as they are considered historic occurrences).

While this information is useful, it does not address all study reaches or all data needs. 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 would be selected prior to selecting equivalent sampling sites on the South Fork of the Merced River.

6.0 Study Methods and Analysis

6.1 Study Area

The study area includes all stream reaches affected by the project, including Lake McClure, the mainstem Merced River and the South Fork of Merced River. Since all of these river reaches have been influence by fisheries management activities such as introductions of non-native species or stocking of native species, conditions will be evaluated or referenced to the Stillwater Sciences (2008) "fish hypothesis" approach of the Merced Alliance biological monitoring and assessment, although this effort will serve as an assessment of project operation "baseline" conditions as of 2009-2010. 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 have 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 General Concepts

The following general concepts apply to the Study Request:

- 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.
- Field crews will be trained to identify sculpins/cottids. Incidental observations of sculpins/cottids will be recorded on data sheets.
- All special-status species observations will be submitted to the California Natural Diversity Database.
- If a field crew encounters an amphibian or reptile which they cannot identify, take a minimum of three photographs with as plain a background as is available/feasible: (1) ventral (underside) of animal, including head and legs, (2) dorsal (upperside) of animal, and (3) lateral (side) view of head. Habitat photos of the area would also be helpful. Include some commonly known item in each photograph, as a size reference (e.g. a coin or pencil).
- 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

"Representative" and "focused" sampling will be performed. 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.

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 *et al.* 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 US 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 anadromous fish blockage(s). .

Two consecutive years of data will be collected with the first year being 2009 at all Level II sites unless CDFG, FS, 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 this is not necessary .

After year 1, Level I site data would be reviewed by CDFG, FS, 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.

For providing oversight and monitoring of technical issues in the study design and conduct, an oversight committee, including technical/scientific representatives, will form the Merced River Aquatic Technical Working Group or ATWG. The group will provide consultation and input to the Applicant (and their consultants) on technical issues with the study. The Relicensing Participants and the Applicant will agree to the composition, rules, and operation of the committee.

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, influence by the two projects, 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.

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)

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 determine 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.

When encountered with large numbers of fish where sedation is necessary for safe and efficient handling, a sedative will be used. Fish will be sedated by either gas or tablet form CO_2. Applicant will only use a sedative if prior written permission is obtained from CDFG (and NMFS for fishes within NMFS' jurisdiction or USPS).

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

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' 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, *et al.* (2007), who recommends 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.

Assess the condition of anadromy. The condition of anadromy will be determined genetic markers (Single Nucleotide Polymorphism or SNP) from DNA extracted from fin clips (Aguilar and Garza, 2007; Donohoe *et al*., 2008) to determine resident or anadromous nature of *O. mykiss*.

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).

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 at 19

locations give a complete watershed profile for temperature conditions for a selected water year.

Level II Snorkeling

Level II snorkeling may need to supplement electrofishing at specific and limited locations where Level II electrofishing is not possible, such as deep pools.

According to O'Neal (2007), snorkeling is often feasible in places where other methods are not; for example, deep, clear water with low conductivity makes quantitative electrofishing prohibitive. Species composition, presence/absence, relative abundance, general size class and habitat use information can be obtained with snorkeling techniques (Slaney and Martin 1987; O'Neal 2007).

Snorkeling surveys will be conducted to supplement electrofishing in habitat types that do not lend themselves to electrofishing, based upon depth, current velocity, and other physical considerations (e.g., access or safety). Snorkeling techniques will generally follow those outlined by Thurow (1994), Dolloff *et al*. (1996), and O'Neal (2007). Surveys will be conducted during the day and during periods with the low annual turbidity levels (generally late summer).

If snorkeling surveys are to be performed within a section of stream where electrofishing has occurred, snorkeling surveys will be conducted immediately after electrofishing is complete. Snorkel lanes will run the full length of each sample unit within the survey site. One diver will swim a lane. Generally two to three divers (as determined by the wetted stream channel width at each site) will snorkel the lanes 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.). Observers will calibrate estimated fish lengths by viewing painted wooden dowels of varying known lengths underwater. 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 on a standardized fish snorkeling survey form and attached to the electrofishing form for the site. The site information and habitat metrics collected for the electrofishing prior to snorkeling will be used for the snorkel datasheet (see Attachment 2). Snorkeling data will be analyzed separately from the electrofishing data.

6.3.3.2 Level I Sampling

Level I qualitative sampling will provide species presence/absence, relative composition, size class frequency, catch per unit effort (CPUE), and distribution. Level I differs from Level II as it is an open sampling approach that only provides qualitative, descriptive data.

Level I Electrofishing

Level I electrofishing will be used for presence/absence, relative composition, length frequency, and relative distribution assessment only. Captured fish will be retained in aerated buckets and/or live cars until sampling is completed. Fish will be sedated as necessary. 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). 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). Captured fish will be released back into the sampling area following completion of the electrofishing effort. Mortalities and fish condition (spinal trauma, burning) will be noted and recorded prior to release. All effort will be made to ensure sampling activities in the field will minimize potential injury or mortality to aquatic species. All data will be recorded on a standardized electrofishing form (see Attachment 3).

Crew size will be limited to 2-3 persons. Level I electrofish sampling will be "spot observations" within accessible locations of a specified reach. A "spot" is defined herein as a uniform area in the stream where, in the opinion of the fisheries biologist performing the Level I sampling, fish are most likely to be found (i.e. pool, undercut bank, pocket water, under cover, root wad, etc.). To the extent possible, clusters of spot locations will be spatially balanced throughout a reach. Alternatively, spot locations will be habitat-unit balanced, if spatially balanced locations are not accessible or unsafe to sample. Spot clusters will be numerous, non-uniform, short (1-2 meso habitat units each), and will vary in length generally from 5 to 10 feet. Sampling effort will be recorded from the electrofisher timer and converted to CPUE.

The number of spot samples will be based upon the length and size of the stream segment to be sampled. The Applicant' prescribed number of spots—also called target spot number—is identified in Attachment 1. The target spot number represents the Applicant' best estimate of the minimum number of spots required to characterize fish assemblages in the stream at Level I goals. For example, a stream prescribed with a target spot number of 50 may require more spots to provide sufficient catch to characterize stream populations. Electrofishing crew leaders will be informed of the known species

composition within a reach to be able to determine if sufficient characterization has been achieved (i.e. the majority, if not all species have been collected). The actual number of spots required will be determined in the field using professional judgment. Additional effort will be limited to no more than twice the prescribed target spot sample number.

To the extent possible, spot samples will generally be located in areas where habitat mapping is available. Habitat data collected during Level I sampling is shown in the field datasheet in Attachment 3.

Level I Snorkeling

Level I snorkeling will supplement Level I electrofishing at specific and limited locations, as necessary, where Level I electrofishing is not possible.

Level I snorkeling will be used to supplement electrofishing where habitat is inappropriate or unsafe to electrofish. Fish will be enumerated, identified to species and length will be visually estimated to size class in increments of 0-2 in., >2-4 in., etc. Crew size will generally be limited to 2 persons. Level I snorkeled sites will be "spot observations" within a specified reach. Snorkeling data will be separate from electrofishing data.

6.3.4 Focus Sampling – Upper Merced River Watershed Thermal Refugia Assessment

The purpose of this focus study is to determine trout habitat use of mainstem Merced River, between Yosemite Valley to the park boundary (El Portal), and the South Fork, Merced River 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).

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). 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 on a standardized fish snorkeling survey form similar to the Level II snorkel sheet used in the Representative Sampling effort (see Attachment 2). In addition to data collected within the Level II 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.

The applicant will review the sampling design and protocols from previous Merced River fish studies [California Department of Fish and Game and Stillwater Sciences (2008)], incorporate, and report all methods and evaluations into the current study effort (e.g., Attachment 4).

6.4 Information Analysis

Following a quality control/quality assurance review, data will be entered into and organized in an Excel spreadsheet. Some parameters may be analyzed in Excel while other parameters will be analyzed using published public domain scientific software for calculating stream fish population statistics. While all species will be recorded, small sample sizes of some species may limit some statistical analyses.

6.4.1 Level II Sampling Data Analyses

The following is a description of the analyses that will be performed on all data collected during the Level II representative sample methodology. Level II sampling is a closed sample approach that will allow for statistical assessments.

6.4.1.1 Age structure

Analysis matrices will be based on age classes. Existing length-age indices will be used to determine the age class. Length-age indices are relatively accurate for smaller fish; however, confidence intervals reduce with larger fish. Scales collected as described above will be read to assist in identifying age class breaks. Regression analysis will be used to analyze the data and if necessary, adjust the indices.

6.4.1.2 Fish Populations and Biomass

Standing stock estimates in terms of fish population numbers and biomass will be calculated by species for each monitoring station and analyzed by age class. Electrofishing data will be analyzed using a scientific software package (e.g. Microfish or other similar program). Capture probabilities (the proportion of fish captured on a given electrofishing pass), size statistics, and biomass will be generated for each sample site using fish capture data. Biomass will be calculated based upon total weight measured for each species. Standing stock estimates will be reported as: 1) numbers and weight (g) of fish by species per 100 m of stream; 2) numbers of fish by species per mile; 3) pounds of fish by species per acre of stream surface; and 4) kilograms of fish by species per hectare.

Fish population analysis will include species composition, relative abundance, and an analysis of size structure based on relative stock densities. To provide an index of size structure for each site, traditional relative stock densities (RSD) of each species will be calculated. The RSD will be presented on a scale of 0 to 100 (Anderson and Neumann 1996). RSD will be calculated as the proportion of fish sampled greater than 6 inches, i.e.: RSD = (# of fish >6-inch in sample) /(# of fish in sample) x 100. The 6-inch length was chosen because it is often used as the smallest size where fish are desired by anglers. A high RSD indicates that a greater proportion of the population consists of fish in the size class desirable to anglers.

(# of fish in sample) x 100. The 6-inch length was chosen because it is often used as the smallest size where fish are desired by anglers. A high RSD indicates that a greater proportion of the population consists of fish in the size class desirable to anglers.

6.4.1.3 Fish Size and Condition

Fish size and weight data will be summarized by species and by sample site. Standard scientific software outputs including minimum, maximum, and mean fork length and weight will be calculated. Length and weight data will be used to calculate a relative condition factor (K_n) (Anderson and Gutreuter 1983) and to provide a general indication of the health of individuals, where factors greater than 1 indicate more healthy

individuals. Relative condition factors for electrofishing sites will be calculated for length and weight data collected at all quantitative electrofishing sites.

6.4.2 Level I Sampling Data Analyses

Level I sampling is an open sample approach that will only allow for qualitative assessments. Fish population analysis will be limited to a summary of species composition, size, relative abundance, CPUE comparison and distribution. Accurate size measurements will allow for length frequencies to be developed and determination of age class.

6.5 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 Level I and Level II sampling, invite interested Relicensing Participants into the field to comment on the selected Level I and II 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.

6.6 Schedule

Applicant anticipates the schedule to complete the study is as follows in two consecutive years, with the first year being in 2009:

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

6.7 Consistency of Methodology with Generally Accepted Scientific Practices

Electrofishing and snorkeling are widely accepted methods for sampling fish populations in stream habitats. The sampling methods in this study plan are described in *Fisheries Techniques 2nd Edition*, a special project publication by the American Fisheries Society (Reynolds 1996); *Salmonid Field Protocol Handbook: Techniques for Assessing Status and Trends in Salmon and Trout Populations* (Temple and Pearsons 2007); *Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities as Part of the National Water-Quality Assessment Program (*Moulton *et al. 2002); and Methods for Sampling Fish Communities as Part of the National Water-Quality Assessment Program (*Meador *et al. 1993)*. These publications are comprehensive references for sampling and data collection methods in fisheries science.

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) Calculations of fish condition factors using measured weight and length data for Level II sample sites; and
5) Summary of species composition, relative abundance and relative density for Level II sample sites.
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 6.4, 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 2009 dollars is as follows:

2009 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**

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ATTACHMENT 1

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

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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 2007 & Fall 2008. 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

Stream	River Reaches:	Level II	# of Sites	Level I	Target Spot # Per Site	Comment or Rationale
	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".
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.

Stream	River Reaches:	Level II	# of Sites	Level I	Target Spot # Per Site	Comment or Rationale
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.
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.

Stream	River Reaches:	Level II	# of Sites	Level I	Target Spot # Per Site	Comment or Rationale
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

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Page A

LEVEL II - Electroshocking

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: ______________ [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: ____________ [redacted]

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)

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

	Obs					Length Class (inches)				
Pass	#	Species	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

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ATTACHMENT 3

Level I Representative Sampling Field Data Form

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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: _____ (Lat deg. (39º)) º _____ (Lat mins (49.510)) N _____ (Long deg. (121º)) º _____ (Long mins (34.051)) W **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%)

_____ (Riffle) + _____ (Pool) + _____ (Glide) =100%

% Cover (nearest 5%)

_____ (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: ____________ 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: ______________________________

[redacted]

Snorkeling Fields Only

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

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

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ATTACHMENT 4

FISH STUDY SURVEY PROTOCOLS AND METHODS

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Fish Study Protocols

5.2.3 Fish Study

The baseline fish population monitoring surveys were designed to complement information available from current and ongoing studies (Section 5.3.3 of Volume I) and to ensure compatibility with ongoing data collection efforts to the maximum extent possible. Observations of species composition relative to habitat, made during the fish surveys, in combination with available pre-existing data, were intended to provide information to support future restoration activities by associating fish habitat type use and timing within the Merced River.

5.2.3.1 Objectives

The objectives of the baseline fish monitoring task were to: 1) document baseline fish community species composition (native and introduced) in the Merced River; 2) identify spatial patterns in fish species composition and distribution at multiple habitat scales (e.g., segment, reach, habitat unit, microhabitat) and during seasonal shifts (e.g., late winter/early spring, late spring/early summer, late summer/early fall); 3) document fish use of specific habitat types in order to better link habitat characteristics to species-specific life history requirements, and; 4) address specific fish hypotheses, as detailed in the next section.

5.2.3.2 Hypotheses

The upper river fish distribution hypotheses incorporate recommendations made by Kisanuki and Shaw (1992) following their habitat mapping studies in Yosemite National Park.

Upper river fish community hypotheses:

1. In the upper Merced River, thermal stratification in large, deep pools provides temperature refugia for trout species. Therefore the longitudinal distribution of trout species will be correlated with pool distribution in reaches where water temperature might otherwise be too warm.
2. Rainbow trout abundance will be greatest in upper Merced River mainstem reaches that have been restored for spawning habitat (Appendix A, Table A-1) and will exceed pre-restoration observations made by Kisanuki and Shaw (1992).

5.2.3.3 Methods

The fish sampling design is summarized in Table 5-5 and described in more detail in the remainder of this section. In general, the study elements focus on fish

community composition and distribution in the upper segments of the Merced River, as well as habitat associations at multiple spatial scales.

Overall, fish survey timing will be based on species biology and life history timing in order to collect data at ecologically meaningful time intervals. In the lower river segment, summertime surveys (July-August) in the upper river will timed to characterize oversummering conditions and distribution will be focused on trout, while fall surveys (October) corresponded to the late-summer rearing period for most resident species Sampling in the upper river segment will designed to occur at least twice during the late summer or fall, when flows are lowest and all ages of rainbow trout, including young-of-the-year (YOY), and brown trout were expected to be observed. Fish monitoring sites were selected throughout the upper Merced River watershed to meet the
following criteria:

1. To represent the range of coarse-scale aquatic habitat types identified during the mapping efforts;
2. To include likely juvenile salmonid rearing habitat (e.g., stream margins under overhanging vegetation, backwaters) in the upper Merced River;
3. To be accessible;
4. To take advantage of existing fish and water quality monitoring data, fluvial geomorphological characterization of stream channel, and riparian habitat monitoring, where possible.

Photos and GPS locations were taken of each site, and site locations subsequently were identified on GIS maps corresponding to mapped aquatic habitat units. Accuracy, precision, recovery, and completeness requirements for field measurements were SWAMP compatible.

Field Methods. Fish surveys were conducted using direct observation (snorkel surveys), seining, backpack electrofishing, and boat electrofishing. The methods will be consistent with the targeted species and life stage, location, seasonal conditions, and regulatory restrictions.

Monitoring sites were comprised of one or more habitat units defined during the aquatic habitat mapping effort (Section 5.2.1). The number of habitat units chosen at a given monitoring site varied directly with the diversity of habitat at the site. In general, sites consisted of one to three habitat units considered representative of local channel conditions, with the number of units surveyed dependent on the amount of time available. The latter was largely determined by the overall length

and complexity of the habitat units present. Sampled habitat units were generally contiguous, and sampling occurred from mid-morning until late in the afternoon, when sunlight conditions maximized visibility. When possible, rare or unexpected species were photographed. As permitted under the CDFG 4(d) Research Program (Appendix F), specimens were collected for laboratory identification if they could not be identified in the field. All methods of collection, transportation, storage of samples, analysis, and data management procedures were conducted in accordance with guidelines established or referenced in the BMAP (Stillwater Sciences 2006) and sources given in Table 5-6. For all methods, data were recorded in the field on standard field datasheets and reviewed for completeness and accuracy prior to leaving the site. In the office, the data were entered into a database developed specifically for the project, and checked for errors using standardized QA/QC protocols.

Table 5-6. Sources used for fish sampling methods.

Author	Year	Title	Publication Information
Murphy, B. R., and D. W. Willis	1996	Fisheries techniques, 2nd edition	American Fisheries Society, Bethesda, Maryland
McCain, M., D. Fuller, L. Decker, and K. Overton	1990	Stream Habitat Classification and Inventory Procedures for Northern California	FHR Currents, Volume 1. USDA Forest Service, Pacific Southwest Region. June.

Direct Observation. Direct observation (snorkel) surveys were conducted similarly to other snorkel surveys described by Edmundson *et al.* (1968), Hankin and Reeves (1988), McCain (1992), Dolloff *et al*. (1996), and Cannon and Kennedy (2003). At each snorkel location, the river was stratified into snorkel lanes aligned parallel to the channel and the direction of flow. Two to three divers, trained staff biologists with experience in identification of Pacific Northwest fish species and swiftwater safety techniques, positioned themselves at the downstream end of the habitat unit, one per snorkel lane, in order to avoid duplicating fish counts. During sampling, divers proceeded upstream through each habitat unit in the designated lanes at approximately the same pace. Multiple habitat units within a monitoring site were generally sampled sequentially from downstream to upstream in a zigzag pattern. This decreased 1) the potential for sediment disturbance, 2) the approach speed of the diver, and 3) the startle-bias due to the upstream orientation of fish in the current. At monitoring sites with higher flows, divers proceeded downstream through each habitat unit. At all snorkel sites, divers recorded their observations on dive slates attached to their forearms. Care was taken to observe and count fish just once by passing individuals or groups of fish and allowing them to escape downstream of the

diver. Numbers of fish were recorded by species and size, with fish lengths estimated to the nearest 50 mm (1.96 in). Graduated markings on each slate were used to calibrate the underwater observations. Start and end times were noted and all data recorded on the dive slates were transcribed to a data sheet upon completion of the snorkel survey. Divers also recorded visibility and weather conditions during each snorkel
survey.

