UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

MAR 2 4 2006

Magalie Roman Salas
Office of the Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Re: COMMENTS, RECOMMENDED TERMS AND CONDITIONS, AND PRELIMINARY PRESCRIPTIONS FOR THE KLAMATH HYDROELECTRIC PROJECT, FERC PROJECT No. 2082

Dear Secretary Salas:

Enclosed are the National Marine Fisheries Service's (NMFS) comments, recommended terms and conditions, and preliminary prescriptions for the Klamath Hydroelectric Project (Project), No. 2082, in response to the Federal Energy Regulatory Commission's (FERC) December 28, 2005 Notice of Application Ready for Environmental Analysis. Attachment A contains NMFS' preliminary fishway prescriptions pursuant to Section 18 of the Federal Power Act. Attachment B contains NMFS' recommendations to protect, mitigate impacts to, and enhance anadromous fish resources pursuant to section 10(j) of the Federal Power Act. Attachment C contains NMFS' recommendations pursuant to section 10(a) of the Federal Power Act. NMFS and the Department of Interior (Department) are filing a joint administrative record in support of these filings. The Department will submit this administrative record to FERC on or about March 28, 2006.

These preliminary fishway prescriptions were developed jointly with and are consistent with those concurrently being filed by the Department. The preliminary comments, recommendations, terms and conditions, and prescriptions herein are provided in accordance with the provisions of the Federal Power Act (FPA), 16 U.S.C. § 791 *et seq.*, the Fish and Wildlife Coordination Act, 16 U.S.C. § 661 *et seq.*, the Endangered Species Act (ESA), 16 U.S.C. §1531 *et seq.*, NMFS' Tribal Trust responsibilities, the National Environmental Policy Act (NEPA), 42 U.S.C. § 4321 *et seq.*, and the Magnuson-Stevens

Fishery Conservation and Management Act, 16 U.S.C. § 1801 *et seq*.
NMFS has previously provided in detail the basis of our interest in these proceedings (NMFS Motion to Intervene 2004) and a detailed description of Project effects on our trust species (NMFS FLA Comments 2004).

NMFS appreciates the opportunity to participate in PacifiCorp's "enhanced traditional" licensing process for the Klamath Project. NMFS is simultaneously participating in a negotiated, confidential settlement process, and believes this process has the best chance for achieving an outcome that represents the best interest of all parties.

The Energy Policy Act of 2005 provides parties to this licensing proceeding the opportunity to request a trial-type hearing on disputed issues of material fact regarding NMFS' preliminary fishway prescriptions and to propose alternative preliminary prescriptions. Accordingly, NMFS hereby offers notice that parties to the licensing proceeding have 30 days from the deadline for submission of preliminary terms and conditions (March 29, 2006) to file a request for hearing and to formally offer alternatives, in accordance with the regulations set forth at 50 C.F.R. Part 221.

If you have any questions regarding these documents, please contact Mr. David White at (707) 575-6810.

We appreciate the opportunity to provide these comments.

Sincerely,

Rodney R McInnis

Regional Administrator

Enclosures

cc: Klamath Service List

Attachment A

NATIONAL MARINE FISHERIES SERVICE
UNITED STATES FISH AND WILDLIFE SERVICE
PRELIMINARY FISHWAY PRESCRIPTIONS

March 27, 2006

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I. EXECUTIVE SUMMARY

On February 26, 2004, PacifiCorp filed an application with the Federal Energy Regulatory Commission (FERC or Commission) for a license to continue operations of the Klamath Hydroelectric Project, located on the Klamath River in northern California and southern Oregon. The U.S. Department of Commerce, National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS), reviewed the application for relicensing of the Project. On October 5, 2004, NMFS filed a *Motion to Intervene* with the Commission. The motion was granted. The existing license for the project expired on February 28, 2006.

The Commission issued a ***Notice of Application Ready for Environmental Analysis*** on December 28, 2005. On February 17, 2006, the Commission extended the deadline for filing comments, recommendations, terms and conditions, and prescriptions until March 29, 2006. In response to the Commission's *Notice*, the U.S. Fish and Wildlife Service and the NMFS hereby submit a joint preliminary prescription for the construction, operation, and maintenance of upstream and downstream fishways pursuant to section 18 of the Federal Power Act (FPA). This preliminary fishway prescription was developed jointly and is consistent with the one concurrently being filed by the Department of Interior (Department). In addition, NMFS hereby submits its comments, recommended terms and conditions pursuant to sections 10(a) and 10(j) of the Federal Power Act (*16 U.S.C. § 811*).

As is discussed in detail throughout this document, the Klamath Hydroelectric Project is responsible for ongoing detrimental impacts to many important Klamath River fish populations and limits options for watershed restoration. Indeed, as this package is prepared for filing, the Pacific Fisheries Management Council and NMFS are considering regulatory actions to severely restrict the 2006 sport and commercial salmon fisheries along much of the coast of California and Oregon. This potential measure is a result of a near record low escapement forecast for the 2006 season of natural spawning Klamath River adult fall-run Chinook salmon (PFMC 2006b).

In formulating its responses to FERC's REA Notice, NMFS carefully considered its authorities which are appreciably different under sections 10 and 18 of the Federal Power Act. Section 10 does not grant mandatory authorities to NMFS to effect dam removals even though removing the lower four dams is our recommendation to FERC under section 10(a) of the Federal Power Act. NMFS *may recommend* dam removal as its preferred alternative to FERC under section 10, which it does respectfully. Section 18, on the other hand, grants *mandatory authorities* to NMFS to prescribe fishways (16 U.S.C. § 811). Because NMFS cannot predict what ultimate license conditions will be imposed by FERC, we submit our preliminary section 18 prescription with the presumption that the existing Project facilities may remain in place throughout a new license term. Should this be the case, it is imperative that fully volitional fishways are satisfactorily designed and implemented as a means to achieve our basic resource goals and objectives.

Preliminary Fishway Prescriptions enumerate- in general terms- the engineered facilities, and the operations and maintenance of such facilities, which are necessary to achieve safe, timely, and effective fish passage conditions in key Klamath streams impacted by the hydroelectric project. Preliminary prescriptions fulfill FERC's requirements at this stage of the process. After review of comments received, NMFS may develop a more refined ***Modified Fishway Prescription*** in the future, according to FERC procedures. Should PacifiCorp decide to continue operations by pursuing a renewed license, all conditions of these fishway prescriptions are mandatory and must be fulfilled pursuant to section 18 of the Federal Power Act (16 U.S.C. § 811). Even if there is a decision to decommission the Project and remove the dams, NMFS reserves the authority to modify its prescription to address the Project's fish passage impacts in the interim- prior to dam removal.

The reader will note the structure of **Section VI:** ***Preliminary Section 18 Prescriptions for Fishways.*** Each fishway prescription is enumerated for each facility, and an independent rationale is provided to justify the major elements of each hydropower development's prescriptions. While the combination of all prescription elements in Section VI adds to the total benefit for the fisheries, ***each element of the fishway prescription stands alone*** with its own independent justification. Other elements are not needed to derive the appreciable fishery benefits listed under each project heading.

Whether through dam removals or implementation of our fishway prescriptions, successful reintroduction of anadromous fish into the historic habitats above Iron Gate Dam will substantially enhance the restoration of struggling Pacific salmon stocks. In lieu of the preferred option - dam removal and habitat restoration - *fishways are a necessary precursor and a fundamental element of any successful reintroduction action*. Moreover, in lieu of dam removal, NMFS believes its minimum, long-term, resource goals and objectives can only be achieved *via effective fishways at all project facilities*. Therefore, NMFS is filing preliminary section 18 prescriptions for the fish passage facilities necessary to achieve full volitional fish passage at key Project facilities.

NMFS gave a hard look at a broad array of issues in formulating its preliminary fishway prescriptions. Consideration of the breadth and scope of these issues is well documented in the Administrative Record, which is submitted to FERC via the Department of Interior. As a matter of process, NMFS reasoned its fish passage prescriptions are feasible and justified based on – but not limited to - the following highlighted reasons: (1) numerous long-standing state, federal, and tribal fisheries conservation goals are achieved through fish passage, (2) NMFS participated in a comprehensive historical review which conclusively documented the robust anadromous fish runs in the watershed above Iron Gate Dam prior to dam construction, (3) NMFS participated in a comprehensive review of existing riverine conditions. It concluded that anadromous fish will thrive in the watershed above Iron Gate Dam *if* reintroduced through effective fish passage facilities, (4) modeling of anadromous fish habitat and life-cycles was conducted. NMFS believes the Applicant's conclusions and interpretations of modeling results and elements of the models themselves are flawed, (5) fish passage for these same species has been accomplished successfully in a number of other locations, (6) benefits for fish in the habitat *within the Project area* are substantial, and these improvements alone can justify fish passage at any given facility, (7) facilitating fish passage into the uppermost watershed can provide an extraordinary, additional gain of approximately 360 miles of suitable habitat, (8) coordinated state, federal, and tribal action plans exist which point to the likelihood of meaningful habitat restoration in the upper watershed once anadromous fish are reintroduced. Specific citations and more detailed explanations in support of these reasons can be found in the text of this document, as well as in the Administrative Record.

Throughout this document, and in voluminous filings contained in the Administrative Record for this FERC action, NMFS describes its thorough consideration of the factors related to the feasibility of our fishway prescriptions vis-à-vis the Project's effects on fisheries. Because of the seriousness of this situation, *NMFS believes that within this relicensing process the best alternative to contribute to restoration of all fish species of concern in the Klamath watershed is the decommissioning and subsequent removal of the four lower Project dams (Iron Gate, Copco 1 & 2, and J.C. Boyle), combined with improvements in fish passage at remaining facilities.* The dam removal alternative is a superior alternative from a fish passage, water quality, and habitat restoration standpoint. Without man-made barriers to blockade essential fish movements, all fish may move freely and naturally, according to their life history adaptations for fulfilling their biological requirements. This is the basis of our section 10(a) recommendations. Implementing this dam decommissioning and dam removal alternative would go a long way toward resolving decades of degradation where Klamath River salmon stocks are concerned. NMFS and several key participating stakeholder groups are in full agreement with this important principle. Therefore, this perspective should not be overlooked in the final analysis.

II. INTRODUCTION, BACKGROUND, AND PROCEDURAL CONSIDERATIONS

The U.S. Fish and Wildlife Service and NMFS hereby submit a joint prescription for the construction, operation, and maintenance of upstream and downstream fishways pursuant to section 18 of the Federal Power Act (FPA). For the sake of grammatical simplicity, a naming convention is adopted in this document. Where language pertains independently to the U.S. Fish and Wildlife Service, the word "Service" (singular) is used. Where language pertains independently to the National Marine Fisheries Service, the acronym "NMFS" is used. Where language reflects the joint position of the Service and NMFS, the term "Services" (plural) is used.

PacifiCorp (Applicant) is seeking a new license from the Federal Energy Regulatory Commission (FERC or Commission) for the continued operation of the Klamath Hydroelectric Project (Project), which consists of five mainstem dams, two developments on the Federal Link River Dam, and one tributary development. The Services and other stakeholders have worked directly with the Applicant throughout the relicensing process. The Services regularly offered technical assistance and participated on technical subgroups. Furthermore, they provided comments and recommendations on the Applicant's Initial Consultation Document, Draft License Application (DLA), the Final License Application (FLA), and on numerous studies filed with the Commission. Nevertheless, the Applicant's proposed Project in the FLA (PacifiCorp 2004a) does not include modifications of existing facilities that would provide passage for anadromous fish (including salmon, steelhead, or Pacific lamprey), or provide a consistent, comprehensive strategy for resident fish passage through Project facilities.

The purpose of these Preliminary Fishway Prescriptions is to identify the engineered facilities, and the operations and maintenance of such facilities, which are necessary to achieve safe, timely, and effective fish passage conditions in all streams of the Klamath watershed impacted by the Project. As the Services describe in greater detail throughout this document, the Project is heavily impacting Klamath River fish populations, including fish listed under the Endangered Species Act (ESA).

At this juncture, the Services' joint prescriptions for fishways are preliminary. The Services developed these prescriptions using the best data and information available. We include specific prescriptive conditions which allow amendments through adaptive management in order to develop final design plans or to correct observed deficiencies. Our preliminary prescriptions require that the Licensee shall develop elements of the prescriptions in consultation with the appropriate fishery agencies and Tribes to ensure safe, timely, and effective fish passage. As the Services describe in greater detail throughout the document, these preliminary prescriptions are consistent with the life histories and historical distributions of the target species of fish.

The Services anticipate the Commission will find this new license proposal to be a major, Federal action significantly affecting the quality of the human environment. Thus, the Commission will prepare an Environmental Impact Statement (EIS) pursuant to the requirements of the National Environmental Policy Act (NEPA)[1], and in accordance with the Council on Environmental Quality's implementing regulations.[2] The Services recommend the EIS reflect the full range of issues and alternatives identified in the NEPA scoping process, as well as all reasonable comments submitted in response to the Commission's Ready for Environmental Analysis Notice, plus any future Notice soliciting comments on any subsequent Offer of Settlement. Further, the Services support the Commission's intention to examine other fish passage alternatives, including the retirement of additional developments (besides the Eastside and Westside developments) without dams in place. Finally, and most importantly, both Services respectfully request that the Commission, in its draft EIS, identify a preferred alternative that fully incorporates our joint preliminary fishway prescriptions in their entirety as set forth herein.[3]

III. GOALS AND OBJECTIVES

The Commission's Licensing Regulations direct resource agencies to list the resource management goals and objectives that are the basis for recommended protection, mitigation, and enhancement measures (PM&E) to be incorporated into the new License.[4] These resource management goals and objectives also apply to the preliminary prescription of fishways in this document.

[1] 42 U.S.C. §§ 4321 et seq.
[2] 40 C.F.R. Part 1500
[3] Interagency Task Force Report on NEPA Procedures in FERC Hydroelectric Licensing, May 22, 2000.
[4] 18 CFR4.34(e)(2)

In 1986 Congress adopted the Klamath River Basin Fishery Resources Restoration Act (Klamath Act) (Public Law 99-552; codified as needed at 16 U.S.C.§ 460ss et seq.). This law established a Federal-State cooperative called the 'Klamath River Basin Conservation Area Restoration Program' for the rebuilding of the river's fish resources. The Klamath Act also established the Klamath River Basin Fisheries Task Force, and directed the Task Force to assist the Secretary of the Interior in the creation and implementation of "*…a 20 year program to restore anadromous fish populations of the [Klamath River Basin] Area to optimum levels and maintain such levels*." The Klamath Act also created the Klamath Fishery Management Council, and directed the Council to make recommendations to Federal, State, and Tribal agencies for the management of ocean and in-river harvesting that affects Klamath and Trinity anadromous fisheries.

The Klamath Act and the 1988 California Anadromous Fisheries Program Act recognize as the underlying reason for the decline of the anadromous fish resources the loss of habitat due to: 1) the construction and operation of dams; 2) stream diversions; and 3) adverse land use practices (USDI Klamath River Basin Fisheries Task Force 1991). Access of anadromous fish to habitat in the Klamath River Basin upstream from Iron Gate Dam will assist in reversing the losses due to the construction and operation of dams.

In a letter to PacifiCorp dated March 21, 2001, the Task Force stated its goal that the relicensing of the Klamath Hydroelectric Project will "*result in the successful restoration of anadromous salmonids to their historical range as well as improvements to habitat of the Klamath River below the Project*" (USDI Klamath River Basin Fisheries Task Force 2001). The Services support these goals, with an added emphasis on restoring wild salmonid populations into the Upper Klamath River Basin.

Restoration of anadromous fish to the Klamath River in and above the Project will help meet not only various statutory requirements but also the Federal Trust Responsibilities to the Basin's Indian Tribes. These Tribes hold Federal Reserved fishing rights to take both resident and anadromous fish within their reservations in order to support ceremonial, subsistence, and commercial needs. See, e.g., <u>United States v. Adair</u>, 723 F.2d 1394, 1408-15 (9th Cir. 1984), <u>cert. denied</u>, 467 U.S. 1252; <u>Parravano v. Babbitt</u>, 70 F.3d 539 (9th Cir. 1984), <u>cert. denied,</u> 518 U.S. 1016 (1996); Memorandum from John D. Leshy, Solicitor of the Department of the Interior to the Secretary of the Interior (U. S. Department of the Interior 1993). The loss of fish productivity of the Klamath Basin has led to a substantial diminishment of the harvestable numbers available to these Tribes, and the resulting fish populations have been insufficient for the Tribes to harvest fish in quantities needed that would allow them a moderate standard of living.

NMFS Resource Goals and Objectives

One important NMFS goal is to ensure that the process of negotiation, public consultation, and environmental review results in decisions that provide for full and adequate protection, mitigation, and enhancement of anadromous fish and other resources affected by the Project, in accordance with NMFS statutory obligations under the FPA, the ESA, and other relevant jurisdictional authorities (see: NMFS' 2004 Motion to Intervene). NMFS is also committed to the goals and objectives developed by the Klamath River Basin Fisheries Task Force for restoration of habitat and anadromous fish populations in the Klamath River Watershed.[5]

Resource Goals

1. Protect, conserve, enhance and recover native anadromous salmonids and their habitats by providing access to historical habitats, and by restoring fully functioning habitat conditions.

2. Protect, mitigate or minimize direct, indirect, and cumulative impacts to native anadromous salmonid resources, and to enhance related spawning, rearing, and migration habitats and adjoining riparian habitats.

Resource Objectives

1. ***Flows -*** Implement scheduled flows in the Klamath River and regulated tributaries to the benefit of native anadromous salmonids and their habitats.
This includes establishing a criteria, range, and schedule of flows to consistently provide:

- optimal habitat structure and function;
- hydraulic stability during spawning and incubation of in-gravel life stages;
- safe, timely, and effective migration of all life stages of fish- including adults, juveniles, and anadromous smolts;
- viable redd selection, placement, and continuous submergence; and
- channel forming processes, riparian habitat protection, and movement of forage communities.

This also includes mitigating impacts of other Project structures or operations that:

- act to displace individuals from their forage or shelter;
- destabilize, scour, or undermine the physical habitat; or
- degrade the chemical or biological quality of habitat.

2. ***Water Quality -*** Modify Project structures or operations as necessary to mitigate direct, indirect, or cumulative water temperature and water quality impacts. Enhance water temperature and quality conditions in salmonid habitat where impaired by the Project.

3. ***Water Availability -*** Coordinate operations with other related projects, programs or initiatives. Use water transfers, water exchanges, water purchases, or other forms of agreements to maximize potential benefits to anadromous salmonids from limited water supplies.

4. ***Fish Passage -*** Provide access to historical spawning, rearing and migration habitats necessary for salmonids to complete their life cycles. Utilize seasonal habitats necessary to contribute to the recovery of coho, steelhead, and Chinook populations (and other species of concern). This includes modifications to Project developments and operations necessary to ensure the safe, timely, and effective passage for:

[5] USDI Klamath River Basin Fisheries Task Force 1991 and USDI Klamath River Basin Fisheries Task Force 2001

- upstream migration of adults;
- downstream emigration of juveniles;
- seasonal movement of rearing juveniles to feeding and sheltering habitats; and
- dispersion of adults and juveniles.

5. ***Channel Maintenance -*** Implement flow regimes and non-flow related measures necessary to mitigate and minimize the negative impacts of Project operations native fish populations and the riverine environment that supports them. Reduce or eliminate the direct, indirect and cumulative effects of dam operations on:

- alteration of the natural hydrograph;
- sediment movement and deposition;
- river geometry and channel characteristics;
- stream competence and capacity;
- flood plain conductivity and bank stability;
- extent, duration, and repetition of high flow events; and
- habitat diversity and complexity.

6. ***Hatchery Operations -*** Minimize and mitigate the impact of hatchery developments and operations on native, wild anadromous salmonids. This includes the direct, indirect and cumulative impacts of all hatchery production, and operations on anadromous salmonids and their habitats.

7. ***Predation -*** Minimize and mitigate the impact of Project structures or operations that create suitable habitat for predators, harbor predators, or are conducive to the predation of native anadromous salmonids.

8. ***Riparian Habitat -*** Protect and restore riparian habitat upon which the biological productivity of the riverine environment depends. Enhance riparian habitat and habitat functions as mitigation for the direct, indirect and cumulative impacts of Project developments and operations.

9. ***Flow Ramping -*** Modify Project structures or operations necessary to minimize adverse physical and biological impacts of flow fluctuations, associated with increases or decreases in Project discharges.

10. ***Coordination -*** 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 on-going and future restoration efforts and potentially enhance these efforts.

A primary goal of NMFS is to establish and maintain self-sustaining anadromous fish runs in the Upper Klamath River Basin to fully utilize the available habitat and production capability. In addition, NMFS' preliminary prescriptions and recommended terms and conditions are intended to serve the public interest and meet our environmental trust responsibilities pursuant to our statutory obligations under the resource laws that we administer, as fully described in our October 5, 2004 Motion to Intervene.

NMFS further intends, through implementation of these prescriptions and recommendations, to help achieve related planning goals and objectives established by the following State and Federal watershed plans: The Klamath River Basin Fisheries Task Force's Long Range Plan; The Long Term Plan for Management of Harvest of Anadromous Fish Population of the Klamath River (The Klamath Fishery Management Council); The Northwest Forest Plan; The Klamath National Forest Land and Resource Management Plan; The Six Rivers National Forest Land Management Plan; Klamath National Forest Wild and Scenic River Responsibilities; The Recovery Plan for Lost River and shortnose suckers (USDI Fish &Wildlife Service 1993); California Water Quality Control Plan for the North Coast Region; BLM and Klamath National Forest Wild and Scenic River Responsibilities; several Oregon Department of Fish and Wildlife (ODFW) plans to manage fish resources in the Klamath River[6]; Recovery Strategy for California Coho Salmon (California Department of Fish and Game 2004); and the Joint Iron Gate Hatchery Review Committee Report (California Department of Fish and Game and National Marine Fisheries Service 2001). These plans contain provisions which pertain to the protection, mitigation, and enhancement of fish and wildlife resources in the Klamath River Basin, and the Project area.

Service's Resource Goals and Objectives

The Service has active programs in the Basin for the protection and restoration of the aquatic habitat upon which endangered fish, Tribal treaty and federally reserved fishing rights fisheries, and commercial and sports fisheries depend. The Service's goals (USDI Fish and Wildlife Service 2003) regarding relicensing of the Klamath River Project are:

> 1) Restore native fish populations within the Klamath Basin to provide fishery resources necessary to meet Tribal Trust responsibilities for commercial, subsistence, and ceremonial purposes; and to enhance ocean commercial harvest, recreational fishing, and the economic health of local communities.
>
> 2) Restore volitional passage for all life history phases of anadromous and resident fishes throughout their historical range. Provide necessary water quantity, flow regimes, water quality, and other habitat conditions for the recovery and long-term sustainability of native fishes.
>
> 3) Recover federally-listed threatened and endangered species in the Basin by avoiding jeopardy, avoiding and minimizing take, and completing recovery actions identified and

[6] Oregon Plan for Salmon and Watersheds (ORS 541.405), Oregon Fish and Wildlife Habitat Mitigation Policy (OAR 635-415-0000-0025), Fish and Wildlife Habitat Mitigation Policy (OAR 635-415-0000-0025), Oregon Klamath Basin Fish Management Plan (OARs 635-500-3600 thru -3860), Klamath Basin Fish Management Plan (OARs 635-500-3600 thru -3860)

detailed in recovery plans. Protect and restore habitat for federally-listed and candidate species.

4) Protect, mitigate, and enhance habitat for waterfowl and other migratory birds, terrestrial wildlife, fish, plants, and invertebrates.

5) Enhance ecological function and watershed processes to meet the above goals.

IV. REVIEW PROCEDURES

The Energy Policy Act of 2005 (Act) provides parties to this license proceeding the opportunity to request “trial-type hearings” regarding issues of material fact that support the preliminary prescriptions developed under FPA section 18 (fishway prescriptions) and conditions developed under FPA section 4(e) (Federal reservations). Through this document, the Services submit preliminary prescriptions along with the administrative record supporting those preliminary prescriptions. The Act also allows parties to propose alternatives to preliminary prescriptions and conditions. Procedures for requesting a trial-type hearing on an issue of material fact or for proposing alternatives are set forth at 43 C.F.R. Part 45 (Department of Interior regulations) and 50 CFR Part 221 (Department of Commerce regulations). Requests for hearing must be filed within 30 days of the deadline for submission of this document, with each prescribing agency.

V. NEED FOR FISHWAYS

In order to help achieve success of the many fish management, restoration, and recovery directives, goals and objectives in the Klamath River Basin, safe, timely, and effective fishways must be designed and constructed for all Project facilities that suppress native fish populations. At any particular facility, prospective fishways may need to accommodate upstream and downstream passage of spring and fall-run Chinook salmon, steelhead trout, coho salmon, Lost River and shortnose suckers, rainbow/redband trout, Pacific lamprey, and any other fish to be managed, enhanced, protected, or restored to the Klamath River Basin during the term of the license. The design of all fishways must be compatible with established Federal and State engineering criteria developed for the passage of fish. Fishways must be capable of supporting the life histories (PacifiCorp 2004b) and historical distributions of the named species in the Klamath River (Hamilton et al. 2005). The life history and distribution of these affected species have been previously provided in detail (National Marine Fisheries Service 2003 DLA; National Marine Fisheries Service 2004 FLA).

A. Existing Fishways and Fishways Proposed by the Applicant

As described in greater detail below, neither the existing Project, nor the Applicant’s proposed Project, provide for passage of anadromous fish, or a consistent, comprehensive strategy for resident fish passage through Project facilities.

- The lower three Project dams (Iron Gate, Copco 1 and Copco 2) are not equipped with any fish passage facilities, and the Applicant does not propose any modifications (PacifiCorp 2004a).

- The J.C. Boyle Dam has upstream and downstream fishways, but these fishways do not conform to current criteria for resident and anadromous fish (Table 1) (National Marine Fisheries Service 2003; PacifiCorp 2004b). J.C. Boyle Dam was completed in 1958 and currently has an antiquated fish ladder, fish screens, and bypass facilities. Upstream passage of redband trout has declined more than 90 percent from over 5,500 trout in 1959 (Hanel and Gerlach 1964) to 70 to 588 trout in the years 1988-91 (Hemmingsen 1997; Hemmingsen et al. 1992; Oregon Department of Fish and Wildlife 2006a; USDI Fish and Wildlife Service 2004d). The existing fish ladder entrance is difficult for fish to find during spill events (PacifiCorp 2003c). The fish ladder is in poor condition with ineffective hydraulics and does not conform to current ladder criteria (USDI Fish and Wildlife Service 2005). The J.C. Boyle development has a history of fish passage problems, which may be related to attraction hydraulics, ladder configuration, or the approach to the ladder (USDI Fish and Wildlife Service 2004a; USDI Fish and Wildlife Service 2005). The Applicant proposes only minor modifications to the J.C. Boyle upstream fishway that are already necessary for compliance with the current license and proposes an experimental gulper to replace the existing downstream fishway at J.C. Boyle Dam (PacifiCorp 2004a) that does not meet current criteria.
- The Keno Dam currently has a fishway that conforms to slope and energy dissipation criteria for salmonids, but does not meet current criteria to accomplish lamprey passage and does not meet slope guidelines for sucker passage (Oregon Department of Fish and Wildlife 2006b; USDI Fish and Wildlife Service 2005). Downstream spillway passage at Keno needs to be improved for all species to be consistent with current criteria (see Keno fishway prescription below).
- At the lower end of Upper Klamath Lake, the Bureau of Reclamation has constructed an upstream fishway at Link River Dam to pass endangered suckers that will also allow passage for anadromous fishes. The Applicant's Eastside and Westside power houses receive water diverted at Link River Dam into canals on each side of the river, but they are not equipped with fish screens and bypass facilities. The Applicant is proposing to decommission these facilities (PacifiCorp 2004a).
- The tributary developments at Fall Creek and Spring Creek have no fishways (PacifiCorp 2004b Fish Resources FTR). The Applicant is proposing canal screens and fish ladders for tributary facilities on Fall Creek and Spring Creek.

1. Upstream Fishways

Existing J.C. Boyle Ladder: The J.C. Boyle fish ladder is obsolete and ineffectual. Problems include steep gradient, insufficient attraction flow, hydraulic barriers; in addition problems with entrances limit the passage effectiveness (USDI Fish and Wildlife Service 2005). Studies indicate redband trout are not passing the dam upstream, or if attempting passing, are delayed due to problems with the existing fish ladder. In 2003 and 2004, Oregon Department of Fish and Wildlife (ODFW) radio-tagged 72 adult redband trout in the Klamath River below J.C. Boyle Dam. None of the fish moved up the fish ladder (Bill Tinniswood, ODFW, pers. comm.). In a separate study, one out of 14 radio-tagged redband trout from the bypass reach moved above the dam in 2002, while none of the 28 tagged fish from the peaking reach moved above the dam (PacifiCorp, 2004b). For the one tagged-fish that did migrate above the dam, the data indicate a delay of 3.5 days (PacifiCorp 2004b Fish Resources FTR). Passage problems are related in part to channel degradation near the entrance of the fish ladder which occurred after dam construction. The gradient of the approach to the fishway has not been maintained over the term of the license (USDI Fish and Wildlife Service 2004a; USDI Fish and Wildlife Service 2004d). The J.C. Boyle ladder rises 67 feet through 57 pools resulting in an average rise of 1.2 feet per pool which exceeds current criteria (PacifiCorp 2003c). Typically, 1 ft of rise per pool is recommended for passage of salmon and steelhead, while the recommendation for trout passage is 6 inches of rise per pool (PacifiCorp 2004b). In addition, temperature differences can greatly influence fish selection of alternative paths of upstream movement. According to studies by the Bureau of Commercial Fisheries, adult salmonids avoid temperature changes, prefer to remain in river water, prefer cooler water when given an alternative, and take longer to pass through the test facility in water heated or cooled compared to river water (Weaver et al. 1976). Below the J.C. Boyle Powerhouse and in the peaking reach, fish encounter either water from J.C. Boyle Reservoir (the powerhouse discharge) or water from the bypassed reach (blended spring and river water) (USDI Bureau of Land Management 2003). There are daily temperature differences of up to 12^{o}C during the middle of the summer between these two water sources as a result of daily peaking events (City of Klamath Falls 1986; PacifiCorp 2005; USDI Bureau of Land Management 2003). Thus, after comparing the findings of the Bureau of Commercial Fisheries study to the similar conditions existing at the juncture of J.C. Boyle's bypass reach and powerhouse flows, the Services conclude that upstream migration may be delayed due to these temperature differences.