Seining. Seining surveys will be used primarily to document smaller fish. Seining was conducted by crews of two to three staff biologists using a beach seine net to sample fish in shallow channel margins and on inundated floodplains possessing adequate space for seine haul-out (e.g., bar). The beach seine creates a "wall" extending from the surface to the bottom of the water column. Mesh panels hang from a float line, which sits at the water surface, to a lead line, which sits at the bottom of the seine, and prevent fish from escaping from the net. The beach seine, at 1.8 m (6 ft) high, 9.1 m (30 ft) wide, and possessing a 0.32 cm (0.125 in) mesh, will be hauled through a location by a two person team and then drawn to shore to trap and capture the fish. Fish will be held in buckets for transport and processing. Start and end times and the sampling duration of each seine pass will be recorded. The width of the deployed seine opening will be recorded, and haul distance will be estimated in order to calculate an approximate sample area for use in calculating catch per unit effort (CPUE). All fish will be identified to species, counted, and measured for length and weight before being returned to the river at approximately the same location where they were captured.

Backpack Electrofishing. Backpack electrofishing will be conducted opportunistically along the wadeable stream margins at snorkel sites to: (1) help verify species identifications made during snorkeling; 2) potentially obtain species length and weight relationships for estimating fish biomass from snorkel data; and 3) to capture species that, because of either their behavior or size, were difficult to observe while snorkeling. Backpack electrofishing was also conducted along wade-able stream margins at boat electrofishing sites, in areas that were too shallow to accommodate the boat electrofisher.

Backpack electrofishing throughout the upper Merced River will be conducted with the use of one to two Smith-Root backpack electrofishers (Model LR-24 or Model 12 with 11-inch anode rings and standard "rat-tail" cathodes) and a crew of two to three staff biologists per backpack electrofisher, including one shocker and one to two netters. At sites where backpack electrofishing is employed, all areas within the selected habitat unit will be sampled from the center of the channel towards the stream margins. When two backpack electrofishers are used, sampling consisted of simultaneous and roughly parallel passes upstream through

the habitat unit. In excessively turbulent portions of the waterway, such as high-gradient riffles, netters position their nets directly downstream of the anode ring to maximize capture of fish that can not be easily observed or that were caught in the turbulent flow. Start and end times and the sampling duration (in seconds) are recorded from each backpack electrofisher. At sampling sites, a multiple-pass depletion method (Platts *et al.* 1983) will be used, with block nets (4.76 mm [0.1875 inch] mesh size) placed at each site to prevent the movement of fish into or out of the sampling locations. The bottom edges of the block nets will be sealed with cobble and small boulders and the top edges of the nets propped above the water surface with dowels to prevent fish from escaping during sampling. Multiple passes of equal effort will be made to capture as large a percentage of the population as possible. After completion of each pass, biologists will identify each fish to species level and recorded fork length (mm) and weight (g) of each individual fish. Fish weight, to the nearest tenth of a gram, will be measured using an electronic balance. Scale samples will be collected from selected trout species and stored in labeled envelopes for age verification. All captured fish will be allowed to recover in buckets or live wells before being returned to the river at approximately the same location where they were captured.

Site Characterization. While remote coarse-scale aquatic habitat mapping will be conducted under low-flow conditions to aid in monitoring site selection (Section 5.2.1), site-scale habitat characterization will be conducted at ambient flows during each seasonal fish survey, which includes additional aquatic habitat typing, measurement of habitat dimensions, assessment of cover and bed substrate type and quantity, and measurement of local water quality. Specific parameters to be measured during site-scale habitat characterization are summarized in Table 5-7.

Table 5-7. Site characterization and physical habitat data collected during fish monitoring.

Parameter	Method	Metric/Descriptor	Method Reporting Limit
Sit- Scale Habitat Characterization			
Date/Start time/End time	N/A	Day/month/year	N/A
Latitude/Longitude	Handheld GPS receiver	UTM	N/A
Natural sequence order (Reach ID – Habitat unit #)	N/A	A-1, A-2, A-3, …	N/A
Habitat type	Visual estimation	See Table 5-8	N/A
Average unit width	Measured at multiple transects	meter (feet) (measured at multiple transects)	0.01 m (0.1 ft)
Average unit length	Longitudinal distance measured	meter (feet)	0.01 m (0.1 ft)
Bed substrate composition	Visual estimation	Bedrock, boulder, cobble, gravel, sand, silt, organic	5% increments
Fish cover type	Visual estimation	Boulder, woody debris, bedrock ledges, overhead vegetation, flooded terrestrial vegetation, etc.	5% increments
Cover quantity	Visual estimation	0%, 25%, 50%, 75%, 100%	N/A
Maximum/minimum depth	Vertical distance	meters (feet)	0.15 m (0.5 ft)
Discharge	USGS data	$m^3 s^{-1}$ (cfs)	1 m^3s^{-1} (1 cfs)
Temperature[1]	Field probe	°C	0.1 °C
Dissolved Oxygen[1]	Field probe	mg/L	0.0 mg/L
Conductivity	Field probe	micro siemens (uS) /cm	1.0 uS/cm
pH[1]	Field probe	s.u	0.1 s.u.
Turbidity	Field probe	NTU	0.1 NTU
Visibility	Secchi depth	meters (feet)	0.01 m (0.1 ft)

[1] This parameter conformed to SWAMP SOPs given in Appendix E of SWAMP document (http://www.swrcb.ca.gov/swamp/qamp.html#appendixe) and SWAMP requirements (or suggestions) for accuracy, precision, recovery and completeness, as described in Section 9.1 of the BMAP (Stillwater Sciences 2006a).

Habitat types used for the site-specific habitat assessment are similar to those identified during the coarse-scale aquatic habitat mapping effort, with the addition of backwater floodplain, and margin habitat (Table 5-8). The additional information collected during the sitescale habitat characterization allows for finer-scale habitat assessment than was possible in the remote monitoring effort, thus providing more information on fish choice of habitat and potentially helping to describe the influence of physical habitat parameters on fish behavior and bioenergetics.

Table 5-8. Habitat types used for site-specific fish habitat characterization.

Habitat Type[1]	Abbreviation	Description
Low Gradient Riffle	LGR	Shallow with swift flowing, turbulent water. Partially exposed substrate dominated usually by cobble. Gradient moderate (less than 4%).
High Gradient Riffle	HGR	Shallow with swift flowing, turbulent water. Partially exposed substrate dominated usually by boulder. Steep gradient (greater than 4%).
Cascade	CAS	Steep "riffle" consisting of small waterfalls and shallow pools or pockets, substrate usually composed of bedrock and boulders. Gradient high (more than 4%).
Run	RUN	Fairly smooth water surface, low gradient, and few flow obstructions. Mean column velocity generally greater than one foot per second (fts^{-1}).
Glide	GLD	Fairly smooth water surface, low gradient, and few flow obstructions. Mean column velocity generally less than 1 fts^{-1}.
Pocket Water	POW	Swift flowing water with large boulder or bedrock obstructions creating eddies or scour holes. Gradient low to moderate.
Mid-channel Pool	MCP	Large pools formed by mid-channel scour where the scour hole encompasses more than 60% of the wetted channel. Slow flowing, tranquil water with mean column water velocity less than 1 fts^{-1}.
Lateral Scour Pool	LSP	Formed by flow impinging against one stream bank or against a partial channel obstruction where the associated scour is confined to <60% of wetted channel width.
Plunge Pool	PLP	Found where stream passes over a channel obstruction and drops steeply into the streambed below, scouring out a depression, often large and deep. Substrate size highly variable.
Backwater	--	Off-channel, slow flowing, tranquil water with mean water column velocity generally less than 1 fts^{-1}. Usually shallow and dominated by finegrain substrates.
Floodplain	--	Off-channel, seasonally flooded areas. Usually shallow and slow flowing, tranquil water with mean water column velocity less than 1 fts^{-1}.
Margin	--	Quiet, shallow area found along the edges of the stream which is qualitatively different than habitat found in the mid-channel. Water velocity is generally less than 1 fts^{-1} and sometimes lacking. Substrate varies.

[1] Adapted from McCain et al. 1990, Payne 1992, Armantrout 1998.

Microhabitat, or focal habitat, parameters are characterized for trout to help define parameters that may be useful for future habitat restoration. Microhabitat descriptions included additional measurements such as focal velocity, focal depth, distance to cover, and distance to bank (Table 5-9), measured at the location of individual fish or group of fish.

Table 5-9. Microhabitat parameters for species-specific fish surveys.

Microhabitat Parameter	Unit
Focal velocity	$m\ s^{-1}$
Focal depth	m
Distance to bank	m
Distance to cover	m

SWAMP-compatible methods (Stillwater Sciences 2006) will be used for *in situ* water quality parameters measured during fish surveys. A Yellow Springs Instruments (YSI) multiparameter probe will be used to measure water temperature, pH, conductivity, and dissolved oxygen (DO). Field calibration of the YSI multi-parameter probe should occur daily, and if applicable, after every 20 measurements in a given day, following the calibration/maintenance logs. For DO measurements, the probe is allowed to equilibrate in-stream for at least 90 seconds before recording results to the nearest 0.1 mg/L. Temperature is

measured to the nearest tenth of a degree Centigrade. Once placed in the stream, the pH probe is allowed to equilibrate for 60 seconds before recording to the nearest 0.1 of a pH unit. Turbidity is measured using grab samples taken at each location using a clean, rinsed sample bottle and a HF Scientific Micro TPI or Hach 2100 P turbidimeter. Turbidity is typically measured at the monitoring site following survey completion for each sample unit. When sampling conditions did not allow for immediate processing of grab samples, they should be stored in a cool, dark container, and processed prior to leaving the site. Four to six turbidity sample readings will be taken for an average turbidity at each location. Field calibration of the turbidimeter occurred daily or after every 50 measurements.

Vertical water clarity is measured using a Secchi disk during electrofishing and seining surveys. The disk is suspended from a vinyl tape and lowered into the water column until it disappears, then slowly raised until it reappears. The average of the disappearing and reappearing depths are recorded as the Secchi disk transparency. If the water is too clear or shallow for a disappearing depth to be recorded, the deepest point in the sampled habitat unit is measured, and Secchi depth is recorded as ">X", where X is the greatest depth that is observed.

Both vertical and horizontal water clarity are measured at snorkel sites. Vertical water clarity is measured using the same protocol described above for electrofishing and seining surveys. Horizontal water clarity is estimated by two snorkel crew members, one extending the Secchi disk underwater, with the tape aligned parallel to the water surface, and the other observing the disappearing and reappearing distances as the disk is moved through the water. The horizontal measures are taken both into and away from the sun.

Analytical Methods. Fish survey data are analyzed to characterize species composition and distribution, and to develop metrics including population-level indices (e.g., estimated linear density) and community-level indices (e.g., species richness, species diversity) to support descriptions of spatial and seasonal patterns in the upper Merced River fish community. The fish community is being investigated at a variety of spatial scales, including basin, segment, reach, habitat unit, and microhabitat scales (Figure 5-2). At the basin scale, the presence of fish community assemblages and their longitudinal and seasonal distribution are analyzed throughout the mainstem and South Fork of the Merced River (i.e., across upper river segments), while analyses of native versus introduced species, generally dominant species, and fish length frequency will be conducted. Community-level indices such as species richness and species diversity, as well as population-level indices such as estimated fish linear abundance and percent of total individuals observed by species will be analyzed at the reach scale, including an analysis of seasonal patterns. Habitat associations can be explored at the

segment and reach scale for all species, with selected species analyzed at the microhabitat scale.

Estimated Linear Density. Estimated linear fish density is defined as the total number of fish of each species recovered in all locations (i.e., habitat units) associated with a given monitoring site, divided by the total length of the habitat units sampled during the associated survey. Note that the "total length" here serves as a measure of sampling effort, rather than a monitoring site dimension, because it sums the various lengths of habitat units associated with an observed fish species and not the total length of the monitoring site. It is considered an estimate since the sampling methods described above were not designed to target absolute density for observed fish species. Estimated linear density is expressed as the number of fish per 100 meters. Estimated linear density data will be used in multiple analyses, including an investigation of potential reach-scale trends in overall fish density, community assemblage distribution, and a species-specific analysis in the upper river segment.

Species Richness and Diversity. Species richness is defined as the number of species detected within a given reach, while species diversity measures ecological diversity based on the number of species detected, weighted by the number of individuals of each species, also within a given reach. A high score indicates high ecological (species) diversity. Species diversity is measured using a transformation of the usual Shannon-Weiner index, which is symbolized by H□ (also called Shannon-Weaver index or Shannon index; Krebs 1989). This transformed index, which was introduced by MacArthur (1965) is N1 where N1 = 2H□. The advantage of N1 over H□ is that N1 is measured in terms of species, whereas H□ is measured in terms of bits of information (Nur *et al*. 1999). Thus, N1 is more easily interpreted, and species diversity (measured as N1) and richness can be compared.

The formula for computing species diversity is as follows:

The formula for computing species diversity is as follows:

$$N_1 = e^{H'} \text{ and } H' = \sum_{i=1}^{i=S} (p_i)(\ln p_i)(-1)$$

Where:

S = total species richness
p_i = the proportion of the total number of individuals for the ith species.

Fish Community Assemblages. Multivariate cluster analysis will be used as an exploratory technique to determine whether fish survey results indicated the existence of discrete fish community assemblages in the Merced River. In ecological studies, cluster analyses are often used to organize entities into classes or groups such that within-group similarity is maximized and among-group similarity is minimized, according to some objective criteria (McGargigal *et al.* 2000). For the dataset, fall fish species presence-absence data were analyzed at the basin scale, across all fish monitoring sites, using both hierarchical agglomerative and divisive cluster analysis methods. Results were compared with broad water temperature assemblages and an expanded version of the San Joaquin River Drainage (SJRD) community assemblage model originally defined in Brown *et al.* (2003) (Table 5-10).

Fish Community Assemblage		Description	Species Observed During 2006-2008 Surveys (native species in bold type)	Reference
Valley Floor	Lower Large Tributary (LLT)	Associated with valley floor elevations of the three, large east-side tributaries to the San Joaquin mainstem; the Stanislaus, Tuolumne, and Merced rivers (LLTs). Dominated by species adapted to slow, warmwater habitat.	Bluegill sunfish, Channel catfish, Largemouth bass, Redear sunfish, White catfish	Brown et al. (2003)
	San Joaquin Mainstem #2 (SJ Main #2)	Comprised of introduced, warmwater species found in the mainstem San Joaquin River and commonly extending into lower reaches of LLTs. May not be present in LLTs during high flow years.	Brown bullhead, Common carp, Green sunfish, Goldfish	Brown et al. (2003)
			Bigscale logperch, Black crappie, **Hitch** **Kern Brook lamprey**, Mosquitofish	Moyle (2002)
	San Joaquin Mainstem #1 (SJ Main #1)	Comprised of a second group of introduced species that do not generally extend into the LLTs (e.g., fathead minnow, threadfin shad, red shiner, and inland silverside), but may move into lower reaches of LLTs during low flow years.	None observed	Brown et al. (2003)
Broad Geographic Range (BGR)		Found across a broad range of habitat conditions (e.g., temperature, flow) and multiple fish communities.	**Prickly sculpin**, Smallmouth bass	Brown et al. (2003)
Anadromous		Not assigned a specific range. Prior to construction of foothill dams, or other human-induced migration barriers, these species may have migrated though multiple zones.	**Chinook salmon**, ***O. mykiss***[1] **Pacific lamprey**, Striped bass	Moyle (2002)

[1] *O. mykiss* observed below Crocker Hoffman dam has the potential to be anadromous.

Additionally, longitudinal gradients in fish community assemblages will be assessed by comparison of observed species distributions with expected distributions based on the fish assemblage descriptions given in Table 5-10. The comparison will be based on species-specific estimated linear densities calculated as described above for each SJRD community assemblage for each sampling season. The estimated linear densities will be analyzed along a river mile

continuum to identify potential seasonal shifts in the extent of each assemblage or the predominance of a particular fish species within a given assemblage. Calculations in support of graphical presentation and basic figure generation were done in the R statistical package (R 2006, Version 2.3.1). The figures were then imported into a PowerPoint file and additional ornamentation (captions, legends, etc.) added there.

In order to present the estimated linear density along a river mile continuum, the upper river segments were divided into contiguous stretches ranging from one to four miles in length, so that each stretch contained one and only one of the fish monitoring sites. For plotting purposes, the estimated linear density associated with each monitoring site, scaled to units of fish per 100 meters, will be attributed to the entire corresponding stretch of river. For each species, a rectangle will be drawn spanning the river stretches for which the estimated density was non-zero. Within each of these rectangles, the densities of individual stretches were indicated by shading intensity.

Fish Habitat Associations. Principal components analysis (PCA) will be used to identify key habitat variables from the suite of parameters collected in the field during site-scale habitat characterization (Table 5-7). PCA is an unconstrained multivariate ordination technique, commonly used to condense the information contained in a large number of original variables into a set of principal components, or a set of weighted linear combinations of the original variables representing gradients of maximum variation within the data set (McGargigal *et al.* 2000). For the fish study, PCA analyses can be conducted in the R statistical package (R 2006, Version 2.3.1), using the "rda" function within the library package "vegan" (Oksanen *et al.* 2006).

The fish habitat PCA will be conducted at the segment scale. All seasonal sampling events were included in the analysis. Physical habitat variables and water quality variables are analyzed separately to reduce the potential for confounding effects of simultaneous longitudinal and seasonal variation in water quality parameters. PCA physical habitat variables include percent values for primary habitat types (i.e., riffle, and pool/run/glide), cover types (i.e., boulder, large woody debris, aquatic vegetation, and none), substrate types (i.e., cobble and silt substrates), and average and maximum depth (ft), while the separate set of water quality variables include pH, specific conductivity (uS/cm), turbidity (NTU), dissolved oxygen (mg/L), and water temperature (°C). If multiple categories are available for a given environmental variable, only the most dominant category are included in the analysis. For example, percent cobble and percent silt could be selected to represent bed substrate in the physical habitat PCA because these two were the most common substrates observed during

previous fish surveys. Results of the PCA are scaled by eigenvalues, as described by Oksanen *et al.* (2006), to account for differences in the unit scale among environmental variables. The gradients evident from the first two principal components were intended to identify the most influential set of variables that could be used in later analyses.

PCA can also be applied to fish presence/absence data in order to potentially isolate a few species that were representative of the larger set of all sampled species for inclusion in the habitat associations analysis. The presence/absence data are used for the PCA, rather than estimated linear density, as the latter is considered a less consistent measure for quantitative analysis due to the variety of capture methods (e.g., snorkel, seine, backpack electrofishing, boat electrofishing) that were necessarily used at different monitoring sites. Species PCA results are compared with results from the cluster analysis (see above) as a corroborative check.

CG Study Request 3.1b

ANADROMY SALMONID HABITAT

July 15, 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 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* and *O. tshawytscha* spawning and juvenile rearing habitat is now restricted to the Merced River reach between Crocker-Huffman Diversion Dam (RM 52) and the Highway J59 Bridge Crossing (RM 42). 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. (not sure why this former sentence is included—is it necessary? General management and restoration goals for Steelhead trout, fall-run Chinook salmon, and spring-run Chinook salmon 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 upper 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 protect and enhance species of concern, threatened or extinct populations of California Central Valley Steelhead Trout, Central Valley spring-run Chinook salmon, and fall- and late fall-Chinook salmon in the Merced River watershed to establish data and information useful in developing protection, mitigation, and enhancement (PM&E), Section 7 consultation, ESA 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 interests of fishing, public's use and utilization of anadromous fisheries resources, 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, allow 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 information and alternatives to enhancement of juvenile *O. mykiss* habitat below the Project may provide useful information in developing protection, mitigation, and enhancement (PM&E), consultation with California Department of Fish and Game public trustee responsibilities for the Merced River. The applicant's proposed alternative studies are not sufficient to meet these stated information needs:

- The applicant received potential issues and information needs by Relicensing Participants in August 2008. Applicant chose to ignore or considered "information sufficient" to not develop studies to address Anadromous Fish bypass and restoration.
- The applicant is proposing no studies to address Project Issues (i.e., in-stream water requirements), that may be controlled or affected outside of the FERC Project Boundaries. The applicant stated that anadromous fish do not occur in the Merced River upstream of the Crocker-Huffman Diversion Dam, and thus, the Merced River Hydroelectric Project has no effect on the upstream migration of special-status fishes (MID, 2008). Operations of the Project, in conjunction with PG&E's Merced Falls Hydroelectric Project (FERC No 2467), have a major modifying effect upon Merced River flows, which are significantly different that "run-of-the-river" flows, and have a significant effect on tailwater habitats and conditions for anadromous fishes.
- The applicant stated that California Central Valley Steelhead Trout DPS were reported on USFWS species lists (MID, 2008 @ Page 7.7-5), yet failed to include them on their list of special status species, using a restricted "geographic scope of project" criterion (MID, 2008).

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, *Oncorhynchus mykiss* (*O. mykiss*) and the Central Valley fall/late-run Chinook salmon (*Oncorhynchus tshawytscha*), associated with Merced River reaches affected by the Merced River Hydroelectric Project within the influence of the Federal Energy Regulatory Commission (FERC) Project Area, through the evaluation of the most sensitive juvenile life stage. The objectives of the study are to:

- Assess baseline juvenile *O. mykiss* and *tshawytscha* 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 steelhead and salmon, 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* and Species of Concern *O. tshawytscha* 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.

The decline of *O. mykiss* and *O. tshawytscha* 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. Arguably, there is little scientific controversy over its presence in the Merced River, but scientific knowledge of the Steelhead trout and salmon 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 the *O. mykiss* population as self-sustaining and has an anadromous component 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).
- Increased numbers of smolts captured in rotary screw traps in the Stanislaus and Tuolumne Rivers to the north (FishBio, San Joaquin Basin Update, January 25, 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)
- Limited samples of *O. mykiss* otoliths (Sr:Ca ratios) had anadromy characteristics in a low, but detectable (4%) number, verifying steelhead progeny in Lower Merced River (Zimmerman *et al*., 2008)

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 Pacific Gas and Electric Company's (PG&E) Merced Falls Dam to RM 2 at Hatfield State Park, 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 (N 37° 31.345 W 120° 19.858), downstream to the J-59 Bridge at river mile 42 (N 37° 28.187 W 120° 30.046) (Figure 1)

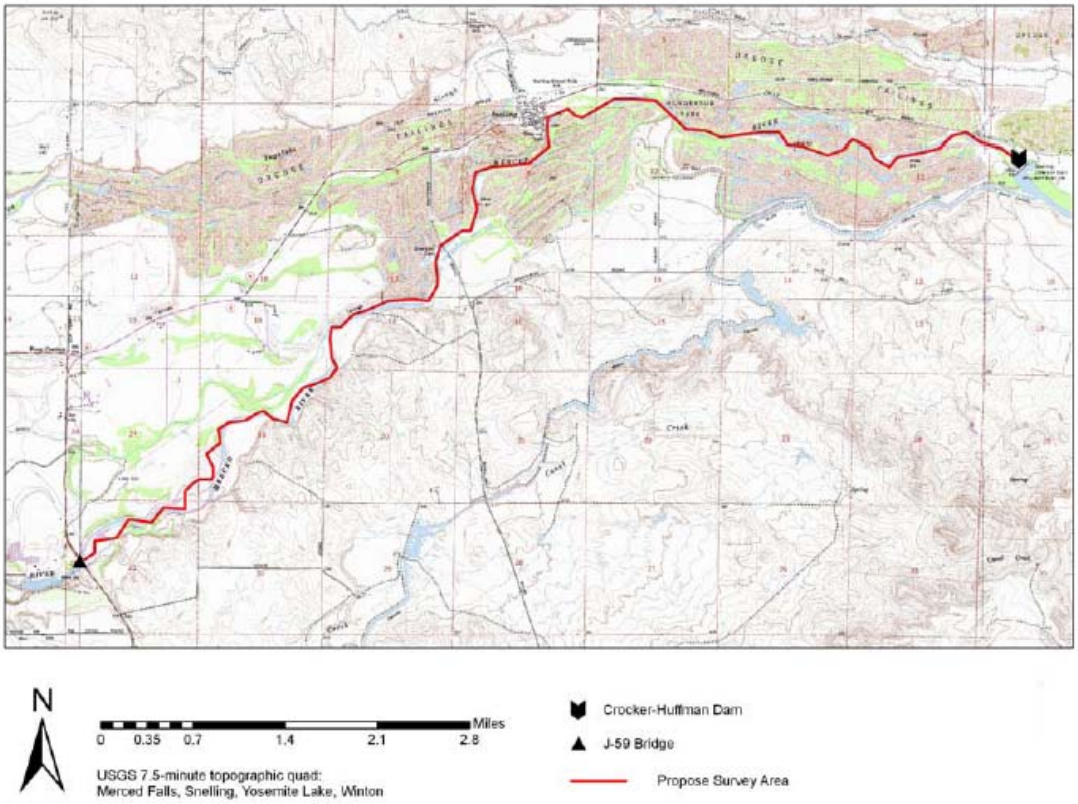

Figure 1. Location of river study area for electroshocking and snorkeling surveys.

The survey locations will be selected based on habitat characteristics most suitable for *O. mykiss* and *O. tshawytscha* (i.e. riffle, run, and pool). Ten survey locations will be selected within the 10 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, 20xx-20xx+1) juvenile and adult *O. mykiss* and *O. tshawytscha* 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* and *O. tshawytscha*;
- Assessment of the abundance of *O. mykiss* and *O. tshawytscha*

For estimates of juvenile *O. mykiss* and *O. tshawytscha* 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* and *O. tshawytscha* (tagged and untagged) 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 anadromy. Any mortality observed from snorkel survey will be collected, and recorded. Scales will be collected for age determination and fin clips for anadromy determination.

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 - Rotary screw traps will be placed at: a) the lower end of good anadromous fish habitat (Robinson Ranch reach) and b) near the bottom end of the river (Fig. 2). Previous RSTs have not worked well at times because there is sometimes not enough flow in the lower river to make them turn properly. Montgomery et al. (2007) noted that the trap operated below optimal revolutions per-minute a large proportion of the season, likely affecting efficiency. Calibration at different flows is needed, along with enough flow to make the screw traps effectively work throughout the tracking period. Traps will be primarily utilized for *O. tshawytscha* smolt tracking. Assess need to divert some flow to improve operational conditions. This could be accomplished by placing a temporary rigid weir structure upstream of the traps extending from the south bank approximately 5 to 6 m into the river. Work closely with CDFG and hatchery personnel to obtain an allotment of hatchery fish for conducting efficiency tests throughout a variety of life stages, time, and environmental conditions. Adjust field data collection protocols to improve measures of trap effort and include trap effort in passage estimate analysis. Install TidBitTM temperature loggers (Onset Technology, Inc.) at the trap and in the live-box to continuously monitor water temperature conditions experienced by passing and trapped fish. Perform pre- and post-sampling cross channel elevation transects to determine river morphology changes due to trapping and/or temporary structure and calculate water velocity profile. Revise and streamline sampling protocols to optimize data collection and improve efficiency in field operations (Montgomery *et al.*, 2007).

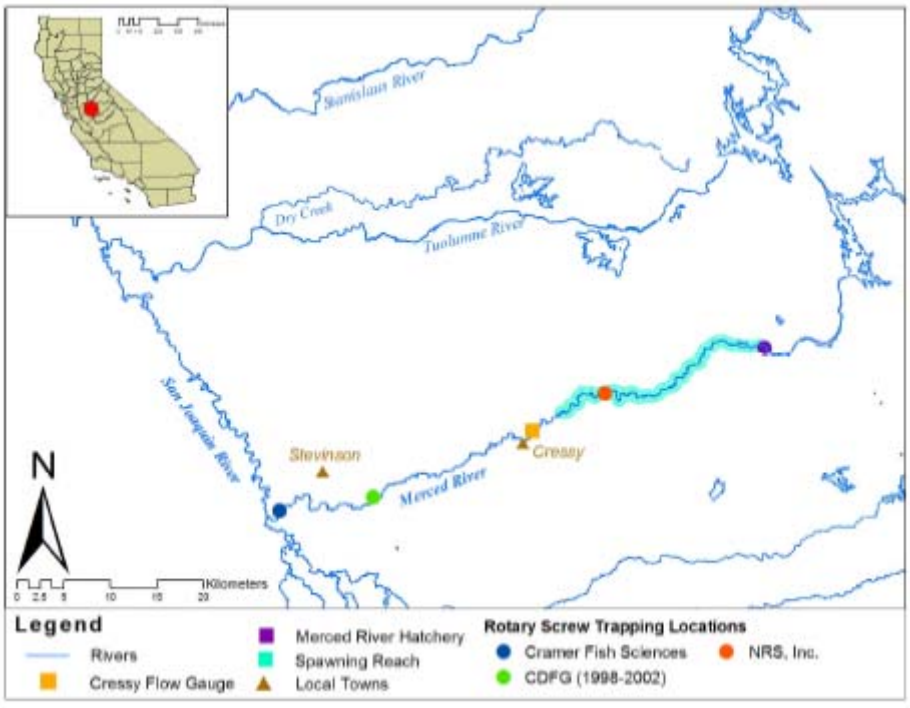

Figure 2-Locations of RSTs on Merced River (from Montgomery *et al.*, 2007).

Step 3 - 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 4 – Assess the condition of anadromy.

The condition of anadromy will be determined genetic markers (Single Nucleotide Polymorphism or SNP) from DNA extracted from fin clips (Aguilar and Garza, 2007; Donohoe *et al.*, 2008) and Sr:Ca ratio analyses of otolith samples to determine resident or anadromous nature of *O. mykiss* (Zimmerman *et al.* 2008).

Step 5 - 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 unit to show boundaries and sampling areas. Water velocities will 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 6 - Investigate the relationship between physical features within habitat types and location of *O. mykiss* and . *O. tshawytscha*

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 7 - 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 *O. tshawytscha* 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 8 – 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 Merced Falls 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* and *O. tshawytscha*

- Consult on Step 2 Rotary Screw Trap Placement and Design
- Consult on Step 3Assess Age Structure
- Consult on Step 4 Assess Anadromy
- Consult on Step 5 Assess Habitat Utilization
- Consult on Step 6 Investigate Physical Features/Habitat Types and Location
- Consult on Step 7 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 salmonid.…….June-Sept 20xx; June-Sept 20xx+1
- Step 2 Assess Age Structure…….…..Oct-Nov 20xx+1
- Step 3 Rotary Screw Trap Assessment……..Jan 20xx-June 20xx
- Step 4 Assess Anadromy……....Oct-Nov 20xx+1
- Step 5 Assess Habitat Utilization ……..June-Sept 20xx; June-Sept 20xx+1
- Step 6 Investigate Physical Features/Habitat Types and Location……. ……June-Sept 20xx; June-Sept 20xx+1
- Step 7 Data Analyses.……Nov-Dec 20xx+1
- Step 8 Report Preparation……..Nov-Dec 20xx+1

It is anticipated that the study will be completed in 20xx+1.

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	**Rotary Screw Trap Juvenile Survey**	**6 person-months**	**$45,000**
Step 3	**Assess Age Structure**	**2 person-months**	**$ 15,000**
Step 4	**Assess Anadromy with SNAP DNA analysis and Sr:Ca ratios**	**400 fin punch samples @ $45; 100 otolith samples @ $90**	**$ 18,000** **$ 9,000**
Step 5	**Assess Habitat Utilization**	**12 person-months**	**$90,000**
Step 6	**Physical Features Habitat types & Locations**	**4 person- months**	**$30,000**
Step 7	**Data Analyses**	**4 person-months**	**$30,000**
Step 8	**Report Preparation**	**6 person-months**	**$45,000**
	TOTAL STUDY COST		**$392,000**

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CG Study Request 3.3
ANADROMOUS CONSERVATION HATCHERY
July 15, 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 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) 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).

Continued project operation and maintenance (O&M) of, or new construction for, the Merced River (and Falls) Hydroelectric Projects have the potential to affect environmental conditions for fish life in the Lake McClure, the Upper Merced River and its tributaries. These potential environmental effects include: introduction of non-indigenous fish genetic lineages (*Oncorhynchus mykiss* or steelhead/rainbow trout), introduction of other indigenous fish species (*Oncorhynchus tshawytscha* or Chinook salmon), competition with existing fish populations, introduction of non-native fish species, water temperature, quantity, and quality; entrainment at diversions and intakes; and changes in physical habitat (e.g., lake elevation changes or extent of littoral zone). Through these effects, the project could affect fish populations in Upper Merced River stream reaches, including the South Fork, which is managed as a "Heritage and Wild Trout" river by California Department of Fish and Game.

The project originally blocked, and continues to block, volitional passage for anadromous salmonids, with the construction of, and non-operation of fish passage facilities at,

Merced Falls Dam (along with partial passage at Crocker Huffman Diversion Dam). This restricts available breeding and rearing habitats for these species throughout the entire Merced River. Upstream conditions need to be evaluated to provide data/information in the process of determining alternatives, feasibility, and potential mitigation for the projects.

Since inception of the project from 1926, Exchequer and New Exchequer Dams (in 1967) have continuously and uninterruptedly blocked volitional anadromous fish passage, as they both were constructed without fish bypass capabilities (Snyder, 1993). In 1966, McSwain Dam was constructed without fish bypass capability. This has resulted in a severe compaction of the potential spawning and juvenile rearing habitats for *O. mykiss* to the "tailwater" section of the Merced River, from RM52 to RM42, which is a reduction of over 99% of its original habitat. Several Recognized Qualifying Comprehensive plans have suggested reconnection of upper and lower river watersheds to improve spawning and rearing habitats for anadromous species. One alternative technique for restoring threatened or endangered species populations is with conservation hatchery supplementation of native stocks in headwater areas.

Applicant (MID, 2008) has proposed two studies: 3.1 Special-Status Fishes and 3.2 Fish Entrainment. They do not address the issue of evaluation of upper Merced River fish populations and the potential for Habitat Expansion for anadromous salmonids through fisheries restoration actions, such as fish passage alternatives and supplementation of anadromous fish stocks.

This Study Request addresses the following preliminary issues as identified in Section 8 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-2: Effect of the Project on warmwater special-status fishes in Lake McClure and upstream of Lake McClure
- Issue AR-3: Effect of the Project on fishes due to entrainment into Project intakes
- AR-7: Effect of the Project on trout and salmon upstream of Lake McClure including populations and fishing
- AR-8: Effect of the Project on special-status fishes, especially fall- and late fall-Run Chinook salmon (NMFS Species of Concern), due to the blockage of passage
- 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)
- Issue T&E-17. Effect of CDFG's Merced River Hatchery on anadromous fishes
- Issue TI-1 Effect of the Project on traditional/spiritual areas and other traditional uses in the FERC Project Boundary and adjacent locations.
- 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 should confer with Resource Agencies and American Indian Tribes that participate in development of this Study Request. At this time, Resource Agencies have not yet identified the specific management goal of this Study Request (establishment of a genetically compatible population of *O. mykiss* in the upper Merced River). Nonetheless, general management and restoration goals for Steelhead trout have been published (see Martin, 2008 for a summary). Potential management goals that should be considered include:

- Maintain, enhance, or restore populations of native aquatic biota, including fish, benthic macroinvertebrates, and riparian species
- 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.
- 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.
- Restore Merced River populations of California Central Valley Steelhead Trout DPS to numbers which avoid extinction or serious depletion (*sensu* ESA)

3.0 Relevant Public Interest Consideration and Potential License Conditions

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

- Study 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 to establish information useful in developing protection, mitigation, and enhancement (PM&E), Water Quality Certification, Section 401, Clean Water Act in the public interest.
- Study is needed to provide data, information, and alternatives to protect and enhance species of concern, threatened or extinct populations of California Central Valley Steelhead Trout, in the Merced River watershed to establish data and information useful in developing protection, mitigation, and enhancement (PM&E), § 7 consultation ESA, CWA § 401 certification, and Federal Power Act § 18 consultation or prescription, in the public interest.

- Study is needed to provide data, information, and alternatives to assess conditions of the Merced River with regard to considering the public interest of fishing, public's use and utilization of anadromous fisheries resources. The information and alternatives to a conservation hatchery may provide useful information in developing protection, mitigation, and enhancement (PM&E) measures, which may result in benefits and protections to the public trust's natural resources.
- Study is needed to provide data, information, and alternatives to be used in National Environmental Policy Act (NEPA) environmental impact assessment(s), under Federal Power Act, § 18. The public interest served by approving this Study Request is that sufficient and critical 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 allow them 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.

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

- The applicant received potential study recommendations and issues by Relicensing Participants in August 2008. Applicant chose to ignore or consider "information sufficient" and to not develop "Preliminary Proposed" studies to address Anadromous Fish bypass and restoration (MID, 2008).
- The applicant proposed a "fish population survey" in the McClure and McSwain impoundments, but did not propose studies to evaluate anadromous fish in the broader "geographic scope", outlined in the FERC Scoping Document 2 for the Merced River Dam Project (FERC, 2009). The applicant stated that anadromous fish do not occur in the Merced River upstream of the Crocker-Huffman Diversion Dam, and thus, the Merced River Hydroelectric Project has no effect on the upstream migration of special-status fishes. Operations of the Project (in conjunction with the PG&E Merced Falls Hydroelectric Project) have major modifying effects upon Merced River flows, which are significantly different that "run-of-the-river flows", and have a significant effect on "tailwater" habitats and conditions for anadromous fishes.
- The applicant stated that California Central Valley Steelhead Trout DPS were not reported on USFWS species lists (MID, 2008), MRCC indicates in a recent query to USFWS, both the steelhead trout and Chinook salmon are reported from the USGS Merced Falls and Snelling Quad maps, and the PGE information is not accurate.
- The extirpated population of spring-run Chinook salmon historically occurred in the Merced River, but the MID (2009) PAD did not further consider spring-run Chinook salmon (*Oncorhynchus tschawytscha*). There are efforts in the San Joaquin River basin to re-introduce this fish, and the Merced River may be repopulated and important to the re-establishment of this species.

The Study Request results will inform the Commission by providing 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 recreation activities
- Fish stocking
- Development of site-specific fishery management plans, if needed
- Development and operation of a Conservation Hatchery for restoration of ESA-listed species

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 determine if enhancement of Steelhead trout in the upper Merced River can be achieved with a Conservation Hatchery interim supplementation, and, if implemented, would this enhancement have significant impacts on the California Central Valley Steelhead DPS in the Merced River.