Existing Keno Fish Ladder: Keno Dam currently has an upstream fishway conforming to salmonid criteria for slope and energy dissipation, but it does not meet Federal and State slope guidelines for sucker passage (Oregon Department of Fish and Wildlife 2006b; USDI Fish and Wildlife Service 2005). The ladder has 24 pools to ascend a 19-ft rise, resulting in an average rise of over 0.8–ft per pool. The Keno Dam fishway and auxiliary water supply system also have attraction hydraulics and flow regulation problems (USDI Fish and Wildlife Service 2005). Monitoring of fish passage at Keno Dam demonstrated small numbers of fish moving upstream through the existing ladder at Keno Dam (PacifiCorp 1997). While trapping studies indicated some trout and suckers use the ladder, it does not meet current criteria for upstream sucker passage (Oregon Department of Fish and Wildlife 2001; Oregon Department of Fish and Wildlife 2006b).

Proposed Upstream Fishways: With the exception of the Link River ladder and the Keno ladder in regard to salmon and steelhead criteria, none of the existing or proposed mainstem upstream fishways meet the design criteria summarized in Table 1. These criteria form the basis for the Services' Preliminary Fishway Prescriptions in Section V below.

Table 1. Recommended Design Criteria and Guidelines for Upstream Fish Passage.

Parameter	**Criteria**	**Reference**
Upstream Fish Ladders		
Resident Trout Maximum vertical jump	0.5 foot	ODFW 2006b

Slope	~10%	
Salmon and Steelhead Maximum vertical jump Slope	 1.0 Foot ~10%	 NMFS 2003, ODFW 2006b NMFS 2003
Federally listed suckers Maximum vertical jump Slope	 No jump <4.0% (4.5%)	 ODFW 2006b ODFW 2006b (4.5% used at Link River fishway)
Lamprey	Rounded ladder steps and corners	ODFW 2006b

2. Downstream Fishways

The existing J.C. Boyle screens and bypass facilities do not meet current criteria. The proposed gulper to replace the existing screen and bypass system is considered experimental (National Marine Fisheries Service 1994) and its protection would be questionable. The Applicant has not proposed downstream fishways at any of the other facilities (PacifiCorp 2004a). As a result, the proposed Project would entrain (draw in and transport) and kill fish. The likelihood of entrainment through the Project powerhouses is acknowledged by the Applicant (PacifiCorp 2004b Fish Resources FTR). In fact, the Applicant estimates that each of its unscreened hydro developments entrains tens of thousands of fish, with about 10 to 20 percent killed as they pass through each powerhouse (PacifiCorp 2003a; PacifiCorp 2003b). However, no studies of entrainment mortality have been conducted, even though requested by the Services (National Marine Fisheries Service 2003 DLA; National Marine Fisheries Service 2004 FLA; U. S. Department of the Interior 2004; U.S. Department of the Interior 2003; USDI Fish and Wildlife Service 2001). Without site-specific studies, the Services look to studies of entrainment at other hydropower installations to estimate entrainment resulting from the Klamath Project. The Electric Power Research Institute (EPRI) reported average mortality through Francis turbines at about 24 percent for all subject species (Electric Power Research Institute 1987). Francis turbines are utilized at all Project generating stations, except Fall Creek. Projects with higher head may have even greater mortality (e.g. J.C. Boyle at 440 feet of head). For projects with Francis turbines, the EPRI study found a high correlation ($r = 0.77$) between head and fish mortality. Four generating stations greater than 335 feet of head had mortality ranging from 33 to 48 percent (Electric Power Research Institute 1987). The facilities in these studies have comparable or less hydraulic head than the J.C. Boyle development and comparable turbine types. Using the above evidence, the Services conclude that entrainment mortality at J.C. Boyle Powerhouse likely falls in this range rather than the 12 to 36 percent range estimated by the Applicant (PacifiCorp 2004a, Exhibit E 4-113).

Finally, EPRI's studies, along with those of Milo Bell (Bell 1986; Bell et al. 1967), measured entrainment for some of the same species and under similar conditions as exist in the Klamath River. This evidence supports a conclusion that significant entrainment mortality (and injury) of resident fish is occurring presently at each Project development.

Klamath Project hydro-turbines entrain suckers, which are listed under the ESA and are present in all Project reservoirs (Desjardins and Markle 2000). In addition, when upstream fishways are provided for anadromous fish above Iron Gate Dam, and throughout the upper Klamath watershed, out-migrating salmonid smolts (including coho salmon which are listed under the ESA) will be entrained along with the resident fish. Unless downstream fishways and juvenile bypass systems are constructed, a significant portion of these restored fish will be killed or injured during entrainment and turbine passage. Therefore, modern fish screening and bypass facilities, which are consistent with the criteria in Table 2, are needed to prevent entrainment mortality of resident and anadromous fish. The Applicant acknowledges that downstream fish passage facilities will need to be in place to protect/bypass out-migrating fish if anadromous fish are reintroduced above Iron Gate Dam (PacifiCorp 2003a).

Existing J.C. Boyle Downstream Fishway: The fish screening and bypass facilities at J.C. Boyle Dam are ineffective and do not conform to current State or Federal criteria (PacifiCorp 2003c, 2004b). Screen approach velocity is nearly six times the modern anadromous salmonid criteria of 0.4 feet per second (PacifiCorp 2003c). The ineffectiveness of the screen is demonstrated by the large number of unidentified suckers and trout that pass downstream- through or around the fish screens. ODFW counted numerous trout and unidentified suckers in the power canal during fish salvage operations (Oregon Department of Fish and Wildlife 2001; Oregon Department of Fish and Wildlife 2006a). PacifiCorp (1997) also reported tagging a high number of fish as a result of a salvage operation in the canal below the dam. Finally, radio-tracking results showed that one 14-inch trout passed upstream through the J.C. Boyle ladder, and the *same* fish also migrated downstream through the power canal and turbines. It was not excluded by screens (PacifiCorp 2004b Fish Resources FTR, Appendix 5C, page 14). This information indicates both small and large fish are passing through or around downstream screens at J.C. Boyle Dam, and are subject to turbine mortality and injury.

Proposed J.C. Boyle Downstream Fishway: The Applicant proposes a surface collection system (gulper) for the J.C. Boyle Reservoir (also referred to as Topsy Reservoir) to exclude fish from the power intake and to facilitate downstream fish passage (National Marine Fisheries Service 1994). The Services consider gulpers to be experimental technology (National Marine Fisheries Service 1994). They would not provide volitional passage and therefore are not consistent with Service goals (USDI Fish and Wildlife Service 2003) and National Marine Fisheries Service draft guidelines and criteria (National Marine Fisheries Service 2003). We are not aware of any instance where gulpers have been shown to work as well as positive barrier fish screens (David White, NMFS, pers comm.). Gulpers would not lend themselves well to the Klamath River system because of the physical conditions needed for their successful operation. Gulpers and guide nets would have physical problems with the huge amounts of algae and organic debris originating in Upper Klamath Lake and tributaries. Klamath River conditions are very different from other systems, such as the Baker River, where gulpers are the only viable option for downstream passage.

None of the existing or proposed mainstem downstream fishways meet the design criteria summarized in Table 2. These criteria form the basis for the Services' Preliminary Fishway Prescriptions in Section V below.

Existing Keno Dam Downstream Passage: The sluiceway intake is not screened. All other flows go under the radial gates and into shallow areas where redband trout (Oregon Department of Fish and Wildlife 1997) and other predator fish hold. The Services conclude that predation mortality is significant at this location because of these facility characteristics and the concentration of predatory fish.

Proposed Keno Dam Downstream Passage: The Applicant does not propose downstream spillway improvements for fish passage at Keno Dam.

Table 2. Recommended Design Criteria and Guidelines for Downstream Fish Passage

Parameter	Criteria	Reference
Downstream Fish Screens and Juvenile Bypass Systems		
Resident Trout Square Screen Opening Approach Velocity Sweeping Velocity	 5/32 in. diagonal 0.33 ft/s 0.66 ft/s	CDFG 2000
Salmon and Steelhead Square Screen Opening Approach Velocity Sweeping Velocity	 3/32 in. side 0.33 ft/s >0.33 ft/s	NMFS 2003, 1997
Federally listed suckers	3/32 in. side 0.33 ft/s >0.33 ft/s	(USDI Fish and Wildlife Service et al. 2005).
Lamprey		Not available

B. Benefits of the Services' Fishway Prescriptions

As the Services explain in greater detail below, provision of safe, timely, and effective upstream and downstream fish passage facilities will provide a suite of benefits for resident trout, suckers, and five of the anadromous fish runs currently present in the Klamath River below Iron Gate Dam: Spring and fall-run Chinook salmon (*Oncorhynchus tshawytscha);* coho salmon (*Oncorhynchus kisutch);* summer steelhead (*Oncorhynchus mykiss*); and Pacific lamprey (*Lampetra tridentatus*). Each of the runs uses the mainstem Klamath River and its tributary streams for spawning and rearing. Klamath River resident fish will realize significant benefits resulting from restored connectivity of populations. For anadromous fish, the Klamath River "Project Reach" (Iron Gate Dam to Link River Dam) contains more than 50 miles of suitable habitat for salmon and steelhead (Table 3). The Klamath River "Above Project Reach" (from Link River Dam to the headwaters of Upper Klamath Lake, including the Wood, Williamson, and Sprague rivers) contains more than 360 miles of suitable habitat for salmon and steelhead. These designations demonstrate the fish passage benefits and habitat characteristics in each of these reaches of the Klamath River (Figure 1).

1. Fishway Benefits by Species – Project Reach

The benefits of providing fishways to restore unimpeded migration to historical habitat within the Project Reach are substantial. The Services estimate that the Project Reach, between Iron Gate Dam and Keno Dam, contains approximately 58.9 miles of suitable habitat for anadromous

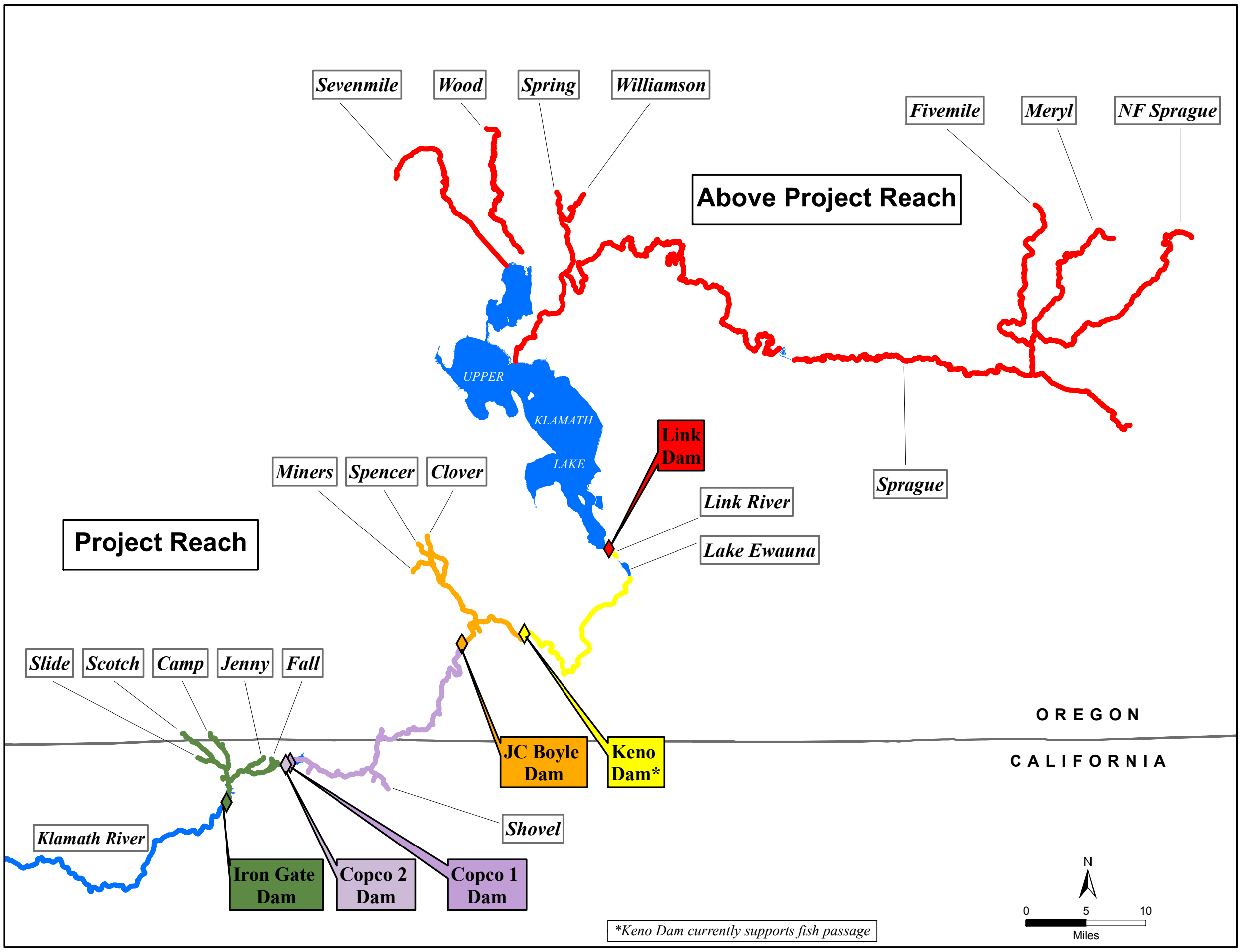

Figure 1. Project Reach and Above Project Reach (in red) designations for the Klamath River above Iron Gate Dam).

fish (Table 3), which compares closely with the estimate of 61 miles of habitat by Huntington (2006) for the Project reach. Fish passage through the Project Reach is also the stepping stone to much larger habitat gains above the Project.

A. Resident trout

For redband trout, a state of Oregon and U.S. Forest Service sensitive species, upstream fishways would restore historical seasonal migration patterns for both adults and immature fish. Upstream fishways would improve access to major spawning areas (such as Shovel and Spencer creeks) (California Department of Fish and Game 2005; Oregon Department of Fish and Wildlife 2006a). In some situations, the Project either blocks or severely impedes the movement of native redband trout. For example, one year after dam construction as many as 5,500 redband trout migrated through the ladder at J.C. Boyle Dam (Hemmingsen 1997). This event was typical of the intra-stream migrations among populations above and below the dam reach under natural conditions (e.g. Frain Ranch reach to Spencer Creek and Upper Klamath Lake) (Fortune et al. 1966). As time progressed, however, the dam's impacts on the native fish runs increased dramatically. After decades of impacts from the Project the number of fish migrating through the ladder has been reduced by 90 percent or more (Hemmingsen 1997; Hemmingsen et al. 1992; Oregon Department of Fish and Wildlife 2006a; USDI Fish and Wildlife Service 2004d). The average size of fish using the ladder decreased significantly (Hemmingsen 1997; Oregon Department of Fish and Wildlife 2006a) since shortly after dam construction.

B. Federally-listed suckers

The fish ladder at Keno Dam does not meet criteria for sucker passage (USDI Fish and Wildlife Service 2005) and the current success of attempted upstream migration by suckers at Keno is unknown. Suckers currently held in other Project reservoirs are unable to return upstream, either because of intervening riverine reaches or lack of upstream passage facilities at dams. However, because the Project reservoirs are probably inherently unsuitable for the completion of life cycles by the suckers (National Research Council 2003) and few, if any, federally-listed suckers occur below Iron Gate Dam, the Service sees little benefit in prescribing ladders to sucker criteria at the lower five mainstem dams at this time.

Screens and bypass systems at J.C. Boyle, Copco 1 and 2, and Iron Gate Dams would have benefits in guiding federally listed sucker movements downstream. Suckers in the project reservoirs may have utility should future reintroduction efforts be necessary (National Research Council 2003). Because these four dams lack screens and bypass systems, these fish are at risk. Current screen and bypass criteria for suckers are the same as those for salmonids (Table 2). Fishways to these specifications would guide suckers downstream and reduce entrainment related mortality. Because no further measures to protect or provide for suckers are prescribed at these facilities, federally listed suckers are not referred to as a target species (Table 4) or included in the prescriptions below Link River Dam.

Tailrace barriers and spillway prescriptions for resident trout and anadromous species would benefit federally listed suckers as well and specifications would be the same. Because no further measures to protect or provide for suckers are prescribed at these facilities, federally listed suckers are not referred to as a target species (Table 4) or included in the prescriptions below Link River Dam.

C. Coho salmon

The Southern Oregon/Northern California Coast coho salmon (SONCC coho) Evolutionarily Significant Unit (ESU), which includes coho salmon in the Klamath River Basin, was listed as Threatened under the Federal ESA in 1997 (62 FR 24588, May 6, 1997; 70 FR 37160, June 28, 2005). In addition, the Klamath River Basin, excluding habitat above Iron Gate Dam, was designated as Critical Habitat for the SONCC coho (64 FR 24049, May 5, 1999). Project dams prevent coho salmon from migrating between the lower Klamath River and Spencer Creek. Coho salmon were distributed at least this far upstream historically (Hamilton et al. 2005). Coho salmon are also excluded from intermediate spawning tributaries such as Fall Creek and Shovel Creek and from historical mainstem and tributary rearing habitat. The 46.5 miles of coho habitat within the Project represents 6 percent of the total 779 miles of historical coho habitat in the Klamath Basin (Charleen Gavette, NMFS, pers. comm.).

Table 3. Project Reach Habitat for Anadromous Fish

River Reach	Habitat Miles Steelhead	Habitat Miles Chinook and Coho Salmon[2]	Source for Miles of Historical Anadromous Habitat or Potential Anadromous Fish Use
Iron Gate to Copco 2:			
Scotch Creek	5	3.9	Snedaker[1]
Slide Creek	1.4	1.1	Snedaker[1]
Camp Creek	3.7	2.9	Snedaker[1]
Jenny Creek	1.0	0.8	Coots-Wales(1952), Huntington(2006)
Copco No. 2 Bypass	1.4	1.4	PacifiCorp (2004b) Fish Resources FTR
Fall Creek	1	0.8	Wales-Coots (1954), Huntington (2006)
Salt Creek	0.2	0.2	Snedaker[1]
Total Miles:	**13.7**	**11.1**	**N/A**
Copco 1 Dam to Boyle:			
J. C. Boyle Peaking	17	17	PacifiCorp (2004b) Fish Resources FTR
Shovel Creek	2.7	2.1	CDFG (2005), Huntington (2006)
J. C. Boyle Bypass	4	4	PacifiCorp (2004b), Fish Resources FTR
Long Prairie Creek	0.4	0.3	(Coots 1965)
Deer Creek	0.4	0.3	Snedaker[1]
Edge Creek	0.3	0.2	Snedaker[1]
Frain Creek	0.1	0.1	Snedaker[1]
Negro Creek	0.6	0.5	Snedaker[1]
Tom Hayden Creek	1.1	0.9	Snedaker[1]
Topsy Creek	0.3	0.2	Snedaker[1]
Beaver Creek	0.2	0.2	(Coots 1965) and FWS estimate
Total Miles:	**27.1**	**25.8**	**N/A**
Boyle to Keno:			
Boyle Reservoir to Keno Dam	4.7	4.7	PacifiCorp (2004b), Fish Resources FTR (page 2-22)
Spencer Creek	9.2	7.1	Fortune et al (1966), Huntington 2006
Hunters Park Creek	0.8	0.6	Snedaker[1]
Miners Creek	2.4	1.9	Snedaker[1]
Clover Creek	0	0	BLM 1995
Total Miles:	**17.1**	**14.3**	**N/A**
Link River	1	1	PacifiCorp (2004b), Fish Resources FTR
Grand Total "Fish Miles" inside Project:	**58.9**	**52.2**	**N/A**

[1] (Scott Snedaker, BLM, pers. comm.)
[2] Habitat Miles for Chinook salmon = steelhead ("anadromous") fish miles x (0.774) in tributaries (Table 1 in Huntington 2004)

Upper Klamath River coho salmon support the SONCC coho ESU in two primary ways. The Upper Klamath, Scott, and Shasta river coho salmon represent three of the four functionally-independent populations of the Klamath system, excluding the Trinity system (Williams et al. 2005). Functionally independent populations are defined as having minimal demographic influence from adjacent populations and viability in isolation. The SONCC coho ESU also contains 32 smaller dependent populations. These populations do not have a high likelihood of sustaining themselves over a hundred year time period in isolation; they must have sufficient immigration from independent populations in order to persist (Weitkamp et al. 1995). Despite their dependent status, they contribute significantly to the viability of the ESU. Because each of the four functionally independent populations of the Klamath Basin is greatly diminished (Weitkamp et al. 1995), the Upper Klamath system plays an important role in preserving the SONCC coho ESU by consistently providing emigrants to dependent populations over a long-term time scale.

Upper Klamath River coho salmon also support the SONCC coho ESU during short-term droughts. Many of the functionally dependent populations exist in rivers and streams of the Coast Range that are supplied by surface run-off water (Weitkamp et al. 1995). Rivers supplied by surface water are especially vulnerable to periods of drought. Because the Upper Klamath system extends beyond the Coast Range and into the Cascade Mountains, it is a snow-melt supplied system. Larger, snow-melt watersheds have more stable hydrology than smaller, rain dependent watersheds, and are therefore comparatively less vulnerable to drought. The Upper Klamath coho population provides emigrants to the dependent populations, re-populating them after short-term catastrophic events, including droughts.

The threatened status of the SONCC coho ESU was one of the primary constraints on the West Coast 2005 mixed-stock ocean fishery. The NMFS ESA consultation standard requires that the ocean exploitation rate of SONCC coho be no more than 13 percent of the Rogue and Klamath hatchery coho stocks (Pacific Fishery Management Council 2006b). Also, there is currently no retention of coho salmon in commercial and recreational fisheries off California (Pacific Fishery Management Council 2005). In some years, these standards constrain ocean fishing for the more abundant Chinook salmon.

Weitkamp et al (1995) has identified the SONCC coho ESU as likely to become endangered in the foreseeable future if the long-term downward trend persists. The National Research Council (2003) recommended effective passage for coho at dams throughout the Klamath within three years, and that elimination of Iron Gate Dam be seriously evaluated because this structure blocks substantial amounts of coho habitat. Restoring access to the historical coho habitat above Iron Gate Dam will increase numbers of Klamath River functionally-independent coho salmon, which will support the dependent populations and appreciably contribute to the recovery of the SONCC coho ESU (Weitkamp et al. 1995). Blockage of coho migration within the Klamath Basin is inconsistent with ESA regulations on take (National Research Council 2003).

D. Fall-run Chinook salmon

The Project excludes fall-run Chinook salmon from migrating to historical spawning, incubation, and rearing habitats (Hamilton et al. 2005). Although degraded from historical conditions, most of this habitat is suitable for the life history of fall-run Chinook (USDI Bureau of Land Management et al. 1995; USDI Bureau of Land Management 2005; California Department of Fish and Game 2005; Huntington 2006). In the Project reach, there is approximately 52.2 miles of spawning, incubation, and rearing habitat for Chinook salmon (Table 3). Historically, fall-run Chinook used habitat in the Spencer Creek watershed (USDI Bureau of Land Management 2005).

E. Lamprey

The Project excludes Pacific lamprey from migrating to historical spawning habitats in the Project area (Hamilton et al. 2005). Populations have declined substantially in many Oregon rivers (Kostow 2002) and information indicates large population declines of lamprey numbers throughout the Columbia and Snake River systems (USDI Fish and Wildlife Service 2004b). Anecdotal evidence (Larson and Belchik 1998) and preliminary analysis suggest a declining trend for all life stages of Pacific lamprey in the Klamath River (USDI Fish and Wildlife Service 2004b). The upstream limits of their distribution are not well documented, but extended at least as far as Spencer Creek (Hamilton et al. 2005). Pacific lamprey are of great importance to Tribal subsistence and ceremonial fisheries (Kostow 2002; Larson and Belchik 1998; USDI Fish and Wildlife Service 2004b; Wydoski and Whitney 2003).

F. Spring-run Chinook salmon

Spring-run Chinook salmon were once the dominant run type in the Klamath-Trinity River Basin. Most spring-run spawning and rearing habitat was above the Project on the Klamath River. The Project excludes spring-run Chinook from historical spawning habitats in and above the Project area (Hamilton et al. 2005) in the Klamath River watershed. As a result of these and other factors, spring-run populations are less than 10 percent of their historic levels, and at least seven spring-run populations that once existed in the Klamath-Trinity Basin are now considered extinct (Myers et al. 1997).

Passage for spring-run Chinook into the Project Reach will restore access to cool water refugial areas such as the 220 cfs of spring water in the J.C. Boyle bypassed reach. During summer months, this area will provide key holding areas, cool water, and refugial habitat necessary for this run of fish (McCullough 1999). Juvenile spring-run salmon will rear in the cool water habitat adjacent to the springs in the J.C. Boyle bypass reach. Water temperatures in this spring-influenced area do not vary substantially from 50 to 55^{o}F throughout the year (USDI Bureau Land Management 2003). During winter months, the reach will also provide relatively warmer water, benefiting rearing spring-run Chinook by providing optimal temperatures for juvenile growth (McCullough 1999). Spring-run Chinook will also use the main channel as an upstream migration corridor necessary to reach historical spawning areas in the Upper Klamath Basin (California Department of Fish and Game 1990).

G. Steelhead
The Project excludes steelhead trout from historical spawning, incubation, and rearing habitats in the Project area (Hamilton et al. 2005). In the Project reach, there are approximately 58.9 miles of steelhead habitat (Table 3).

2. Fishway Benefits by Species - Above Project Reach

The Above Project Reach, upstream from Link River Dam, contains approximately 49 significant tributaries comprising 360 miles of suitable, existing habitat and an additional 60 miles of recoverable[7] habitat for Chinook salmon and steelhead (Huntington 2006). While habitat has been degraded in some sections of the watershed above Link River Dam, substantial quantity and quality of habitat remains and effective habitat restoration programs could increase anadromous fish habitat to 420 miles (Huntington 2006). Ongoing habitat restoration work will continue (USDI Fish and Wildlife Service 2006). The work will expand to fully develop the capacity of the Upper Basin for anadromous fish. Efforts will include a broad range of restoration projects to restore and protect instream and riparian habitats. Chinook salmon and other anadromous fish returning to stream habitats above Upper Klamath Lake will improve the quality of spawning gravels as they construct redds. The Services expect that over a period of time, the condition of spawning sites will be improved in terms of embeddedness, particle size distribution, and compaction.

A. Resident trout
For resident redband/rainbow trout, which are present in the mainstem Klamath River, Upper Klamath Lake, and the lake's tributaries, fishways will allow reconnection of historical migration patterns. In the Upper Klamath Basin, resident redband/rainbow trout support a world class recreational fishery (Bill Tinniswood, ODFW, pers. comm.). These fish, particularly in the Williamson River, are renowned for their large size. Klamath Basin redband trout exhibit a pattern of downstream migration as fry or juveniles (Beyer 1984; Hemmingsen 1997) and return upstream as adults (Fortune et al. 1966). Historically, these populations were connected. Rainbow trout from Spring Creek and Trout Creek (above Upper Klamath Lake) are remarkably similar genetically to trout from Spencer Creek and the Klamath River (below Upper Klamath Lake) and to steelhead from Bogus Creek (below Iron Gate Dam) (Buchanan et al. 1994). This study concluded that some of these Upper Basin populations were likely once associated with runs of anadromous rainbow trout. Fishways will reconnect these now disparate populations and allow redband/rainbow trout and steelhead to be a source of adaptive variability in Klamath Basin salmonid populations.

B. Federally-listed Suckers
Benefits to suckers above the Project are provided by the ability of the fish to pass upstream at Link River Dam. A new ladder designed and constructed to current sucker criteria at Link River

[7] Huntington (2006) used this term to describe habitat that could be rehabilitated to become functional for Chinook salmon and/or steelhead trout within the next 30-50 years.

was completed in 2005. Federally-listed suckers are currently using this fishway to move from Lake Ewauna to as far upstream as the Williamson River (Bennetts 2006).

C. Fall-run Chinook salmon
The Project excludes fall-run Chinook salmon from historical spawning, incubation, and rearing habitats above the Link River Dam (Hamilton et al. 2005). Passage will provide access to approximately 49 significant tributaries comprising 360 miles of suitable, existing habitat and an additional 60 miles of recoverable habitat for Chinook salmon and steelhead (Huntington 2006).

D. Pacific Lamprey
Historically, Pacific lamprey occurred at least to Spencer Creek (Hamilton et al 2005). Lampreys occur long distances inland in the Columbia and Yakima river systems (Wydoski and Whitney 2003) and, with passage, would likely do so in the Klamath River system as well. Passage will provide access to substantial areas of habitat.

E. Spring-run Chinook salmon
The Project excludes spring-run Chinook salmon from historical habitat above the Link River Dam (Hamilton et al. 2005). Restoring spring Chinook runs will contribute to the diversity of runs in the Klamath River and eventually restore fishing opportunities for tribal and recreational users in the Upper Klamath Basin. Historically, the Klamath River spring-run Chinook salmon predominated over the fall-run (Gatschet 1890; Spier 1930), (Hume in (Snyder 1931). Large populations of these fish were found in several of the Klamath's tributaries, including both the Williamson and Sprague rivers upstream of Upper Klamath Lake (California Department of Fish and Game 1990). Historical run sizes were estimated to be at least 5,000 spring–run Chinook in both the Sprague and Williamson Rivers (California Department of Fish and Game 1990). Adequate passage is necessary at dams below Link River Dam to facilitate fish movement to these rivers.

F. Steelhead
The Project excludes steelhead from historical spawning, incubation, and rearing habitats above the Link River Dam (Hamilton et al. 2005). Adequate upstream fish passage at dams below Link River Dam would restore these runs to 360 miles of currently productive anadromous fish habitat (if anadromous fish had access to this habitat) and an additional 60 miles of recoverable habitat (Huntington 2006).