The objectives of the Study Request are:

- Assess the feasibility of supplemental restoration of *O. mykiss* of the upper Merced River
- Develop a conservation hatchery to supplement natural *O. mykiss* stock in the upper Merced River

5.0 Existing Information and Need for Additional Information

Steelhead trout restoration and re-introduction has not been previously considered in the Merced River watershed. Re-introduction evaluations for anadromous salmonid species in the upper Merced River should follow the evaluation phases that were suggested by McEwan (2001) regarding the reintroduction of steelhead above impassable dams in the

Central Valley. The first phase is to assess the availability and restorability of spawning, rearing, and adult holding habitats. The second phase would be to conduct a feasibility study of the best way to provide access (trap and truck, installation of passage facilities, dam removal etc.) (McEwan 2001). A third phase would be to "jump-start" the upriver population with appropriate Merced River Steelhead *O. mykiss* through Conservation Hatchery supplementation. Appropriate stock selection for re-introduction will be critical. Focus should remain on establishing additional population of the few remaining wild genetic stocks of at-risk Merced River-origin steelhead. It cannot be overemphasized that while it might be convenient to use existing hatchery and/or hatchery introgressed stocks, these should not be used for re-introduction. Successfully establishing wild stocks to the Merced River may require the short-term propagation of wild stocks. Any propagation or hatchery related program must have well defined dates of termination and be limited to less than a decade in length. While a Merced River reintroduction program will help meet natural production goals, re-introducing hatchery fish will not help protect the genetic diversity of stocks that might be at further risk, perhaps catastrophic risk, under climatic warming by mid-century.

All of the current broodstock and fish planting activities in the upper Merced River uses non-local broodstock (Fraser River or McCloud redband *O. mykiss*) (Mitchell, CDFG, pers. comm.). A conservation hatchery is a rearing facility to breed and propagate a stock of fish with equivalent genetic resources of the native stock, and with the full ability to return to reproduce naturally in its native habitat. A conservation hatchery is therefore a facility equipped with a full complement of culture strategies to produce very specific stocks of fish in meaningful numbers. It can also permute individual strategies to match the particular requirements and biodiversity of any individual stock to its ecosystem. NMFS has specific strategies for conservation hatcheries (Flagg and Nash, 1999): a) inbreeding, outbreeding, domestic selection, and other genetic considerations; b) broodstock sourcing, broodstock maturation and reproduction; c) enriched environments growth rate modulation; rearing density; anti-predation conditioning; d) release size, release time and volitional releases, imprinting and homing; e) habitat carrying capacity; and f) hatchery monitoring and evaluation. A conservation hatchery must have: (1) objectives, criteria, and procedures for use in selecting the appropriate stock(s) for supplementation; (2) objectives and principles used to develop a supplementation strategy, in conjunction with anadromous fish passage; (3) initial recommendations on stock selection and reintroduction strategies; and (4) the need for a robust adaptive management strategy to serve as an appropriate framework for the restoration program. The NMFS (Flagg and Nash, 1999) conservation hatchery decision tree is shown in Appendix 1. The decision tree for genetic stock selection should follow the recommendations of the San Joaquin River Restoration Project, shown in Appendix II.

An analysis is needed to understand project effects on, as well as options or alternatives for, California Central Valley steelhead trout DPS, listed under the Federal Endangered Species Act, in order to fulfill the requirements of the National Marine Fisheries Service

and its Section 7 consultation. To comply with the applicable regulations (50 CFR 402.14(c)) developed under ESA Section 7, the consultation initiation package must include, among other information, a description of the manner in which the action may affect any listed species or critical habitat and an analysis of any cumulative effects. In conducting its own analysis, NMFS will need to understand the total effects of all past activities, including effects of the past operation of the project, current non-federal activities, and Federal projects with completed Section 7 consultations, in addition to future direct and indirect impacts of the operation over the new license or contract period, including effects of any interrelated and interdependent activities, and any reasonably certain future non-Federal activities (cumulative effects). In addition, 18 CFR 5.9 (Integrated Licensing Process procedures) states that Study Requests should include information and studies need for consultation under Section 7 of the Endangered Species Act.

6.0 Study Methods and Analysis

6.1 Study Area

The study area includes aquatic habitats within the Federal Energy Regulatory Commission (FERC) Project Boundary and extends 0.5 mile of the normal maximum water surface elevation of Project reservoirs and normal high water line of Project-affected stream reaches, along with the reach of the Merced River from Pacific Gas and Electric Company's (PG&E) Merced Falls Dam to the Crocker-Huffman Diversion Dam, and including the Merced River Fish Facility and the Calaveras Trout Farm. Since the study involves blocked volitional migration of anadromous fish, the study area includes the mainstem Merced River and the South Fork of Merced River, upstream of the Federal Energy Regulatory Commission (FERC) Project Boundary of Lake McClure to the Yosemite Valley on the mainstem and on the South Fork to 4 miles downstream of Wawona. Conservation Committee believes that this is the "action area" of potential direct effects of the operation and maintenance of the Merced River Hydroelectric Project. The feasibility of trapping, spawning, and rearing genetically appropriate Merced River *O. mykiss* is an important element of the investigation for determining factors which can mitigate project effects.

6.2 General Concepts

The following general concepts apply to the Study Request:

- 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.
- 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 the 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.

6.3 Study Methods

Step 1 – **Review and Evaluate Existing Facilities for Conservation Hatchery** - This task is to evaluate the physical, biological, and practical issues involved with the development of a Merced River Steelhead Trout Conservation Hatchery. For the existing Calaveras Trout Farm and the Merced River Hatchery, evaluate the NMFS hatchery operations and management requirements and the SJRRP stock genetic selection process, referred to in Section 5.0. Include in the analysis an economic evaluation of the costs of conversion, and any institutional constraints on the feasibility of doing such a conversion. One of the most important physical issues limiting hatchery production for Steelhead trout and fall-run Chinook (and spring run Chinook) is excess summer and late fall temperatures in the hatchery (Vogel, 2007).

Step 2 – **Feasibility of Constructing New Facilities** – This task is to evaluate the physical, biological, and practical issues involved with the development of an alternative Merced River Steelhead Trout Conservation Hatchery, should constraints prevent the conversion of existing hatchery facilities. Include in the analysis an economic evaluation of the costs of construction and development, and any institutional constraints on the feasibility of doing such a construction and development.

Step 3 – **Feasibility of Merced River Steelhead trout Supplementation –** This task is to evaluate all issues with respect to operation of a Steelhead trout Supplementation Program. Include in the analysis an economic evaluation of costs of Conservation Hatchery operations and maintenance, along with the benefits (economic and environmental), consistent with the timeframe of the 2014 FERC license.

Step 4 - **Environmental Compliance Evaluation for the Merced River Steelhead Trout Conservation Hatchery** – This task is to evaluate all issues with respect to

permitting and environmental compliance (e.g., NEPA, ESA or CESA) of the development and operations of a Conservation Hatchery.

Step 5 – **Develop a Hatchery Management Plan with a Genetic Component**– This task is to develop and publish a formally recognized genetic hatchery management plan in consultation with Natural Resource Trustees and the Tribes, with participation of the Relicensing Participants.

Step 6 – **Prepare Report** - This task is to prepare a report for the entire study that includes these topics: Study Goal and Objectives; Methods; Results; Conclusions; and Description of Variances from the FERC-approved study proposal. The report will be submitted in the license applications, as appropriate.

The report will be provided to NMFS, CDFG, and tribe for findings relative to the establishment and operation of a supplementation Conservation Hatchery.

6.4 Consultation and Communication

The applicant will consult with the Relicensing Participants in the 1) Study Design, 2) the selection of Consultants and/or Experts with Specific expertise in Conservation Hatchery Development and Operations, 3) development of the specific study plan and details of the study proposal, 4) development of a hatchery genetic management plan, 4) results and conclusions of the Study.

6.5 Schedule

Applicant anticipates the schedule to complete the study proposal:

Step 1 – **Review and Evaluate Existing Facilities for Conservation Hatchery** ……...June-July 20xx
Step 2 – **Feasibility of Constructing New Facilities** …..……..July-August 20xx
Step 3 – **Feasibility of Merced River Steelhead Trout Supplementation** ……...September-October 20xx
Step 4 - **Environmental Compliance Evaluation for the Merced River Steelhead Trout Conservation Hatchery**……..November 20xx
Step 5 – **Hatchery Genetic Management Plan**……...October-November 20xx
Step 5 – **Prepare Report**……..……November 20xx-January 20xx+1

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 and information is collected and tabulated, it will be made available to the Relicensing Participants in a reviewable .doc or .pdf file.

Products will include but not be limited to the following:

An overall Project Report will be prepared.

8.0 Level of Effort and Cost

A preliminary estimate for the Study Request cost in 2009 dollars is as follows:

2009 Cost Estimate Based upon Efforts and Costs of study steps

Step in Study	Study Task	Estimate person time	Cost
Step 1	**Review and Evaluate Existing Facilities for Conservation Hatchery**	**4 person-months**	**$30,000**
Step 2	**Feasibility of Constructing New Facilities**	**4 person-months**	**$30,000**
Step 3	**Feasibility of Merced River Steelhead Trout Supplementation**	**4 person- months**	**$30,000**
Step 4	**Environmental Compliance Evaluation for the Merced River Steelhead Trout Conservation Hatchery**	**2 person-months**	**$15,000**
Step 5	**Genetic Hatchery Management Plan**	**2 person-months**	**$15,000**
Step 6	**Report Preparation**	**6 person-months**	**$45,000**
	TOTAL STUDY COST		**$165,000**

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Schick RS, Edsall AL, Lindley ST. 2005. Historical and current distribution of Pacific salmonids in the Central Valley, CA. National Marine Fisheries Service/NOAA NOAA-TM-NMFS-SWFSC-369, Santa Cruz CA. 25 pp.

Snyder JB. 1993. Memorandum to Park Superintendent Mike Finley: "Did salmon reach Yosemite Valley or Hetch Hetchy?" 9 May 1993 Manuscript. Historian, P.O. Box 577, Yosemite National Park. 8 pp.

Vogel DA. 2007. A Feasibility Investigation of Reintroduction of Anadromous Salmonids above Crocker-Huffman Dam on the Merced River. Report Prepared

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APPENDIX 1

NMFS CONSERVATION HATCHERY DECISION TREE (Flagg & Nash, 1999)

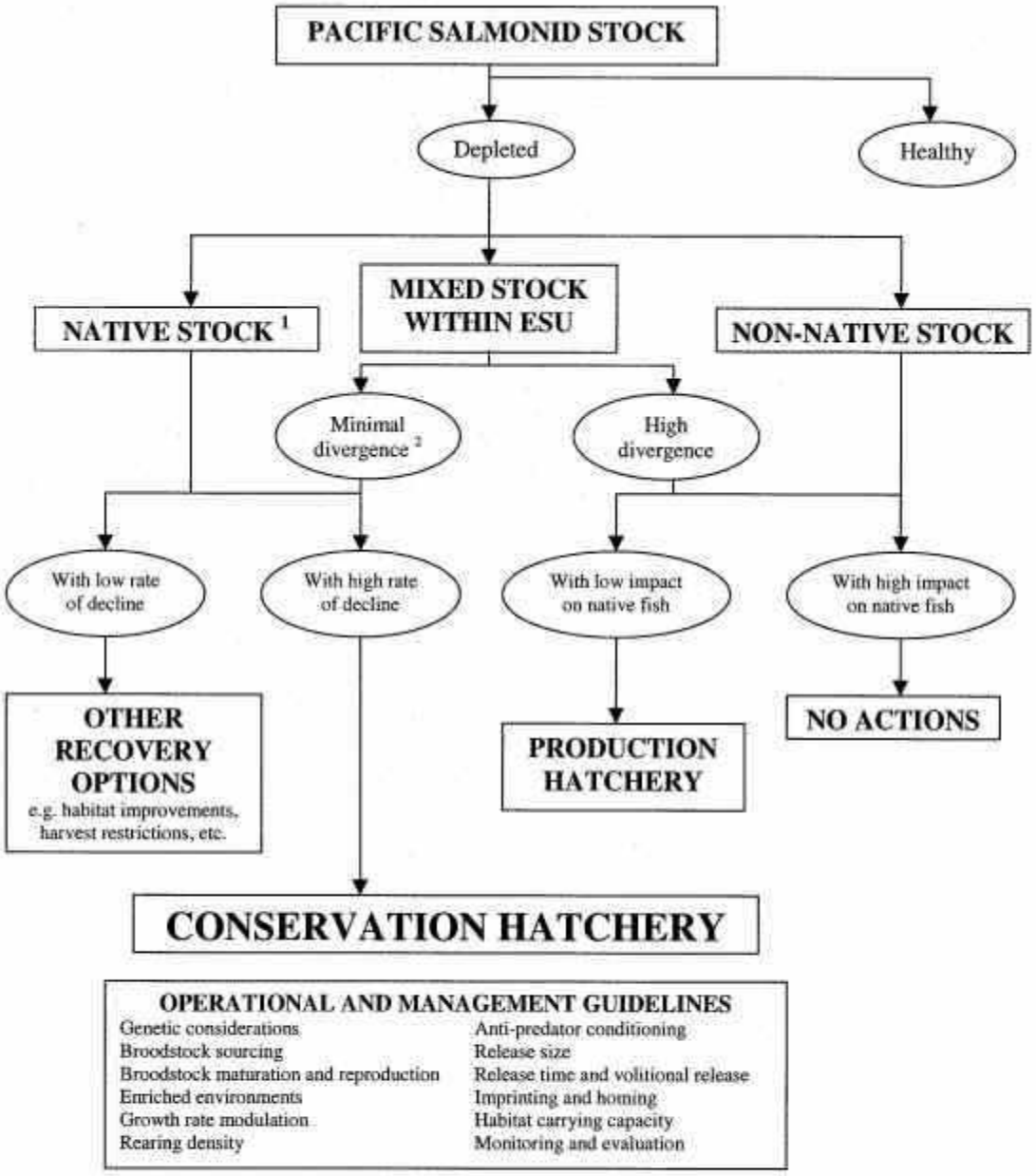

Figure 1. Conservation hatchery decision tree. Decision pathways depend on population status, genetic composition, and rate of decline of the stock, and impact of the operation on native fish.

[1] In all cases this would be the preferred source. For an extirpated stock another from within the same Evolutionarily Significant Unit (ESU) can be substituted.

[2] Stock with traits identified as useful for recovery.

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APPENDIX II

FIGURE OF RECOMMENDED STOCK SELECTION FOR CHINOOK SALMON REINTRODUCTION PROJECT (SJRRP, 2008)

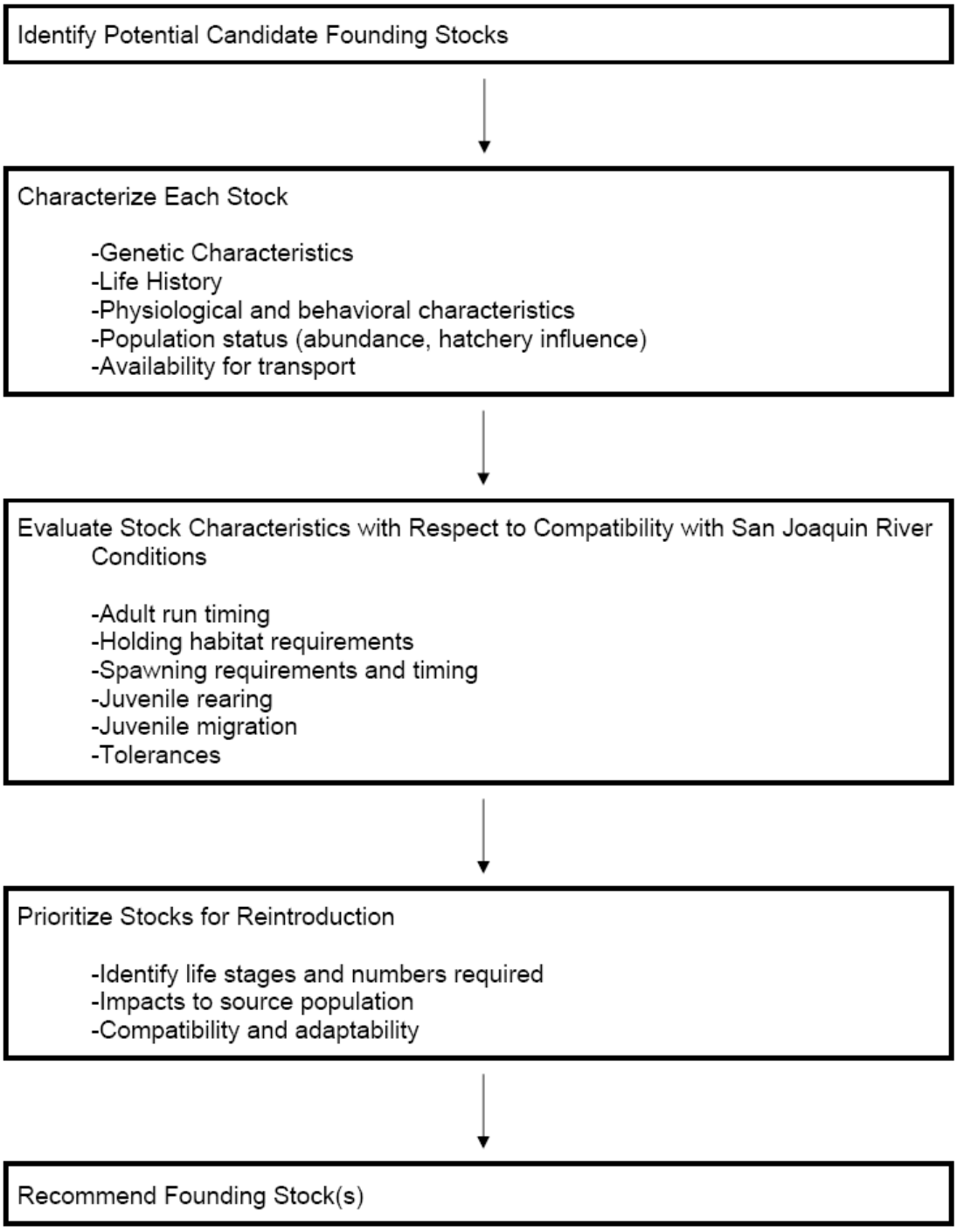

Figure 8. Overview of recommended stock selection process.

Resource Agencies/CG Study Request 3.4

ANADROMOUS FISH PASSAGE

July 15, 2009

1.0 Project Nexus and Issue

The goal of this Study Request is to provide information to the Relicensing Participants concerning California Central Valley Steelhead trout DPS, *Oncorhynchus mykiss* (*O. mykiss*), and its designated Critical Habitat, under the Endangered Species Act and associated with Merced River reaches affected by the Merced River Hydroelectric Project within the influence of the Federal Energy Regulatory Commission (FERC) Project Area, through the evaluation of improvements or alternatives for anadromous fish passage.

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 are 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). In 1966, McSwain Dam (Merced Irrigation District Merced River Hydroelectric Project) was constructed without fish bypass structures. Thus, the upstream reaches of the Merced River, above Crocker-Huffman Diversion Dam and Merced Falls Dam, have been, and continue to be, affected by the Project. These blockages of fish passage have caused the elimination of approximately 99% of the original spawning and rearing habitats for Steelhead trout (*Oncorhynchus mykiss* or *O. mykiss*) and spring-run Chinook salmon (*Oncorhynchus tshawytscha*) in the Merced River watershed (Martin, 2008). Fall run and late-fall run Chinook salmon spawning may have ascended the Falls at North Fork, and Schick *et al*. (2005) stated that it currently occupies about 8% of its historic habitat (= 92% has been eliminated).