3. Additional Fishway Benefits
Restoration of populations of anadromous fish above Iron Gate Dam will provide a drought resistant genetic source (see discussion on SONCC coho above), helping to protect coastal coho and Chinook salmon stocks during extreme drought or flood events (Weitkamp et al. 1995).

Increases in the abundance of natural Klamath River Chinook stocks will not just be limited to the Klamath River and associated fisheries. There are multiplier benefits to Chinook salmon fisheries coastwide from increases in the abundance of these natural Klamath River Chinook. In many years, the abundance of Klamath River Chinook salmon can directly affect the coastal mixed stock fisheries. When Klamath abundance is low, overall fishing effort is restricted to protect those fish. For example, in 2000, the ratio of Klamath Chinook to Chinook harvest in other fisheries was projected to be approximately 1:25 fish (Allen Grover, CDFG, pers. comm.). An increase in the abundance of Klamath River fall-run Chinook in that year would have resulted in substantial multiplier benefits to overall Chinook harvest, if other harvest restrictions (e.g. to protect federally listed coho and CA Coastal Chinook) had not been in place. In years 2003-2005, the low abundance of Klamath stocks was again a factor in the restriction of coastal Chinook fisheries south of the Columbia River and in 2005 there was also a request for disaster relief associated with the restricted fisheries due to the low abundance of Klamath stocks (Pacific Fishery Management Council 2006b). In 2006, a forecast for low abundance of Klamath stocks could require closure of most salmon fisheries from Cape Falcon, Oregon to Point Sur, California (Pacific Fishery Management Council 2006a).

There are significant ecosystem benefits associated with anadromous fish reintroduction. Restoration of anadromous runs will provide benefits to native fishes such as bull trout (*Salvelinus confluentus*) - a threatened species present in the Wood, Sycan, and Sprague rivers. This species is known to seek anadromous fry and juveniles as food sources (Wydoski and Whitney 2003). Anadromous fish runs provide nutrient input from the marine environment. They are an important source of energy and nutrients for subsequent generations of salmon; and they help to maintain proper ecological function (Stockner 2003). Over the past century, the natural contribution of marine-based nutrients to Pacific Northwest rivers declined in proportion to the decrease in salmon spawning (Gresh et al. 2000). When salmon return from the ocean to spawn, they bring vital nutrients with them to the watershed. Their decomposing carcasses provide a vital source of food and nutrients, not just for other fish species and wildlife, but for a whole host of organisms in the watershed. In addition to elemental nutrients, salmon carcasses contain minerals, amino acids, proteins, fats, carbohydrates, and other essential biochemicals for living organisms (Wipfli et al. 2003). The significance of these biochemicals and their availability to the food web may be more important than nitrogen, phosphorous, or other nutrients (Wipfli et al. 2003). Reintroduction of marine-derived nutrients from salmon carcasses will have a positive effect on the recovery of riparian ecosystems in the Klamath River Basin and provide associated benefits to other species, including federally listed suckers and terrestrial wildlife.

As a strategic approach to restoring Pacific Northwest watersheds, efforts should first focus on reconnecting isolated, high quality fish habitats made inaccessible by artificial obstructions (Roni et al. 2002). The safe, effective, and timely passage of fish around dams on the Klamath River is consistent with this strategy. The portion of the Klamath River watershed below the current upstream limit of anadromy continues to support viable (albeit diminished) runs of Pacific lamprey, steelhead, coho salmon, as well as spring-run and fall-run Chinook salmon. A run of over 30,000 hatchery and natural spring-run Chinook salmon still exists in the Trinity River and a remnant run of wild spring-run Chinook persists in the Salmon River. In the area of the Basin upstream from Iron Gate Dam, existing habitat continues to support fluvial and ad-fluvial populations of redband trout, and in some places, cold water species such as brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), and bull trout. Many of the necessary components of the ecosystem above Iron Gate Dam appear to be present and functional, or are restorable to functional form (California Department of Fish and Game 2005; Klamath Basin Ecosystem

Foundation 2005; USDI Bureau of Land Management 2005; USDI Bureau of Land Management et al. 1995; USDI Fish and Wildlife Service 2004c).

The safe, effective, and timely passage of fish around dams on the Klamath River has significant potential to assist in the recovery of depressed stocks of anadromous fish. While the entire Upper Klamath and Trinity Rivers Chinook ESU is not listed under the ESA (Myers et al. 1997), the Klamath River spring-run Chinook population is considered to be at high risk of extinction (Nehlsen et al. 1991). The Klamath Mountains Province steelhead ESU is not listed under the ESA (Busby et al. 1996), but summer steelhead in the lower Basin are in decline and are identified as being at high risk of extinction (Nehlsen et al. 1991). Access to hundreds of miles of historical anadromous habitat above dams on the Klamath River (Huntington 2006) would greatly benefit these stocks and may reduce the potential for future ESU listings under Federal and State Endangered Species Acts.

C. Summary of Benefits and Need for Fishway Prescriptions

The Upper Klamath River, above Iron Gate Dam, historically supported the spawning and rearing of large populations of both anadromous and resident fish. Due to several factors, including impacts from the Project, Klamath River anadromous fish populations are substantially diminished and, in some cases, struggling to survive. Safe, timely, and effective fishways at all hydropower and water diversion developments on the river are essential precursors to the eventual re-establishment of more robust and resilient fish populations.

Fish passage at Project developments at and above Iron Gate Dam will provide multiple benefits to society and the environment:

- Access to hundreds of miles of habitat for returning anadromous species
- Restoration of native and resident fish populations
- Restoration of historical migration patterns and access to refugial areas
- Improved species diversity and ecosystem integrity
- Resilience of commercially important Chinook stocks
- Significant contributions to coastwide and Klamath River fisheries
- Fulfillment of numerous government and stakeholder goals and objectives
- Restoration of important public trust resources
- Minimizing the loss of federally listed suckers due to entrainment by the Project

VI. PRELIMINARY SECTION 18 PRESCRIPTIONS FOR FISHWAYS

Section 18 of the Federal Power Act (16 U.S.C. 811) states in part that: “the Commission shall require the construction, maintenance, and operation by a Licensee of... such fishways as may be prescribed by the Secretary of Commerce or the Secretary of Interior.” Section 1701(b) of the National Energy Policy Act of 1992, P.L. 102-486, provides guidance as to what constitutes a fishway. Section 1701(b) states: “The items which may constitute a ‘fishway’ under section 18 for the safe and timely upstream and downstream passage of fish shall be limited to physical structures, facilities, or devices necessary to maintain all life stages of such fish, and Project operations and measures related to such structures, facilities, or devices which are necessary to ensure the effectiveness of such structures, facilities, or devices, for such fish.”

These preliminary fishway prescriptions are based on the best biological and engineering information available, as described more fully in the explanatory statements that accompany each preliminary prescription. Although the maximum benefits to the fisheries are accrued with the combination of all the prescription elements in Section V, each prescription also stands on its own, and provides its own benefits. These prescriptions have been developed over a period of several years by the biological and engineering staff of the Services, in consultation with the Applicant, the U.S. Bureau of Land Management (BLM), the California Department of Fish and Game (CDFG), ODFW, affected Tribes, the Klamath Intertribal Commission, and other entities that are participating in this relicensing proceeding. Each preliminary prescription is based on substantial evidence contained in the record of this licensing proceeding before the Commission, in the attached Appendix, and filed herein with the Commission. The explanatory statements below are intended only to summarize the supporting information and analysis upon which these preliminary prescriptions are based. Several documents previously submitted to the record in this proceeding contain detailed and specific information describing the Project’s impacts on fish and wildlife (National Marine Fisheries Service 2003 DLA; National Marine Fisheries Service 2004 FLA; U. S. Department of the Interior 2004). These documents, including the relevant descriptions of baseline reference conditions and ongoing Project effects relative to applicable resource planning goals, provide relevant supporting information pertaining to Project impacts on anadromous fish and their habitat. All documents previously filed with the Commission by the Services are hereby incorporated by this reference.

For the Service, the preliminary prescriptions for fishways herein are issued under the authority of the Secretary of the Interior pursuant to section 18 of the Federal Power Act (see 64 Stat.1262). The Service’s preliminary prescriptions are also consistent with the requirements of the Guidance for the Prescription of Fishways Pursuant to Section 18 of the FPA (USDI Fish and Wildlife Service 2002).

NMFS hereby prescribes, on a preliminary basis, the following license conditions for the construction, operation and maintenance of upstream and downstream fishways for the Klamath Hydroelectric Project pursuant to its authority under section 18 of the Federal Power Act, 16 U.S.C. § 811 as delegated to NMFS by the Secretary of Commerce.

A. RESERVATION OF AUTHORITY TO PRESCRIBE FISHWAYS

NMFS reserves the right to modify these preliminary fishway prescriptions and recommended terms and conditions in any comments filed responding to any subsequent Notice of Offer of Settlement issued by the Commission. In addition, NMFS reserves the right to modify its preliminary fishway prescriptions and its recommended terms and conditions, based on the results of new information and conclusions developed during the Commission's NEPA analysis, comments received as a result of public or agency review, or in connection with the fulfillment of other statutory consultation and review requirements, including review pursuant to regulations at 50 CFR Part 221 for implementing requirements under the Energy Policy act of 2005, or pursuant to section 7 of the ESA 16 U.S.C 1536 (implementing regulations at 50 C.F.R Part 402), or section 305(b) of the Magnuson-Stevens Act, 16 U.S.C. 1855(b), regarding essential fish habitat (implementing regulations at 50 C.F.R. Part 600, Subpart K). NMFS anticipates submitting any modified prescriptions and terms and conditions by no later than 60 days after the Commission's issuance of a Draft Environmental Impact Statement (DEIS). Finally, NMFS expressly reserves the right to revise its fishway prescriptions and recommended terms and conditions prior to a final licensing decision based upon significant new information or modifications to the Commission's proposed licensing alternative following the Commission's completion of an EIS or upon rehearing of the Commission's licensing order.

NMFS exercises its authority under section 18 and requests that the Commission include the following condition in any license it may issue for the Project:

> NMFS expressly reserves its authority under section 18 of the FPA to prescribe such additional or modified fishways at those locations and at such times as it may subsequently determine are necessary to provide for effective upstream and downstream passage of anadromous fish through the Project developments, including without limitation its authority to amend the following fishway prescriptions upon approval by NMFS of such plans, designs and implementation schedules pertaining to fishway construction, operation, maintenance and monitoring as may be submitted by the applicant (licensee) in accordance with the terms of the license articles containing such fishway prescriptions. NMFS is prescribing the design and construction standards for fishways herein. As an alternative, if necessary, authority is reserved to prescribe performance standards to ensure safe, timely, and effective movement of fish.

The Service reserves the right to modify its preliminary fishway prescriptions based on the results of new information and conclusions developed during the Commission's NEPA analysis, comments received as a result of public or agency review, or in connection with the fulfillment of other statutory consultation and review requirements, including review pursuant to 43 C.F.R Part 45 and consultation under section 7 of the ESA (16 U.S.C 1536 (implementing regulations at 50 C.F.R Part 402)). The Service anticipates submitting any modified prescriptions by no later than 60 days after the Commission's issuance of a Draft Environmental Impact Statement (DEIS). Finally, the Service expressly reserves the right to revise its fishway prescriptions prior to a final licensing decision based upon significant new information or modifications to the

Commission's proposed licensing alternative following the Commission's completion of an EIS or upon rehearing of the Commission's licensing order.

This reservation of authority allows the Service to consider additional data as it becomes available, to respond to changed circumstances, and modify the existing section 18 prescriptions as may be necessary. The reservation of mandatory authorities under the FPA has been accepted by the Commission and judicially affirmed. *Wisconsin Public Services Corp.*, 62 FERC ¶ 61,905 (1993), *aff'd*, *Wisconsin Public Serv. Corp. v. FERC*, 32 F.3d 1165 (7th Cir. 1994).

The Klamath Tribes of Oregon hold treaty-protected property rights, including fishing and water rights, in the upper Klamath Basin. The United States and the Klamath Tribes have jointly filed claims in the State of Oregon's water rights adjudication for the surface waters of the Klamath Basin in Oregon, including instream flow claims within the Project area (from Link River Dam to the Oregon-California border), to protect the Tribes' fishing and water rights reserved to them pursuant to their 1864 Treaty with the United States. In addition, the Hoopa Valley and Yurok Tribes have confirmed reserved fishing rights in the lower Klamath Basin, and the water necessary to protect those rights may likewise be determined in a subsequent proceeding.

Any license articles required for this Project's license, including those to protect federal interests, must be consistent with these reserved rights. Additional data or other information, including a binding decree resulting from the State of Oregon's water rights adjudication, may require modification to the license conditions. Thus, the Service is submitting this reservation of authority. The Service's other recommendations do not ask Commission to take any action or otherwise engage in the issues being addressed in the water rights adjudication.

The Service has prepared its preliminary prescriptions for fishways in response to the proposals being considered by the Commission in this proceeding. If any proposal is modified prior to licensing, as a result of licensing, or after licensing, then the Service will require adequate opportunity to reconsider each prescription and make modifications it deems appropriate and necessary for submittal to the Commission. Therefore, the Service exercises its authority under section 18 and requests that the Commission include the following condition in any license it may issue for the Project:

> Authority is reserved for the Service to prescribe the construction, operation, and maintenance of fishways at the Klamath River Hydroelectric Project, Project No. 2082, as appropriate, including measures to determine, ensure, or improve the effectiveness of such fishways, pursuant to section 18 of the FPA, as amended. This reservation includes, but is not limited to, authority to prescribe fishways for spring and fall-run Chinook salmon, coho salmon, steelhead trout, Pacific lamprey, Lost River and shortnose suckers, and any other fish to be managed, enhanced, protected, or restored to the Klamath River Basin during the term of the license. Authority is reserved to the Service to prescribe an upstream fishway to sucker criteria at Keno Dam pending the evaluation of the need for such a fishway. The Service is prescribing the design and construction standards for

fishways herein. As an alternative, if necessary, authority is reserved to prescribe performance standards to ensure safe, timely, and effective movement of fish.

The Services reserve the authority to modify these prescriptions for fishways at any time before license issuance, as well as any time during the term of the license, after review of new information.

B. PRELIMINARY PRESCRIPTIONS FOR FISHWAYS

These prescriptions for the Klamath Project include design specifications and implementation schedules, operating requirements and procedures, and specifications for post-installation implementation, evaluation, and maintenance. The Services have carefully reviewed these preliminary prescriptions, and consider them to fall fully within the scope of their section 18 authority. In general, the Licensee shall develop all elements of the prescriptions in consultation with appropriate technical specialists of the Services, along with CDFG, ODFW, and affected Tribes where appropriate.

Design, construction, evaluation, monitoring and modifications of developments shall be conducted according to NMFS guidelines (National Marine Fisheries Service 2003). The Services expect that the Licensee shall employ all measures necessary and appropriate to maximize upstream and downstream fish passage effectiveness for resident and anadromous species over the full range of river flows for which the Project maintains operational control. The Licensee shall manage Project reservoirs and forebays to ensure that all upstream and downstream fish passage facilities are fully operational at all times and at all reservoir elevations and inflows. Other general prescriptions for fishways are specified to provide for the modification, inspection, and maintenance of upstream and downstream fishways during the term of the license.

<u>Rationale for General Preliminary Prescriptions</u>*:*

Agency Review and Approval: Because the Services, along with other Federal, State, and Tribal partners, have considerable expertise, experience, and responsibilities in fishway system design and operations, it is standard procedure for this type of design review procedure to be instituted for any plans proposed by the Licensee or its agent(s). This is particularly true where Federal and State oversight is implied by law, either explicitly or implicitly, as is the case here. The Services possess multi-disciplinary technical review capabilities to assist the Licensee in developing effective functional fishway system designs. A Fisheries Technical Subcommittee (FTS), to be established by the Services and comprised of engineers, biologists, and other fish passage specialists, will help ensure quality and performance of complex hydraulic and biological systems.

Sequencing of Construction and Operations Rationale: As explained in greater detail below in the rationale for specific preliminary prescriptions, adult and juvenile fish may migrate into Project facilities that may cause injury or mortality if measures are not in place to ensure their protection. For example, if adult fish are allowed to migrate upstream via a fish ladder, they may become susceptible to entrainment in hydro-turbines unless the downstream screening facilities are also in place. Large numbers of juvenile fish (downstream migrants) will be particularly susceptible to entrainment into hydro-turbines if screen and bypass systems are not in place and functioning for their protection. The Services intend to work with the Licensee to design the best sequence for the construction and operation of fishway facilities when more specific design information is known.

Design and Construction: Fish passage facilities shall be completed on a phased schedule to allow appropriate time for design and contracting construction. The Licensee shall complete downstream fishways (screens, bypasses, and spillway modifications) at each development, at or before the completion of the upstream fishway at that development, to prevent injury or mortality to fallback fish.

Access to Developments and Records Rationale: The Licensee shall grant reasonable access to developments and Project records so that Agency personnel will be able to evaluate fishway performance, inspect fishway facilities, and help to optimize facility performance based upon those evaluations and inspections.

Post-Construction Evaluation: The Licensee must complete a Post-construction Evaluation Plan for review and approval by the Services because it will be necessary to determine fishway system effectiveness and to identify and correct any fish delay, loss, injury, or hydraulic problems that may be present. Adjustments are often required to achieve optimal fish passage conditions within the fishway, in front of screens, and within bypass systems, or to achieve effective attraction flows in front of fishway entrances. After the initial adjustments have been made, wear and tear, accumulation of sediment and other debris, and various other factors can, over a period of time, alter hydraulic conditions and decrease the effectiveness of fishways (National Marine Fisheries Service 2003). Therefore, periodic evaluations of fishway effectiveness are necessary to assure continuing compliance and the safe, timely, and effective passage of fish.

Maintenance Requirement: It is essential that the Licensee observe proper maintenance practices for the correct, long term operation of each facility. Large scale fishways and fish protection systems are subject to continuous operations and harsh riverine and climatic conditions. Because vital fish migrations occur at each site on a regular basis, the Services must be notified whenever system maintenance is required that may cause excessive delay, injury, or mortality to migrating fish, or other species. An explicit element of fishway maintenance is the design of facilities that can withstand the elements and perform in continuous duty. Proper maintenance is necessary to ensure the temporal movement of fish in completing their biological requirements, including spawning, smolting, and outmigration (National Marine Fisheries Service 2003).

Maintenance, Inspection, and Operation Plan Rationale: Effective operation and performance of the fishways, including fish screens, conveyance, and bypass facilities, are also dependent on regular inspection and maintenance to assure proper operating conditions within the fishway. Wear and tear, corrosion, accumulation of sediment and debris, and various other factors decrease the effectiveness of the fishway's physical features such as screens and seals. If left untreated, this would increase fish losses. Annual inspections of the physical features prior to each migratory period are necessary to assure that all elements of the fishways are in good condition and will operate effectively (National Marine Fisheries Service 2003). Maintenance procedures during shutdown periods need to include provisions for timing fishway maintenance to avoid peak migration periods and safely removing fish from the fishways and returning them to the river. All fishway elements need to be made available to fishery agencies (the Services, CDFG, ODFW, and the Tribes) for immediate inspection to ensure proper implementation of and compliance with fishway operation and maintenance conditions.

Fishway Evaluation and Modification Plan Rationale: It is important that the Licensee complete Fishway Evaluation and Modification (FEMPs) for the optimal operation of each fishway for the safe, effective, and timely passage of each species. These plans need to include measures to remedy problems with fish passage observed through operations and maintenance and fishway evaluations. FEMPs are necessary to achieve program goals, objectives, and strategies. To assess progress towards these goals and objectives, and minimize fish losses, the Service and NMFS-Engineering must approve these plans.

Annual Work Plan Rationale: The FEMPs will include an Annual Work Plan describing prospective actions the Licensee will take to implement and monitor fish passage. The Work Plan will ensure adequate and timely coordination between the Licensee and the Services, allowing the Services to determine whether program goals are being achieved and whether the Licensee is utilizing appropriate methodologies.

Attraction Flow Rationale: The higher percentage of total river flow used for attraction into the fishway, the more effective the facility will be in providing upstream passage. Experience with other fish facilities often shows that lack of adequate attraction flow, poor auxiliary water system design and operation, or unsatisfactory water quality can be major limiting factors in successful fish passage (National Marine Fisheries Service 2003)[8]. However, water allocated for attraction flow cannot be used for electricity generation. Therefore, the Services will allow the Licensee to scientifically test whether fish passage efficiency can be satisfactorily maintained with attraction flow rates between 5 and 10 percent. Testing will be based upon experimental testing protocols recommended by the Services to optimize the balance between attraction flow and fish passage efficiency. If statistically valid testing proves that flows less than ten percent, but not less than 5 per cent (National Marine Fisheries Service 2003), can provide equivalent passage efficiency, then the Services may authorize the Licensee to adopt a different attraction flow regime. It is recognized that attraction flows may vary depending on a variety of factors and over time. This prescription recognizes that variability and offers the Licensee the opportunity to demonstrate the viability of different attraction flow regimes and to adaptively manage Project operations during the new license term.

High and Low Passage Design Flow Rationale: The design streamflow range for fish passage, bracketed by the designated fish passage design high and low flows, constitutes the bounds of the

[8] Some large hydropower installations use pump-back systems to recover auxiliary water so that it can be used for electricity generation.

fish passage facility design where fish passage facilities must operate within the specified design criteria. Within this range of streamflow, migrants must be able to pass safely and quickly. The low passage design flow is the lowest stream discharge for which migrants are expected to be present, migrating, and dependent on the proposed facility for safe passage. The high fish passage design flow rationale is the highest stream discharge for which migrants are expected to be present, migrating, and dependent on the proposed facility for safe passage. Within this range of streamflow, migrants should be able to pass in a safe and timely fashion. Outside of this flow range, fish are expected to be either not present or not be actively migrating, or shall be able to pass safely without need of a fish passage facility. Site-specific information is critical to determine the design time period and river flows for the passage facility. Local hydrology may require that these design streamflows be modified for a particular site (National Marine Fisheries Service 2003).

General Preliminary Prescriptions:

The following general prescriptions for fishways apply to each of the specific prescriptions below for the construction, operation, and maintenance of upstream and downstream fishways at the Project. These preliminary prescriptions are included to ensure the effectiveness of the fishways pursuant to section 1701(b) of the 1992 National Energy Policy Act (P.L. 102-486, Title XVII, 106 Stat. 3008).

1.1.1. *Design and Construction Plans*: For each facility, the Licensee shall develop detailed design, construction, evaluation, and monitoring plans for review and approval by the Services prior to construction. All original plans, and subsequent modifications of facilities, shall be conducted according to NMFS guidelines for the design of fish screens, fishways, and other fish passage structures (National Marine Fisheries Service 1997, 2003). The Licensee, or their authorized and qualified agent(s),[9] shall have all designs reviewed by the FTS. The Licensee and its agents must establish close consultation with Agency fisheries engineering and fish passage specialists at the outset of design and throughout the entire process. The initial design meetings shall commence at the pre-design, or conceptual-level design phase. Prior to advancing to feasibility-level of design, the Services must concur with all preferred alternatives for each independent facility, or any major feature of a facility. The Licensee will then proceed with the feasibility and final design phases providing detailed design, specification, and construction plans at the 50, 90, and 100 percent stage of completion. The Licensee shall schedule and provide a minimum of 90 days for the Services' engineering and technical specialists to review and approve comprehensive plans. Shorter review periods may be possible, depending on the nature of the subject, as approved by the Services. The Licensee shall implement any design modifications as required by the Services as

[9] "Authorized agents" will typically be qualified engineering and/or biological consulting firms who specialize in this area of work.

necessary to fulfill the objective of safe, timely, and effective passage for all species considered. The Licensee shall include in plans and obtain any critical spare parts or equipment, as needed to effect timely repairs of critical system components. The Licensee shall complete and begin operation of fish passage facilities in a phased schedule. The phased schedule will allow appropriate time and sequencing for design, contracting, and construction. Unless otherwise approved, downstream fishways (screens, bypasses, and spillway modifications) at each development must be complete prior to the completion of the upstream fishway at any given development. After approval by the Services, the Licensee shall file final designs with the Commission. The Services may specify the acquisition of any critical spare parts or equipment, as needed to effect timely repairs of critical system components. Fish passage facilities shall be completed, and brought on line, in a phased schedule. This will allow appropriate time and sequencing for design, contracting, construction, and in some cases, studies of the optimal design for tailrace barriers, or other facility enhancements not immediately apparent. Unless otherwise approved, downstream fishways (screens, bypasses, and spillway modifications) at each development must be complete prior to the completion of the upstream fishway at any given development. The designs approved by the Services shall be filed with the Commission.

1.1.2. *Access to Developments and Records*: The Licensee shall provide timely site access to Agency personnel at all Klamath River Hydroelectric Project developments, as well as pertinent Project records for the purpose of inspecting fishways to determine compliance with this fishway prescription.

1.1.3. *Maintenance Requirement:* The Licensee shall keep all fishways in proper order, and shall keep all fishway areas clear of trash, sediment, logs, debris, and other material that would hinder passage, or create a personnel safety hazard. The Licensee shall perform anticipated maintenance well in advance of any critical migratory periods so that fishways can be tested, inspected, and be operating effectively during fish migration. If any fishway system becomes seriously damaged or inoperable, the Licensee shall notify NMFS Engineering and the Service within 48 hours. The Licensee shall take remedial in a timely manner and in a manner satisfactory to NMFS-Engineering and the Service.

1.1.4. *Fishway Operation, Inspection, and Maintenance Plans*: The Licensee shall, in consultation with the Services, affected Tribes, CDFG and ODFW, develop a fishway operation, inspection, and maintenance plan describing anticipated operation, inspections, maintenance, schedules, inspections, and contingencies for each fish passage facility. The operation, inspection, and maintenance plans shall be submitted to the Service and NMFS Engineering for final review and approval with final designs for fishway construction. To minimize fish losses, the Licensee must complete these plans and ensure adequate time for review and approval by the Service and NMFS Engineering prior to the completion of construction and operation of each upstream and downstream fish passage facility. After approval by the Services, the Licensee shall file these plans with the Commission.

1.1.5. *Post Construction Fishway Evaluation Plans:* Prior to the completion of construction of the new fishways, the Licensee shall, in consultation with the Services, ODFW, CDFG, and affected Tribes, develop post-construction monitoring and evaluation plans to assess the effectiveness of each fishway, spillway, and the tailrace barrier prescribed below. The plans shall include hydraulic, water quality, and biological evaluations using Passive Integrated Transponder (PIT) or similar technology to detect and record fish passage and assess the performance of the fishway, including measures for follow-up evaluations of effectiveness and fish survival through fishways. The Licensee shall provide a report on the monitoring and evaluation of the developments annually for the term of the new license. Specifically, the plans must include measures to estimate numbers of fish passed by species on a daily basis (including but not limited to spring-run and fall-run Chinook salmon, coho salmon, steelhead, Pacific lamprey, Lost River and shortnose suckers, and redband/rainbow trout), sampling of fish size, and the sampling of age class of fish passed at each development on a daily basis; a record of the daily observations by a qualified fisheries biologist on the physical condition of the fish using the fishways; and a continuous record of DO (dissolved oxygen) and water temperature at locations in the fishway as determined by the Services, and in front of and adjacent to the entrance(s) and exit(s) of the fishways. The evaluation plans shall be submitted to the Services for final review and approval within six months of the date when final designs for fishway construction are approved by the Services. At least 60 days shall be provided for Services to review the evaluation plans. The Licensee shall fund and implement the approved plans and any plan modifications, operational or physical changes necessary for the safe, effective, and timely passage of fish as may be required by the Services. The Agency approved designs shall be filed with the Commission.

1.1.6 *Fishway Evaluation and Modification Plans:* The Licensee shall, in consultation with the FTS, prepare a Fishway Evaluation and Modification Plan (FEMP) for each fishway, spillway, and tailrace barrier prescribed to achieve the Services' fish passage goals and objectives. The Licensee shall provide an outline of the FEMPs to the Services no later than one year after license issuance. Consultation with the agencies listed above shall begin as early as possible following license issuance. The Licensee shall document all consultation, including the agencies' responses to requests for consultation, and include this documentation in the FEMPs. The complete FEMPs shall be submitted to the Services for review and approval no later than eighteen months from the date of license issuance. At least 60 days shall be provided for review. After receiving the Services' approval, the Licensee shall file the FEMPs with the Commission.

A. Each FEMP shall include:

1. A specifically quantified program to meet the Services' fish passage goals, objectives, and strategies;
2. The Services criteria by which to measure progress towards fisheries management goals;
3. Procedures for redirecting effort, including funding, as necessary under adaptive fishway management to achieve the Services' goals and objectives;
4. Schedule for implementation of activities to achieve the Services' goals and objectives;
5. A monitoring plan to evaluate progress towards, and achievement of the Services' goals and objectives; and
6. A format for the Annual Report and Annual Work Plan, which are described below.

B. The Services, in consultation with the States of Oregon and California as well as affected Tribes, will review the FEMPs and reserve the right to accept, reject, or modify the FEMPs, in whole or in part, to ensure the safe, timely, and effective passage of resident and anadromous fish. Any reviews or amendments to the FEMPs, over the term of the license, shall be subject to the same level of Services' review and approval as the original FEMPs. After receiving the Services' approval, the Licensee shall file with the Commission FEMPs and any amendments therein.

C. By February 1 of every year, for the term of the License and all annual licenses, the Licensee shall submit to the Services for approval an Annual Report detailing the work accomplished under the FEMPs during the previous calendar year, progress made toward program goals and objectives, plans or suggestions to redirect effort per adaptive fishway management with a detailed justification of why this is warranted, and documentation of consultation with the Services and their responses. After receiving Services' approval, the Licensee will submit each Annual Report to the Commission.

D. By December 1 of every year, for the term of the License and all annual licenses, the Licensee shall submit to the Services for approval an Annual Work Plan detailing the Licensee's proposed activities for the next calendar year as necessary to implement the FEMPs. The work plan must provide sufficient detail for the Services to determine whether the Plan continues to provide for the safe, effective, and timely passage of resident and anadromous fish. The Annual Work Plan shall include, but not be limited to, detailed information on methods to be employed; schedule of activities; and explanations of how planned activities will help attain program goals.