Although a comprehensive evaluation of downstream migration of Steelhead trout below Crocker-Huffman Diversion Dam has not been made (see Study Proposal-Anadromy Salmonid Habitat), studies of fall and late-fall run Chinook salmon have shown significant successful spawning cycles, especially in years with suitable habitat conditions, i.e. high water flow years, and severe population declines with low in-stream flows. There are substantive issues of adverse impacts to migration of anadromous species, including the absence of diversion screening, adverse water quality impacts from temperature and toxic conditions, predation, and unsuitable juvenile rearing habitat, i.e. physical and temperature constraints. The spawning habitat for *O. mykiss* and *O.*

tshawytscha in the Merced River watershed has been greatly reduced from its historic range. The vast majority of historical spawning habitat has been eliminated by fish passage barriers and impediments associated with water storage, withdrawal, conveyance, and diversion for agriculture, flood control, and domestic and hydropower purposes. Modification of natural flow regimes has resulted in increased water temperatures, changes in fish community structures, depleted flow necessary for migration, spawning, rearing, and flushing of sediments from spawning gravels. These changes in flow regimes may be driving a shift in the frequencies of various life history strategies, especially a decline in the proportion of the population migrating to the ocean. Land use activities, such as those associated with agriculture and urban development, have altered steelhead habitat quantity and quality. The effects of disease and predation on *O. mykiss* remain largely unknown, but are hypothetically important factors in controlling population size and viability (see Windham, 2007 for an analysis of threats to *O. mykiss*).

Restoration of connectivity between the lower Merced River (below Crocker-Huffman Diversion Dam) and the upper Merced River (Lake McClure and upper Merced River-mainstem and South Fork) is the only promising alternative to spawning and rearing habitat improvement and restoration for the watershed. In lower Merced River basin reaches, maintenance of "tailwater" habitats, suitable for *O. mykiss* juvenile rearing, clearly requires sustained in-stream flows to provide proper temperature conditions because the population has crashed and not recovered under past and current Project operations. Historically, upstream habitat and temperature conditions are more favorable for over-summering needs of *O. mykiss* juvenile populations. It appears to be infeasible to construct volitional anadromous fish bypass structures around McSwain Dam and New Exchequer Dam, thus a "trap and truck" bypass alternative is considered as being more practical and feasible. Although generally more difficult to operate than constructed fish ladders, the technology is available and has been used as a prescriptive remedy in numerous Pacific Northwest fish passage projects, and including the San Clemente Dam, Carmel River and Keswick Dam (winter run Chinook salmon supplementation hatchery) on the Sacramento River. The recent National Marine Fisheries Service (NMFS, 2009) Biological and Conference Opinion on OCAP for the State Water Project and Central Valley Project, indicates the severity of the spawning and rearing habitat problems in the San Joaquin River basin. There are two key elements to the success of a "trap and truck" bypass: trapping and transport of adults (= escapement or upstream spawning migration fish) and trapping and transport or providing facilities bypass of juveniles (downstream smolt migration to the sea). The trapping of upstream adults appears to be feasible at the existing Merced River Hatchery, below the Crocker-Huffman Diversion Dam. The feasibility of an upstream "trap and truck" alternative (or other volitional bypass) needs further evaluation and study. The proximity of the upstream FERC project boundary (i.e., Lake McClure) and its location relative to the Wild and Scenic River boundary needs consideration in the study process; the design of a permanent weir or other fish

trapping facility must avoid placing buildings or permanent structures within the Wild and Scenic River corridor.

This Study Request addresses the following preliminary issues as identified in Section 6 of the Applicant's Pre-Application Document (PAD) (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-PAD, 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. Purpose of this prior sentence??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). Potential management goals should be considered:

- Maintain reservoir levels to protect beneficial uses.
- Protect and enhance stream and reservoir fishing opportunities consistent with overall fishing-based recreation.
- Maintain reservoir levels to enhance a sustainable rainbow trout (and Chinook salmon) fishery in Lake McClure and its upstream tributaries.

- Maintain reservoir levels and habitat availability for "assisted" anadromous salmonid species.
- Populations of native aquatic biota, including fish, benthic macroinvertebrates, and riparian species are viable with adequate habitat consistent with species' needs. Maintain, enhance, or restore all life stages of native aquatic species.
- 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 fish for ceremonial and spiritual purposes
- Provide fish bypass by construction, maintenance, or operation of any dam which impedes passage of fish *sensu* California Fish and Game Code 5901 and 5930 *et seq*
- Provide fish bypass alternatives for Endangered Species Act consultation.
- Develop feasible alternatives for fish passage prescription (FPA § 18 Fishway Prescription)

3.0 Relevant Public Interest Consideration and Potential License Conditions

The requester is not a resource agency and states the public interest consideration 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 to establish data and information to 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 protect and enhance species of concern, threatened or extinct populations of California Central Valley Steelhead Trout, Central Valley spring-run Chinook salmon, and fall- and late fall-Chinook salmon in the Merced River watershed to establish data and information useful in developing protection, mitigation, and enhancement (PM&E), Section 7 consultation, ESA in the public interest.

Study and analysis 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 interests of fishing, public's use and utilization of anadromous fisheries resources, 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, allow 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 dam and project operations should be examined for fish passage. The information and alternatives to fish passage may provide useful information in developing protection, mitigation, and enhancement (PM&E), consultation with California Department of Fish and Game public trustee responsibilities for the Merced River.

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 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 trust 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

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 received potential study recommendations and issues by Relicensing Participants in August 2008. Applicant chose to ignore or consider "information sufficient" and to not develop "Preliminary Proposed" studies to address Anadromous Fish bypass and restoration (MID, 2008).

The applicant is proposing no studies to address Project Issues (i.e., in-stream water requirements), which may be controlled outside of the FERC Project Boundaries. The applicant stated that anadromous fish do not occur in the Merced River upstream of the Crocker-Huffman Diversion Dam, and thus, the Merced Falls Hydroelectric Project has no effect on the upstream migration of special-status fishes. Operations of the Project, in conjunction with MID's Merced Falls Hydroelectric Project (FERC No 2467) have a major modifying effect upon Merced River flows, which are significantly different that "run-of-the-river flows, and have a significant effect on tailwater habitats and conditions for anadromous fishes.

The applicant stated that California Central Valley Steelhead Trout DPS were reported on USFWS species lists (MID, 2008); CGs indicate in a recent query to USFWS, both the steelhead trout and Chinook salmon are reported from the USGS Merced Falls and Snelling Quad maps, and the MID information is not complete and accurate.

The extirpated population of spring-run Chinook salmon historically occurred in the Merced River, but the MID-PAD (2008) "eliminated from further consideration spring-run Chinook salmon (*Oncorhynchus tschawytscha*)" in the San Joaquin River basin Restoration This fish will be reintroduced into the San Joaquin River in 2012., and the Merced River may be repopulated and important to the re-establishment of this species.

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 or removal of fish barriers within reservoirs.

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 Applicant and Relicensing Participants concerning the Project effects on blockage of volitional fish migration of anadromous threatened, endangered, fully protected species, and species of concern in the Merced River and in Project reservoirs. The objectives of the study are:

- Document the location, nature, and characteristics of barriers to anadromous fish migration in project affected reaches, into and out of important tributaries, and into the inlets and out of Project reservoirs and diversion pools.
- Identify Project facilities and operations (e.g., diversion structures, instream flow releases and reservoir water surface elevations) that may affect anadromous fish passage.
- Examine the biological and physical technical issues associated with the potential for re-establishing migratory passage and fish protection at Project facilities.

- Develop a fish passage assessment model to evaluate various combinations of alternative fish passage program elements and goals for the Merced River Hydroelectric Project relicensing project environmental documentation. The model should be user interactive and allow evaluation and sensitivity analyses of multiple model elements and scenarios in a single model run. The model should provide output totals for metrics on the performance ranges and expected outcomes for the model runs. These model output totals should be documented in summary output reports and allow for easy comparison of model run alternatives.
- A monitoring protocol will be developed to gauge the success of fish passage (and screening) corrections. The monitoring protocol will address both adult and juvenile fish passage. Baseline and post correction data must be collected and analyzed to determine effectiveness and need for adaptive management
- Evaluate the feasibility of anadromous fish bypass alternatives, including "trap and truck" operations to restore Merced River connectivity and to increase dangerously restricted spawning and rearing habitats for the ESA threatened listed species California Central Valley Steelhead trout DPS (*O. mykiss*) population.

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, blocked by CDFG in the early 1970's with the construction of an artificial spawning channel for mitigation for fall- and late fall-run Chinook Salmon by Merced Irrigation District (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; Department of Fish and Game believed that the fish ladders would detract from their operations and this management decision needs to be re-evaluated. Only the artificial spawning and rearing of young stages of fall-run Chinook salmon has continued. Anadromous Fish Restoration Project (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 benefits of the project would be to provide and additional amount of spawning and rearing habitat for Chinook salmon and steelhead, but would require some management actions to "rehabilitate" those habitats, such as improvements in spawning substrates (Vogel, 2007). The constraints include increased entrainment of downstream migrants into the Main Canal, concerns for introduction of disease to hatcheries, and lack of fish passage. Alternative water supplies for the Main Canal and hatcheries, and improved fish passage structures can be implemented to avoid these constraints. At the present time, there are clearly four barriers to volitional anadromous fish migration in the Merced River: a) Crocker-Huffman Diversion Dam (inoperable 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). With structural deficiencies and fish passage issues, 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, whilst passage past McSwain Dam (and reservoir) and New Exchequer Dam (and reservoir) are serious and formidable challenges. However, without the Merced River Hydroelectric Project in place, anadromous fish passage could be achieved with relative simplicity, by simply reconfiguring existing fish ladders to modern standards. Further, but for the Merced River Hydroelectric Project, there would be less available water to divert (only by the Crocker-Huffman Diversion Dam, which was the historic condition in 1925) and the Merced River would return to a more natural "run-of-the-river" hydrography, which would improve connectivity and habitat quantity/quality for Steelhead trout.

Regarding natural barriers to anadromous fish in the entire Merced River, there is a 25-ft waterfall on the mainstem near the North Fork at RM 86 (Stanley and Holbek 1984), but it was probably not steep enough to have posed a substantial obstacle to salmon and steelhead migration and stream hydrologics not understood at this time could potentially support fish passage at high flows. Further evaluation of its status and state of fish passage blockage is needed. Merced ID proposed a McClure Reservoir study proposal, but did not include evaluation of the North Fork Fall on the mainstem. Other potential obstacles to fish passage are the levels and condition of the Lake McClure. If the reservoir is drawn down at the time of migration, there could be issues of water velocities and quantities to get spawning fish upstream to spawning areas. The operation of the reservoir, along with surveys of potential barriers to migration in Lake McClure and upstream is needed. For example, if the reservoir is near capacity and there is a normal or

wet year runoff, sufficient flows are arguable present to allow unimpeded migration above Lake McClure, since the state of the river would be similar to those from historic periods. Although uncertain, future rainfall patterns and watershed water resources may not be the same as historic patterns

6.0 Study Methods and Analysis

6.1 Study Area

The study area includes aquatic habitats within the Federal Energy Regulatory Commission (FERC) Project Area and extends 0.5 mile of the normal maximum water surface elevation of Project reservoirs and normal high water line of Project-affected stream reaches, including the section of the Merced River from Pacific Gas and Electric Company's (PG&E) Merced Falls Dam to the Crocker-Huffman Diversion Dam. Since the study involves blocked volitional migration of anadromous fish and the ability of Steelhead trout to ascend to historic spawning and rearing habitats, the study area includes the mainstem Merced River and the South Fork of Merced River, upstream of the Federal Energy Regulatory Commission (FERC) Project Boundary of Lake McClure to the Yosemite Valley on the mainstem and to 4 miles downstream of Wawona on the South Fork.

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-mainstem and South Fork of the Merced River. In this step, Applicant will identify potential barriers for all existing and historic anadromous fish species (e.g., natural falls, tributary junctions, road crossings, shallow riffles, and diversions or dam structures) in the reaches listed in Section 6.1 Study Area.

From early 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 to all adult anadromous fish barriers or to 0.5 mile upstream from the confluence with the main stem, 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 project 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 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. Applicant will collaborate and consult with the natural resources agencies (BLM, CDFG, USFWS, NMFS, USFS, SWRCB, SSMN) and the NGO Participants to review and adopt a Final Study Plan.

Step 2 – Identify and Qualitatively Assess Potential Upstream and Downstream Anadromous Fish Species' Migration Barriers in Project Reservoirs. In this step, Applicant will identify and qualitatively assess potential barriers (*i.e.*, a potential barrier 3 feet in height or greater or a thalweg depth of less than 0.3 feet) to upstream and downstream anadromous fish species migration in major project reservoirs in spring when anadromous fish species in the reservoir might move upstream into streams to spawn. Reservoirs and reservoir tributaries that lie above the dams listed in Section 6.1 will be examined: Crocker-Huffman Diversion Dam, Merced River Falls Dam, McSwain Dam, and New Exchequer Dam reservoirs. The area of the tributary to the reservoir to be examined is from about the normal spring reservoir pool conditions to normal maximum water surface elevation. To identify potential barriers to upstream and downstream anadromous fish migration out of, and into, reservoirs, Applicant will use the same process as described in Step 1.

Step 3 – Consult with Agencies and Tribe Regarding Project Dams. Applicant will also consult with Relicensing Participants regarding existing project facilities that may affect anadromous fish species passage. Information that will be examined includes: 1) the facilities, including physical descriptions, location, degree of anadromous fish passage blockage, and all field observations; and 2) conclusions of the overall potential barriers to fish passage of the facilities singularly or jointly operated. The Agencies and Tribe will judge the adequacy of the fish passage study information and recommendations; where indicated, the need for additional evaluation, with respect to design/needs for fish passage prescriptions will be reported in Step 4. Consideration of, and evaluation of, alternatives including dam removals shall be included in the evaluations of fish bypass.

Step 4 – Consult with Relicensing Participants. In this step, Applicant will consult with Relicensing Participants regarding the results of Steps 1 through 2, 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.

Step 5: 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;
- Determination of reservoir elevations needed to provide upstream passage out of reservoirs.

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 (MID, 2008);
- Physical and hydraulic characterization of potential barriers based on measurements from the field and/or Project engineering drawings;
- Fish passage assessment methodology outlined in Powers and Orsborn (1985) and Thompson (1972) modified, where necessary, for the specific species (e.g., trout, salmon, lamprey)

Hydraulic modeling will be included in the assessment:

- Characterization of the seasonality, magnitude, and frequency of flows at the barrier over a range of water year types using the existing and unimpaired flow information;
- Coordination with the Instream Flow Study Plan, if appropriate, to provide hydraulic data and modeling to estimate fish passage over the range of flows.

Step 6 – Step 6 – Develop a fish passage assessment model that incorporates variables to represent fish passage program conditions and interactions, and be designed to evaluate fish passage. Upstream available spawning habitat quantification will be based results of the “Effects of the Project on fish habitat availability upstream the Project” as the amount of suitable habitat under various upstream tributary flows. Consequently, the actual amount of potentially suitable spawning habitat may likely less than the amounts utilized in the model, so the model estimates should provide optimistic assessments of potential fish passage production. Upstream water temperatures were assumed to be suitable for Steelhead trout under the assumption that the upstream conditions would provide

appropriate water temperature conditions in the event that anadromous salmonids were present in the upstream tributaries, based upon historical occupancy and current occupancy by resident rainbow trout. Potential biases in the values used in the model would not affect the ability to compare between passage program alternatives because of consistent application across all scenarios.

Salmonid population and habitat models have been proven useful in developing fish passage models and assessing fish passage suitability. Fish passage evaluations should utilize habitat models such as the "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) allows the user to track fish populations through their life stages and habitats, and then back to the spawning grounds. A transformation function allows hatchery spawners in the river to produce natural fish (based on the input of stray rates). Stochastic variability and uncertainty in functional relationships can be introduced into the model, and then multiple simulations can be used to develop a distribution of outcomes or quasi-confidence intervals based on model assumptions. This approach can also be used to estimate species extinction risk or predict population trends over time following initiation of a habitat action. SHIRAZ runs on a Microsoft Excel platform. Currently the Muckleshoot Indian Tribe is using SHIRAZ in the Green/Duwamish Rivers and NOAA Fisheries is applying SHIRAZ to the Snohomish River (Bartz, *et al*., 2006; Scheuerell, *et al*., 2006).

The RIPPLE Population Model (Stillwater Sciences, 2006) follows the multi-stage stock-production approach to population modeling. 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, hatchery management, 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.

Step 7- Identify "trap and truck" facilities and operations that evaluate the feasibility of providing upstream and downstream migration of Steelhead trout, including supplementation conservation hatchery operations, upstream spawning adult capture and release, downstream juvenile smolt migrant capture and release, and construction of facilities and operations within, or immediately adjacent to, the current FERC project boundaries. Evaluate and consider existing and additional needs for facilities that are required to conduct a "trap and truck" operation for anadromous fish.

Step 8 - Consult with Relicensing Participants Regarding Quantitative Fish Barrier, Fish Passage Assessment Model, and "Trap and Truck" Alternative. Applicant will consult with Relicensing Participants regarding Steps 5 through 7. The Agencies and Tribe will

judge the adequacy of the study information and recommendations; where indicated, the participants will evaluate the need for additional study, with respect to design/needs for fish passage prescriptions considered in the Merced River.

Step 9 – 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 locations of any identified potential barriers to upstream or downstream anadromous fish species movement.

6.4 Consultation and Communication

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

- Consult with Agencies and Tribe regarding potential upstream an downstream migration barriers in the mainstem and South Fork, Merced River(Step 1)
- Consult with Agencies and Tribe regarding potential upstream an downstream migration barriers in Project Reservoirs (Step 2).
- Consult with Agencies and Tribe regarding Quantitative Fish Barrier Study (Step 5); Fish Passage Assessment Model (Step 6), and "Trap and Truck" Alternative (Step 7

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 Step 6.

6.5 Schedule

The schedule to complete the study proposal is:

Mainstem Migration Barrier Assessment (Step 1).....April-May & November 20xx
Reservoir Assessment (Step 2) .....…..April-May & November 20xx
Consultation (Steps 3, 4, and 8)..... October 20xx – December, 20xx
Quantitative Fish Barrier Study (Step 5)…….April-May & November 20xx + 1 year
Fish Passage Assessment Model (Step 6)……...…..April through September 20xx
Trap and Truck Alternative (Step 7).……..April through September 200xx
Report Preparation (Step 8).....……...September – December 20xx + 1 year

It is anticipated that the study will be completed in December 20xx + 1 year.

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

A preliminary estimate for the study cost in 2009 dollars is as follows:

2009 Cost Estimate Based upon Efforts and Costs of study elements

Step in Study	Study Task	Estimate person time	Cost
Step 1 & 2	**Field Survey of Barriers in River and Reservoirs**	**6 person-months**	**$45,000**
Step 3, 4 & 8	**Consultation process**	**1/2 person-months**	**$ 4,000**
Step 5	**Quantitative fish barrier study (collaboratively determined)**	**18 person- months**	**$135,000**
Step 6	**Fish passage assessment model**	**14 person-months**	**$105,000**
Step 7	**Trap and Truck Facilities Operation**	**12 person-months**	**$90,000**

Step 9	**Report Preparation**	**6 person-months**	**$45,000**
	TOTAL STUDY COST		**$424,000**

9.0 References Cited

Bartz KK, Lagueux KM, Scheuerell MD, Beechie T, Hass AD, Ruckelshaus MH. 2006. Translating restoration scenarious into habitat conditions: an initial step in evaluating recovery strategies for Chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 63: 1578-1595. doi:10.1139/F06-055

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Schick RS, Edsall AL, Lindley ST. 2005. Historical and current distribution of Pacific salmonids in the Central Valley, CA. National Marine Fisheries Service/NOAA NOAA-TM-NMFS-SWFSC-369, Santa Cruz CA. 25 pp.