1.1.7. *Upstream Fishway Attraction Flows and Range of Design Flow*: The following general prescriptions for design flow ranges and attraction flows for fishways apply to each of the specific prescriptions below for the construction, operation, and maintenance of upstream fishways at the Project. These prescriptions are included to ensure the effectiveness of the fishways consistent with NMFS guidelines and criteria (National Marine Fisheries Service 2003).

A. The Licensee shall design each upstream fish passage facility to pass migrants throughout a design streamflow range, bracketed by a designated High and Low Fish Passage Design Flow.

1. Low Fish Passage Design Flow - For each upstream fish passage facility the Low Fish Passage Design Flow shall be the mean daily average stream discharge that is exceeded 95 percent of the time during periods when migrating fish are normally (historically) present at the site, as determined by a flow-duration curve summarizing at least the previous 25 years of daily discharges or, if discharge records are not available, by an artificial streamflow duration methodology approved by the Services. This could also be an applicable minimum instream flow, as determined by state regulatory agencies, by ESA consultations with NMFS, or by an article in Project license.

2. High Fish Passage Design Flow - For each upstream fish passage facility, the High Fish Passage Design Flow shall be the mean daily average stream discharge that is exceeded 5 percent of the time during periods when migrating fish are normally (historically) present at the site, as determined by a flow-duration curve summarizing at least the previous 25 years of daily discharges or, if discharge records are not available, by an artificial streamflow duration methodology.

B. Each upstream fish passage facility shall provide physical facilities capable of producing at least 10 percent attraction flow as a percent of High Fish Passage Design Flow. Attraction flow is the total amount of flow discharged from the fishway entrance pool at any given time. For fishways in streams with mean annual streamflows exceeding 1000 cubic feet per second (cfs), the Licensee shall determine the optimum attraction flow in consultation with the Services (National Marine Fisheries Service 2003). During facility evaluations, attraction flows may be throttled for testing purposes between the range of 5 percent and 10 percent, in order to determine whether fish passage efficiency can be maintained at a lower attraction flow.

C. The Licensee shall ensure that any reduction in attraction flow shall not result in reduction in fish passage efficiency below performance standards (established by the Services) during seasons of important fish migrations. The Licensee shall test fishway performance in accordance with experimental testing protocols recommended by the FTS. The Licensee shall report testing results to the Services, and implement adaptive management measures to alter attraction flows (to no less that 5 percent), if approved by the Services. The Licensee shall report any changes in attraction flows to the Commission. In the absence of valid experimental results, the default attraction flow is 10 percent.

Specific Fishway Prescriptions for Klamath Hydroelectric Project Fishways

All general prescriptions above shall apply to the specific prescriptions below. The preliminary prescriptions for developments in the Project are summarized in Table 4.

Table 4. Summary of Preliminary Fishway Prescriptions and Timetable for the Klamath Hydroelectric Project (Commission Project #2082)

Development	Target Species	Fish Ladder and Passage Impediment Modification (in Chronological Order)	Tailrace Barrier	Screens and Bypass	Spillway Modifica-tions	Interim, Seasonal Trap and Haul
Copco 2 Bedrock Sill	Salmonids, lamprey	2 yrs (Bypass Barrier/Impediment Modification)	Not Applicable (NA)	NA	NA	NA
JC Boyle	Salmonids, lamprey	2 yrs (Bypass Barrier/Impediment Modification)	NA	NA	NA	NA
Eastside	Salmonids, lamprey, suckers	BOR current facility	3 yrs[1]	3 yrs[2] (to sucker criteria)	NA	Seasonal downstream trapping and hauling for Chinook
Westside	Salmonids, lamprey, suckers	BOR current facility	3 yrs[1]	3 yrs[2] (to sucker criteria)	NA	Seasonal downstream trapping and hauling for Chinook
Fall Creek	Resident trout	3 yrs (0.5 ft/drop and ≤ 10%)	5 yrs[3]	3 yrs	NA	NA
Spring Creek	Resident trout	3 yrs (0.5 ft/drop and ≤ 10%)	NA	3 yrs	NA	NA
Keno	Salmonids, lamprey,	3 yrs (0.5 ft/drop and ≤ 10%)	NA	NA	3 yrs	Seasonal upstream trapping and hauling for Chinook
Iron Gate	Salmonids, lamprey	5 yrs (0.5 ft/drop and ≤ 10%)	NA	5 yrs	5 yrs	Modify existing trapping facility
Copco 2	Salmonids, lamprey	6 yrs (0.5 ft/drop and ≤ 10%)	8 yrs[3]	6 yrs	6 yrs	NA
Copco 1	Salmonids, lamprey	6 yrs (0.5 ft/drop and ≤ 10%)	8 yrs[3] (if adults in C2 pool)	6 yrs (bypass below C2)	6 yrs	NA

[1]Study of impacts to and the potential design and construction of tailrace barrier is given priority due to the presence of federally listed suckers
[2] Screen and bypass system given priority due to the presence of federally listed suckers
[3] Tailrace Barrier design and construction deferred for study to determine optimal design

1. <u>Iron Gate Dam</u>

Upstream Prescription Rationale: Historically coho salmon, Pacific lamprey, steelhead, and spring-run and fall-run Chinook salmon (Hamilton et al. 2005) and resident trout migrated above the site of Iron Gate Dam to reach holding, spawning, incubation, and rearing habitat. Iron Gate Dam is a barrier to this passage and thus to critical holding, spawning, incubation, and rearing habitat in tributaries (Slide, Scotch, Camp, Jenny, Salt, and Fall creeks) and the Copco 2 bypass reach. The goal of the Services and the Klamath River Basin Fisheries Task Force is to successfully restore anadromous salmonids to their historical range and habitat. A goal of the Service is to successfully restore resident fish to their historical range and habitat as well. The means of reaching these goals is restoration of safe, timely, and effective fish movement. Volitional fish passage at Iron Gate Dam would be consistent with the goals and objectives of the Services and the Klamath River Basin Fisheries Task Force for resource management. The Licensee shall provide effective facilities to meet these goals and mitigate for the impacts of the dam. A holding, sorting, and counting facility is necessary to segregate and mark fish for management purposes, including returning fish resulting from upstream restoration for transport efforts. The 5 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Benefits: Specific benefits of fishways at Iron Gate Dam include:

<u>Resident Trout:</u> For the resident redband trout currently present both above and below Iron Gate Dam, fishways would restore historical seasonal movement for immature fish, restore population connectivity and genetic diversity, and allow greater utilization of existing habitat and refugial areas. Fish passage at Iron Gate Dam alone would restore the connectivity of resident redband populations in the mainstem Klamath River with those in the Copco 2 bypassed channel and Slide, Scotch, Camp, Jenny, Salt, and Fall creeks. These tributaries also provide important habitat elements, such as spawning and temperature related refugial areas. In particular, Fall Creek provides a steady volume of high quality water and historically provided good habitat for resident fish, including rainbow/redband trout, Klamath small-scaled suckers (*Catastomus rimiculus*), and Klamath sculpin (*Cottus klamathensis*) (Coots 1957). With fish passage, seasonal migration of trout and access to refugial areas would be restored.

- <u>Coho:</u> Coho salmon are present in the Klamath River below the dam and were present historically above the dam. Iron Gate Dam blocks these fish species from reaching elements of their historical habitat. Between Iron Gate Dam and the next barrier upstream (Copco 2 Dam), coho salmon would regain access to 11.1 miles of habitat, including tributaries and the Copco 2 bypass reach (Table 3). National Research Council (2003) considered the amount of this tributary habitat between Iron Gate Dam and the next barrier upstream to be substantial. Coho are known to have spawned in Fall Creek (California Department of Water Resources 1964; Coots 1954; Coots 1957; Coots 1962). In both 1951 and 1952, at least 10 adult coho spawned in Fall Creek and greater than 29,600 young of the year and juvenile coho salmon outmigrated in 1954 (Coots 1954). No information is available for Scotch, Slide, Camp, and Jenny creeks, but the lower reaches of these streams are relatively low gradient and appear to be suitable coho habitat. With fish passage, coho will have access to this habitat and access to refugial areas would be restored.

- Fall-run Chinook: With fish passage at Iron Gate Dam, fall-run Chinook salmon access would be restored to 11.1 miles of habitat, including Scotch, Camp, Jenny, and Fall Creeks (Table 3) between Iron Gate Dam and the next barrier upstream (Copco 2 Dam). Prior to the construction of Iron Gate Dam, escapement of Chinook salmon to Jenny and Fall Creeks averaged 215 and 1,384 adults respectively from 1950 to 1960 (Coots 1957; Coots 1962; Coots and Wales 1952; Wales and Coots 1954). With fish passage, fall-run Chinook will have access to this habitat again. Seasonal migration of fall-run Chinook and access to refugial areas would be restored.
- Spring-run Chinook: With fish passage at Iron Gate Dam, spring-run Chinook salmon would regain access to cool water refugial areas necessary for this run of fish (McCullough 1999) such as Fall Creek. Spring-run Chinook would also regain access to upstream migration corridors necessary to reach historical spawning areas in the Upper Klamath Basin (California Department of Fish and Game 1990).
- Pacific Lamprey With fish passage at Iron Gate Dam, Pacific lamprey would regain access to 13.7 miles of habitat, including tributaries and the Copco 2 bypass reach (Table 3) between Iron Gate Dam and the next barrier upstream (Copco 2 Dam). Pacific lamprey are known to have been present and spawning in Fall Creek (Coots 1954, 1957). With fish passage, lamprey will have access to this habitat again.
- Steelhead With fish passage at Iron Gate Dam, steelhead would regain access to 13.7 miles of habitat, including tributaries and the Copco 2 bypass reach (Table 3), between Iron Gate Dam and the next barrier upstream (Copco 2 Dam). Adult steelhead have been documented in Fall Creek (Coots 1957, 1962). During 1951-1952, 471 steelhead spawners were counted in Fall Creek and between January and April 1954, more than 6,500 fry and 1,200 yearling steelhead emigrated from Fall Creek (Coots 1954). Steelhead are generally tributary spawners and able to access reaches of tributaries upstream from areas where salmon spawn (Platts and Partridge 1978). Therefore, with fish passage, steelhead would have access to habitat in its entirety in tributaries above Iron Gate Dam. Steelhead would have access to 13.7 miles of habitat in Slide, Scotch, Camp, Jenny, and Fall creeks. Seasonal migration of steelhead and access to refugial areas would be restored.

Downstream Prescription Rationale: Downstream fishways and fishway modifications are prescribed for Iron Gate Dam. Redband/rainbow trout and other resident fish (including federally listed suckers) are currently present in Iron Gate Reservoir. The Services conclude that trout (in particular fry and juveniles) move downstream (Hemmingsen 1997), a significant portion move through the powerhouse, and turbine entrainment at Iron Gate Dam causes significant mortality to downstream migrating redband trout (see discussion of turbine-caused mortality later in this paragraph). In addition, with the construction of a functional adult fish ladder at Iron Gate Dam, Pacific lamprey, salmon, and steelhead would return to hold, spawn, and rear in habitat where they were present historically (Hamilton et al. 2005). However, the progeny of these fish must negotiate not only the reservoir but the dam, powerhouse, and spillway during their outmigration. To ensure that the fish can outmigrate, downstream passage through the dam, powerhouse and spillway is necessary. Unless protected by fish screening and bypass systems, fish migrating downstream can suffer injury or death by passing through turbines at hydroelectric plants (Electric Power Research Institute 1987). Turbine caused mortality can have serious consequences for fish populations, especially among anadromous species (Cada 2001). Survival of juvenile salmonids passing dams during their seaward migration is highest through spillways and lowest through turbines (Muir et al. 2001), turbine mortality being caused by pressure changes, cavitation, shear stress, turbulence, strike, and grinding (Cada 2001). The Electric Power Research Institute (Electric Power Research Institute 1987) reported that Francis turbines, which are used at Iron Gate Dam, had average mortality to downstream moving fish of about 24 percent (see section IV.A.2 of this document for additional discussion of turbine entrainment). In light of the foregoing evidence, the Services conclude that turbine entrainment at Iron Gate Dam presently causes a degree of mortality to downstream migrating resident fish comparable to that cited in the studies above and would cause comparable losses of reintroduced anadromous fish populations in the future, absent effective fish screening systems. The Applicant has acknowledged, based on their initial review of other studies, that tens of thousands of resident fish are likely entrained annually at each of the unscreened mainstem Klamath River developments and estimated that between 7 to 21 percent of those fish are killed passing through the Iron Gate Powerhouse (PacifiCorp 2004a, Exhibit E 4-113). The Applicant has estimated that approximately 85,848 fish are entrained annually at each mainstem development and that many of these fish are nongame or warmwater fish species. Volitional fish passage would be consistent with fish movement through Klamath River system for purposes such as spawning, rearing, feeding, and seasonal use of habitat, as well as ensuring that the goals and objectives of the Klamath River Basin Fishery Task Force and the Services for resource management are met. The Licensee must provide effective facilities to meet these goals and objectives and mitigate for impacts of the dam. The 5 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Spillway Prescription Rationale: Spill survival estimates for juvenile salmonids are numerous and range from 70 percent to 100 percent, depending on species, life stage, amount or proportion of water spilled, spillway configuration, tailwater hydraulics, the methodology of estimating survival, and predator conditions (Bell and DeLacy 1981 in National Marine Fisheries 2000). Fish passing down a spillway may experience physical, chemical, and biological effects. Turbulent mixing of spilled water with receiving waters may result in gas supersaturation and resultant gas bubble disease in fish. Dissolved nitrogen concentrations of more than 130 percent of normal equilibrium levels have been measured in tailwaters (Ebel and Raymond 1976). The threshold value for significant mortality among juvenile Chinook salmon and steelhead trout occurs when nitrogen gas levels are about 115 percent of normal. Along the Columbia River, where many spillways discharge from a given dam and there are many consecutive dams along the stream course, supersaturation increases cumulatively from one dam to the next. Losses of salmon and steelhead trout in this river due to supersaturation have been severe in years of high spillage (Ebel and Raymond 1976). Fish passing over spillways can be injured by strikes or impacts with solid objects (e.g. baffles, rocks, or walls in the plunge zone), rapid pressure changes, abrasion with the rough side of the spillway, and the shearing effects of turbulent water. Given the steepness and configuration of the Iron Gate Dam spillway, the Services conclude that spillway mortality will likely occur at levels near the high end of the range found in the studies above. Therefore, the following spillway modifications and 5 year timeline are necessary to meet resource goals and objectives as quickly as possible.

1.1 Iron Gate Dam Upstream Fishway

1.1.1 Fishway Design Features and Performance Standards: The Licensee shall construct, operate, maintain, and evaluate a volitional fishway at Iron Gate Dam to provide for the safe, timely, and effective upstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout. The fishway shall be operated year-round and shall consist of a fish ladder designed in accordance with NMFS criteria for anadromous fish (National Marine Fisheries Service 2003) or alternative acceptable criteria for other species as determined by the Services. The ladder shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The ladder shall have a minimum of two entrances and associated entrance pools. An auxiliary water system (AWS) shall be designed to augment ladder flow from the forebay. The AWS shall be screened and bypassed in accordance with NMFS juvenile fish screen and bypass criteria (National Marine Fisheries Service 1997) or such alternative criteria as may be determined acceptable to the Services. The AWS shall be designed to provide the correct water quality and quantity to effectively attract fish. The fish ladder and AWS together must supply at least 5-10 percent of high fish passage design flow (National Marine Fisheries Service 2003) for adequate attraction to the ladder. The ladder shall have a maximum drop between pools of 0.5 ft and the maximum slope of the fish ladder shall not exceed 10 percent (Table 1). The ladder shall include features to detect and record data for PIT-tagged (or fish identified using similar technology) upstream migrating fish. The construction shall include features to modify the existing development to hold, count, and mark fish and to sort fish by age, species, and origin for the purposes of fish population restoration and management. The upstream fishway must be constructed to current criteria for passage of Pacific lamprey. The Licensee shall complete construction and begin operation of the fishway within 5 years of the issuance of the new license.

1.1.2 Design Consultation: The ladder design shall include features to detect and record data for PIT-tagged (or fish identified using similar technology) upstream migrating anadromous fish. The Licensee shall develop design and construction plans according to the terms of 1.1.1 above within 2 years of the issuance of a new license for review and approval by the Services prior to construction. The design shall include features to modify the existing development to hold, count, and mark fish; and to sort fish by age, species, and origin for the purposes of fish population restoration and management.

1.1.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

1.2 Iron Gate Dam Downstream Fishway

1.2.1 Intake Fish Screens and Bypass Facilities: The Licensee shall, to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout, construct, operate, maintain, and evaluate a fish screen and bypass facility for volitional fish passage at Iron Gate Dam. The screens and bypass shall be operated year-round and shall be designed in accordance with NMFS juvenile fish screen criteria (National Marine Fisheries Service 1997) or alternative criteria as determined by the Service and NMFS Engineering. The screens and bypass shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The bypass facility shall include features to detect and record data for PIT-tagged downstream migrating fish (or fish identified using similar technology). The Licensee shall complete construction and begin operation of the fishway within 5 years of the issuance of the new license.

1.2.2 Design Consultation: The bypass facility design shall include features to detect and record data for PIT-tagged downstream migrating fish (or fish identified using similar technology). The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 2 years of the issuance of the new license for review and approval by the Service and NMFS prior to construction.

1.2.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

1.3 Iron Gate Spillway

1.3.1 Spillway Modification: The Licensee shall modify, maintain, and evaluate hydraulically-engineered spillway modifications to improve volitional downstream fish passage at Iron Gate Dam for Chinook and coho salmon, steelhead trout, and redband trout. The purpose of all spillway modifications is to improve hydraulic conditions and overall fish passage conditions on the downstream side of the dam, to prevent false attraction to non-passable areas, and to make the entrance of the fishway more accessible. The spillway modifications shall be constructed and operational within 5 years of the issuance of the new license.

1.3.2 Spillway Design Consultation: Within 2 years of the issuance of the new license, the Licensee shall develop design and construction plans according to the terms of 1.1.1 above for review and approval by the Service and NMFS Engineering.

1.3.3 Spillway Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

2. Fall Creek Diversion Dam

The prescriptions for fishways at the Fall Creek Diversion Dam are made solely by the Service. The prescription for the Fall Creek Powerhouse Tailrace Barrier is made jointly by NMFS and the Service.

Upstream Prescription Rationale: There are currently no upstream fish passage facilities at the Fall Creek Diversion Dam for any species (PacifiCorp 2004b Fish Resources FTR). This dam is a seasonal or low flow barrier to the upstream movement of fish (Scott Snedaker, BLM pers. comm.). The Applicant has proposed an upstream fishway at this development. The Service's prescription is consistent with this proposal. Redband/rainbow trout are present in Fall Creek below the dam and above the dam. The fish need to be able to move between the two areas to make seasonal use of habitat. Volitional upstream passage would be consistent with the Service goal to successfully restore resident fish to their historical range. One objective of reaching this goal is the restoration of safe, timely, and effective fish movement, and to ensure the Project does not impair future restoration of fish populations in the upper Fall Creek and Klamath River systems. The Licensee must provide effective facilities to meet the volitional passage goal and mitigate for impacts of the diversion dam. The 3 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Downstream Prescription Rationale: There are currently no downstream fish passage facilities at the Fall Creek Diversion Dam for any species (PacifiCorp 2004b Fish Resources FTR, Exhibit E). The Applicant has proposed a downstream fish screen at this development. We agree with the Applicant's proposal to screen downstream migrating fish. In addition, a bypass system is needed to guide the movement of redband/rainbow trout and restore historical fish populations in Fall Creek. Redband trout are present above the diversion. The Service concludes that trout (in particular fry and juveniles) move downstream here as they do in the Klamath River system elsewhere (Hemmingsen 1997), a significant portion move through the diversion canal, and that turbine entrainment at the Fall Creek Powerhouse causes significant mortality to downstream migrating redband trout (see the discussion for the Downstream Prescription Rationale for the Iron Gate Dam development). The Licensee must provide effective facilities to protect rainbow/redband trout and mitigate for impacts of the dam. With the 5 cfs proposed for instream flows by the Licensee and the construction of a functional fish ladder at the Fall Creek Diversion Dam, biological connectivity for rainbow trout would be restored to some degree in upper Fall Creek. However, the progeny of these fish must be excluded from the power canal and turbines. Adequate passage conditions would be consistent with the Service's goal of restored fish populations in the Fall Creek system. The 3 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Fall Creek Powerhouse Tailrace Prescription Rationale: With an upstream fishway at Iron Gate Dam, anadromous fish would migrate to Fall Creek. Water discharging from the Fall Creek Powerhouse can represent a significant portion of the total flow of Fall Creek in the vicinity of the powerhouse. Coots (1954; 1957; 1962) reported steelhead, Pacific lamprey, and both coho and Chinook salmon in Fall Creek downstream from the powerhouse. The natural tendency for fish attracted to such an area is to hold and wait for upstream passage opportunities or to attempt to move past the obstacle either by swimming or leaping. Depending on powerhouse operations, water velocities in hydropower facilities range from roughly 5 to 10 fps; these velocities easily fall within the swimming abilities of salmonids (Weaver 1963). The types of injury sustained by some fish entering draft tubes or contacting turbines vary from site to site, as do immediate and delayed mortality rates. Several studies, however, attribute injuries in migrating salmonids to powerhouse structures associated with tailrace structures (Department of Fisheries Canada 1958; International Pacific Salmon Fisheries Commission 1976; Schadt et al. 1985; Williams 1985). To prevent injury or mortality to salmonids caused by attempts to swim upstream into the tailrace, a barrier is required to prevent fish from entering this area (National Marine Fisheries Service 2003). The 5 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

<u>2.1 Fall Creek Diversion Dam Upstream Fishway</u>

<u>2.1.1</u> <u>Fall Creek Upstream Fishway:</u> The Licensee shall construct, operate, maintain, and evaluate a volitional upstream fishway at the Fall Creek Diversion Dam to provide for the safe, timely, and effective upstream passage of rainbow/redband trout. The fishway shall be operated year-round and shall consist of a fish ladder designed in accordance with NOAA's National Marine Fisheries Service (NMFS) criteria (National Marine Fisheries Service 2003) or alternative criteria as determined by the Service. The ladder shall provide for the uninterrupted passage of fish over the full range of Fall Creek flows for which the Project maintains operational control. The ladder shall have a maximum drop between pools of 0.5 ft and the maximum slope of the fish ladder shall not exceed 10 percent (Table 1). The fishway shall be constructed and operational within 3 years of the issuance of the new license.

<u>2.1.2</u> <u>Design Consultation:</u> The Licensee shall develop design and construction plans according to the terms of 1.1.1 above within 1 year of license issuance for review and approval by the Service prior to construction.

<u>2.1.3</u> <u>Monitoring, Reporting, and Evaluation:</u> The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

2.2 Fall Creek Diversion Dam Downstream Fishway

2.2.1 Intake Fish Screens and Bypass Facility: The Licensee shall construct, operate, maintain, and evaluate a fish screen and bypass facility at the Fall Creek Diversion Dam to provide for the safe, timely, and effective downstream passage of rainbow/redband trout. The screens and bypass facility shall be operated year-round and shall be designed in accordance with NMFS juvenile fish screen and bypass facility criteria (National Marine Fisheries Service 1997) or alternative criteria as determined by the Service. The screens and bypass facility shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The downstream fishway shall be constructed and operational within 3 years of the issuance of the new license.

2.2.2 Design Consultation: The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above, within 1 year of the issuance of the new license, for review and approval by the Service prior to construction.

2.2.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

2.3 Fall Creek Powerhouse Tailrace Barrier

2.3.1 Tailrace Barrier Construction: The Licensee shall construct a tailrace barrier and guidance system at Fall Creek Powerhouse. The tailrace barrier and guidance system shall be constructed according to approved design plans and within 5 years of the issuance of the new license.

2.3.2 Tailrace Barrier Design: The Licensee shall, within three years of the issuance of the new license develop detailed design and construction plans for Service and NMFS Engineering approval for a tailrace barrier and guidance system to protect adult fish according to the terms of 1.1.1 above.

2.3.3 Tailrace Barrier Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

3. Spring Creek Diversion Dam

The prescriptions for fishways at the Spring Creek Diversion Dam are made solely by the Service.

Upstream Prescription Rationale: There are currently no upstream fish passage facilities at the Spring Creek Diversion Dam for any species (PacifiCorp 2004b Fish Resources FTR). The Applicant has proposed an upstream fishway at this development. We agree with this action and our prescription is consistent with the Applicant's proposal. Redband/rainbow trout are present in Spring Creek below the dam and above the dam. The fish need to be able to move between the two areas to make seasonal use of habitat. Volitional upstream passage would be consistent with the Service goal to successfully restore resident fish to their historical range. The objective in reaching these goals is the restoration of safe, timely, and effective fish movement, and to ensure the Project does not impair future restoration of fish populations in the upper Spring Creek, Jenny Creek, and Klamath River systems. The Licensee must provide effective facilities to meet the volitional passage goal and mitigate for impacts of the diversion dam. The 3 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Downstream Prescription Rationale: There are currently no downstream fish passage facilities at the Spring Creek Diversion Dam for any species (PacifiCorp 2004b Fish Resources FTR). The Applicant has proposed a downstream fish screen at this development. We agree with the Applicant's proposal to screen downstream migrating fish. In addition, a bypass system is needed to guide the movement of redband/rainbow trout and restore historical fish populations in Spring Creek. The Service concludes that trout (in particular fry and juveniles) move downstream here as they do in the Klamath River elsewhere (Hemmingsen 1997), a significant portion move through the Spring Creek diversion canal to Fall Creek, and turbine entrainment at the Fall Creek Powerhouse causes significant mortality to redband/rainbow trout that have originated in Spring Creek (see the discussion for the Downstream Prescription Rationale for the Iron Gate Dam development). Volitional fish passage to a bypass around the Spring Creek Diversion Dam is consistent with the Service goals and objectives for resource management. The Licensee must provide effective facilities to meet these goals and mitigate for impacts of the dam. With minimum flows and the construction of a functional fish ladder at the Spring Creek Diversion Dam, biological connectivity for rainbow trout would be restored to some degree in Spring Creek. However, these fish must be excluded from the power canal and turbines. Adequate passage conditions would be consistent with the Service's goal of restored fish populations in the Spring Creek system. The 3 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

3.1 Spring Creek Diversion Dam Upstream Fishway

3.1.1 Spring Creek Upstream Fishway: The Licensee shall construct, operate, maintain, and evaluate a volitional fishway at Spring Creek Diversion Dam to provide for the safe, timely, and effective upstream passage of rainbow/redband trout. The fishway shall be operated year-round and shall consist of a fish ladder designed in accordance with NMFS criteria (National Marine Fisheries Service 2003) or alternative criteria as determined by the Service. The ladder shall provide for the uninterrupted passage of fish over the full range of Spring Creek flows for which the Project maintains operational control. The ladder shall have a maximum drop between pools of 0.5 ft (Table 1) and the maximum slope of the fish ladder shall not exceed 10 percent (Table 1). The fishway shall be constructed and operational within 3 years of the issuance of the new license.

3.1.2 Design Consultation: The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 1 year of the issuance of the new license for review and approval by the Service prior to construction.

3.1.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

3.2 Spring Creek Diversion Dam Downstream Fishway

3.2.1 Intake Fish Screens and Bypass Facility: The Licensee shall construct, operate, maintain, and evaluate a fish screen and bypass facility at the Spring Creek Diversion Dam to provide for the safe, timely, and effective downstream passage of rainbow/redband trout. The screen and bypass facility shall be operated year-round and shall be designed in accordance with NMFS juvenile fish screen and bypass facility criteria (National Marine Fisheries Service 1997) or alternative criteria as determined by the Service. The screens and bypass facility shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The downstream fishway shall be constructed and operational within 3 years of the issuance of the new license.

3.2.2 Design Consultation: The Licensee shall develop design and construction plans according to the terms of 1.1.1 above within 1 year of the issuance of the new license for review and approval by the Service prior to construction.

3.2.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

4. Copco 2 and Copco 1 Dams

Copco 2 and Copco 1 Upstream Prescription Rationale: Historically coho salmon, Pacific lamprey, steelhead, and spring-run and fall-run Chinook salmon (Hamilton et al. 2005) and resident trout migrated above the site of Copco 2 and Copco 1 dams to reach holding, spawning, incubation, and rearing habitat. Copco 2 and Copco 1 dams are a barrier to this passage and thus to holding, spawning, incubation, and rearing habitat in tributaries (Shovel, Long Prairie, Deer, Edge, Frain, Negro, Tom Hayden, Topsy, and Beaver creeks) and the Boyle peaking and bypass reaches (Table 3). The goal of the Services and the Klamath River Basin Fisheries Task Force is to successfully restore corresponding life history phases of anadromous salmonids to their historical range and to this habitat. The Service goal is to successfully restore resident fish to their historical range and habitat as well. The objective in reaching these goals is restoration of safe, timely, and effective fish movement through volitional fish passage. Providing volitional fish passage at Copco 2 and Copco 1 dams is consistent with goals and objectives for resource management of the Services and the Klamath River Basin Fisheries Task Force. The Licensee shall provide effective facilities to meet these goals and mitigate for the impacts of the dam. The 6-8 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Benefits – The Copco Dams are less than one half mile apart. Specific benefits of fishways at Copco 2 and Copco 1 dams include:

- Resident Trout: For the resident redband/rainbow trout currently present both above and below Copco 2 and 1 dams, fishways would restore historical seasonal migration patterns for immature fish, restore population connectivity and genetic diversity, and allow greater utilization of existing habitat and refugial areas. For resident rainbow/redband populations, fish passage at the Copco dams alone would result in restoring the connectivity of fish populations in the mainstem Klamath River below the Copco dams with those in tributaries above the dams and the Klamath River reach designated as Wild Trout water by the CDFG (California Department of Fish and Game 2005). The lower 2.7 miles of Shovel Creek are accessible and provide important habitat elements for rainbow/redband trout, including spawning and temperature related refugial areas. With fish passage, Shovel Creek would again become accessible to resident trout from below the Copco dams and seasonal migration and habitat use would be restored.
- Coho: Coho salmon are present in the Klamath River below Iron Gate Dam and were present historically below and above Copco 2 and Copco 1 dams. Copco 2 and Copco 1 dams block these fish from reaching elements of their historical habitat. Between Copco 1 and Copco 2 dams and the next barrier upstream (J.C. Boyle Dam), coho salmon would have access to 25.8 miles of habitat, including the J.C Boyle peaking and bypass reaches of the Klamath River mainstem (Table 3). With fish passage, coho would have access to this habitat again and connectivity to refugial areas would be restored.
- Spring-run Chinook: With passage, spring-run Chinook salmon access to cool water refugial areas such as the 220 cfs of spring water in the J.C. Boyle bypassed reach would be restored. During summer months, this would provide key holding, coolwater refugial habitat necessary for this run of fish (McCullough 1999). Juvenile spring-run Chinook would be able to rear in the cool water habitat adjacent to the springs in the J.C. Boyle bypass reach. These springs also provide warmer, ice-free habitat during winter months (Hanel and Gerlach 1964). The temperature of incoming spring water does not vary substantially from 50 to 55^{o}F throughout the year (USDI Bureau Land Management 2003) and would be optimal for juvenile Chinook growth (McCullough 1999). Spring-run Chinook adults would also have access to the main channel as an upstream migration corridor necessary to reach historical spawning areas in the Upper Klamath Basin (California Department of Fish and Game 1990).
- Fall-run Chinook: Between Copco 2 and Copco 1 dams and the next barrier upstream (J.C. Boyle Dam), passage for fall-run Chinook salmon would restore access to 25.8 miles of habitat, including the J.C Boyle peaking and bypass reaches of the Klamath River mainstem (Table 3). Snyder (1931) reported large numbers of salmon annually passed the point where the Copco dams are now located. The lower 2.7 miles of Shovel Creek continue to provide good salmonid habitat. The reach of the Klamath River between Copco 1 Reservoir and the Oregon/California State line is designated Wild Trout

water and is currently managed under the Wild Trout Program by the CDFG (California Department of Fish and Game 2005). With fish passage, this area would again become accessible to fall-run Chinook salmon.

- Pacific Lamprey Between Copco 2 and Copco 1 dams and the next barrier upstream (J.C. Boyle Dam), passage for Pacific lamprey would restore access to 27.1 miles of habitat, including the J.C Boyle peaking and bypass reaches of the Klamath River mainstem (Table 3). Pacific Lamprey were present historically above Copco 2 and Copco 1 dams (Hamilton et al. 2005). Pacific Lamprey are able to access higher gradient stream reaches and would fully use the 27.1 miles of habitat in Shovel, Long Prairie, Deer, Edge, Frain, Negro, Tom Hayden, Topsy, and Beaver creeks (Table 3). With fish passage, this habitat would again be utilized by Pacific lamprey.
- Steelhead Between Copco 2 and Copco 1 dams and the next barrier upstream (J.C. Boyle Dam), passage would allow steelhead to regain access to 27.1 miles of habitat, including the J.C Boyle peaking and bypass reaches of the Klamath River mainstem (Table 3). Steelhead occurred historically above the Copco 2 and Copco 1 dams (Hamilton et al. 2005). Steelhead are generally tributary spawners and able to access reaches of tributaries upstream from areas where salmon spawn (Platts and Partridge 1978). Therefore, with fish passage, steelhead would utilize habitat in its entirety in tributaries above the Copco dams. This means that steelhead would fully have access to the 27.1 miles of habitat in Shovel, Long Prairie, Deer, Edge, Frain, Negro, Tom Hayden, Topsy, and Beaver creeks (Table 3). Seasonal migration of steelhead and access to refugial areas would be restored.

Copco 2 and Copco 1 Downstream Prescription Rationale: Downstream fishways and fishway modifications are prescribed for Copco 2 and Copco 1 dams. Redband/rainbow trout and other resident fish are currently present in Copco reservoirs. The Services conclude that trout (in particular fry and juveniles) move downstream here as they do in the Klamath River elsewhere (Hemmingsen 1997), a significant portion move through the powerhouses, and turbine entrainment at Copco 2 and Copco 1 dams causes significant mortality to downstream migrating redband trout (see discussion of turbine-caused mortality later in this paragraph). In addition, with the construction of a functional adult fish ladder at Iron Gate Dam and the Copco dams, Pacific lamprey, salmon, and steelhead would return to hold, spawn, and rear in habitat where they were present historically (Hamilton et al. 2005). The progeny of these fish must negotiate not only the reservoirs but the dams, powerhouses, and spillways during their outmigration. To ensure these fish can safely outmigrate, downstream passage around the dams, powerhouses, and spillways is necessary. Fish migrating downstream can suffer injury or death by passing through turbines at hydroelectric plants (Electric Power Research Institute 1987). Turbine caused mortality can have serious consequences for fish populations, especially among anadromous species (Cada 2001). Survival of juvenile salmonids passing dams during their seaward migration is highest through spillways and lowest through turbines (Muir et al. 2001), turbine mortality being caused by pressure changes, cavitation, shear stress, turbulence, strike, and grinding (Cada 2001). The Electric Power Research Institute (Electric Power Research Institute 1987) reported that Francis turbines, which are used at both Copco dams, had average mortality to downstream moving fish of about 24 percent. In light of the foregoing evidence, the Services conclude that turbine entrainment at each Copco dam presently causes levels of mortality to downstream migrating resident fish comparable to those cited in the studies above and would cause comparable losses of reintroduced anadromous fish populations in the future, absent effective fish screening systems. The Applicant has estimated that approximately 85,848 fish are entrained annually at each mainstem development and has estimated that between 7 to 20 percent of fish passing through the Copco 2 Powerhouse are killed and that between 6 to 18 percent of the fish passing through the Copco 1 Powerhouse are killed (PacifiCorp 2004a, Exhibit E 4-113). Volitional fish passage would be consistent with fish movement through the Klamath River system for purposes such as spawning, rearing, feeding, and seasonal use of habitat. Volitional fish passage is consistent with the goals and objectives for resource management of the Klamath River Basin Fishery Task Force and the Services. The Licensee must provide effective facilities to meet this goal and mitigate for impacts of the dam. The 6 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Tailrace Prescription Rationale: Water discharging from the Copco 2 and Copco 1 powerhouses can represent the major portion of the total river flow of the Klamath. Under the current license, the powerhouses each can discharge up to ~3000 cubic feet per second (cfs) and the Copco 2 bypass reach contains as little as 5-10 cfs. Even with the Applicant's proposed minimum instream flow, the disparity in flow levels can contribute to false attraction of upstream migrating fish to an area which provides no upstream passage, and delay these fish in their migration. The natural tendency for fish attracted to such an area is to hold and wait for passage conditions to improve, or to attempt to move past the obstacle either by swimming or leaping. Depending on powerhouse operations, water velocities in hydropower facilities range from roughly 5 to 10 feet per second (fps); these velocities easily fall within the swimming abilities of salmonids (Weaver 1963). The types of injury sustained by some fish entering draft tubes or contacting turbines vary from site to site, as do immediate and delayed mortality rates. Several studies, however, attribute injuries in migrating salmonids to powerhouse structures associated with tailrace structures (Department of Fisheries Canada 1958; International Pacific Salmon Fisheries Commission 1976; Schadt et al. 1985; Williams 1985).

Adult anadromous fish are attracted into oncoming flows (National Marine Fisheries Service 2003). Migration upstream may be delayed when tailrace flows from the powerhouse exceed river bypass reach flows. A migration delay, or combined delays at several facilities, may prevent fish from reaching suitable spawning habitat when they are ready to spawn or conditions are optimal for survival. Migration delays caused by tailrace effects may have a greater impact on fish populations than injury and mortality from turbine impacts (Federal Energy Regulatory Commission 1994). Migration delays may occur to a greater percentage of migrating adults than the percentage of adults impacted by turbine mortality. Migration delays are well documented for anadromous salmonids in the Pacific Northwest (Haynes and Gray 1980; Rondorf et al. 1983; Schadt et al. 1985; Vogel et al. 1990). For migratory adults, false attraction occurs when upstream migrants are attracted to turbine discharge or spillway flows rather than to fishway flows. False attraction also occurs when upstream migrants detect the scent of their natal stream downstream of its natural outlet (Fretwell 1989). This happens when water from a natal stream is diverted through a canal or pipe to a hydroelectric project. In either instance, without proper project design or operation modifications, there may be migratory delays.

To prevent injury, delay, or mortality to salmonids, caused by attempts to swim upstream into the tailrace, a barrier is required to guide migrating fish away from this area and encourage them to continue their upstream migration (National Marine Fisheries 2003). The 8 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Spillway Prescription Rationale: Spill survival estimates for juvenile salmonids are numerous and range from 70 percent to 100 percent, depending on species, life stage, amount or proportion of water spilled, spillway configuration, tailwater hydraulics, the methodology of estimating survival, and predator conditions (Bell and DeLacy 1981 in National Marine Fisheries Service 2000). Fish passing down a spillway may experience physical, chemical, and biological effects. Turbulent mixing of spilled water with receiving waters may result in gas supersaturation and resultant gas bubble disease in fish. Dissolved nitrogen concentrations of more than 130 percent of normal equilibrium levels have been measured in tailwaters (Ebel and Raymond 1976). The threshold value for significant mortality among juvenile Chinook salmon and steelhead trout occurs when nitrogen gas levels are about 115 percent of normal. Along the Columbia River, where many spillways discharge from a given dam and there are many consecutive dams along the stream course, supersaturation increases cumulatively from one dam to the next. Losses of salmon and steelhead trout in the Columbia River due to supersaturation have been severe in years of high spillage (Ebel and Raymond 1976). Fish passing over spillways can be injured by strikes or impacts with solid objects (e.g. baffles, rocks, or walls in the plunge zone), rapid pressure changes, abrasion with the rough side of the spillway, and the shearing effects of turbulent water. After examining the height of Copco 1 Dam, the angle of the spillway, and the stair-stepped design of this spillway, the Services conclude that spill entrainment mortality at the Copco 1 development will likely occur at levels near the high end of the range found in the studies above. While Copco 2 Dam is not as high, mortality may occur here as well (National Marine Fisheries Service 2000). Therefore, spillway modifications and a 6 year timeline are necessary to meet resource goals and objectives as quickly as possible.

Transverse Bedrock Sill Fish Barrier Evaluation/Modification Rationale: A transverse bedrock sill is located about RM 197.3 or 0.5 miles above the Copco 2 Powerhouse (1 mile below Copco 2 Dam). Historical fish distribution upstream from this point (Hamilton et al. 2005) indicates this sill was not a fish barrier prior to the Project, but the sill is a depth barrier to salmonids under the current 5-10 cfs release during normal operation, except during periods of spill, and may continue to be a depth barrier under the flows specified in the new license. This impediment to fish was observed during the summer of 2005 (David K. White, NMFS, pers. comm.). The 2 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

4.1 Copco 2 Upstream Fishway

4.1.1 Copco 2 Upstream Fishway: The Licensee shall construct, operate, maintain, and evaluate a volitional fishway at Copco 2 Dam to provide for the safe, timely, and effective upstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout. The fishway shall be operated year-round and shall consist of a fish ladder designed in accordance with NMFS criteria (National Marine Fisheries Service 2003) or alternative criteria as determined by the Service and NMFS Engineering. The ladder shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The ladder shall have a minimum of two entrances and associated entrance pools and the auxiliary water system (AWS) shall be designed to augment ladder flow from the forebay. The AWS shall be screened in accordance with NMFS juvenile fish screen criteria (National Marine Fisheries Service 1997) or such alternative criteria as may be determined acceptable NMFS Engineering and the Service. The AWS shall be designed to provide the correct water temperature and water quality to attract fish. The fish ladder and AWS together must supply at least 5-10 percent of fish passage design high flow for adequate attraction to the ladder. The ladder shall have a maximum drop between pools of 0.5 ft and the maximum slope of the fish ladder shall not exceed 10 percent (Table 1). The ladder shall include features to detect and record data for PIT-tagged upstream migrating anadromous fish (or fish identified using similar technology). The upstream fishway must be constructed to current criteria for passage of Pacific lamprey (Table 1). The fishway shall be constructed and operational within 6 years of the issuance of the new license.

4.1.2 Design Consultation: The ladder design shall include features to detect and record data for PIT-tagged upstream migrating anadromous fish (or fish identified using similar technology). The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 3 years of the issuance of the new license for review and approval by the Service and NMFS prior to construction.

4.1.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

4.2 Copco 2 Downstream Fishway

4.2.1 Intake Fish Screens and Bypass Facility: The Licensee shall construct, operate, maintain, and evaluate a fish screen and bypass facility for volitional fishway at Copco 2 Dam to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout. The screens and bypass facility shall be operated year-round and shall be designed in accordance with NMFS juvenile fish screen and bypass facility criteria (National Marine Fisheries Service 1997) or alternative criteria as determined by the Service and NMFS Engineering. The screens and bypass facility shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The bypass facility shall include features to detect and record data for PIT-tagged downstream migrating fish (or fish identified using similar technology). The downstream fishway shall be constructed and operational within 6 years of the issuance of the new license.

4.2.2 Design Consultation: The bypass facility design shall include features to detect and record data for PIT-tagged downstream migrating fish (or fish identified using similar technology). The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 3 years of the issuance of the new license for review and approval by the Service and NMFS Engineering prior to construction.

4.2.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

4.3 Copco 2 Spillway

4.3.1 Spillway Modification Design Consultation: The Licensee shall modify, maintain, and evaluate a spillway for the volitional passage at Copco 2 Dam to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout. The spillway modifications shall be constructed and operational within 6 years of the issuance of the new license.

4.3.2 Spillway Design: The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 3 years of the issuance of the new license for review and approval by the Service and NMFS Engineering prior to construction.

4.3.3 Spillway Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

4.4 Copco 2 Tailrace Barrier

4.4.1 Tailrace Barrier Construction: The Licensee shall construct a tailrace barrier and guidance system at Copco 2 Dam. The tailrace barrier and guidance system shall be constructed according to approved design plans and within 8 years of the issuance of the new license.

4.4.2 Tailrace Barrier Design: The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 5 years of the issuance of the new license, for review and approval by the Service and NMFS Engineering prior to construction.

4.4.3 Tailrace Barrier Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

4.5 Copco 2 Bypass Channel Barrier/Impediment Modification

4.5.1 Barrier Modification: The Licensee shall modify the sill (as provided in 4.5.2 below), unless the Licensee demonstrates through an evaluation (conducted in consultation with the Services and CDFG and in a manner approved by the Services) using accepted fish barrier evaluation methodology (Powers and Orsborn 1985) that the transverse bedrock sill approximately 0.5 miles above the Copco 2 Powerhouse in the Copco 2 bypassed reach is not a barrier to fish passage under normal operating flows specified for the Copco 2 bypassed reach in the new license. The evaluation shall be completed within six months of the issuance of the new license and its conclusions must be approved by the Services.

4.5.2 Design and Construction: The Licensee shall develop design and construction plans for the barrier modification according to the terms of general article 1.1.1 above within 1 year of the issuance of the new license for review and approval by the Service and NMFS Engineering prior to construction. The barrier shall be modified in accordance with specified guidelines and criteria for fish passage (National Marine Fisheries Service 2003), including providing at least 1.0 foot of swimming depth across the sill and with adequate attraction, velocity, capacity and vertical jump characteristics.

4.5.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

5. Copco 1 Dam

5.1 Copco 1 Dam Upstream Fishway

5.1.1 Copco 1 Upstream Fishway: The Licensee shall construct, operate, maintain, and evaluate a volitional upstream fishway at Copco 1 Dam to provide for the safe, timely, and effective upstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout. The fishway shall be operated year-round and shall consist of a fish ladder designed in accordance with NMFS criteria (National Marine Fisheries Service 2003) or alternative criteria as determined by the Service and NMFS Engineering. The ladder shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The ladder shall have a minimum of two entrances and associated entrance pools and the auxiliary water system (AWS) shall be designed to augment ladder flow from the forebay. The AWS shall be screened in accordance with NMFS juvenile fish screen criteria (National Marine Fisheries Service 1997) or such alternative criteria as may be determined acceptable to NMFS Engineering and the Service. The AWS shall be designed to provide the correct water temperature and water quality as to attract fish. The fish ladder and AWS together must supply at least 5-10 percent of fish passage design high flow for adequate attraction to the ladder. The ladder shall have a maximum drop between pools of 0.5 ft and the maximum slope of the fish ladder shall not exceed 10 percent (Table 1). The ladder shall include features to detect and record data for PIT-tagged upstream migrating anadromous fish (or fish identified using similar technology). The Licensee shall construct the upstream fishway according to current criteria for passage of Pacific lamprey (Table 1). The fishway shall be constructed and operational within 6 years of the issuance of the new license.

5.1.2 Design Consultation: The ladder design shall include features to detect and record data for PIT-tagged upstream migrating anadromous fish (or fish identified using similar technology). The Licensee shall develop design and construction plans according to the terms of general article1.1.1 above within 3 years of the issuance of the new license for review and approval by the Service and NMFS Engineering prior to construction.

5.1.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

5.2 Copco 1 Downstream Fishway

5.2.1 Intake Fish Screens and Bypass Facility: The Licensee shall construct, operate, maintain, and evaluate a fish screen and bypass facility for volitional fish passage at Copco 1 Dam to below Copco 2 Dam to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout. The screens and bypass facility shall be operated year-round and shall be designed in accordance with NMFS juvenile fish screen and bypass facility criteria (National Marine Fisheries Service 1997) or alternative criteria as determined by the Service and NMFS Engineering. The screens and bypass facility shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The bypass facility shall include features to detect and record data for PIT-tagged downstream migrating fish (or fish identified using similar technology). The downstream fishway shall be constructed and operational within 6 years of the issuance of the new license.

5.2.2 Design Consultation: The bypass facility design shall include features to detect and record data for PIT-tagged downstream migrating fish (or fish identified using similar technology). The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 3 years of the issuance of the new license for review and approval by the Service and NMFS prior to construction.

5.2.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

5.3 Copco 1 Spillway

5.3.1 Spillway Modification: The Licensee shall modify, maintain, and evaluate a spillway for volitional passage at Copco 1 Dam to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout. The spillway modifications shall be constructed and operational within 6 years of the issuance of the new license.

5.3.2 Spillway Design: The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 3 years of the issuance of the new license for review and approval by the Service and NMFS prior to construction.

5.3.3 Spillway Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

5.4 Copco 1 Tailrace Barrier

5.4.1 Tailrace Barrier Construction: The Licensee shall construct a tailrace barrier and guidance system at Copco 1 Dam to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout. The tailrace barrier and guidance system shall be constructed according to approved design plans and within 8 years of the issuance of the new license.

5.4.2 Tailrace Barrier Design: The Licensee shall, within 5 years of the issuance of the new license, develop design and construction plans according to the terms of general article 1.1.1 for review and approval by the Service and NMFS Engineering prior to construction.

5.4.3 Tailrace Barrier Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

6. J.C. Boyle Dam

Upstream Prescription Rationale: Historically coho salmon, Pacific lamprey, steelhead, and spring-run and fall-run Chinook salmon (Hamilton et al. 2005) and resident trout (Hanel and Gerlach 1964) migrated above the current site of J.C. Boyle Dam to reach holding, spawning, incubation, and rearing habitat. The upstream fishway at J.C. Boyle Dam is obsolete and does not meet current design criteria. It is a partial barrier to trout passage and thus to critical holding, spawning, incubation, and rearing habitat in tributaries (Spencer, Hunters Park, and Miners creeks) and the Boyle Reservoir to Keno Dam reach (Table 3). The goal of the Services and the Klamath River Basin Fisheries Task Force is to successfully restore corresponding life history phases of anadromous salmonids to their historical range and this habitat. The Service goal is to successfully restore resident fish to their historical range and habitat as well. The objective in reaching these goals is the restoration of safe, timely, and effective fish movement. Providing fishways that meet current criteria at J.C. Boyle Dam is consistent with the goals and objectives for resource management of the Services and the Klamath River Basin Fisheries Task Force. The Licensee shall provide effective facilities to meet these goals and mitigate for the impacts of the dam. The 4 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Benefits: Specific benefits of fishways at J.C. Boyle Dam include:

- <u>Resident Trout:</u> Fish passage at J.C. Boyle Dam alone would restore the unimpaired connectivity of resident redband trout populations in the mainstem Klamath River with those in Spencer Creek. This tributary, in particular, provides important habitat elements, such as spawning and temperature related refugial areas for redband trout. A number of reports document the importance of Spencer Creek habitat to redband trout (Buchanan et al. 1990; Buchanan et al. 1991; Hemmingsen 1997; Hemmingsen et al. 1992; USDI Bureau of Land Management et al. 1995). The Spencer Creek population of Klamath River redband trout is migratory and has connectivity to the population in the mainstem Klamath River and nearby tributary watersheds. This Basin connectivity coupled with homing behavior (and straying of individuals) allows Spencer Creek redband/rainbow trout to be a source of adaptive variability in Klamath Basin trout populations (USDI Bureau of Land Management 1995). This connectivity has been greatly impaired by inadequate passage at J.C. Boyle Dam. The number of redband trout using the J.C. Boyle fish ladder have declined 90 percent or more since shortly after the dam was constructed (Hanel and Gerlach 1964; Hemmingsen et al. 1992; Oregon Department of Fish and Wildlife 2006a). An upstream ladder, built to current criteria and with the entrance located to avoid false attraction flows, would provide for the safe, timely and effective passage around J.C. Boyle Dam for redband trout migrating to Spencer Creek and upstream. With fish passage, habitat in Spencer Creek and habitat between J.C. Boyle Dam and Keno Dam would be fully utilized. Seasonal migration of steelhead and access to refugial areas would be restored.
- <u>Coho:</u> Coho salmon are present in the Klamath River below Iron Gate Dam and were present historically below and above the J.C. Boyle Dam to at least Spencer Creek. With passage at J.C. Boyle Dam, coho salmon would regain access to 9.6 miles of habitat (Table 3). With fish passage, access to this habitat would no longer be unutilized. Seasonal migration of coho and access to refugial areas would be restored.
- <u>Spring-run Chinook</u>: With fish passage at J.C. Boyle Dam, spring-run Chinook salmon would regain access to seasonal cool water refugial areas necessary for this run of fish (McCullough 1999) between J.C. Boyle Dam and the next dam upstream (Keno Dam). Spring-run Chinook would also have access to the main channel as an upstream migration corridor necessary to reach historical spawning areas in the Upper Klamath Basin (California Department of Fish and Game 1990).
- <u>Fall Chinook:</u> With fish passage, fall-run Chinook salmon would regain access to 14.3 miles of habitat, including tributaries and the mainstem Klamath River (Table 3) between J.C. Boyle Dam and the next dam upstream (Keno Dam). With fish passage seasonal migration of fall-run Chinook and access to refugial areas would be restored.

- Pacific Lamprey: With fish passage, Pacific lamprey would regain access to at least 17.1 miles of habitat, including tributaries and the mainstem Klamath River (Table 3) between J.C. Boyle Dam and the next dam upstream (Keno Dam).
- Steelhead: With fish passage, steelhead would regain access to 17.1 miles of habitat between J.C. Boyle Dam and the next dam upstream (Keno Dam). Steelhead are generally tributary spawners and able to access reaches of tributaries upstream from areas where salmon spawn (Platts and Partridge 1978). Therefore, with fish passage, steelhead would utilize habitat in its entirety in tributaries above J.C. Boyle Dam. This means that steelhead would fully have access to the 17.1 miles of habitat in Spencer, Hunters Park, and Miners creeks as well as the mainstem Klamath River below Keno Dam (Table 3). Seasonal migration of steelhead and access to refugial areas would be restored.

Downstream Prescription Rationale: Redband/rainbow trout, federally listed suckers, and other resident fish are currently present in J.C. Boyle Reservoir (Desjardins and Markle 2000; PacifiCorp 2004b). The Services conclude that trout (in particular fry and juveniles) move downstream as they do in the Klamath River elsewhere (Hemmingsen 1997) and that the vast majority of these move through the J.C. Boyle Powerhouse because the screens are ineffective and the facility seldom spills. Dam operators at the J.C. Boyle development generally do not spill until Klamath River discharge exceeds 3,000 cfs. Over the past 25 years the Klamath River exceeded this threshold a median of 4.5 days per year and in 12 years it did not exceed 3,000 cfs (Oregon Department of Fish and Wildlife 2006a). The Services conclude that turbine entrainment at J.C. Boyle Dam causes significant mortality to downstream migrating redband trout (see discussion of turbine-caused mortality later in this paragraph). With the construction of a functional adult fish ladder at J.C. Boyle Dam, Pacific lamprey, salmon, and steelhead would return to hold, spawn, and rear in habitat where they were present historically (Hamilton et al. 2005). However, the progeny of these fish would also move downstream and must negotiate not only the reservoir but the dam, powerhouse, and spillway during their outmigration. Turbine caused mortality at dams can have serious consequences for fish populations, especially among anadromous species (Cada 2001). Survival of juvenile salmonids passing dams during their seaward migration is highest through spillways and lowest through turbines (Muir et al. 2001), turbine mortality being caused by pressure changes, cavitation, shear stress, turbulence, strike, and grinding (Cada 2001). The Electric Power Research Institute (EPRI) (Electric Power Research Institute 1987) reported that the Francis turbines which are used at the J.C. Boyle development have an average mortality of about 24 percent for all subject species. EPRI's studies, and those of Milo Bell (Bell 1986; Bell et al. 1967) measured entrainment for some of the same species and under similar conditions as exist at J.C. Boyle Dam, and thus support the conclusion that entrainment mortality is presently occurring at significant levels for resident fish. The J.C. Boyle development, at 440 feet of head, may have even greater mortality due to turbine entrainment, as pressure gradients will be even greater. For projects with Francis turbines, the EPRI study found a high correlation ($r = 0.77$) between head and fish mortality. Four hydroelectric developments with Francis turbines that had greater than 335 feet of head had mortality ranging from 33 to 48 percent (Electric Power Research Institute 1987). The facilities in these studies have comparable or less hydraulic head than the J.C. Boyle development and comparable turbine types. Using the above evidence, the Services conclude that entrainment mortality at J.C. Boyle Powerhouse likely falls in this range rather than the 12 to 36 percent range estimated by the Applicant (PacifiCorp 2004a, Exhibit E 4-113). When anadromous fish are restored above J.C. Boyle Dam, out-migrating salmonid smolts, including federally listed coho, would be entrained and a significant portion killed during turbine passage absent downstream fish screens and bypass systems. Volitional fish passage would be consistent with fish movement through Klamath River system for purposes such as spawning, rearing, feeding, and seasonal use of habitat. It is also consistent with the goals and resource management objectives of the Klamath River Basin Fishery Task Force and the Services.

The development of detailed design and construction plans for review and approval by the Service and NMFS Engineering is critical to ensure that effective passage measures are incorporated into the design. The 4 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Sidecast Rock Barrier Removal Prescription Rational: Sidecast rock extends from the J.C. Boyle canal access road into and across the J.C. Boyle bypass channel, blocking or inhibiting fish passage. Presently, all flows in the bypass reach filter through the sidecast rock and there is no unimpeded route for anadromous fish passage at the typical bypass flows observed. The rock has been deposited in this channel recently and is sidecast from Project construction and operation of the J.C. Boyle canal and access road. This impediment to fish was observed during the summer of 2005 (David K. White, NMFS, pers. comm.). Historically, higher flows in the bypassed channel might have been able to disperse this material and restore fish movement. Removal is necessary to achieve the safe, timely, and effective passage through the channel past this obstruction and would be consistent the goals and objectives for resource management of the Services and the Klamath River Basin Fishery Task Force. The 2 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Tailrace Prescription Rationale: Water discharging from the J.C. Boyle Powerhouse represents a significant portion of the total river flow of the Klamath River. Under the current license the powerhouse can discharge up to 3000 cubic feet per second (cfs) and the bypass reach contains as little as 320 cfs. Even with the instream flow in the bypassed channel proposed by the Applicant, this disparity in flows contributes to false attraction for upstream migrating fish to an area which provides no upstream passage. The natural tendency for fish attracted to such an area is to hold and wait for passage conditions to improve or to attempt to move past the obstacle either by swimming or leaping. Depending on powerhouse operations, water velocities in hydropower facilities range from roughly 5 to 10 fps; these velocities easily fall within the swimming abilities of salmonids (Weaver 1963). The types of injury sustained by some fish entering draft tubes or contacting turbines vary from site to site, as do immediate and delayed mortality rates. Several studies, however, attribute injuries in migrating salmonids to powerhouse structures associated with tailrace structures (Department of Fisheries Canada 1958; International Pacific Salmon Fisheries Commission 1976; Schadt et al. 1985; Williams 1985).

Adult anadromous fish are attracted into oncoming flows (National Marine Fisheries Services 2003). Migration upstream may be delayed when tailrace flows from the powerhouse exceed river bypass reach flows. A migration delay, or combined delays at several facilities, may prevent fish from reaching suitable spawning habitat when they are ready to spawn or conditions are optimal for survival. Migration delays caused by tailrace effects may have a greater impact on fish populations than injury and mortality from turbine impacts (Federal Energy Regulatory Commission 1994). Migration delays may occur to a greater percentage of migrating fish than the percentage of fish impacted by turbine mortality. Migration delays are well documented for anadromous salmonids in the Pacific Northwest (Haynes and Gray 1980; Rondorf et al. 1983; Schadt et al. 1985; Vogel et al 1990). For migratory fish, false attraction occurs when upstream migrants are attracted to turbine discharge or spillway flows rather than to fishway flows. False attraction also occurs when upstream migrants detect the scent of their natal stream downstream of its natural outlet (Fretwell 1989). This happens when water from a natal stream is diverted through a canal or pipe to a hydroelectric project. In either instance, without proper project design or operation modifications, there may be migratory delays.