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Resources Agencies/CG Study Request G1

GRAVEL SEDIMENT BUDGET & MOBILITY

July 15, 2009

1.0 Project Nexus and Issue

The goal of this Study Request is to provide information to the Commission, the applicant, and Relicensing Participants on how project operations, maintenance, and construction affect Merced River habitat, specifically river channel and floodplains with respect to spawning and rearing habitat, necessary for the maintenance and enhancement of anadromous salmonid fish.

Under 18 CFR§ 5.9 (a), natural resource agencies "...should include information and studies needed for consultation under section 7 of the ESA. This study request addresses the need for information beyond that proposed to be gathered by the applicant. The applicant intends to study impacts from the Project predominantly within its Designated FERC Project Boundary and believes that there is sufficient information and the issue has "no nexus to the Project. Existing information demonstrates that New Exchequer Dam, McSwain Dam, Merced Falls Dam and Crocker-Huffman Diversion Dam have affected, and continue to affect, gravel and sediment replenishment, recruitment and mobilization throughout the entire Merced River watershed downstream of Lake McClure. Not only do the Project dams block anadromous fish access to suitable spawning habitats in the upper watershed where these fish historically reproduced, the Project dams block gravel and sediment transport needed for spawning (below Crocker-Huffman) within areas currently occupied by anadromous fish and designated as critical habitat under ESA and essential fish habitat under MSA. In addition, the entrapment of gravel and sediment behind Project dams has impaired natural river morphological functions such as floodplain formation and inundation, which are also critical components of suitable habitat for rearing juvenile salmonids.

To satisfy information needs for the ESA, 16 U.S.C. §§ 1531 et seq., MSA, 16 U.S.C. §§ 1801 et seq., FWCA, 16 U.S.C. §§ 661 et seq., and Reorganization Plan No. 4 of 1970, 84 Stat. 2090, CGs submits the following Study Request, which follows18 CFR§ 5.9 (b).

The applicant only intends to study Project effects within its impoundments, and a short reach of the Merced River, between Merced Falls and Crocker-Huffman Diversion dams. However, it is clear that the Project dams capture large volumes of sediment from the mainstem upper Merced River that could otherwise continue downstream into habitat currently occupied by anadromous fishes. These fishes use suitable gravel and sediments for spawning and incubation. In addition, gravel and sediment movements maintain channel processes that provide habitat for rearing juvenile salmonids. The Project dams (principally, New Exchequer Dam) modify "run of the river" flows, and cause impaired seasonal flow regimes, which historically and frequently altered in-river substrates and

floodplains. Because of the ability of the Project to capture sediment, the Project alters gravel and sediment recruitment and thereby affects ESUs and DPSs listed under the ESA, Critical Habitat designated under the ESA, and essential fish habitat. In addition, Project dams completely block access to historical Chinook salmon and steelhead spawning habitats. Blockage of anadromous fish habitat by Project dams and sediment capture affect anadromous fish and their habitat directly, indirectly and cumulatively throughout the Merced River watershed and downstream to the San Joaquin – Sacramento River confluence. The information generated from this study would inform the development of potential license conditions including;

a) operational changes to facilitate sediment transport and floodplain inundation;
b) anadromous fish passage into areas with suitable spawning gravels;
c) instream flow modifications to promote channel processes and optimize existing spawning and incubation gravels, and floodplain habitats;
d) gravel additions and wing-dam construction and maintenance downstream of Project dams

The geographic scope of the study should be from Lake McClure to the Shaffer Bridge (FERC Flow Compliance point for Merced River Hydroelectric Project).

2.0 Resource Agency and Tribal Management Goals

NMFS (2009) requested that Merced ID perform a new Sediment Budget Evaluation Study. Specifically, NMFS requested Merced ID develop a sediment budget model for the Merced River, both upstream and downstream of the Project, focusing on spawning gravel requirements for steelhead and Chinook salmon. Deliverables from the study would include channel sediment storage, bedload flux, residence time, and particle size distribution. CGs agree with, and support, NMFS' Study Proposal Request, and recommend the following modifications and study request criteria be included in the final FERC-recommended Study Plan for the Merced River Hydroelectric Project No.2179. CGs have consulted with NMFS regarding this study plan and believe that NMFS staff supports the Study Request. The Study Request will provide information to inform the Commission and Relicensing Participants of license requirements, and project compliance with NMFS Resource Management Goals and Objectives for native anadromous fish of the Merced River

NMFS Resource Management Goals and Objectives:

Resource Goals

2.1.1. Protect, conserve, enhance, and recover native anadromous fishes and their habitats by providing access to suitable habitats and by restoring fully functioning habitat conditions.

2.1.2. Identify and implement measures to protect, mitigate or minimize direct, indirect, and cumulative impacts to, and enhance native anadromous salmonid resources, including related spawning, rearing, and migration habitats and adjoining riparian habitats.

Resource Objectives

2.2.1. Flows - Implement scheduled flows in the Merced River to the benefit of native anadromous salmonids and their habitats. This includes providing a range or schedule of flows necessary to: a) optimize suitable habitat, including the distribution of holding and spawning habitat; b) stabilize flows during spawning and incubation of in-gravel forms; c) maintain flows necessary to facilitate the efficient migration of spawning adults; and the safe and timely emigration of smolts and kelts, and movement of rearing juveniles between feeding and sheltering areas; d) maintain flows necessary to ensure redd placement in viable areas; and e) maintain flows necessary for channel forming processes, riparian habitat protection, and maintenance movement of forage communities. This also includes impacts of flood control, irrigation or other project structures or operations that act to displace individuals or their forage or destabilizes, scours, or degrades physical, chemical, or biological quality of habitat.

2.2.2. Water Quality - Modify Project structures or operations necessary to mitigate direct, indirect, or cumulative water temperature and quality impacts associated with project structures and operations or enhance water temperature and quality conditions in salmonid habitat. This includes water temperature management necessary to ensure the optimal survival and distribution of all life stages of Central Valley fall-run and spring-run Chinook salmon, Central Valley steelhead, and green sturgeon (in the Sacramento – San Joaquin Delta).

2.2.3. Water Availability - Coordinate operations with other projects, programs, or initiatives and/or use water transfers, water exchanges, water purchases, or other forms of agreements to maximize potential benefits to anadromous fishes from limited water supplies.

2.2.4. Fish Passage - Passage to suitable spawning, rearing, and migration habitats within or near the project as necessary to complete their life cycles and utilize seasonal habitats necessary to contribute to the recovery of Central Valley spring-run Chinook salmon, Central Valley steelhead, and other species of concern. Access into the Project may include passive or active structures or devices that provide upstream and/or downstream passage. Passage within or near the Project boundary may include modifications to project facilities and operations necessary to ensure the safe, timely, and efficient passage of upstream migrating adults, downstream passage of emigrating juveniles, and passage necessary for juveniles to access habitat necessary for the seasonal movement of rearing juveniles to feeding and shelter habitats.

2.2.5. Channel Maintenance - Implement flow regimes and non-flow related measures necessary to mitigate and minimize direct, indirect, and cumulative impacts of project facilities and operations on sediment movement and deposition, river geometry, and channel characteristics. This includes impacts on stream competence, capacity, flood plain conductivity, bank stability and extent, duration, and repetition of high flow events. In addition, this includes impacts to habitat diversity and complexity such as pool riffle sequencing and instream cover.

2.2.6. **Hatchery Operations** - Minimize and mitigate the impacts of hatchery facilities and/or operations on native, wild anadromous salmonids. These include the direct, indirect, and cumulative impacts of hatchery product on anadromous salmonids and the direct, indirect, and cumulative impacts of hatchery facilities and operations on salmonids and their habitats.

2.2.7. Predation - Minimize and mitigate the impact of Project structures or operations that either have in the past or continue to introduce predators, create suitable habitat for predators, harbor predators, or are conducive to the predation of native anadromous salmonids.

2.2.8. Riparian Habitat - Protect, mitigate or minimize direct, indirect, and cumulative impacts to, and enhance riparian habitat and habitat functions necessary to mitigate and minimize direct, indirect, and cumulative impacts of project facilities and operations.

2.2.9. Flow Ramping - Modify Project structures or operations necessary to minimize impacts of flow fluctuations associated with increases or decreases in project discharges.

3.2.10. Coordination - In developing alternatives for relicensing, include a full range of alternatives for modifying project and non-project structures and operations to the benefit of anadromous salmonids and their habitats, while minimizing conflicts with operational requirements and other beneficial uses. This includes developing alternatives for greater coordination with other stakeholders and water development projects to ensure that, at a minimum, project structures and operations are consistent with and can potentially enhance on-going and future restoration efforts.

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 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, Federal Power 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 protect and enhance species of concern, threatened or extinct populations of California Central Valley Steelhead Trout, Central Valley spring-run Chinook salmon, and fall- and late fall-Chinook salmon in the Merced River watershed to establish data and information useful in developing protection, mitigation, and enhancement (PM&E), Section 7 consultation, ESA 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 interests of fishing, public's use and utilization of anadromous fisheries resources, 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, allow 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 information and alternatives to enhancement of juvenile *O. mykiss* habitat below the Project may provide useful information in developing protection, mitigation, and enhancement (PM&E), consultation with California Department of Fish and Game public trustee responsibilities for the Merced River. The applicant's proposed alternative studies are not sufficient to meet these stated information needs:

- The applicant received potential issues and information needs by Relicensing Participants in August 2008. Applicant chose to ignore or considered "information sufficient" to not develop studies to address Geology and Soil Issues (MID, 2008).
- The applicant is proposing no studies to address Project Issues (i.e., supply and movement of essential spawning gravels), which are likely to influence and change sediments/gravel outside of the FERC Project Boundaries (see MID and Natural Resource Sciences, 2003). The applicant states that "no need for additional information" or "analysis immediately downstream of both Lake McClure and Lake McSwain" and there is "no nexus to the Project" (MID, 2008). CGs disagrees with those conclusions and will provide comments in its filing on the appropriate sections of the PSP with regard to the "Information Needs" and "Nexus Issue". The direct effect of the project is to trap gravel and sediment in the project reservoirs, that requires the applicant from time to time to remove when it interferes with project operations (Vogel, 2007). CGs also believe that the Project contributes (along with the PG&E's Merced Falls Hydroelectric Project) to the modifications of "run-of-the-river flow" downstream hydrologic conditions to affect gravel and sediment movements (scouring or deposition) which, in turn, affects benthic macroinvertebrates, fish spawning habitat and behavior, and riparian vegetation. There are three direct effects caused by the Merced River Hydroelectric Project, and the other two dams on the river. The first direct effect was initially caused, and then completely and uninterruptedly

continued today, by the construction of the dams. Those Project events terminated all gravel and sediment replenishment from the upstream basins below each of the dams. The second direct effect occurs during operations from flow releases of the Merced River Hydroelectric Project (and the other FERC Project). When flows exceed 2000 to 5000 cfs (or higher), benthic gravel and sediment may be displaced and re-deposited, but it is uncertain what the degree of Project flow causes movement of gravel and sediment (MID-NRS 2003 @ page 24), along with potential reconfiguration of the channel/bed in its lateral and vertical profiles. The third direct effect of Project operations is the release of relatively clear waters, which causes "armoring" of the riverbed. The Merced River Hydroelectric Project reservoir traps the downstream movement of gravels and releases clear water, which causes the winnowing of smaller particles in reaches downstream of dams resulting in progressively coarser particles over time. This process of "armoring" occurs in the reach downstream of Merced Falls Dam (Vogel, 2007 @ page 66).

- The applicant stated that California Central Valley Steelhead Trout DPS were reported on USFWS species lists (MID PAD Page 7.7-5), yet failed to include them on their list of special status species, using a restricted "geographic scope of project" criterion (MID, 2008).

The results of this Study Request will inform the Commission of license requirements and will provide data, analyses, and information, useful in development of license 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 for gravel/sediment spawning habitat enhancement and floodplain enhancement

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

4.0 Study Goals and Objectives

Specific Objectives and Information to be obtained for this Study Request:

a. Evaluate current sediment transport and recruitment from the upper to lower Merced River watershed, including the quantity of sediment actively being captured behind Project dams.
b. Assess the impacts to anadromous fish spawning and incubation gravel and sediments from Project dams and water operations.
c. Assess the impacts to river geomorphic processes from Project dams and water operations and how those impacts affect anadromous fish habitats.
d. Evaluate the impacts of an impaired sediment regime on floodplain formation and inundation and how juvenile salmonids are thus affected.

5.0 Existing Information and Need for Additional Information

No information was presented in the PAD on sediment yield. The applicant should update this information to accurately reflect existing data regarding sediment yield, bedload and erosion in the Merced River watershed. In addition, the following information may be useful for background information and should be included in the analysis of the effects of the Projects:

Arkley, RJ. 1962, The geology, geomorphology, and soils of the San Joaquin Valley in the vicinity of the Merced River, California, In: Geologic guide to the Merced Canyon and Yosemite Valley, California: California Division of Mines and Geology Bulletin, no. 182, p. 25-31.

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Earlier investigators of gravel movement and anadromous salmonid habitat needs for gravel in the lower Merced River include: Stillwater Sciences (2004), MID and NRS, Inc. (2003), Vogel (2007) and DWR (2006). Recommendations from these studies included: a) conduct studies when it can be expected that additional clean gravels will be provided to reconstruct the wing dams after a high- flow period (flows > 3000 cfs); b). studies should be conducted only if funding was secured to purchase additional clean gravels or the wing dam material was stockpiled at the site in advance of the study; c) gravel supplementation below Merced Falls Dam would result in movement of material downstream into slower and deeper water, and analysis of bedload transport would be required to determine if it were filling in the reservoir at Crocker Huffman Diversion; d) model results suggest that the ongoing gravel augmentation and wing dam construction have not resulted in reach-scale effects on the Dredger Tailing Reach (DTR) of the Merced River, although, locally, both aggradation and a decrease in median grain size are clearly visible; e) model simulation of the current condition, where gravel is introduced from augmentation sites and by construction of wing dams, and observation of grain size patterns in the DTR indicate that the introduced gravel has some localized effect in aggrading the channel bed and decreasing surface median grain size. There remains the question and issue of whether sufficient in-stream flows are present to successfully mobilize and re-distribute gravels and keep river substrate from degrading, from removal of fine sediments and armoring.

In the Robinson Reach Project (RRP) site, Helley-Smith data should have provided a basis for roughly estimating total sediment load, but the data was “too sparse in both the

range of flows and in the number of samples collected at each flow and section to enable engineers to develop an accurate estimate of sediment transport in the reach" (DWR, 2006). They recommended further measurements on two or three riffle sections in the future with at least 4 samples at each section and each flow to provide better transport rate profiles. This information will enable "a better sediment budget and maintenance plan to be developed for the reach that will give planners a better tool to more accurately plan future maintenance of the project." Tracer gravel data was not collected in the RRP reach at different stages of the each flow event, so graphs of rock movement percentage versus discharge could not be created to identify the incipient mobility range. DWR (2006) found that the bed appeared to be slightly more mobile during 2002 flows (1,400 cfs) than during the 2003 flows (1,550 cfs), but offered this explanation of why that may have happened: the tracer data, the Helley-Smith data, and the scour of the mean be elevation of riffles in the upper reach of RRP in 2002 "support the hypothesis that artificially placed gravels are more mobile than those that have been sorted by river processes".

DWR (2006) discussed Future Monitoring Plans and Activities and Future Data Analyses for the Robinson Reach Project. They have five questions that they are attempting to answer with additional data collection:

- Are point bars developing in the downstream reaches (i.e. downstream of river station 63+70?
- What is the size of material depositing on the point bars?
- Are spawning-sized gravels being transported into the reach from upstream? Are they moving through pools?
- Has an armor layer developed on the riffles?
- Has the channel morphology changed in response to 2005 flows?

They also outlined goals of all future data analysis, in order to develop a process-based understanding of the changes that have occurred in the Robinson Reach from construction to the present date in order to:

- Improve applied sediment transport theory for designing and managing future restoration project on the Merced River and beyond;
- Provide a sound science basis for future gravel augmentation on the Merced River and beyond;
- Develop an understanding of how sediment transport and flow processes (e.g. bed load, shear stress) create and maintain the river channel and bed habitat (e.g. pools, riffles, point bars, cross-sectional shape, surface and subsurface bed material) and the hydraulic habitat (depth, velocity).

All of these aforementioned goals of future environmental analyses of the lower Merced River are directly affected by the Merced River Hydroelectric Plant construction, maintenance, and operations.

6.0 Study Methods and Analysis

Given the amount of available sediment budget and anadromous fish spawning habitat data, including the development of a sediment transport model of the DTR (Stillwater Sciences, 2004) and the DWR(2006) studies on the lower Merced River, CGs consider that the information for this request could be partially obtained without field work. In the evaluation of the DTR, Stillwater (2004) found at approximately 250 m (820 ft) downstream of Crocker-Huffman Dam, the CDWR/CDFG gravel augmentation had resulted in approximately 2.5 cm (1 inch) of aggradation and a decrease in median grain size from 55 mm to 49 mm. At approximately 0.5 km (0.3 mile) downstream of Crocker-Huffman Dam and beyond, neither bed elevation nor surface grain size have changed as the result of the CDWR/CDFG gravel augmentations. It should be noted that the lack of significant decrease in median grain size at gravel augmentation sites is most likely the result of having to use the post-gravel augmentation grain size distributions and channel geometry to simulate background conditions because pre-gravel augmentation grain size distribution and channel geometry data were not available. That is, gravel augmentation may have resulted in much more significant decrease in local particle grain size than indicated in the model run because the initial condition used in the model run does not really reflect the true pre-gravel augmentation condition. Overall, the simulation results suggest that gravel augmentation and wing dam construction at the current intensity will have localized effects in aggrading the channel bed and decreasing surface grain size, but may not have reach-scale effects because the river does not have the energy (= flows) to transport a significant amount of bedload. In simulation of background condition (where no gravel is introduced to the river artificially), daily mean flows over the past 30 years have been largely incapable of inundating the floodplain and have not had the required energy (= flows) to mobilize the existing channel bed, except in a few locations during extremely high flow events. Model results suggest that the ongoing gravel augmentation and wing dam construction have not resulted in reach-scale effects on the DTR reach although, locally, both aggradation and a decrease in median grain size are clearly visible.

Several techniques are standard practices for evaluation of particle size distributions and estimating total sediment bedloads at test flow conditions: pit traps, tracer gravels, and Helley-Smith bedload samplers can be mentioned here. Sliding bead monitors and erosion pins are typically used to measure changes in bed surface elevation. Floodplain connectivity is evaluated by measuring top wetted width following each of the test flow releases and by measuring flow depths with a staff gages, GPS, and transet during the test flow release supplemented with documentation photographs and video. A rapid assessment of geomorphic and sediment conditions in the upper watershed should be assessed by field reconnaissance and photogrammetry with present conditions being compared to historic records. Channel sediment storage, bedload flux, and residence times should be assessed upstream and downstream of the Project dams to compare influx and outflux of coarse sediments. Particle size distribution should be used in a rate of travel model and validated by bedload sampling and/or tracer (painted) pebble monitoring. Using all of the aforementioned data collection methods the applicant should develop a sediment model and a hydrologic/hydraulic model for the Merced River

watershed, which include inputs (separately) for the spawning gravel requirements for steelhead and Chinook salmon. These models should be designed around the basic tenants of fluvial geomorphology and the biology of Pacific salmonids with collaborative input from all Relicensing Participants.

6.1 Study Area

The study area includes the Merced River from, and including, Lake McClure, including inflow, to Shaffer Bridge, beyond the FERC identified "geographic scope of analysis" for water quality, but within the scope for federally listed species (FERC, 2009). Gravel and sediment alterations may affect critical habitat for federally listed species.

If additional features or information needs are identified during the Relicensing, 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 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 fixed. If the study costs more, applicant

should be 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.

- 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 preparer's satisfaction and after all metadata have been documented, applicant will provide the Shapefiles to Relicensing Participants upon request.

6.3 Study Methods

6.3.1 Hydraulic and Sediment Transport Modeling

There are several available "off the shelf" models for the evaluation of sediment bedload transport: a one-dimensional hydraulic model (HEC-RAS or HEC-2) and a sediment mobility model.

Step 1: Review and Evaluate the Existing Models: The first step in this study request will be to evaluate the existing models and determine their applicability and adequacy for Relicensing. Applicant should review the existing models including the inputs, assumptions, operations, and current states of calibration to ensure that they are consistent with applicant's understanding of operations and factors that govern sediment transport and channel geometry in the Merced River, at the study sites.

An existing HEC-RAS model, a one dimensional channel model simulates flow through a channel, based upon 2001 to 2004 Merced River channel geometries to support the analysis of sediment transport calculations (DWR, 2006). Applicant should review the current version of the model to determine its adequacy for implementation in the Study Request. CGs believe that the existing model may provide a useful foundation or platform, but it may require some additional levels of refinement to address project-specific needs, such as flow schedules above ""low-flow conditions", as were encountered in previous studies of the Merced River (DWR, 2006). The design process for the study will begin with hydraulic and sediment models' creation. For the hydraulic model, applicant should use surveyed cross sections and water surface elevations at study sites to construct a HEC-RAS water surface profile computation model. The model should allow designers to determine water elevations and other characteristics that will guide the channel flow data and characteristics. Calibration at high flows will involve comparison to other "higher" flow models, such as the Caltrans HEC-2 model, while low flows can be calibrated by comparing to surveyed low-flow water elevations. Creation of this model should take approximately one week.

The sediment mobility model uses data gathered on cross sections near and within study riffle reaches. Input data utilized in the model include velocity profile data, cross sectional profiles, and bulk sample results. These data calculate sediment transport energies to determine mobility of existing material. For example, this model can help to determine the necessary size, within the suggested size ranges for Chinook salmon and Steelhead trout, of the additional gravel to be added for spawning habitat restoration, disrupted by project construction, operations, or maintenance. Creation of this model should take approximately three days.

Step 2: Modify Existing Models or Develop New Models for Relicensing. After review of the existing model, applicant can evaluate and proceed with one of the following options:

1. Use the existing models without modification
2. Use the existing models with some modification
3. Develop new hydraulic and/or sediment transport models

If the applicant decides that the existing models are not adequate for Relicensing, applicant shall evaluate a range of software currently available for sediment mobility and hydraulic modeling in stream reaches. Applicant shall evaluate the strengths and weaknesses of various software platforms for modeling the sediment and gravel transport, that have been previously employed in salmonid spawning habitat restoration projects. The models should be evaluated for integration into the water balance/operations model described in Study Plan 2.2 and the water temperature model described in Study Plan 2.4 (MID, 2008) to simulate hydraulic and sediment-transport effects that result from reservoir operations simulated in the water balance/operations model.

Regardless of which models the applicant selects, the following steps shall be completed.

Step 3: Validate the Models

Models validation should occur in three tasks.

Model validation of the HEC-RAS model should be evaluated for its calibration and sensitivities to the Merced River, following the recommendations of the DWR "Review of HEC-RAS Hydraulic Model of the North Delta, Report by Peer Review Panel March 2003"
http://www.water.ca.gov/floodmgmt/dsmo/docs/RevisedFinalReport_4_241.pdf

Model validation of the sediment transport model (such as TUGS) should be calibrated and evaluated for sensitivities in the Merced River application, such as reported by Stillwater Science (http://www.stillwatersci.com/resources/sedtrans_brochure.pdf).

Calibration criteria should be developed for locations upstream and downstream of the FERC Merced River Hydroelectric Project boundaries for the broadest set of data available for the Merced River. Differences greater than 5% between actual historic conditions and model runs should be evaluated, the causes identified, and documented. Where substantial differences cannot be explained, the model should be adjusted so that the model output estimates are closer to the historic values, than those developed with the default model inputs.

In the second task, applicant should meet with interested Relicensing Participants to review the model. This should include a general briefing meeting to introduce the Relicensing Participants to the model. Relicensing Participants should be given a copy of the executable version of the model, a written report that describes the model's inputs, logic, and general information on running the model, and the complete written documentation and analyses, applicant used to evaluate and develop the model. After the initial meeting, applicant should hold a series of workshops with interested Relicensing Participants to collaboratively review the model, and make adjustments where appropriate.

In the last task, applicant should finalize the model, and associated reports, and provide these to the Relicensing Participants. These documents and information should be included in the applicant's application submittal for a new license.

Step 4: Field Reconnaissance. A field survey should be prior to sampling to view the actual channel and floodplain configurations. Reach-level field sites should be selected where major nodes or changes in streamflows result in deposition or erosion of sediments and gravels, under different hydrographic conditions. These would include riffles and runs into lakes or deep pools. Hydraulic and sediment transport field sites should be located in close proximity to rapid recording stream gages, to facilitate comparisons of flow measurements with hydraulic and sediment transport data parameters. Potential field survey sampling sites include, but are not limited to: a) Merced River at junction

with Lake McClure (use Briceburg-adjusted streamflow data, incorporating North Fork data); b) Merced River downstream of McSwain Dam; c) Merced River downstream of Merced Falls Dam; d) Merced River at Crocker-Huffman Gaging Station; e) Merced River at Snelling Gaging Station, and f) Merced River at Cressy Gaging Station.

Step 5. Field Sampling with Methods.

6.3.2 Merced River Basin Sediment Transport Evaluation-Field Studies

Channel sediment storage, bedload flux, and residence time should be assessed in river reaches upstream and downstream of the Project dams to compare influx and outflux of coarse sediments. Wathen *et al.* (1997) found particle size distribution can be used in a rate of travel model and validated by bedload sampling and/or painted pebble monitoring. Reach-scale sediment storage is rarely quantified in sediment budget studies, yet it has a considerable effect on the sediment delivery ratio at the basin scale, and on the accuracy of morphological methods of bedload estimation at the reach scale. Wathen *et al.* (1997) deployed magnetic tracer particles to characterize sediment fluxes in gravel-bed rivers and quantified storage activities using a "reservoir theory" approach. Activities were quantified at reach and sub-reach scales in two reaches of a gravel-bed river. Their studies found that accurate transit time measurements are exceedingly difficult because of a number of technical issues, such as tracer exhaustion and imperfect tracer recover rates. A refined transit time measurement, the response time, was defined as the time, after input of tracer sediment, when cumulative tracer output exceeds the amount of tracer sediment remaining in storage. It is expressed relative to "time since the start" rather than age, thus providing a more informative measure of activity. Quantification absolute and relative size effects in transport is also possible from response time data. Applicant's study plan should include estimates of sediment fluxs and quantified storage activities, using a "reservoir theory" approach.

6.3.3 Hydraulic/Hydrologic Measurements of Riverbed Field Evaluations

6.3.3.1 Hydraulic/Hydrologic Gage Measurements (Flows). Measurements, data, and information can be divided into two types (hydraulic/hydrologic) and geomorphic. Precise measurement of streamflows for determining velocity profiles and flow characteristics are essential data to understand the possible geomorphic changes in riverbeds and river flood plains. CGs recommend that each data collection site or measurement site be equipped with a "temporary" stream flow gage, and calibrated to the "official" gages operated on the river, for Merced River streamflows (New Exchequer, McSwain, Merced Falls, Crocker-Huffman, Snelling and Cressy gages). Those gages can be used for calibration, and verification of proper operation of the study sites.

The best measurement accuracies for flow gages are in more "artificial" weir-shaped channels, with a completely stable bottom, and free from backwater influences, such as

downstream ponding. A naturally formed channel section at the upstream ends of the study project reach should be selected, using the following criteria:

1) Gage should be installed on the riverbank with a goal of recording depth at the chosen location. The maximum range of water levels and their locations should be estimated visually before establishment of the gage station.
2) The main goal for the installed gage is to accurately measure water level changes, directly proportion to river flows. Avoid unstable riverbed and riverbanks and vegetation, because they can complicate measuring process.
3) In general, straight sections of channel with little turbulence are more desirable for measuring water depths, velocities, and discharges than bends or pool sections.
4) Correct measurements from a gage require a uniform flow regime for some distance upstream and downstream. The most desired type of velocity profile distribution across the reach is smooth without obstacles or debris.
5) It is preferable that the channel and riverbank of the cross-section be cleared of any debris or obstacles before gage installation, and they continue to be maintained during the project.
6) The best locations for the gages are in sections of the river with high banks, where the higher flows are contained in the main channel.
7) Select a location that avoids backwater effects from downstream features if at all possible.

A relatively simple, accurate, and inexpensive streamflow gage station can be found in the DWR (2006) report on the Robinson Reach Geomorphic Monitoring report. DWR (2006) stated that it took one day for measurements, one day for collecting and assembling materials and two hours for installation of their gaging station.

6.3.3.2 Calibration of gages. After installation is complete, the sensor needs to be calibrated with water depth measurements at the sensor location. The measurement sequence (interval timing) should coincide with the nearest "official" gage(s), normally at 15-minute intervals. A calibration curve should be developed for known flows and water depths.

Discharge is calculated based upon water depth with the equation:

$$Q = 10.345\ d^{3.696}$$

Where "Q" is total discharge and "d" is the recorded stage.

6.3.3.3 Velocity profiling. Velocity information is crucial data to understand the channel dynamics, which in turn leads to a better understanding of, and application to, the geomorphic changes in a reach. CGs recommend measurements of vertical velocity profiles in 20 cross-sections in riffle, pool, and transition reaches at the study sites. At each position the total depth is recorded and the effective cross-sectional areas is calculated. Each mean velocity multiplied by the area results in discharge quantities for

each subarea. These discharge quantities are then summed to get the total discharge. The method includes using a standard cup-type and graduated staff current meter or an Acoustic Doppler Current Profiler (ADCP) (Vogel, 2007). Depths are recorded every two feet, and velocity measured at 4 to 10 vertical intervals along the section depending on width. Typical velocity measurements should be made within 45 seconds at each depth with a standard current meter (DWR, 2006). Average water velocity for each cross-section resulting from these measurements may be defined as:

$$V_{average} = 1/36\ (17V_{0.2} + 3V_{0.6} + 16V_{0.8}),$$

Where "$V_{0.2}$, $V_{0.6}$, and $V_{0.8}$." are the velocities at 0.2, 0.6, 0.8 of the total water depth (DWR, 2006).

6.4 Geomorphic Measurement of Riverbed/Floodplain. These data and measurements track changes in the bed, banks, and floodplains of the river. Study elements described below include bulk sediment sampling, Woman pebble counts, tracer gravel monitoring, cross-sectional surveys, and bedload transport measurements. Data from these activities will allow a better understanding of how water releases from the Merced River Hydroelectric Project (and Merced Falls Hydroelectric Project) affect downstream sediment/gravel distributions, relative to "run of the river" distributions, found at the upper interface between the Merced River and Lake McClure. The data will be utilized to develop and refine models that describe the sediment/gravel transport processes so that we may better predict future changes as well as compare observed changes that occur under "baseline" conditions.

6.4.1 Channel Bed Characteristics

Channel bed characteristics refer to the quantifiable metrics of channel bed materials. There are a number of methods for measuring these characteristics, but commonly pebble counts and bulk samples are employed:

a) Wolman-Pebble count (1954): For each cross-section, a 100-sample pebble count was carried out using the random step-toe procedure. Samples on particle size were drawn randomly by wading through the river section close to the previously survey cross-section, and drawing the particles that are closest to the toe of the collector's wader. The intermediate axes of the particle was measured (neither the longest nor shortest of the three mutually perpendicular sides of each particle picked up). If distinctly different homogenous facies exist, each facie was sampled individually. Particles were categorized by using Wentworth size classes in which the size doubles with each class (2, 4, 8, 16, 32, etc.) or smaller class intervals based on 1/2 phi values. The method is very well described in Harrelson *et al.* (1994). Data analysis on particle size distribution was carried out using the statistical methods by Bunte and Abt (2001).
b) Bulk or core samples: Core or bulk samples of riverbed substrate should be taken using a 30.5-cm diameter McNeil sampler. The sampler is inserted approximately 30 cm into the streambed. Substrate composition for each sample should be determined by wet sieving collected streambed material through four U.S. Standard brass sieves (American Society for Testing and Materials – ASTM) in the following sieve sizes:

ASTM Sieve Number	Sieve Size Openings Millimeters
½	12.5
4	4.75
8	2.36
20	0.85

The purpose of the bulk sampling is to determine the level of fine material present in the sub-surface strata, not the coarse particle tendency. Bulk sampling to assess coarse particle central tendency should be more than 200 kg if gravels include stones 100 mm in diameter (Kondolf *et al*, 2003). Samples less than 200 kg and with smaller sieve sizes cannot be utilized to evaluate coarse particles sizes (Vogel, 2007).

6.4.2 Bed Mobility

Bed mobility is a characteristic of the riverbed surface, based upon the theory that any particle on the riverbed surface exerts a vertical force equal to its weight on the particles on which it rests. To move a gravel particle, the drag forces exerted by the flow on the grain must overcome the resisting force due to the immersed weight of the particle. The force exerted can be understood as a torque, or couple, exerted by the flowing water dragging over the exposed top of the particle, or as a direct force of the water impinging

on the area exposed to the flow. In either case, the force exerted is usually thought of as a drag stress proportional to the exposed area of the particle. In those portions of the riverbed with the highest likelihood of particle movement (turbulent portions), the very small turbulent eddies near the riverbed surface cause a fluctuation of the local flow velocity at any one point. This gives a random or statistical chance that a given particle will move rather than its neighboring particle. DWR (2006) gives the equation for determining the force required to roll a particle out of its pocket:

$$\tau_c = \tau_{c*} (p_s - p_w)gD$$

where τ_c is the critical shear stress (N/m^2) required to mobilize a grain with a diameter D, τ_{c*} is the dimensionless critical shear stress [an empirically derived coefficient that typical ranges from 0.030 to 0.086 for natural gravel bed rivers (Buffington and Montgomery, 1997)], p_w is the density of water (kg/m^3), p_s is the density of sediment (kg/m^3), and D is the b-axis dimension of the grain (m).

Basic sediment transport theory tells us that when the mean shear stress exerted on the bed particles by the flow of water [$\tau = p_w gdS$; where S= slope; d = depth (m)] equals the critical shear stress required to move a particle of diameter D, that particle will move.

To collect data regarding sediment transport, a six-inch Helley-Smith bedload sampler should be used. The sampler should be deployed at each monitoring station by placing it on the channel bed for 6 minutes. It collects transported rocks and sand that move along the surface of the bed in an attached 0.25mm mesh collection bag. The sampler is lifted after a specified period of time (site specific determination, with intercalibration), and the sample is saved for later analyses. The procedure involves using a cable strung across the channel at higher flows (above wading speed) so that a boat can be held in place for each sample. The sampler can be attached to the boat with a boom and lowered vertically into the flow. The cable can be anchored to a truck (or tree) on each bank. This method can be used only up to bankfull flows.

6.4.3 Tracer gravel studies

Tracer gravel studies involve taking specified sizes of gravel and placing them in the channel in a way that individual grains can be tracked for movement in response to water flows. This activity allows investigators to understand the integrated streamflow forces that affect sediment particles in the channel and channel changes as a whole. Typically, tracer gravel experiments are performed so that observations of particle movement are recorded at various flows. These mobility percentages at each flow are then used to produce a chart of discharge vs. percent moved for each size class. The gives the observer a better understand of the flows at which bed material is under incipient and total mobility, which allows controllers of streamflow (MID) to refine future volumes and size distribution of gravel augmentation, where warranted. If observations are

conducted at proper flows, information can also be obtained about the later distribution of shear in the study sections.

Assorted gravels (diameters between 40 & 115 mm, based upon naturally occurring gravel distributions in unaffected Merced River streambed) are placed across each study transect, with the D_{84} on the section line of the transect, D_{50} one foot downstream, and D_{31} an additional foot downstream (see DWR, 2006 for details). Each of the particles is tapped into the bed with a boot so that they are integrated into the streambed and will behave as part of the bed as flows increase. The distance traveled of each particle is measured.

6.4.4 Channel Geometry

The configuration and geometry of a river channel is created and changed by water flow forces acting on it. The forces are primarily due to water flowing through the channel (flows that do not exceed bankfull) and over the banks and floodplain (overbank or flood flows).

It is widely thought that a naturally evolved and maintained river channel is primarily shaped by bankfull flows. These flows work on the bed and banks of the channel to create river features. Each feature, such as a riffle or pool, has a unique cross-sectional shape. Overbank flows on the Merced River occur with little frequency. Overbank flows can affect channel cross-section shape, but also can affect the later location of the channel. This metric can provide information about how the channel has reacted to the flows it has received.

6.4.4.1 Cross-sectional Survey

This is arguably the most important and basic method of determining changes in the channel bed by periodically recording (monitoring) the cross-sectional profile of the channel at the study sites. Most often this is done by marking the study areas with semi-permanent markers (rebar pins) on each bank. A profile is recorded by means of precise engineering survey equipment. If careful attention is paid to the location of the semi-permanent markers, comparisons can be made at study locations to show erosion or deposition of the channel bed, channel migration or shape changes.

Water depth measurements should be made while measuring flow to calculate flow area and for estimating cross-section changes for the duration of the study. At each site, a representative number of measurements should be made (20 cross-sections). In addition, the study sites should be tied to a permanent elevation marker, to tie in all project elevation data.

6.4.4.2 Channel Thalweg Profiles

This is a measurement of the lowest point of the channel in the cross-sectional profiles at the study sites. It shows the maximum depth of the change, and may show flow obstructions that cause ponding of water upstream. These should occur at all cross-sectional surveys (see Section 6.4.4.1)

6.4.4.3 Aerial Photographs

Photographs of the sited in plan view are a useful tool for monitoring several features through comparison of photos taken over time. Any change in channel location or width is recognizable, as well as changes in the vegetative cover on the stream banks. Underwater topography methods should be evaluated for their usefulness and application. These photographs should occur at all locations of study.