In order to prevent injury, delay, or mortality to salmonids, caused by attempts to swim upstream into the tailrace, a barrier is required to guide migrating fish away from this area and encourage them to continue their upstream migration. The 4 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Spillway Prescription Rationale: Spill survival estimates for juvenile salmonids are numerous and range from 70 percent to 100 percent, depending on species, life stage, amount or proportion of water spilled, spillway configuration, tailwater hydraulics, the methodology of estimating survival, and predator conditions (Bell and DeLacy 1981 in National Marine Fisheries Service 2000). Fish passing down a spillway may experience physical, chemical, and biological effects. Turbulent mixing of spilled water with receiving waters may result in gas supersaturation and resultant gas bubble disease in fish. Dissolved nitrogen concentrations of more than 130 percent of normal equilibrium levels have been measured in tailwaters (Ebel and Raymond 1976). The threshold value for significant mortality among juvenile Chinook salmon and steelhead trout occurs when nitrogen gas levels are about 115 percent of normal. Along the Columbia River, where many spillways discharge from a given dam and there are many consecutive dams along the stream course, supersaturation increases cumulatively from one dam to the next. Losses of salmon and steelhead trout in the Columbia River due to supersaturation have been severe in years of high spillage (Ebel and Raymond 1976). Fish passing over spillways can be injured by strikes or impacts with solid objects (e.g. baffles, rocks, or walls in the plunge zone), rapid pressure changes, abrasion with the rough side of the spillway, and the shearing effects of turbulent water. The configuration of the J.C. Boyle Dam spillway includes numerous rocks and many such solid objects and it is reasonable to conclude that significant mortality will occur while passing fish through the spillway. Therefore, the following spillway modifications and 4 year timeline are necessary to meet resource goals and objectives as quickly as possible.

6.1 J.C. Boyle Bypass Channel

6.1.1 Barrier Removal: The Licensee shall remove the sidecast rock barrier approximately 2.5 mile above the J.C. Boyle Powerhouse in the J.C. Boyle Bypass reach within 2 years of the issuance of the new license to provide for the safe, timely, and effective upstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout.

6.1.2 Design and Construction: The Licensee shall develop design, construction, and maintenance plans according to the terms of general article 1.1.1 above within 1 year of the issuance of the new license for review and approval by the Service and NMFS Engineering prior to construction.

6.1.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

6.2 J.C. Boyle Upstream Fishway

6.2.1 J.C. Boyle Upstream Fishway: The Licensee shall construct, operate, maintain, and evaluate a volitional fishway at J.C. Boyle Dam to provide for the safe, timely, and effective upstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout. The fishway shall be operated year-round and shall consist of a fish ladder designed in accordance with NMFS' criteria (National Marine Fisheries Service 2003) or alternative criteria acceptable to the Service and NMFS Engineering. The ladder shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The ladder shall have a minimum of two entrances and associated entrance pools and the auxiliary water system (AWS) shall be designed to augment ladder flow from the forebay. The ladder entrance shall be located downstream of the fish screen bypass outfall and existing velocity barrier below the existing ladder. The AWS shall be screened in accordance with NMFS juvenile fish screen criteria (National Marine Fisheries Service 1997), or such alternative criteria as may be determined acceptable by NMFS Engineering and the Service. The AWS shall be designed to provide the correct water temperature and water quality as to attract fish. The fish ladder and AWS together must supply at least 5-10 percent of fish passage design high flow for adequate attraction to the ladder. The ladder shall have a maximum drop between pools of 0.5 ft and the maximum slope of the fish ladder shall not exceed 10 percent (Table 1). The ladder shall include features to detect and record data for PIT-tagged upstream migrating anadromous fish (or fish identified using similar technology). The upstream fishway must be constructed to current criteria for passage of Pacific lamprey. The fishway shall be constructed and operational within 4 years of the issuance of the new license.

6.2.2 Design Consultation: The ladder design shall include features to detect and record data for PIT-tagged upstream migrating anadromous fish (or fish identified using similar technology). The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 2 years of the issuance of the new license for review and approval by the Service and NMFS Engineering prior to construction.

6.2.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

6.3 J.C. Boyle Downstream Fishway

6.3.1 Intake Fish Screens and Bypass Facility: The Licensee shall construct, operate, maintain, and evaluate a new fish screen and a bypass facility at J.C. Boyle Dam to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout. The screen and bypass shall be operated year-round and shall be designed in accordance with NMFS juvenile fish screen and bypass facility criteria (National Marine Fisheries Service 1997) or alternative criteria acceptable to the Service and NMFS Engineering. The screen and bypass facility shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The screen shall divert all fish to a bypass facility. The bypass facility shall include features to detect and record data for PIT-tagged downstream migrating fish (or fish identified using similar technology). The Licensee shall complete construction and begin operation within 4 years of the issuance of the new license.

6.3.2 Design Consultation: The bypass facility design shall include features to detect and record data for PIT-tagged downstream migrating fish (or fish identified using similar technology). The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 2 years of the issuance of the new license for review and approval by the Service and NMFS Engineering prior to construction.

6.3.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

6.4 J.C. Boyle Spillway

6.4.1 Spillway Modification: The Licensee shall modify, maintain, and evaluate a spillway for the volitional passage at J.C. Boyle Dam to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, and redband trout. The spillway modifications shall be constructed and operational within 4 years of the issuance of the new license.

6.4.2 Spillway Design: The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 2 years of the issuance of the new license for review and approval by the Service and NMFS engineering prior to construction.

6.4.3 Spillway Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

6.5 J.C. Boyle Tailrace Barrier

6.5.1 Tailrace Barrier Construction: The Licensee shall construct a tailrace barrier and guidance system at J.C. Boyle Dam. The tailrace barrier and guidance system shall be constructed according to approved design plans and within 4 years of the issuance of the new license.

6.5.2 Tailrace Barrier Design –The Licensee shall, within 2 years of the issuance of the new license, develop design and construction plans according to the terms of general article 1.1.1 for review and approval by the Service and NMFS Engineering prior to construction.

6.5.3 Tailrace Barrier Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

7. Keno Dam

Upstream Prescription Rationale: Historically steelhead, spring-run and fall-run Chinook salmon (Hamilton et al. 2005), and resident fish migrated through the current site of Keno Dam to reach holding, spawning, incubation, and rearing habitat. Keno Dam is a partial barrier to this passage and thus to holding, spawning, incubation, and rearing habitat in the Link River reach. The goal of the Services and the Klamath River Basin Fisheries Task Force is to successfully restore corresponding life history phases of anadromous salmonids to their historical range and habitat. The goal of the Service is to successfully restore resident fish to their historical range and habitat as well. The objective in reaching these goals is restoration of safe, timely, and effective fish movement. Providing fish passage that meets current standards at Keno Dam is consistent with goals and objectives for resource management of the Services and the Klamath River Basin Fisheries Task Force. The Licensee shall provide effective facilities to meet these goals and mitigate for the impacts of the dam.

Keno Reservoir in its current state would be primarily a migration corridor for anadromous salmonids because the depth and velocity of the impoundment provide little suitable habitat. Link River is the only free flowing reach of the Klamath River between Keno Dam and Link River Dam. Link River provides habitat for Klamath largescale suckers (Catastomus snyderi) during all months of the year, and for Lost River and shortnose suckers in summer when water quality is poor in downstream Lake Ewauna (Rich Piaskowski, BOR, pers. comm.) For salmonids, Link River provides habitat most of the year other than summer months. During most years, the Lake Ewauna reach of the Klamath River (Link River Dam to Keno Dam) has dissolved oxygen concentrations greater than 6 mg/L and temperatures less than 20C from mid-November through mid-June (Jason Cameron, BOR, pers. comm.). These conditions are within the criteria for migrating adult anadromous salmonids for these months (U. S. Environmental Protection Agency 2003). However, interim, seasonal, upstream trap and haul for adult Chinook salmon around Keno Reservoir and Lake Ewauna would be necessary during summer months when DO and temperature are out of criteria for this life stage of this species (USEPA 2003) and water quality conditions may not be suitable for migration. The Services expect that the major runs of these fish would occur from March to June for spring- run adult Chinook and October through December for fall-run adults. The Services expect trap and haul to be an effective interim, seasonal fish passage method for adult Chinook salmon under these summer conditions because only this species would be transported and only for a short distance. Other species need volitional fishways to access habitat in Keno Reservoir and Link River year round. Conditions in this reach are expected to improve over time to a point when volitional passage will be effective year-round for all target species. Water quality is expected to improve over the term of a new Project license through the implementation of the Total Maximum Daily Load (TMDL) process, imposition of state water quality certification conditions, and provisions of a new license including terms and conditions added by the Commission as well as the inclusion of recommendations pursuant to FPA section 10(j). Upper Klamath Lake above Link River Dam currently provides habitat for salmonids. Water quality problems in the lake during the summer months are relatively short lived and springs in the lake provide thermal refugial areas for redband trout and other species. Redband trout are also well known for migrating upstream into the Wood and Williamson rivers when Upper Klamath Lake water quality deteriorates. Once fish pass Keno Dam, Keno Reservoir, and Lake Ewauna, the current upstream fishway at Link River Dam would pass anadromous fish species (including Pacific lamprey) on their way to currently available, good quality upstream habitat upstream (Oregon Department of Fish and Wildlife 1997; Huntington 2006). The 3 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

Keno Dam may impede native suckers occupying habitat below the dam from reaching elements of their historical habitat including Lake Ewauna, Link River, and Upper Klamath Lake, the core recovery area for this species (USDI Fish and Wildlife Service 1993). The existing fishway at Keno Dam does not meet Service and ODFW criteria for sucker passage (Table 1) because the slope is too steep (USDI Fish and Wildlife 2005). However, the potential contribution of the J.C. Boyle Reservoir population for conservation of the species may be limited. Monitoring of fish passage at Keno Dam has demonstrated small numbers of fish moving upstream through the existing ladder at Keno Dam (PacifiCorp 1997). Until additional information becomes available regarding the populations of federally listed suckers in J.C. Boyle Reservoir and the need for passage of federally listed suckers upstream, the Service will reserve the authority to prescribe an upstream fishway to sucker criteria at Keno Dam.

Benefits of fishways at Keno Dam include:

- <u>Resident Trout:</u> Significant recreational fisheries for redband trout currently exist in the Project area, as well as in and upstream of Upper Klamath Lake. Upstream fish passage at Keno Dam would result in restoring the connectivity of resident redband populations in the mainstem Klamath River with those in Keno Reservoir/Lake Ewauna, Link River, and Upper Klamath Lake. In 2005, Reclamation completed a new fishway at Link River Dam designed to pass endangered suckers, trout, lamprey, and other native species. Adequate upstream fish passage at Link River Dam has resulted in restoring the connectivity of resident redband populations in the Link River reach with those in Upper Klamath Lake and its tributaries. These tributaries, including the Wood, Williamson, and Sprague rivers in particular, provide important habitat elements, such as spawning and temperature related refugial areas for redband trout (Oregon Department of Fish and Wildlife 1997). With fish passage, habitat between Keno and Link River Dam would be fully utilized. Seasonal migration of trout and access to refugial areas would be improved.

- Spring-run Chinook salmon, fall-run Chinook, and steelhead: All these species occurred historically above the current site of Keno Dam and Upper Klamath Lake (Hamilton et al. 2005). With upstream fishways at downstream dams and the new ladder at Link River Dam, adequate anadromous fish passage facilities at Keno Dam would mean these runs would regain access to 49 significant tributaries in the Upper Klamath Basin, comprising 360 miles of currently productive anadromous fish habitat (if anadromous fish had access to this habitat) and an additional 60 miles of recoverable habitat (Huntington 2006). Large populations of spring-run Chinook were found in several of the tributaries to Upper Klamath Lake, including both the Williamson and Sprague rivers (California Department of Fish and Game 1990). Historical run sizes in each these two rivers were estimated to be at least 5,000 spring-run Chinook salmon (California Department of Fish and Game 1990). Substantial numbers of what were apparently fall-run Chinook were still being harvested in the Sprague River up until about 1910 (Lane and Lane Associates 1981). Steelhead are generally tributary spawners and able to access reaches upstream from areas where salmon spawn (Platts and Partridge 1978). Therefore, with fish passage, steelhead would have access to tributaries above Keno Dam. Seasonal migration of anadromous salmonids and access to refugial areas would be restored.
- Pacific lamprey: At Keno Dam the existing fishway does not meet current criteria to accomplish lamprey passage because corners and ladder steps are not rounded (USDI Fish and Wildlife 2005). Lampreys occur long distances inland in the Columbia and Yakima river systems (Wydoski and Whitney 2003) and would likely do so in the Klamath River system as well, as habitat conditions are similar.

Spillway Prescription Rationale: Spill survival estimates for juvenile salmonids are numerous and range from 70 percent to 100 percent depending on species, life stage, amount or proportion of water spilled, spillway configuration, tailwater hydraulics, the methodology of estimating survival, and predator conditions (Bell and DeLacy 1981 in National Marine Fisheries Service 2000). Fish passing down a spillway may experience physical, chemical, and biological effects. Fish passing over spillways can be injured by strikes or impacts with solid objects (e.g. baffles, rocks, or walls in the plunge zone), rapid pressure changes, abrasion with the rough side of the spillway, and the shearing effects of turbulent water. Water exits Keno spillways via undershot gates with small openings and plunges into a wide, shallow bedrock sill that is an area known for predatory fish (Oregon Department of Fish and Wildlife 1997). It is likely that fish will be injured as water is passed through the gates under pressure and that predation will occur in the receiving waters. Therefore, the spillway modifications and 3 year timeline are necessary to meet resource goals and objectives as quickly as possible.

7.1 Upstream Fishway at Keno Dam

7.1.1 Keno Upstream Fishway: To provide for the safe, timely, and effective upstream passage of Chinook salmon, steelhead trout, Pacific lamprey, and redband trout, the Licensee shall modify, operate, and maintain the existing volitional fishway. The Licensee shall also construct, operate, and maintain a holding and sorting facility to accommodate upstream interim, seasonal trap and haul for anadromous salmonids at Keno Dam. In addition, the modification shall include features to trap, hold, and sort anadromous salmonids by age and species, as well as accomplish the transfer of these fish upstream above Link River Dam between June 15 and November 15 for the purposes of restoration and the safe, effective, and timely passage of fish. If agreed to by the Services, seasonal trap and haul shall not be employed during this time in periods when dissolved oxygen concentrations are greater than 6 mg/L and temperatures lower than 20°C, as measured at Miller Island using a method that is acceptable to the Services. The upstream fishway shall be operated year-round regardless of trap and haul operations to allow for the passage of lampreys, suckers and other species. The ladder shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The auxiliary water system (AWS) shall be designed to augment ladder flow from the forebay. The AWS shall be screened in accordance with NMFS juvenile fish screen criteria (National Marine Fisheries Service 1997) or such alternative criteria acceptable to NMFS Engineering and the Service. The AWS shall be designed to provide the correct water temperature and water quality as to attract fish. The fish ladder and AWS together must supply at least 5-10 percent of fish passage design high flow for adequate attraction to the ladder. The ladder shall include features to detect and record data for PIT-tagged upstream migrating anadromous fish (or fish identified using similar technology). The upstream fishway shall be modified to current criteria (Table 1) for passage of Pacific lamprey. The fishway shall be modified and operational within 3 years of the issuance of the new license.

7.1.2 Design Consultation: The Licensee shall develop design and modification plans according to the terms of general article 1.1.1 above within 1 year of the issuance of the new license for review and approval by the Service and NMFS Engineering prior to construction. The design shall include features to hold and sort anadromous salmonids by age and species, as well as accomplish the transfer of these fish upstream between June 15 and November 15 for the purposes of restoration and the safe, effective, and timely passage of fish. Facilities shall be designed so that fish to be trapped and hauled above Keno are held a maximum of 8 hours before transport. The ladder design shall include features to detect and record data for PIT-tagged upstream migrating anadromous fish (or fish identified using similar technology). The upstream fishway must be modified to current criteria for passage of Pacific lamprey.

7.1.3 Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

7.2 Keno Spillway

7.2.1 Spillway Modification: The Licensee shall modify, maintain, and evaluate the radial gate(s) to provide a spillway at Keno Dam to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, suckers, lamprey, steelhead trout, and redband trout. The spillway modifications shall be constructed and operational within 3 years of the issuance of the new license.

7.2.2 Spillway Design: The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 1 year of the issuance of the new license for review and approval by the Service and NMFS engineering prior to construction.

7.2.3 Spillway Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

8. Eastside and Westside Developments

Eastside and Westside Downstream Prescription Rationale: PacifiCorp's Eastside and Westside developments divert water at Link River Dam to downstream powerhouses. Significant numbers of redband trout and other resident fish are presently moving downstream from Upper Klamath Lake and being entrained by PacifiCorp's Eastside and Westside developments, including tens of thousands of larvae and juveniles of federally listed suckers annually (Gutermuth et al. 2000). Unless protected by fish screens and bypasses, fish migrating downstream can suffer injury or death by passing through turbines at hydroelectric plants (Electric Power Research Institute 1987). Turbine-caused mortality can have serious consequences for fish populations, especially among anadromous species (Cada 2001). Survival of juvenile salmonids passing dams during their seaward migration is highest through spillways and lowest through turbines (Muir et al. 2001); turbine mortality being caused by pressure changes, cavitation, shear stress, turbulence, strike, and grinding (Cada 2001). The Electric Power Research Institute (Electric Power Research Institute 1987) reported that Francis turbines, which are used at PacifiCorp's Eastside and Westside developments, have an average mortality of about 24 percent. Based upon these studies, turbine similarities, and known entrainment, the Services conclude that turbine entrainment at PacifiCorp's Eastside and Westside developments causes comparable levels of mortality to downstream migrating fish as found in studies cited above. Volitional fish passage would be consistent with fish movement through the Klamath River system for purposes such as spawning, rearing, feeding, and seasonal use of habitat. Volitional fish passage would be consistent with the goals and objectives for resource management of the Klamath River Basin Fishery Task Force and the Services. Downstream fishways at PacifiCorp's Eastside and Westside developments would screen and divert both resident and anadromous fish from turbine intakes. This would guide downstream migrating fish, minimize mortality of federally listed suckers, and ensure that delay and entrainment mortality of redband trout, other resident species, and anadromous outmigrants would be minimized. With the adult fish ladder in place at BOR's Link River Dam and construction of functional adult fish ladders at dams downstream of Link River, Pacific lamprey, salmon, and steelhead will return to hold, spawn, and rear in habitat where they were present historically (Hamilton et al. 2005). However, the progeny of these fish must negotiate not only the reservoir but the dam, powerhouse, and spillway during their outmigration. To ensure that these fish can outmigrate, downstream passage facilities at the Eastside and Westside developments are necessary.

Temporary, seasonal trap and transport for downstream migrants would be necessary due to seasonal water quality problems in Lake Ewauna and Keno Reservoir. During most years, the Lake Ewauna reach of the Klamath River (Link River Dam to Keno Dam) has dissolved oxygen concentrations less than 6 mg/L and temperatures greater than 20^{o}C from mid-June through mid-November (Jason Cameron, BOR, pers. comm.). These conditions are not within criteria (USEPA 2003) for outmigrating juvenile anadromous salmonids and may not be conducive to downstream migration during this period. Transporting outmigrant anadromous salmonids around Keno Reservoir during this period would avoid poor water quality during summer months until restoration efforts improve reservoir dissolved oxygen and water temperatures.

The Services expect that the major outmigrations of juvenile Chinook salmon would occur from March to June for spring-run Chinook and February to May for fall-run juveniles. The Services expect trap and haul to be an effective interim, seasonal fish passage method for Chinook salmon under these summer conditions because only this species would be transported and only for a short distance. Other species need volitional fishways to access habitat in Keno Reservoir\Lake Ewauna and Link River year round. Seasonal trap and haul would be performed on an interim basis. Water quality is expected to improve over the term of a new Project license through the implementation of the Total Maximum Daily Load (TMDL) process, imposition of state water quality certification conditions, and provisions of a new license (the inclusion of 10(j) recommendations).

Migrating suckers make use of habitat in Lake Ewauna as long as water quality is adequate (i.e. outside of July, August, September (Rich Piaskowski, BOR, pers. comm). Downstream migrating suckers captured during periods when water quality is inadequate in Keno Reservoir\Lake Ewauna would be returned to Upper Klamath Lake.

Eastside and Westside Tailrace Barrier Prescription Rationale: Water discharging from the Eastside and Westside powerhouses represents a significant portion of the total river flow of the Klamath River. These developments have no tailrace barriers and have never been tested for mortality to federally listed suckers, other resident fish, or anadromous salmonids. The natural tendency for fish attracted to such an area is to hold and wait for passage conditions to improve, or to attempt to move past the obstacle either by swimming or leaping. Depending on powerhouse operations, water velocities in hydropower facilities range from roughly 5 to 10 fps; these velocities easily fall within the swimming abilities of salmonids (Weaver 1963). The types of injury sustained by some fish entering draft tubes or contacting turbines vary from site to site, as do immediate and delayed mortality rates. Several studies, however, attribute injuries in migrating salmonids to powerhouse structures associated with tailrace structures (Department of Fisheries Canada 1958; International Pacific Salmon Fisheries Commission 1976; Schadt et al. 1985; Williams 1985).

Adult anadromous fish are attracted into oncoming flows (National Marine Fisheries Service 2003). Migration upstream may be delayed when tailrace flows from the powerhouse exceed river bypass reach flows. A migration delay, or combined delays at several facilities, may prevent fish from reaching suitable spawning habitat when they are ready to spawn or conditions are optimal for survival. Migration delays caused by tailrace effects may have a greater impact on fish populations than injury and mortality from turbine impacts (Federal Energy Regulatory Commission 1994). Migration delays may occur to a greater percentage of migrating fish than the percentage of fish impacted by turbine mortality.

Migration delays are well documented for anadromous salmonids in the Pacific Northwest (Haynes and Gray 1980; Rondorf et al. 1983; Schadt et al. 1985; Vogel et al 1990). For migratory fish, false attraction occurs when upstream migrants are attracted to turbine discharge or spillway flows rather than to fishway flows. False attraction also occurs when upstream migrants detect the scent of their natal stream downstream of its natural outlet (Fretwell 1989).

This happens when water from a natal stream is diverted through a canal or pipe to a hydroelectric project. In either instance, without proper Project design or operation modifications, there may be migratory delays. In order to prevent injury, delay or mortality to suckers and salmonids, caused by attempts to swim upstream into the tailraces, barriers are required to guide migrating fish away from the tailrace area to continue their upstream migration.

The 3 year construction timeline is necessary to meet resource goals and objectives as quickly as possible.

8.1 Eastside and Westside Downstream Fishways

8.1.1 Intake Fish Screens and Bypass Facilities: The Licensee shall construct, operate, maintain, and evaluate fish screens and bypass facilities for volitional fishways at both Eastside and Westside developments to provide for the safe, timely, and effective downstream passage of Chinook salmon, steelhead trout, Pacific lamprey, federally listed suckers, and redband trout,. The fish screens and bypass facilities shall be located as close as is practicable to the beginning of each diversion to minimize entrapment in the diversion canals. The fish screens and bypass facilities shall transport fish to holding, sorting, counting, and tagging facilities where fish would either be passed into a volitional fishway or into temporary, seasonal trap and haul facilities for transport downstream. The facilities shall be constructed to accomplish the transfer of these fish downstream between June 15 and November 15 for the purposes of restoration and the safe, effective, and timely passage of fish. If agreed to by the Services, seasonal trap and haul shall be not be employed during this time in periods when dissolved oxygen concentrations are greater than 6 mg/L and temperatures lower than 15^{o}C, as measured at Miller Island using a method that is acceptable to the Services. The bypass facilities shall include features to detect and record data for PIT-tagged downstream migrating fish (or fish identified using similar technology), including features to detect and record data from fish tagged above the facilities to evaluate survival and fishway effectiveness. The downstream fishway shall be operated year-round regardless of trap and haul operations to allow for the passage of lampreys, suckers and other species. The screens and bypass facilities shall be operated year-round and shall be designed in accordance with sucker criteria (Table 2), or alternative criteria as acceptable to the Services. The screens and bypass facilities shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The construction shall include features to return suckers to Upper Klamath Lake. The downstream fishways shall be constructed and operational within 3 years of the issuance of the new license.

8.1.2 Design Consultation: The Licensee shall develop design and construction plans according to the terms of general article 1.1.1 above within 1 year of the issuance of the new license for review and approval by the Service and NMFS Engineering. The design of the bypass facilities shall include features to detect and record data for PIT-tagged downstream migrating fish (or fish identified using similar technology) and to hold, sort, count, and mark downstream migrating anadromous fish by age and species. The facilities shall include features to detect and record data from fish tagged above the facilities to evaluated survival and fishway effectiveness. The design shall include features to accomplish the transfer of these fish downstream between June 15 and November 15 for the purposes of restoration and the safe, effective, and timely passage of fish. The design shall include features to return suckers to Upper Klamath Lake. Facilities shall be designed so that fish to be trapped and hauled are held a maximum of 8 hours before transport.

<u>8.1.3</u> Monitoring, Reporting, and Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

<u>8.2 Tailrace Barriers at Eastside and Westside Developments</u>

<u>8.2.1</u> Tailrace Barrier Construction: The Licensee shall construct a tailrace barrier and guidance system at the Eastside and Westside powerhouses. The tailrace barriers and guidance system shall be constructed according to approved design plans and within 3 years of the issuance of the new license.

<u>8.2.2</u> Tailrace Barrier Design: The Licensee shall, within 1 year of the issuance of the new license, develop design and construction plans according to the terms of general article 1.1.1 for review and approval by the Service and NMFS Engineering prior to construction.

<u>8.2.3</u> Tailrace Barrier Evaluation: The Licensee shall complete reporting, monitoring, and evaluation of this facility as specified in General Prescriptions, above.

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Attachment B

National Marine Fisheries Service 10(j) Recommendations

March 27, 2006

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National Marine Fisheries Service 10(j) Recommendations
Klamath Hydroelectric Project - FERC No. 2082

Recommended License Conditions Pursuant to 10(j) of the Federal Power Act

Pursuant to Section 10(j) of the Federal Power Act (16 U.S.C. 791 *et seq*.) and to carry out the purposes of the Fish and Wildlife Coordination Act (16 U.S.C. 661 *et seq.*), NMFS recommends that the following terms and conditions to protect, mitigate damages to, and enhance fish and wildlife resources be included in the new Project license.

These recommendations were developed by the National Marine Fisheries Service (NMFS) to support the resource agency management goals and objectives. NMFS' primary goal is to establish safe and effective fish passage, restoration, and habitat conservation for anadromous fish at the Project's facilities consistent with the management goals detailed in these plans and policies. The purpose of NMFS' proposed mitigation measures is to restore and maintain productivity of anadromous fish populations and their habitats affected by Project developments, as well as offset ongoing or continuing impacts that result from Project operation and maintenance. NMFS' resource goals and objectives have been described previously in this document (see NMFS' Resource Goals and Objectives).

NMFS has prepared these preliminary terms and conditions based on current information regarding the proposed relicensing of the Project. As more detailed plans are developed, new information becomes available, and Project operations begin under a new license, deficiencies may be observed and modifications to protection, mitigation, and enhancement measures may be necessary. NMFS will amend these section 10(j) recommendations as needed to be consistent with finalized design plans and with new information developed as a result of the Federal Energy Regulatory Commission's (Commission) environmental review process or to correct deficiencies or problems found during post-licensing monitoring or evaluations.

1. **Downstream Fish Passage Habitat Program Protection, Mitigation, and Enhancement Plan**

Recommendation: The Licensee shall, within one year of license issuance and after consulting with the U.S. Fish and Wildlife Service (Service), NMFS, affected Tribes, Oregon Department of Fish and Wildlife (ODFW), California Department of Fish and Game (CDFG), and Bureau of Land Management (BLM), file for FERC approval, a Downstream Fish Passage Program Habitat Protection, Mitigation, and Enhancement Plan to mitigate for unavoidable and ongoing Project impacts to downstream migrating anadromous fish. The Bureau of Reclamation (Reclamation) should be consulted regarding fish passage at or associated with facilities owned or operated by Reclamation. The plan shall describe specific actions to be undertaken, and contain provisions to monitor the success of those actions. The plan shall include any comments received from the consulted agencies on the proposed plan, and a description of how the agency comments are accommodated by the developed plan. All mitigation measures will be reviewed by the FTS

(Fisheries Technical Subcommittee as defined in NMFS' Section 18 Fishway Prescription) prior to approval. The plan shall at a minimum:

A. Assess the effectiveness of all downstream fishways for anadromous species. Assessment will be done at each downstream fishway and will include the use of Full Duplex PIT tagging (Passive Integrated Transponder).with PIT tag detection facilities at each downstream fishway on Project dams, including the downstream fishways at the East Side and the West Side developments. Full Duplex tagging and detection technology is necessary to track small fish (≥60mm in fork length) of interest to agencies. Monitoring may need to be augmented with radio telemetry. This assessment will be every other year for the first twelve years for the license and every three years thereafter.

    a. Juvenile anadromous fish shall be collected from the East Side and the West Side developments and from important Klamath River tributaries in the Project reach (Scotch, Camp, Jenny, Fall, Shovel, Long Prairie, and Spencer Creeks) and/or locations upstream and PIT tagged with Full Duplex marking.

B. Evaluate the survival of downstream migrating juvenile fish as well as ongoing and unavoidable losses resulting from the Project fish passage program;
C. Identify fish habitat protection, mitigation, and enhancement measures which fully mitigate the ongoing and unavoidable losses including, but not limited to, modifications to Project facilities and operations necessary to maximize the efficiency of fishway operations including reservoir elevations and flows and specific measures necessary to control predators and predation associated with Project facilities and operations; and
D. Implement the measures above, and monitor them to ensure their effectiveness.

Justification: Other than 1) decommissioning the East Side and West Side Diversions, 2) a gulper (surface collector) proposed at J.C. Boyle reservoir to replace the downstream fishways at J.C. Boyle Dam, and 3) modifications to the J.C. Boyle upstream fishway that are necessary for compliance with the current license, the Applicant has not proposed fishways at mainstem developments nor has the Applicant proposed to mitigate for unavoidable and ongoing Project impacts to downstream migrating anadromous fish. Downstream fish movement, even with the prescribed downstream fish passage facilities, will be negatively affected by continuing impacts associated with the Project relative to a without project scenario. These include the loss of fish migrating through Project reservoirs; handling stress; disease; losses from angling in Project reservoirs; delayed migration timing; avian and other predation; residualization; and other factors. Even when screens and downstream migrant facilities perform to criteria, some salmon and steelhead smaller than 60 mm will be entrained in the system's surface and/or deep water intakes and lost. These losses would reduce the number of outmigrating fish available for passage and diminish biological productivity and connectivity. While there are other proposed environmental measures that seek to address some of the Project's ongoing effects, the intent of this additional program is to increase overall smolt production above the dams to offset this continued, unavoidable loss of outmigrating fish. Downstream fishways may not operate in an effective manner to pass fish when first installed. Monitoring and appropriate operation modifications of fishways are likely to be necessary. In addition, downstream fishways may have qualitative impacts on target fish populations.

Impacts: Downstream fishways often do not operate in an effective manner to provide safe, timely and effective fish passage when first installed. Monitoring and appropriate operation modifications of fishways are likely to be necessary. In addition, downstream fishways may have qualitative as well as quantitative impacts on target fish populations. For example, the effects of stress have been studied at passage facilities at several projects, including the effects of passage stress in relationship to predation (Petersen et al. 1990). They noted that stress had sublethal effects to fish physiology, and that these effects probably increased the fish's exposure and vulnerability to predation. Another study ((Park et al. 1984) in (Wedemeyer et al. 1985)) examined the post-transport mortality of downstream migrating spring-run Chinook and steelhead. They noted that spring-run Chinook are among the least resistant to stress-mediated fish diseases. Their study also indicated that delayed mortality in spring-run Chinook was higher than that for steelhead, and was as high as 50 percent. Delayed mortality of salmonids in the estuary or ocean residence is also linked to earlier downstream passage through hydropower systems (Budy et al. 2002). Delayed mortality has been found to comprise a portion of the total mortality and this delayed mortality is caused by sublethal impacts to fish sensory systems associated with passage through hydropower facilities and the resulting increased vulnerability to predation (Ferguson et al. 2006). These studies indicate that downstream fishways on the Klamath River will need to monitored and adjusted to minimize outmigrant mortality.

2. Upstream Fish Passage Program Habitat Protection, Mitigation, and Enhancement Plan

Recommendation: The Licensee shall, within one year of license issuance and after consulting with the Service, NMFS, affected Tribes, Oregon Department of Fish and Wildlife, California Department of Fish and Game, and Bureau of Land Management file for FERC approval an Upstream Fish Passage Program Habitat Protection, Mitigation, and Enhancement Plan to mitigate for unavoidable and ongoing Project impacts to upstream migrating anadromous and resident fish. Reclamation should be consulted regarding fish passage at or associated with facilities owned or operated by Reclamation. The plan shall describe specific actions to be undertaken, and contain provisions to monitor the success of those actions. The plan shall include any comments received from the consulted agencies on the proposed plan, and a description of how the agency comments are accommodated by the developed plan. All mitigation measures will be reviewed by a FTS (Fisheries Technical Subcommittee) prior to approval. The plan shall, at a minimum:

A. Assess the effectiveness of all upstream fishways for anadromous species. Assessment will be done at each upstream fishway and will include the use of Full Duplex PIT tagging with Full Duplex PIT tag detection facilities at each upstream fishway on Project dams, including Keno Dam. Monitoring may need to be augmented with radio telemetry. This assessment will be every other year for the first twelve years for the license and every three years thereafter.

B. Evaluate the survival of upstream migrating adult fish as well as ongoing and unavoidable losses resulting from the Project fish passage program;

C. Identify fish habitat protection, mitigation, and enhancement measures which fully mitigate the ongoing and unavoidable losses, including but not limited to modifications to Project facilities and operations necessary to maximize the efficiency of fishway operations, including but not limited to flows and reservoir operations; and
D. Implement the measures above, and monitor them to ensure their effectiveness.

Justification: Upstream fishways may not operate in an effective manner to pass fish when first installed. Upstream fish movement, even with the prescribed upstream fish passage facilities, will be negatively affected by continuing impacts associated with the Project relative to a without project scenario. These include the loss of fish migrating through Project reservoirs; handling stress; disease; losses from angling in Project reservoirs; delayed migration timing; avian and other predation; and other factors. Even when upstream migrant facilities perform to criteria, some salmon and steelhead will be lost. These losses would reduce the number of fish available for spawning and diminish biological productivity and connectivity. While there are other proposed environmental measures that seek to address some of the Project's ongoing effects, the intent of this additional program is to minimize mortality to and increase overall returns of anadromous fish above the dams to offset this continued, unavoidable loss to migrating fish.

Impacts: Upstream fishways often do not operate in an effective manner to provide safe, timely and effective fish passage when first installed. Monitoring and appropriate operational modifications of fishways are likely to be necessary. In addition, upstream fishways may have qualitative impacts on target fish populations. For example, migration delays caused by tailrace effects may have a greater impact on fish populations than injury and mortality (Federal Energy Regulatory Commission 1994). Migration delays are well documented for anadromous salmonids in the Pacific Northwest (Haynes and Gray 1980; Rondorf et al. 1983; Schadt et al. 1985; Vogel et al. 1990). False attraction can occur when upstream migrants are attracted to turbine discharge or spillway flows rather than to fishway flows. False attraction also occurs when upstream migrants detect the scent of their natal stream downstream of its natural outlet (Fretwell 1989). This happens when water from a natal stream is diverted through a canal or pipe to a hydroelectric project. In either instance, without proper Project modifications there may be extensive migratory delays.

3. Fish Habitat Protection, Mitigation, and Enhancement Plan

Recommendation: Within one year of license issuance, the Licensee shall, for the conservation, development, and mitigation of damages to fish and wildlife resources, file for FERC approval, a Fish Habitat Protection, Mitigation, and Enhancement Plan (FHP). The FHP shall be completed in consultation with the Service, NMFS, CDFG, ODFW, and the affected Tribes. The goal of the FHP shall be the restoration of fish habitat above and below the Project to mitigate the continued effects of the Project on fish habitat. The schedule for completing the plan shall accommodate a 30-day review period for agencies to submit comments. If the Licensee does not adopt agency recommendations a rationale for why these were not included should be included in the plan.

Fish habitat restoration will be funded by the Licensee to mitigate affected habitat connectivity and habitat loss. Implementation of the Plan shall be completed by the fifth anniversary of the issuance of a new license.

The FHP shall include, but not be limited to, the following measures:

A. Provide compensatory mitigation for a total of five miles of bypass channel (four miles below J.C. Boyle Dam and one mile below Copco 2 Dam).

B. Provide compensatory mitigation for a total of 14.2 miles of riverine channel inundated by project reservoirs (6.1 miles for Iron Gate reservoir, 4.4 miles for Copco reservoirs; and 3.7 miles for J.C. Boyle reservoir.

C. Develop and complete a plan for habitat mitigation and enhancement for U.S. Forest Service and Bureau of Land Management lands on Jenny, Fall, Spencer, and Shovel Creeks. Some of these projects have already been identified by the USFS and BLM for Spencer Creek Pilot Watershed Analysis (BLM 1995). Habitat mitigation may include cooperative funding with the water users on these tributaries, adult and juvenile fish passage facilities at irrigation diversions or other constructed fish barriers in the upper basin. Habitat enhancement may also include purchase of instream water rights. The Licensee shall fund the planning and implementation of projects on Federal lands to meet associated agency requirements under the National Environmental Policy Act and the Endangered Species Act. The Licensee shall fund the maintenance of these projects and monitoring to determine their effectiveness.

D. Provide compensatory mitigation for any continuing effects on anadromous fish that are not avoided in future operations. These may include, but are not limited to: 1) effects of hydroelectric peaking operations on: a) fish productivity in the bypassed reaches, b) fish productivity in the peaking reach, and c) fish productivity in the Link River and Keno reaches to the extent that hydroelectric operations affect flows in those reaches; 2) effects of water impoundment on: a) water quality, including temperature, within the project area and downstream, b) the prevalence of toxic algal blooms and fish diseases within the project area and downstream, c) gravel depletion, d) reduced flood flows, and e) ramping and stranding impacts.

Justification: The Applicant has not proposed any mitigation for the loss of fish habitat resulting from continued operation of the Project. This recommendation is consistent with resource agency goals and objectives for the restoration of fish habitat.

Impacts: The Project continues to reduce fish habitat quality through the continued loss of 14.2 miles of riverine habitat within the Project's reservoirs. Of this, much of the river was low gradient stream habitat and at least 2.5 miles was important spawning habitat for anadromous salmonids. These river segments historically provided spawning, incubation, and rearing areas for juvenile anadromous salmonids (Fortune et al. 1966; Lane and Lane Associates 1981;

Hamilton et al. 2005). Production capacity for Chinook, coho and steelhead will be reduced due to the continued occupation of the river habitat by Project's reservoirs. Spring-run Chinook spawning and rearing habitat will continue to be unavailable for use by this segment of the Chinook population. In addition, there will be continued loss of upstream and downstream migrating fish caused by fishway inefficiencies, reservoir mortality due to predation, migration delays, and water quality impacts.

4. **Decommissioning Plan for the East Side and West Side Developments**

Recommendation:

Within one year of license issuance, the Licensee shall, for the conservation, development, and mitigation of damages to fish and wildlife resources, file for FERC approval, a Decommissioning Plan for the East Side and West Side Developments. The Decommissioning Plan shall be completed in consultation with the Service, NMFS, CDFG, ODFW and the affected Tribes. The schedule for completing the plan shall accommodate a 30-day review period for agencies to submit comments. If the Licensee does not adopt agency recommendations a rationale for why these were not included should be included in the plan. The goal of the Decommissioning Plan shall be the development and implementation of a comprehensive management plan to identify optimal periods of the year to avoid impacts to fish and wildlife resources due to decommissioning activities. The Decommissioning Plan shall include, but not be limited to identification of optimal periods of the year to avoid impacts to fish and wildlife resources due to decommissioning.

The Service, NMFS, CDFG, ODFW and the affected Tribes reserve the right to require modifications to the Decommissioning Plan. Licensee shall implement decommissioning within three years of license issuance and results shall be monitored to develop future needs with continued consultation with the Service, NMFS, CDFG, ODFW and the affected Tribes.

Justification:

The Applicant has proposed decommissioning of the East Side and West Side Developments, but provided very little detail of how decommissioning would be implemented. Measures to minimize impacts to fish and wildlife resources have not been identified. A Decommissioning Plan for East Side and West Side Developments will ensure that all aspects of decommissioning are considered and timed to avoid impacts to anadromous salmonids.

Impacts: Dismantling water related developments and dewatering power canals often result in the loss of habitat or mortality to anadromous fish. Without careful consideration and planning for the needs and habitat use anadromous salmonids, and other fish and wildlife resources, decommissioning may negatively impact these species and fail to minimize mortality.

5. **Run of River Operations**

Recommendation:

The licensee shall operate J.C. Boyle and Copco hydroelectric facilities in a run-of-river mode and without hydroelectric peaking, for the protection of fish and wildlife resources in the Klamath River. The licensee, in operating Project facilities in an instantaneous run-of-river mode, shall at all times maintain discharge below each dam such that flow in the Klamath River, as measured immediately downstream from the structure, equals the instantaneous sum of inflow to each Project reservoir. Gages shall be installed where needed to appropriately monitor inflow and outflow from each facility. Instantaneous run-of-river operation may be temporarily modified, if required, by operating emergencies beyond the control of licensee, and for short periods upon mutual agreement between Licensee and the Service, NMFS, CDFG, ODFW and the affected Tribes.

Justification: The Applicant has not proposed any deviation from the Project current operations. Run of the River operation will restore the historical hydrological regime and benefit the composition, structure, and functioning of aquatic, riparian, and wetland ecosystems.

Impacts of Project Operations: The Klamath Hydroelectric Project has significantly altered the natural hydrologic pattern and the functioning of the Klamath River within the project reaches and downstream. The ecological structure and functioning of aquatic, wetland, and riparian ecosystems depend on the hydrologic regime, or pattern and quantity of water flowing through the system (Gorman and Karr 1978, Junk et al. 1989, Poff and Ward 1990, National Research Council 1992, Sparks 1992, Mitsch and Gosselink 1993, Poff et al. 1997). Intra-annual variation in hydrologic conditions plays an essential role in the dynamics among species within such communities through influences on reproductive success, natural disturbance, and biotic interactions (Poff and Ward 1989). Modifications of hydrologic regimes can indirectly alter the composition, structure, and functioning of aquatic, riparian, and wetland ecosystems (Stanford and Ward 1979; Ward and Stanford 1983, 1989; Bain et al. 1988; Lillehammer and Saltveit 1984; Dynesius and Nilsson 1994).

The Project has significantly changed the timing and magnitude of flows within the Project reaches and downstream of Iron Gate Dam in order to maximize power production revenues. Unfortunately, aquatic resources, especially fish, have been impacted by these alterations (also see (PacifiCorp 2004b; Addley et al. 2005; PacifiCorp 2005a; NRC 2004). Since 2002, Reclamation has pursued a Conservation Implementation Program to restore aquatic resources to the Klamath River and to recover endangered and threatened fishes (National Marine Fisheries Service 2002), and the Department of the Interior has pursued restoration of anadromous fisheries in the Klamath River since 1986 for the benefit of indigenous Tribes, local economies, and the commercial fishing industry (pursuant to P.L. 99-552 § 460ss). Resident fish in the Project reaches and anadromous fish downstream of the Project would be significantly benefited by restoration of more natural patterns of flow and the cessation of hydroelectric peaking operations.

Effects of Hydroelectric Peaking

A comparison of hydrological metrics for Without Project (WOP) scenarios versus Existing Conditions shows significant impacts due to peaking. The Service and the Klamath Tribes commissioned Clearwater BioStudies to compare flow regimes under Existing Conditions and

WOP scenarios in the J.C. Boyle Bypass and Peaking Reaches, using the suite of statistics used in standard Indicators of Hydrologic Alteration analyses (IHA, (Richter et al. 1996)), using hourly flow results for 2000 and 2001 from the RMA-2 simulations (Huntington 2004). This IHA-like analysis provides a useful basis for comparing the general patterns, timing, frequency, and relative magnitude of the Project effects on hydrology in these two reaches, something that is not explicitly provided in the FLA.

Huntington's analysis reveals the extent of these radical flow alterations. The J.C. Boyle Bypassed Reach has been altered from a normal snowmelt hydrograph to an essentially constant (except during spill events) flow far below normal low flows for this portion of the Klamath River. Conversely, Peaking Reach flows are hyper-variable, exhibiting a 1,070 percent increase in daily range of flows, a 3,091 percent and 885 percent increase in high and low pulse flow counts, respectively, and >500 percent increases in both rise and fall rates (all compared to WOP).

Impairment of Trout Growth and Survival Rates: Comparison of the Keno, J.C. Boyle bypassed, and J.C. Boyle peaking reaches provides an indication of the impacts of the large flow fluctuations caused by PacifiCorp's hydroelectric peaking operations. Oregon Department of Fish and Wildlife's Fish Management Plan (1997) identifies the primary objective for these Klamath River reaches as wild trout management for the native redband/rainbow trout. Creel census information from Toman (1983) show that numbers of trout in the J.C. Boyle bypassed and J.C. Boyle peaking reaches were less than in the Keno reach and the size of fish was significantly larger in the Keno reach. This pattern is also demonstrated in the PacifiCorp report ((PacifiCorp 2005a)section 3.9.3, (Addley et al. 2005)) which showed that trout are significantly larger in the Keno reach. Further analysis by PacifiCorp indicates that the larger size of trout in the Keno reach is due to greater numbers of older fish and higher growth rates in older fish (Addley et al. 2005; PacifiCorp 2005a).

The bioenergetics analyses performed by Utah State University for PacifiCorp for the Project area best summarizes this aspect of peaking impacts (Addley et. al. 2005). This study assessed bioenergetics and trout growth based on empirical data from the J.C. Boyle peaking, J.C. Boyle bypassed, and Keno reaches. The bioenergetics foraging model compared trout growth under existing peaking conditions and two hypothetical scenarios: without-project and run-of-river. The predicted trout growth for both non-peaking scenarios significantly exceeded growth under existing conditions. These results support the findings from Anglin et al. (2005) that instability of flow translates into a significant energetic cost for fish.

Energetic Costs Decrease Trout Densities: Oregon Department of Fish and Wildlife research from 1988-91 (Buchanan et al. 1991; Hemmingsen et al. 1992; Buchanan et al. 1994) and the Final EIS for the proposed Salt Caves Project (FERC 1990) also noted low adult trout densities in the upper end of the peaking reach. The FERC EIS reported that trout in the upper peaking reach, where peaking impacts would be most visible, had relatively low growth rates and that large trout were under represented in the population age structure. The FERC EIS cited five years of investigation compiled by the City of Klamath Falls. The FERC EIS concluded that flow fluctuations below the J.C. Boyle powerhouse caused chronic stress on trout and stranding of eggs, fry, and juveniles. Stress occurred from daily flow fluctuations and related changes in water temperature and water quality. These flow fluctuations caused trout to continue to seek new feeding and resting habitat while water temperature changed metabolism and feeding rates.

Increased energetic costs of movement due to artificial flow fluctuations in the peaking reach are not modeled or considered as an explanation of differences between the Keno and peaking reaches in the Bioenergetics Report (Addley 2005). This is likely because the Flow Fluctuations Report ((PacifiCorp 2005a)page 35) de-emphasizes trout movements in the peaking reach caused by flow fluctuations. However, it is likely that trout have significantly increased energetic costs due to movements required to adjust to extreme flow fluctuations from hydroelectric peaking operations. The Flow Fluctuations Report (PC 2005) mentions observations of fish movements in a radio-telemetry study, but discounts their importance. In contrast, more extensive studies of trout activity patterns in the face of hydroelectric peaking operations indicate that significant movements are undertaken by fish (Pert and Erman 1994) that are likely to be energetically costly (Rincon and Lobon-Cervia 1993). PacifiCorp's characterization of the Pert and Erman (1994) study results is incorrect (PC flow fluct 2005, page 35), because, in their study, only some individual fish exhibited strong general site fidelity, and all individuals shifted their habitat preferences to deeper and faster water as discharge increased, likely increasing energetic costs significantly.

Secondary Production is Impaired, Food Availability for Trout is Decreased: Artificial flow fluctuations create a varial zone on the streambed that experiences alternating desiccation and rewetting. PacifiCorp's analysis estimated that peaking operations reduce the wetted perimeter of the peaking reach by 10 to 25 percent (PacifiCorp August 2005 flow effects). The extreme fluctuations in the varial zone significantly impact the benthic community leading to significant reductions in the biomass of algae and macroinvertebrates. PacifiCorp found a distinctly lower abundance and diversity of macroinvertebrates in the varial zone of the peaking reach than in adjacent constantly wetted sites (PacifiCorp Aug 2005 flow effects report and Addley 2005). This effect strongly reduces food availability to fish in the peaking reach, leading to smaller size fish than those found in the Keno Reach (PacifiCorp Aug 2005 flow effects report and Addley 2005).

A measure of food availability to trout, macroinvertebrate drift density, was measured in the three reaches and reported in the Bioenergetics Study (PacifiCorp Aug 2005 flow effects report and Addley 2005). Drift density was especially high in the Keno reach and low in the J.C. Boyle bypassed and peaking reaches. The Keno reach receives high amounts of nutrients that support primary and secondary production, yielding high macroinvertebrate densities. The J.C. Boyle bypassed reach receives few nutrients because the flows received from upstream are very low and the spring inflows are low in nutrients, yielding low rates of primary and secondary production. The J.C. Boyle peaking reach receives high amounts of nutrients from upstream (the hydroelectric flows are returned to this reach), but the effects of peaking on the varial zone reduce the ability of this reach to assimilate nutrients, limiting primary and secondary production.

PacifiCorp provided a Bioenergetics Report (Addley 2005) that analyzes the impacts of hydroelectric peaking on trout growth by comparing growth in different reaches of the Klamath River and by comparing growth with macroinvertebrate prey densities. The growth model accurately predicts existing condition growth in the peaking reach assuming observed drift density and no spawning. However, the model strongly underestimates growth in the Keno reach and strongly overestimates growth in the bypassed reach (Figure 47). Addley's analysis indicates that the higher drift density of invertebrate prey likely is responsible for some but not all of the higher growth rates in the Keno reach, and suggests that trout may be switching to more abundant or higher energy prey and/or migrating and modifying their temperature regime in later growth stages (page 34).

Fish Spawning and Incubation are Inhibited: There is no documentation of trout spawning in the Peaking Reach. However, it is not known whether this lack of spawning is due to the effects of hydroelectric peaking operations or that the Peaking Reach lacks any significant accumulation of traditionally suitable-sized spawning gravel. Limited spawning, that has not been observed, may occur and future management improvements such as gravel augmentation and anadromous fish reintroduction may result in increased spawning in the Peaking Reach by salmonids. Stage changes that occur during hydroelectric peaking cycles are quite large, and may be inhibiting spawning from occurring presently, and would likely dewater redds if spawning takes place during the higher flows of the peaking cycle.

Water Quality is Impaired: The large flow fluctuations associated with peaking hydropower operations limit the assimilative capacity of the river to remove hypereutrophic components of the water entering the system from upstream. Indeed, highly variable flow regimes limit the success of benthic species of algae due to repeated desiccation and rewetting of benthic environments in the river (PacifiCorp WQ modeling status report April 2005). Benthic algae are responsible for the removal of nutrients from the water column through assimilation. Without peaking operations, the Project reaches would provide stronger assimilation and removal of nutrients (PacifiCorp WQ April 2005). The Klamath River below Iron Gate Dam assimilates and removes nutrients due to uptake by algae and dilution from tributary streams (PacifiCorp WQ April 2005). Without peaking, the Project reaches of the Klamath River would likely remove nutrients more quickly, reducing the harmful effects associated with eutrophication of the Klamath River downstream.

Water Temperature Fluctuations are Greater: Another effect of peaking operations is that water temperatures likely exhibit greater diurnal fluctuations than they would without peaking. PacifiCorp provided water quality modeling results showing that, in the peaking reach, a steady flow alternative would provide slightly lower daily maximums and higher minimums, and a without project alternative would provide even lower daily maximums and similar minimums, in comparison to the existing condition (August 2005 Peaking study, p. 27 and Addley 2005). Research on rainbow trout has shown that large daily fluctuations in temperature compromise growth and survival rates (Hokanson et al. 1977). The thermal effects of peaking are a concern because temperatures in the summer months are at or above thermal tolerances for salmonids in the Project area, and the increase in diurnal fluctuations likely cause additional impacts.

Hydroelectric peaking operations cause much greater diurnal fluctuations in water temperature than would occur without peaking (PacifiCorp 2004 Water Res Tech Rep, 2005, August Peaking study). Daily temperature fluctuations of up to 12 EC occur in the J.C. Boyle peaking reach during the middle of the summer as a result of daily peaking events (City of Klamath Falls Oregon 1986; USDI Bureau of Land Management 2003). Daily water temperature fluctuations in the peaking reach were much less, ranging only 2EC, after peaking operations were stopped temporarily in September, 2002, in comparison to a range of 8EC shortly before (PacifiCorp 2004). BLM's (2003) analysis of water temperature data during this time period and in June, 2003, another time when peaking was stopped temporarily, showed that daily water temperature fluctuations are impacted by peaking because of the alternating prevalence of cool spring waters from the bypassed reach with peaking (BLM 2003). PacifiCorp provided water quality modeling results showing that, in the peaking reach, a steady flow alternative would provide lower daily maximums and higher minimums, and a without project alternative would provide even lower daily maximums and similar minimums, in comparison to the existing condition (August 2005 Peaking study, p. 27 and Bioenergetics report). Research on rainbow trout has shown that large daily fluctuations in temperature compromise growth and survival rates (Hokanson et al. 1977). The thermal effects of hydroelectric peaking are a concern because temperatures in the summer months are at or above thermal tolerances for salmonids in the Project area, and the increase in diurnal fluctuations likely cause additional impacts.

6. Instream Flows

Currently, PacifiCorp operates Link River Dam under contract with Reclamation. As stipulated under this contract, PacifiCorp operates Link River Dam and controls Upper Klamath Lake elevations to benefit its power generation. PacifiCorp's manipulation of Upper Klamath Lake elevations and Link River Dam releases are, however, subject to overall control by Reclamation to meet its obligations for the Klamath Reclamation Project. In addition, PacifiCorp manipulates reservoir elevations in Lake Euwana and discharges from Keno Dam to further enhance power generation below Keno Dam.

Based upon modeling results, water releases from Reclamation's Klamath Project (Link River Dam) would take 2-3 days to reach Iron Gate Dam if the hydroelectric Project did not act to reduce travel time. With the hydroelectric Project in place and operating, that same release would take a week or more to reach Iron Gate Dam. In addition, the hydroelectric Project impounds approximately 5,900 acre feet of potential storage. To date, the Applicant has been unclear and not entirely responsive in providing information on Project operations. However, it is clear from flow records that the Applicant makes use of storage to "shape" releases and has the ability to provide minimum flows, on a daily, weekly, or even monthly basis that differ from the real-time inflow from Link River Dam (Eureka Times-Standard 2003) (personal communication Todd Olsen).

<u>Recommendation:</u>

The Licensee shall operate the Project to provide flow releases that equal or exceed the following minimum flows for Project-affected reaches, below. Under especially dry conditions, these flows may not be available from upstream sources. In these unlikely events, all available flows will be provided to each reach.

- <u>Link River</u>: The Project proposal is to decommission East Side and West Side powerhouses. Accordingly, whether through agreement, contract or other device, the licensee shall, at all times, undertake measures, as necessary to operate hydroelectric facilities and any other controlling structures in a manner that avoids fluctuations in flow in the Klamath River and in so doing shall cease hydroelectric peaking, and load following operations for the protection of fish and wildlife resources in the Klamath River. Gages shall be installed where needed to appropriately monitor inflow, outflow and reservoir elevation from each facility. In the event that the Licensee reverses its decision to operate these facilities or FERC disapproves of the proposed decommissioning of East Side and West Side powerhouses, it will be necessary for NMFS to recommend instream flows to protect anadromous salmonids. Therefore, if the new License includes facilities and operations at the East Side and West Side developments, the Licensee shall consult with NMFS on a flow and facilities operations schedule that minimizes impacts on anadromous salmonids. NMFS reserves the authority to recommend flows for the protection of its trust resources.

- Keno Reach: The Keno facility shall be managed as a modified run of the river facility. Keno Dam shall not be used to re-regulate flows to peak at downstream Project facilities. On a 24 hour basis, the Licensee shall hold river flows below Keno Dam to within ±10 percent of the measured Project inflow. Project inflow shall be measured as the sum of the daily flow from Link River and the Reclamation projects including Straits Drain, Lost River, and North/ADY Canal.

- J.C. Boyle Dewatered Reach: As measured at the point of diversion, Licensee shall provide a minimum flow of 640 cfs in the J.C. Boyle dewatered reach. If inflow is less than 640 cfs, Licensee shall direct all inflows into the dewatered reach. If 40 percent of inflow is greater than 640 cfs, Licensee shall direct 40 percent of the inflow into the dewatered reach. Inflow shall be computed as a running average of flows at Keno gage (#11509700) added to flows at Spencer Creek gage (#11510000) during the prior three days.

- J.C. Boyle Peaking Reach: Licensee shall operate in a run-of-river mode. In so doing, the J.C. Boyle Dam and hydro development shall not be used to re-regulate flows to peak, or pond flows. At all times the Licensee shall operate facilities such that cumulative inflows equal downstream flows as measured immediately below the confluence of the powerhouse discharge and the dewatered reach. Project inflow shall be measured as the sum of the daily flow from Link River and the Reclamation projects including Straits Drain, Lost River, and North/ADY Canal.

- Copco 2 Dewatered Reach: Licensee shall provide a minimum flow of 730 cfs in the Copco 2 dewatered reach. If inflow is less than 730 cfs, Licensee shall direct all inflows into the dewatered reach. If 40 percent of inflow is greater than 730 cfs, Licensee shall direct 40 percent of the inflow into the dewatered reach. Inflow shall be computed as a running average of flows at J.C. Boyle Powerhouse gage (#11510700) added to a new gage to be installed at Shovel Creek, during the prior three days.

- Iron Gate Dam: In making its flow recommendations NMFS has fully considered all available information including the report titled: /Evaluation of Interim Flow Needs in the

Klamath River. Phase II. Final Report. /(Phase II). Based upon this review NMFS finds the flow schedule recommended in Phase II, with specific modifications as described in the Iron Gate Dam Flow Recommendations Rationale, represents the best available information on the instream flow based needs of anadromous salmonids and the aquatic ecosystem of the Klamath River upon which they depend.

However, based upon the current configuration of Project facilities, it is unlikely that the Applicant is capable of providing any appreciable flows in excess of Project inflow on a continuous basis. Project inflow is derived from a combination of tributary inflow, spring accretion flow, irrigation return flows and releases made by the U.S. Bureau of Reclamation (BOR) from its Klamath Irrigation Project. Of these sources, flows below Iron Gate Dam are largely controlled by Reclamation releases. Therefore, in order to ensure that Project inflows are delivered to aquatic resources below Iron Gate Dam without interruption or interference by the Licensee, NMFS recommends that the following language be included as a term and condition in the new License:

With the exception of biologically based pulse releases, the Licensee shall operate its facilities to ensure that the Project operates as a run-of-the-river facility. In so doing the Licensee shall make releases from its Iron Gate Dam facility that are equivalent to the combined instantaneous inflow to the project including tributary inflow, spring accretion flow, irrigation return flows and releases made by the U.S. Bureau of Reclamation (BOR) from its Klamath Irrigation Project.

<u>Ramp Rates at Iron Gate dam</u>
The Licensee shall attenuate flow fluctuations below Iron Gate Dam based on USBR's Klamath Irrigation Project 2003 Operations Plan (consistent with FWS and NMFS BO's):

1. Decreases in flows of 300 cfs or less per 24 hour period and no more than 125 cfs per 4 hour period when IGD flows are above 1750 cfs.
2. Decreases in flows of 150 cfs or less per 24 hour period and no more than 50 cfs per 2 hour period when IGD flows are at 1750 cfs or below.