6.5 Direct Bedload Sampling. A bedload trap should be installed in the selected sample locations determined by the field reconnaissance (Garcia *et al.* 2000). Each station should have three automatic bedload pit traps, a NEP-390-CBL Turbidity probe, an ISCO-3700 automatic sampler with 24 1-litre sample bottles and a water level actuator, and a water level sensor. The bedload trap is installed to enable a continuous measurement of bedload flux for single timed events with a sampling period of at least five hours. The bedload trap consists of a concrete structure which contains a metal box with a capacity of 0.22 m3 supported on top of a water pillow (MSC Survival), which records the increase by weight of the entering bedload and transmits it by a means of a pressure sensor (PTX-1730) to a Campbell CR1000 data-logger. Sediment capacity of each trap is around 330 kg (submerged weight). Recording interval is 5 minutes. Pit traps should be preliminary calibrated A water temperature sensor and data logger should be installed at the sample locations, where continuously recording temperatures are absent from permanent streamgages. Besides permanent instrumentation, sediment transport devices can be deployed from bridges or diversion structures above the station during floods to complement the automatic sediment transport recording devises. Bedload will be measured by means of a 76 kg 152 mm-intake Helley-Smith Sampler (see section 6.4.2, above) and suspended sediment by means of a US DH-74 depth integrated sampler (Vericat and Batalla, 2005).

6.6 Water-stage sediment sampler

Three water-stage sediment samplers should be installed at each station. The samplers enable the measurement of suspended sediments in the river water with sediment concentrations being measured at different depths of water flow inside the river. The sampler should be designed for a wide-range of flow events anticipated in different water years. The water samplers can be constructed to sample multiple levels of the flood and higher-water events. The water-stage sediment sampler needs to be emptied and reset after each flood event.

6.7 Water discharge, suspended sediment and turbidity data

Turbidity meters should be installed at the upper river sampling station, and at least two of the downstream of project location, which enables the continuous measurement of turbidity with a temporal resolution of 15 minutes [(NEP-390-CBL Turbidity probe 0 – 3000 NTU (-2.5 v to * 2.5 v dc)]. Data is collected by means of Campbell CR10X data-logger. At the same locations, ISCO-3700 Samplers with water level actuator should be installed that take up to 24 l water samples for single flood events. Direct water samples should be routinely taken to support the calibration of the turbidity and automatic sampler measurements.

6.8 Temporary sediment storage in riverbeds

The temporary sediment storage along the study transects should be assessed with a simple technique after Hilton *et al*. (1993) for cross-sections along a river reach. The technique can be applied to determine the role and the order of magnitude of in-channel storage in the annual sediment budget of the river basin. The total storage volume allows then the estimation of the residence time of fine sediments in the river system. The following methodology should be employed during the sampling of the sediment storage:

1. Sampling interval of cross-sections: 300-500 meters
2. Record station number, GPS location while standing at bankfull level on the right side of the river
3. Record approximate width, depth and form at bankfull discharge (sketch river reach)
4. 4. Start survey of sediment storage at the right side of the river, at bankfull level
5. Along 1-meter intervals (horizontal line) record perpendicular to the flow direction:
   a) sampling interval in meters,
   b) sampling interval covered with water: yes/no,
   c) % fraction of fine sediments,
   d) 5 measurements of the height (in cm) of the sediment layer (from right to left), every 20 cm, using the graduated steel bar.

The high-resolution height measurements of sediment thickness in the riverbed can then be transformed to sediment volume or mass (per unit meter width of the cross-section) to obtain estimates for the mass of sediment stored in a river stretch. The high spatial resolution data on riverbed storage volume can then be related to estimates of riverbed slope, shape, geological, geomorphological and cross-sectional characteristics along the longitudinal profile of the river to study geospatial units and pattern formation of the river system.

6.9 River Environmental Characteristics

Measurement of Physical Characteristics

To enable the integration of process-based river transport models, a spatial distributed data set on water flow and sediment-transport characteristics should be collected in river reaches sampled for sediment transport.. The following data for that integration, recommended by CGs are: a) detailed cross-section and longitudinal slope profiles; b) flow velocity measurements for the determination of Manning's n[1]; c) riverbed gradation; d) vegetation type and cover inside and surrounding the river stretch; and e) water temperature and dissolved oxygen content. For the entire transect of stations, river cross-sections at each location should be surveyed with an array station metrics with an interval of minimum 0.25 meters, and information on current water depth, bankfull depth, and flood-plain areas. The longitudinal height profile will probably range over a distance of 6 to 30m. Channel widths & lengths should be measured for the derivation of slope estimates.

Measurement of flow velocity

Flow velocity with a small current meter follow the detailed protocols of Harrelson *et al.* 1994. At least 25-30 readings were taken for each river cross-section with an interval of 0.25 to 100 cm. Each reading should last a minute and was taken at a depth of0.6 times the total depth of current water level.

Estimate of river bed slope or gradation

Riverbed gradation should be measured following two methods described by Harrelson *et al.* 1994 and Kondolf *et al.* 2003:

a) Photographic method: at one to three locations at each cross-section, a photograph should be taken from a height of approximately 1 – 1.5 meters with scale in the picture. Additionally, soil samples of finer sediments were collected and analyzed in the laboratory for their particle size distribution.
b) Cross-sectional survey combined with Channel Thalwig Profiles (See Sections 6.4.4.1 and 6.4.4.2). This will combine, integrate, and calculate bedslope utilizing these metrics.

[1] Many natural and man-made channels are approximately trapezoidal. This calculation uses the most commonly used equation for analyzing open channels - the Manning equation. The Manning equation is best used for uniform steady state flows. Uniform means that the cross-section geometry of the channel remains constant along the length of the channel, and steady state means that the velocity, discharge, and depth do not change with time. Though these assumptions are rarely ever strictly achieved in reality, the Manning equation is still used to model most open channel flows where conditions are relatively steady and for reaches (portions of rivers) that have a reasonably constant cross-section for a long enough distance that the depth remains fairly constant.

Characterization of river reach:
Each river reach should be classified according to the scheme of Montgomery and Buffington (1997) and Rosgen (1997). Montgomery and Buffington (1997) classified channel-reach morphology in mountain drainage basins into seven distinct reach types mainly as a function of sediment-transport and flow dynamic characteristics: colluvial, bedrock, and five alluvial channel types (cascade, step pool, plane bed, pool riffle, and dune ripple). Their classification is based on a coupling of reach-level channel processes with the spatial arrangement of reach morphologies, their links to hillslope processes, and external forcing by confinement, riparian vegetation, and woody debris. Rosgen (1994) categorizes rivers according to morphological stream characteristics such as entrenchment, gradient, width/depth ratio, sinuosity, bed material and landforms .In addition, a descriptive discussion for each cross-section, the dominant vegetation inside and along the river, should be reported as well as the % vegetation cover inside the main channel. Water temperature and oxygen content should be measured with a multi-sensor device at all transects.

6.10 Study Proposal Consultation

As described above, applicant will work collectively with interested Relicensing Participants to review and modify the Models as appropriate. The final version of the Models, and their Development and Validation Reports will be made publically available (see Step 3 Validate the Models).

6.11 Schedule

The schedule to complete the study proposal is:

Review and Evaluate the Existing Sediment Bedload and……November 20xx
Sediment Mobility Models (Step 1)
Modify Existing Models or Develop New Models For Relicensing (Step 2)
…….December 20xx-February 20xx

Validate the Models (Step 3)…… March 20xx – May 20xx
Field Reconnaissance (Step 4)……..January 20xx
Field Sampling (Step 5)…… February 20xx – July 20xx
……September 20xx – October 20xx +1 year
Report Preparation (Section 7.0 Products).....October – December 20xx + 1 year

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 river reaches evaluated for sediment transport. An overall sediment budget for the entire river watershed will be produced, which shows the unimpeded input mass, a distribution characterization of sediments and gravels in unimpeded reaches (above Lake McClure), a distribution characterization of sediments and gravels in impeded reaches (Lake McClure, Lake McSwain, Merced Falls impoundment, and Crocker Huffman impoundment. The report should contain data and analyses of bedload transportation at flows at or > 3,000 cfs, as well as estimates (or measurements) of bedload transport at < 3,000cfs. Field data will be compared with modeling estimates, incorporating the best available bedload transport and hydraulic/hydrological models, which allow inclusion of floodplains (or terraces and dredger tailings piles, and inclusion of gravel augmentation and construction of gravel wing dams as gravel pulses.

8.0 Level of Effort and Cost

Given the amount of available sediment budget and anadromous fish spawning habitat data on both the lower Merced River, CGs consider that the information for this request may be in part obtained without field work. CGs estimate this study costing the applicant between $120,000 to $150,000. Considering the potential volumes of sediment-gravels captured by dams and mined from the lower Merced River, the potential for environmental disturbance, the status of a species listed under the ESA, and the recent closure of Chinook salmon fisheries on the West Coast of the United States, the magnitude and proportion of effort and costs for the applicant are not significant. The applicant has not proposed a sediment budget study nor is this information provided in the PAD. However, FERC (2009) identified in SD-2 the need to investigate the effect of the Project on geomorphic processes for purposes of the environmental assessment and required consultations with State and Federal government agencies. Because gravel and sediment recruitment and movement is an integral component of anadromous fish habitat, this study is essential for evaluating the overall impacts to anadromous fish habitat in the Merced River watershed including areas designated as critical habitat and essential fish habitat.

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APPENDIX B

APPENDIX B

Fish (Salmon), Miners, & Indians in 19th Century Yosemite

By Tom Bopp

Compiled from the **Mariposa Gazette** (from Bopp, 2008):

Articles listed by date of issue/page/column (spelling & grammar per the original).

11/12/1856 p2/col2 Entire article:

The Indians upon the South Fork, and upper parts of the main Merced river, are much dissatisfied at the failure of their Salmon fishing, which is caused by one or two dams upon the lower part of the river, which obstructs the course of the fish. *Large quantities of salmon are annually killed by these Indians, and being prepared in their own manner, form the staple article of food during the winter*. – Fishing thus, being a failure, we may look out for some stealing, particularly if the season should be severe.

08/24/1857 p2/col3 Entire article:

Mr. Clark, residing at the Yo Semite crossing of the South Fork of the Merced , informs us that a number of Indian hunters have killed two grizzleys and eleven deer near his place during the past week. Their piscatorial performances are also worth noticing. On Wednesday last they dug about six bushels of a weed known as the "soap root;" pounded it up fine and poured it into the South Fork, which at present is very low. It had the effect to stupefy and to produce a sort of inebriating influence on the trout of which there is an abundance in that stream. *Over 2000 fine, fat, tipsey fellows, weighing from half a pound to three pounds, were taken while under the influence of this "soap root" decoction.*

11/24/1877 p3/col3 Entire article:

Those Dam Fish Ladders. –The last Grand jury in their report, which we published two weeks ago, made strong allusions to the cause that impeded the salmon from climbing over the fish ladders, that don't exist either at the McCrellish dam (commonly known as the "Johnson or Crown Lead.") or the dam, of the Mariposa Land and Mining Company, both of which are on the Merced River about four miles apart. The law requires that ladders shall be built, in order that the salmon may pass up the river, as at certain seasons of the year it is their inclination to do. Hitherto, the salmon have been, and are yet deprived of the sacred privilege of navigating the streams to their source, on account of the dams heretofore named. Which have not only deprived "Lo" *the poor Indian of his regular annual feast of salmon*, but likewise the honest miner and citizens who inhabit the banks and vicinity of the Merced river a distance of 75 miles above the dams alluded

to. It is now expected, under the instructions of the Grand Jury, that the District Attorney will forthwith commence legal proceedings against the dam owners referred to and unless they speadily [sic] respond to the notice given them to comply with the law in such cases they will find a dam big bill in judgment against them, of a magnitude sufficient, that if converted into fish ladders, a numberless school of salmon could pass over at once without the least impediment.

12/13/1879 p3/col3 Entire article:

Those Fish Ladders Again. –It will be remembered that this scaly subject of fish ladders, which is one of importance, has been for the past ten years harped upon without arriving to a successful termination, except that, which has of late brought about a prospect of success. District Attorney Goucher in response to numerous complaints called the attention of a late Grand Jury, who, after an investigation found a bill against the owner or owners of the Crown Lead Dam. Upon being informed of this fact they have taken steps toward the construction of a proper ladder, over which the salmon family can pass successfully. This bit of news although fishy will be most favorably received by the people residing on the Merced River and vicinity above the Crown Lead Dam, who have not seen a salmon for years. We were shown a letter under date of the 8th instant, addressed to District Attorney Goucher from Col. Frisbe, State Fish Commissioner, purporting to the effect, that Fred McCrellish owner of the aforesaid dam property, had given orders to his agent in charge, Mrs. M. E. Porter, to examine at once the Benton Mill Dam Fish Ladders, and have those of the Crown Lead constructed in like manner, and if she cannot procure the necessary material for construction, to have the same sawed at the mill, and draw on him for the payment. It is to be hoped, there will be no more dam obstruction to be complained of hereafter.

08/07/1880 p2/col2 Entire article:

Lookout for Salmon!!! –The owners of the Crown Lead dam on the Merced river , represented by Fred. MacCrellish, of the Alta, have at last completed good fish-ladders on that dam obstruction. Salmon are now coming up the river, several having been already killed at Benton Mills, and as there are fish-ladders at the latter place, the finny tribes will doubtless soon swarm in the headwaters of the Merced river . This will be a blessing to the people living anywhere near the river, but just at present it is not lawful to kill salmon, as the law prohibits it from August 1st to November 1st in each season. However, long may MacCrellish wave!

04/17/1886 (p3/col4) [Article excerpt]:

COMMUNICATED.

April 8th, 1886 .

Editor, Mariposa Gazette—Dear Sir

--Herewith I send you a copy of my communication to the Fish Commissioners for the State of California , and their reply to the same as it pertains to matters of interest, or ought to be of interest to all citizens of Mariposa county. I would be pleased to have you, in behalf of the citizens, publish the same, with any comments from yourself deemed pertinent to the case. By so doing you will favor your subscribers at-large, as well as your sincerely. H. H. Todd.

To Angevine Reynolds, Esq., Mariposa , Cal .

Dear Sirs:--I desire to bring to your notice, a serious grievance, complained of, by the citizens of Mariposa county, and especially by those who reside easterly from, or above certain dams on the Merced river, namely, in their being deprived of the fish food (principally salmon), that they are entitled to.

My complaint is based, chiefly on information and complaints received from various, but to me, reliable sources, also, from a personal observation of six years, during which time I have been engaged in mining contiguous to both the Main Merced river, and that of the South Fork of the Merced river, and near to where they both unite. During said period, to my personal knowledge, no salmon have been seen in those rivers from the Benton Mills dam to the headwaters of the same. The Causes are as follows:

1st. At the lower, or Crown Lead Mining dam, situated about one-half mile below Split Rock Ferry property, owned in San Francisco , but not worked for some ten years, or over. Fish ladders are in place, that were evidently so constructed as to evade the law, for when the salmon, either by accident, or otherwise are allowed to get over, they are caught in racked sluice boxes, then killed with clubs or other weapons in the hands of the party or parties in charge of (the property.

2nd. In addition to the Crown Lead dam, there is also at a point some two miles further up the river, the Benton Mills dam, where there are also ladders, so constructed, that it would be impossible for any fish to get over.

Above the dams herein complained of the Main Merced river, with its North and South fork and innumerable strong feeders coming from the high Sierras (part through the Yosemite Valley), has an extended water course of many hundreds of miles in which no salmon has been seen for the past fifteen or twenty years, and out of which, at an earlier date the populace of an immense scope of country were blessed with an ample supply of this most valued of all fish food, the salmon.

In connection with the above, I would state that these water courses are clear mountain streams free from mining debris, and also at one time well-stocked with mountain trout, but even they are being rapidly depleted by the too free use of giant powder in the hands of Chinese and other irresponsible parties.

I am given to understand that year after year the officials of this county (with due respect to them), have been notified, probably verbally, only, of the above facts, but so far, no

seeming action has been taken by them for the abatement of the evil complained of, hence the necessity of this communication, and trusting your honorable body will deem it worthy of serious consideration, and that early action will be taken in the matter. I am, dear sirs, Yours respectfully,

(Signed.) H. H. Todd.

To the Hon. Fish Commissioners, State of California

Dear Sir:--Your favor of March 9th, at hand. It is surprising that your county officials should permit, and your citizens submit, to the grievous and unlawful wrongs mentioned in your letter. No person or party has the right to obstruct the streams of the State, and thereby prevent the free passage and habitation of food fish therein. State law subordinates the rights of dam owners and other obstructionists to the rights common of piscasy, in securing by legislative enactments the free passage and protection of fish. These enactments were made in order that fishing and its food, in its full profit and value, could be freely enjoyed. Merced river is as much covered by the protection of the law, as is the Sacramento , Feather and other rivers, or the bays of the State.

In order to protect fishing rights and to secure and increase fish supplies, the methods and season for the taking of fish are regulated by law, and violations are made offenses. The placing of deleterious, poisonous or explosive substances in the waters of the State, for the purpose of taking or destroying fish is made a crime.

The failing to construct and keep in repair (after notice so to do) sufficient fishway or ladders, or dams, or obstructions is made a misdemeanor. See Section 637, Penal Code; subdivision 6 of Section 642 Penal Code, makes it the duty of the Fish Commissioners "To furnish plans for, and direct and compel the construction and repair of fish ladders and ways upon dams and obstructions."

In order to enforce this provision of the law, the aid of the District-Attorney must invoked, to institute proceedings for the arrest of persons charged…[rest of article cut off; available on microfilm].

04/17/1886

(p3/c3)[Entire article]:

FISH LADDER.

In the matter of these structures at certain points on the Merced river, known an "Crown Lead Dam, and Benton Mills Dam" complained of as being insufficient to admit the free passage of the Salmon Fish, it is but a few years since, and during the official time of ex-District Attorney Goucher, that these localities were subjected to an investigation and underwent repairs, which were all supposed to be in proper working order as nothing has been heard of them since. At least the Gazette has received no word pro or con, since,

regarding the fish dams. That the wrong complained of by Capt. Todd, again prevails, we have no doubt. It is only a wonder that some one, or Capt. Todd himself, has not complained before. The only legitimate reason to be assigned why notice of the matter has not been taken before, is the fact that, there is scarcely a man living on the river above the Benton Mills Dam till the section of river is reached where the Cranberry mine is located, and where Capt. Todd at present resides. No doubt, the fish ladders need repairing and should be attended to by the respective owners, who will no doubt do so when they have been stirred up by Capt. Todd's reminder. He undoubtedly misses his home market in Oakland and would like a mess of salmon. **05/01/1886 p3/col.1**

[reference to article]:

“Captain" H. H. Todd is appointed Deputy Fish Commissioner: "got himself into office just by ... endeavoring to obtain ... their regular mess of fish…"

10/01/1887 p3/col2 Entire article:

In another column of this paper will be found a response from Fish Commissioner, T. J. Sherwood to a letter from Captain H. H. Todd, Deputy Fish Commissioner, with one enclosed, written by Warren R. Shilling, in regard to fish ladders on the Merced river, we suppose. Commissioner Sherwood’s letter would indicate that he intends to go after the cause why salmon cannot successfully travel up the Merced river , and give them a chance to see their friends and the sources of the mountain streams.

06/30/1894 p 3/col.1 Entire article:

Salmon are abundant in the Merced river , and fishing is carried on extensively at Merced Falls . Everybody within a radius of twenty miles who can get to the Falls, tries to emulate the example of the chief executive of the nation, “and sit and fish and think.” Some very large fish are caught at many places along the river.

06/12/1897 p1/col2 Entire article:

Salmon is now running in the Merced river . Numbers have been caught by those liking the sport.