<u>Justification:</u>

Establishing minimum flows in dewatered and other Project-affected reaches is critical to restoring the physical and ecological processes that influence aquatic and riparian habitat conditions in the Klamath River. Flow restoration will sustain well-connected and functional riparian and aquatic habitats to which the native aquatic and riparian communities are adapted. Under the present license, PacifiCorp may divert all stream flow from the Link River and Klamath River during much of the year except during spring high flows. Frequent flow oscillations in the Keno Reach and daily peaking in the J.C. Boyle Peaking Reach cause many fold differences in stream flows for fish and other aquatic life. As a consequence, much of the natural streambed is exposed or rendered marginal for support of aquatic life. A small amount of streamflow remains in the diverted, regulated and peaking reaches at a time of the year when maximum biological production should occur. The original license favored power production to the great detriment of aquatic life. To correct this imbalance, minimum flows will provide significant increases in required flows in the dewatered and regulated reaches to support aquatic life and to improve water quality.

Development of Flow Recommendations

NMFS recommends implementing an instream flow regime based on the best available information in order to meet the objective of restoring instream habitat for fish in the Project reaches. The Instream Flow Council (IFC) recommends developing instream flow prescriptions that address five riverine components: 1) hydrology; 2) habitat; 3) geomorphology; 4) water quality; and 5) connectivity (Annear et al., 2004). The Project operations and facilities, coupled with upstream land and water use, have profoundly impacted all five of these components. As a result, data must be carefully evaluated in the context of multiple interacting parameters. No one tool should be considered definitive, but rather employed in conjunction with other sources of information to provide perspective and guidance in developing recommendations.

The IFC also notes that utilizing a percentage of unimpaired hydrology can serve as a robust and reasonable starting point in preparing a flow recommendation where site specific data is problematic (page 161, Annear et al., 2004). The caveat to using this standard setting approach is the need to augment it with site specific assessments of how biological and geomorphic processes respond to flow. This essential validation phase provides the rationale for the adaptive management component of our recommendation.

Two aspects of using a percentage of inflow approach lend themselves to the Project in particular. First, this approach translates into a simple and direct flow prescription. Requiring PacifiCorp to bypass a percentage of inflow eliminates the confounding complexities of multiple other water users and regulators in the upper Klamath basin. Second, this approach provides flexibility to accommodate ongoing watershed restoration. Interior and many other stakeholders are actively working towards enhancing instream flows in the Klamath River through efforts such as wetland restoration and water conservation. By avoiding a static flow prescription, this approach will allow impacted resources to benefit from future restoration initiatives both within and upstream of the Project.

We recommend a minimum flow in each mainstem Project reach that equals 40 percent of the mean annual inflow for that reach. The recommended minimum flow releases based on 40 percent of the mean annual inflow are summarized in the table below.

Table 1. Flows that would result from implementing Minimum Flow Requirements for Mainstem Reaches Based on 40 Percent of Mean Annual Flow as Measured at USGS Gages (1961 through 2004)

Mainstem Project Reach	Required Minimum Flow (cfs)
Below Link River dam	run-of-river

Below Keno dam	run-of-river
Below J.C. Boyle dam (a.k.a. Boyle dewatered reach)	640
Below J.C. Boyle powerhouse (a.k.a. peaking reach)	run-of-river
Below Copco 2 dam (a.k.a. Copco dewatered reach)	730

Moving downstream, the required minimum flows gradually increase reflecting accretion from tributaries and springs and mimicking the natural hydrologic pattern of the mainstem Klamath River.

The recommended reservation of at least 40 percent of the mean annul flow is supported by the hydrologic methods proposed by Tennant (1976), Tessman (1980), Estes and Orsborn (1986), and the IFC (Annear 2004). Reserving at least 40 percent of the mean annual flow for aquatic resources is also supported by site specific information from the PHABSIM results, wetted perimeter analysis, an unimpaired hydrology approach, and water temperature modeling information (see discussions below). In his study of 11 streams in Montana, Nebraska, and Wyoming, Tennant (1976) found empirical support for the Montana Method, which recommends base flows that provide good survival conditions for most aquatic species. Tennant recommends base flows of 40 percent of the mean annual flow received under unimpaired conditions to provide "outstanding" habitat from October to March and "good" habitat from April to September (Tennant 1976).

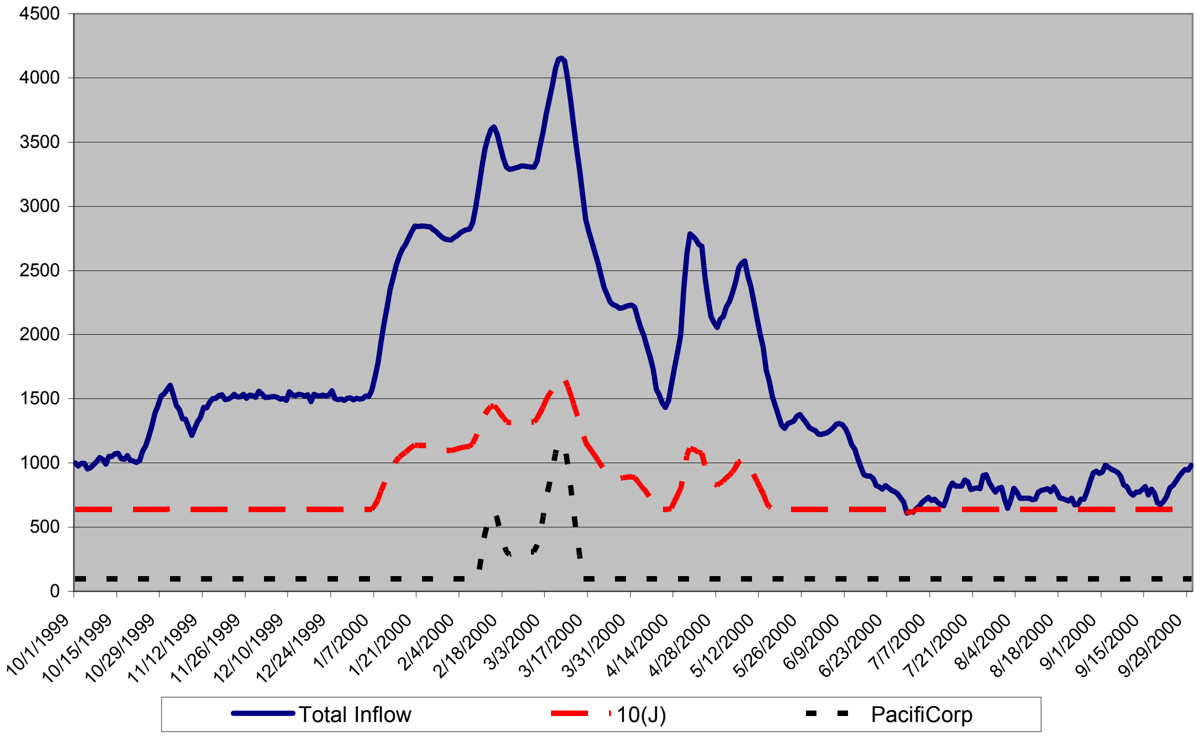
Seasonal flows above the 40 percent minimums will take place in all of the mainstem Project reaches except the dewatered reaches, where most higher flows are diverted to the powerhouses. In order to promote a more natural hydrologic pattern in the dewatered reaches, we decided to use a modified Montana method as utilizd by Tessman (1980). Tessman (1980) modified the Montana Method by using either 40 percent of the mean annual flow or 40 percent of the mean monthly flow, whichever was greater. This modification represents an important improvement over the traditional "flatline" Tennant flow requirement and provides intra-annual variability during the wetter part of the year. We adapted the Tessman approach to the two dewatered mainstem reaches by requiring either: 1) 40 percent of mean annual flow or 2) 40 percent of the three day running average, whichever is greater below the J.C. Boyle and Copco 2 dams. Our approach uses a smaller time step than Tessman, 3 days instead of monthly, to provide for more frequent variations, facilitate Project operations, and accommodate the relatively small storage capacity of the Project reservoirs.

There is a long history of competing water uses in the Klamath basin. Upstream storage and diversions have impacted flow into PacifiCorp's Project since construction. As a result, we do not have access to an "unimpaired" hydrograph. We do have access to USGS gage data over an extended period of record (i.e. the past 44 years), that includes a range of water year types as well as a variety of regulatory constraints. This record of what has actually been delivered to the PacifiCorp Project provides the foundation for the recommended minimum base flows in the dewatered reaches. By using 40 percent of the mean annual flow received by PacifiCorp over 44 years, we have recommended minimum flows that will, on average, be available to the Applicant.

We acknowledge that during drier months and drier water year types, these flows will not always be available. This is not unique to the Klamath. As Tessman notes, "There will be circumstances when the actual flow is less than the minimum flow value. The minimum flow is not intended to suggest that stream flow should be augmented when naturally occurring flows are less. Minimum flows simply serve as a constraint on withdrawal." (Tessman, 1980, p. 7-8). In instances when the minimum release of 40 percent of the mean annual flow is not available, Tessman recommends releasing a flow equal to the mean monthly flow into dewatered reaches. Under our recommendation, whenever the three day running average drops below the required minimum releases, diversion at that facility shall cease and all inflow be directed to the respective dewatered reach.

See Figure 1 for an illustrated comparison of the current PacifiCorp operations and the Tessman variation we are recommending pursuant to Section 10(j) in the dewatered reach below J.C. Boyle dam. The flow data for this illustration comes from Water Year 2000, an average water year.

Figure 1
Comparsion of Flows Below JC Boyle Dam Using WY 2000



PHABSIM Results: Physical Habitat Simulation (PHABSIM) is a method of assessing the habitat values that channels currently provide at different flows to assist with setting flow standards (Annear et al. 2004). A limitation of the PHABSIM model is that it does not predict the effects of flow on channel change (Annear et al. 2002). The Applicant conducted a PHABSIM analysis for the dewatered reaches and the Peaking Reach (PacifiCorp April 2005 HSC report), but limited their analyses to non-anadromous species (only redband/rainbow trout and suckers). The Applicant also chose not to utilize the analytical cover algorithm recommended by ODFW and CDFG instream flow specialists (see letters from California Department of Fish and Game dated October 21, 2004 and August 8, 2005; and from Oregon Fish and Wildlife Department dated November 4, 2004 and August 12, 2004). Instream flow analysis for anadromous species would be appropriate because the resource agencies plan to pursue reintroduction of anadromous species into the Project reaches.

The PHABSIM analysis conducted by the Applicant in the Klamath River reflects the results of a highly modified flow alteration and impacts on channel shape in the regulated dewatered and peaking reaches. The combination of 4 major factors, 1) Project flow alteration, 2) lack of gravel recruitment, 3) lack of seasonal flood flows, and 4) growth of riparian vegetation either along the low flow channel of dewatered reaches or at the high water mark of the peaking reach, result in highly modified channels. The Weighted Usable Area (WUA) relationships with flow for rainbow trout presented by Applicant in their April 2005 addendum to the instream flow study are remarkably flat, indicating that microhabitat is unresponsive to changes in flow. While the total surface area appears to be reasonably correlated with flow, the amount of suitable habitat remains very low (ranging from less than one to less than ten percent of total surface area), regardless of flow.

Currently the Project-affected dewatered and peaking reaches do not provide productive habitat to sustain the native redband population. While the PHABSIM relationships to flow may reflect existing microhabitat changes with respect to flow, they are not the kind of natural productive stream channels that provide good fish habitat. Our goal is to restore good fish habitat to these channels, at which time the PHABSIM relationships should change. Therefore, the current PHABSIM relationships have limited utility in assisting with setting flow recommendations at this time.

The Applicant's WUA curves are relatively flat because the aquatic habitat has been impacted by flow alteration. The "peaks" in the WUA curves are not meaningful for determining flow recommendations since the WUA curves are so broad over the range of flows. However, many of the WUA curves demonstrated that as flow is increased, habitat increases for fry, particularly as flows reach edge habitat provided by shoreline riparian vegetation. The fry stage is likely one of the more important life stages to manage for because this life stage determines successive productivity in subsequent life stages and may ensure the best potential for all 3 stages. The PHABSIM does not conduct a cohort analysis but evaluates the microhabitat found at different flows for each life stage. The fry stage appears to be the most impacted by flow regulation. For example, these are demonstrated in the following 2 WUA curves for redband trout fry for the J.C. Boyle dewatered and peaking reaches.

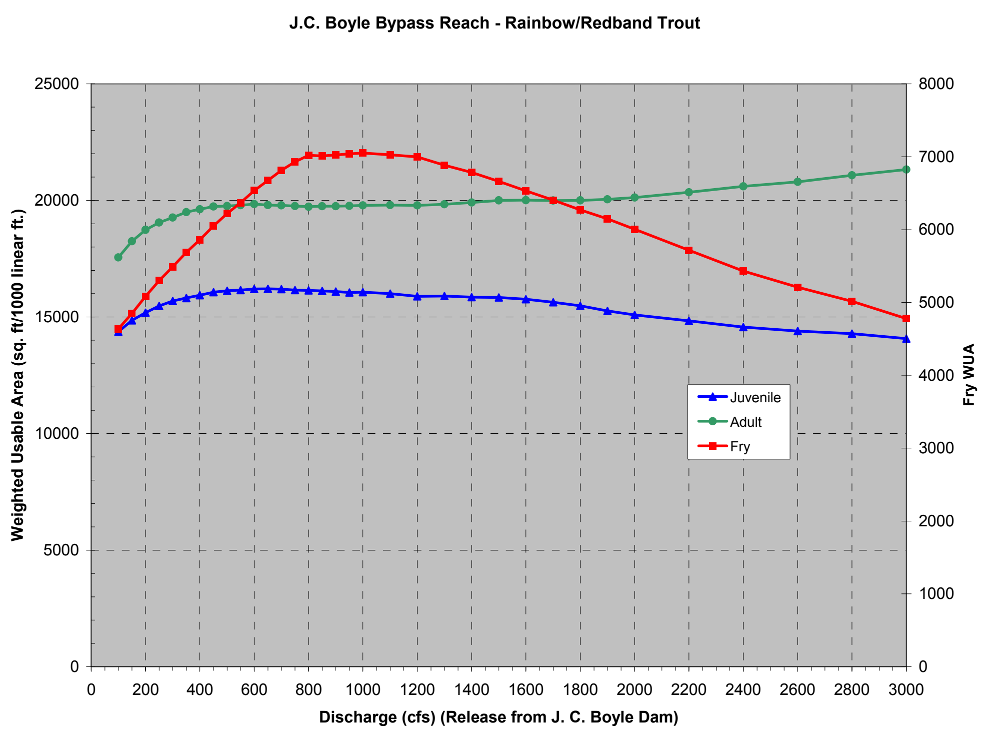


Figure 2. Weighted Useable Area (WUA) curve for redband trout in the J.C. Boyle dewatered reach (from PacifiCorp 2005 HSC).

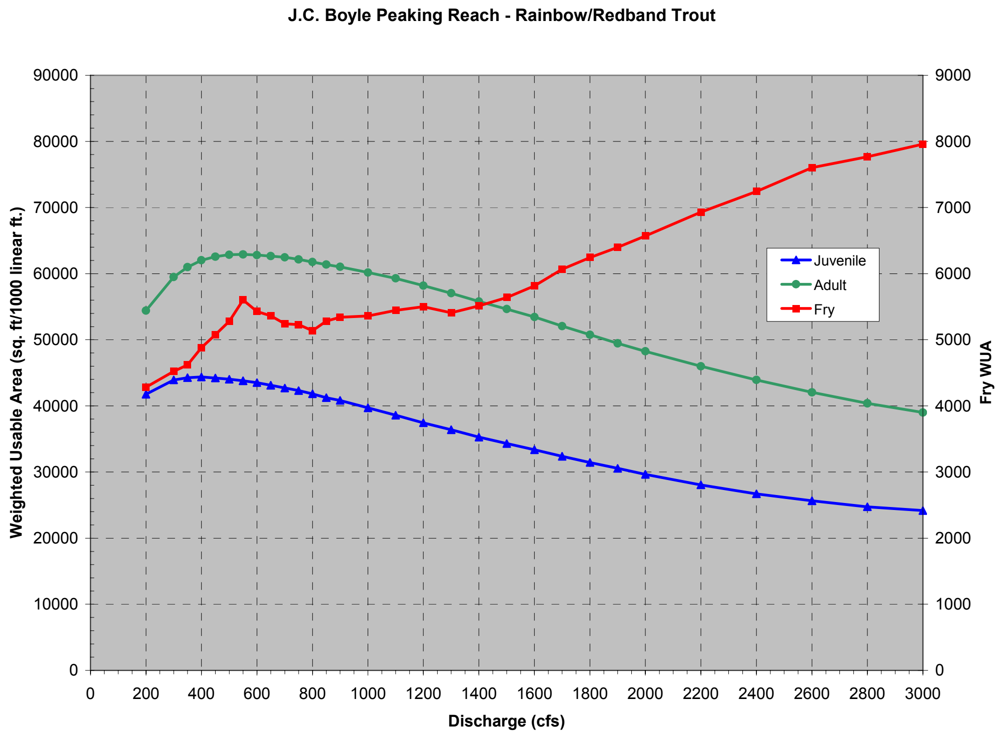


Figure 3. Weighted Useable Area (WUA) curve for redband trout in the J.C. Boyle peaking reach (from PacifiCorp 2005 HSC).

The results of the two PHABSIM studies BLM (2002) and PacifiCorp (2005) conducted in the J.C. Boyle peaking and dewatered reaches document that almost 50 years of flow alteration has impacted fish habitat and that there is very little fry habitat. Peaking operations below J.C. Boyle powerhouse scour river margins and have reduced fry habitat to virtually zero on a daily basis (USDI Bureau of Land Management 2002)

J.C. Boyle Dewatered Reach: In the case of the J.C. Boyle bypass reach, Project operations have reduced flow to a fraction of historic flows, and truncated flood flows, preventing ecological functions of scour and deposition, and a natural seasonal hydrologic regime. Meanwhile the dam has prevented gravel recruitment, resulting in a modified channel with riparian vegetation that is growing at the low flow of 100 cfs from the dam to the springs and approximately 320 cfs below the spring input to the powerhouse. At the same time, because of lack of channel and riparian function, non-native Reed canary grass out competes the native species and dominates the riparian habitat. In the J.C. Boyle dewatered reach, a minimum flow release of 6 percent of the mean annual flow has facilitated the invasion of exotic species, encroachment of riparian vegetation and transformation of a major river into a wadable stream.

J.C. Boyle Peaking Reach: In the case of the peaking reach, flows change daily just below the powerhouse from a low flow of approximately 300 to either a high flow of 1,500 cfs (1 turbine) or 3,000 cfs (2 turbines). The PHABIM analysis shows that WUA for fry occupies generally less than 5 percent of the habitat provided and generally increases as flow increases. Lack of fry habitat overlaid with a daily peaking flow indicates why very few fry survive in the peaking reach. Because the reaches are so impaired by flow alteration, fry is the first but not only life stage impacted.

Copco 2 Bypass Reach: The riparian encroachment of large alder trees in the riverine channel is reflected in the WUA curves for fry habitat. The peak of fry habitat at 50-100 cfs is generally located where the encroached riparian vegetation is inundated and creates edge habitat. In the dewatered Copco 2 bypass reach, the minimum flow release of 10 cfs is less than 0.5 percent of the mean annual flow and has transformed a major river into a wadable stream and boulder field. Almost 100 years of flow alteration has created an artificial channel that limits the applicability of PHABSIM WUA curves for developing appropriate instream flows. The riparian encroachment of large alder trees in the riverine channel creates fry habitat at much lower flows than would have naturally occurred in the channel.

Wetted Perimeter Analysis: The Applicant also conducted a wetted perimeter analysis in the peaking reach (PacifiCorp 2005). The Applicant's analysis of wetted perimeter in the J.C. Boyle peaking reach was limited to a comparison of the peaking cycle base flow (lowest flow reached during a peaking cycle) against a single, assumed continuous flow under undefined "Run of River" (ROR) flow regime (Figure 3). However, the full range of peaking impacts occurs over the lowest to highest flows occurring during peaking cycles, including both single- and two-turbine operations, with a range of approximately 350 cfs to 1500 cfs and 350 cfs to 3000 cfs. The wetted perimeter analysis in the peaking reach indicated that the percent of wetted perimeter change for a single turbine peaking operation is 32 percent for all types of habitat and 47 percent in riffle habitats. Over the range of two-turbine peaking operations the changes are 48 percent and 61 percent, respectively. These are very substantial changes and represent severe dewatering of the channel bed on a daily basis due to peaking.

Inflection points on the wetted-perimeter analysis indicate areas of rapid changes, especially in sensitive habitat types and/or specific areas within those habitats. Representation of an overall average curve does not adequately permit examination of these changes as they are obscured when combined with all the non-sensitive areas. The greatest amount of wetted perimeter change occurs over the range of 350 to 800 cfs, indicating the highest degree of impact in this range. Figure 4 suggests that the flow in the peaking reach should generally range above 700 – 800 cfs in order to avoid the most extreme dewatering and associated impacts, i.e., in the approximate range of the inflection point in average wetted perimeter. Based on these criteria, the recommended minimum flow of 720 cfs for the peaking reach provides a reasonable amount of suitable habitat during the drier periods of the hydrograph.

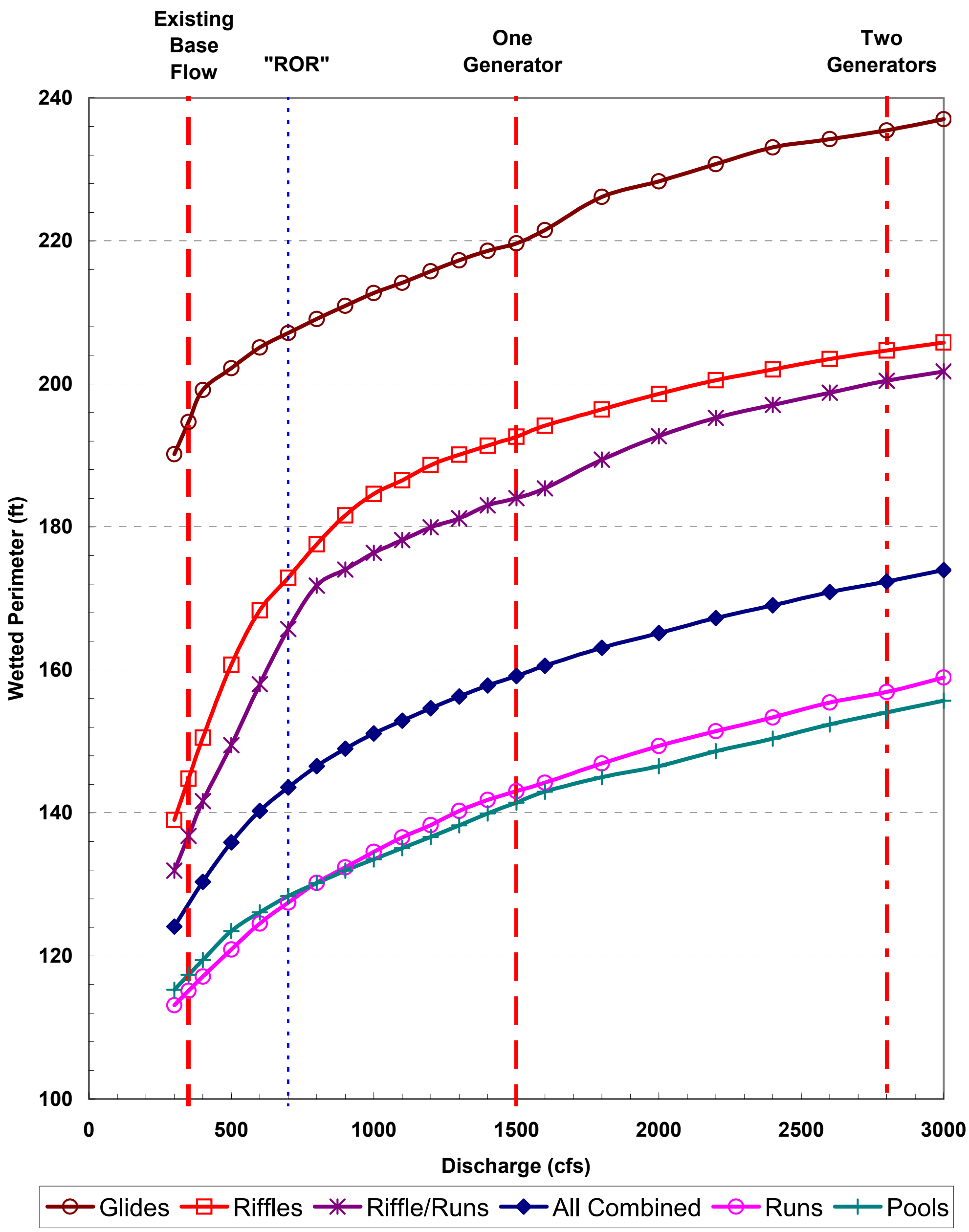


Figure 4. Wetted perimeter versus discharge for all habitat types in the J.C. Boyle peaking reach (from PacifiCorp 2005).

Flow Recommendation for the Link River: In the event that Eastside and Westside diversions are not decommissioned, we will recommend a minimum flow below Link River Dam. Redband trout and federally listed suckers are currently impacted by low flows and ramping fluctuations that de-water the Link River below Link River Dam. Restoration of flows will substantially improve habitat and water quality for these native fish species and for anadromous salmonids and lamprey.

In addition, the US Bureau of Indian Affairs (BIA) also conducted a PHABSIM analysis in the Link River and Keno reaches. The BIA filed on behalf of the Klamath Tribes a claim for anadromous fish flows of 700 cfs from January to December. The Proof of Claim submitted to the Oregon Water Resources Department (OWRD) for the Use of Surface Waters of the Klamath River and Tributaries for BIA (April 1997) requested a natural flow up to 700 cfs year round from Upper Klamath Lake to Lake Ewauna. The Proof of Claim also stated that the flow claims were developed based on IFIM, and the flows will provide conditions to ensure adequate migratory passage of anadromous salmonid fishes into and out of the Upper Klamath River Basin.

Flow Recommendation for the Keno Reach: We propose run-of-river operations. This flow recommendation is to provide greater protection and greater certainty of flows for fish and aquatic life in the Keno reach of the Klamath River. Flows received at Keno Dam are a combination of flows from Link River and irrigation return water from canals downstream from Link River that return water to Lake Ewauna. Reclamation controls these flows and calculates estimates of accretions between Link River and Iron Gate Dam to total their Biological Opinion obligations for coho downstream from Iron Gate Dam.

Similar to the Link River discussed above, increasing the minimum base flow by implementing run-of-river will substantially restore aquatic and riparian resources toward a more natural condition that supports salmon and steelhead, redband trout and suckers. The BIA conducted a PHABSIM analysis in the Link River and Keno reaches. The BIA filed on behalf of the Klamath Tribes a claim for anadromous fish flows of 700 cfs from January to December. The Proof of Claim submitted to the OWRD for the Use of Surface Waters of the Klamath River and Tributaries for BIA (April 1997) requested a natural flow up to 700 cfs year round from Upper Klamath Lake to Lake Ewauna, Keno Dam to J.C. Boyle Reservoir, and J.C. Boyle reservoir to the Oregon/California border. The Proof of Claim also stated that the flow claims were developed based on IFIM, and the flows will provide conditions to ensure adequate migratory passage of anadromous salmonid fishes into and out of the Upper Klamath River Basin.

Flow Recommendation for the J.C. Boyle and Copco No. 2 Dewatered Reaches: Tennant (1976) found that a base flow equaling 40 percent of the mean annual flow, as estimated from an unimpaired hydrologic record, provides good quality aquatic habitat in the 11 stream systems he studied, and that higher percentages of the mean annual flow would provide greater benefits to aquatic life. Tennant conducted detailed field studies on 11 streams in Wyoming, Montana, and Nebraska to assess the degree that aquatic resources are supported by various base flows to make his determination (Tennant 1976). Tessman (Tessmann 1980), (Estes 1984; Estes 1998), and others have adapted Tennant's percentages of mean annual flows to provide a more natural pattern of variation of flow recommendations, as suggested by the Instream Flow Council (Annear et al 2004). We recommend flow prescriptions in the Project reaches in a similar manner.

We base our recommendations on a 44 year hydrologic record of flows impaired by the Hydroelectric Project, Reclamation's irrigation project, and other irrigation projects in the upper Klamath Basin. Given that this record is not a natural pattern of hydrology for the basin, we cannot support a minimum flow recommendation of less than 40 percent of the mean annual flow. While Tennant noted that, based on his research, 30 percent of the mean annual flow using an "undepleted" hydrology could provide good habitat for a portion of the year, we find that the higher percentage is appropriate for the highly regulated Klamath River.

We adapted the Tessman approach to provide natural variation on both an intra and inter annual basis for the dewatered reaches. We recommend providing the two dewatered reaches with either a minimum based on 40 percent of the mean annual flow or 40 percent of the three day running average of inflow, whichever is greater to achieve a more natural pattern of variability after Tessman (1980). The inflow for the dewatered reaches shall be estimated using a running average of gaged inflow for the prior three days in order to smooth out some of the unnatural variability in the hydrologic pattern, while providing for reasonable tracking of natural fluctuations.

Comparison with PHABSIM Results: The recommended minimum flows of 640 cfs in the J. C. Boyle Dewatered Reach and 730 cfs in the Copco 2 Dewatered Reach are supported by the Applicant's PHABSIM results in that they would provide approximately 95 percent, 100 percent, and 93 percent of maximum WUA for fry, juvenile, and adult redband/rainbow trout, respectively, in the Boyle Dewatered Reach and 95 percent, 98 percent, and 87 percent of maximum WUA for fry, juvenile, and adult redband/rainbow trout, respectively, in the Copco 2 Dewatered Reach.

Comparison with Unimpaired Hydrology and Tennant Approach: Another line of evidence in support of the minimum recommended flows utilizes the recently developed Natural Flows of the Upper Klamath River (USDI Bureau of Reclamation 2005). The Tennant method recommends a minimum of 30 percent of unimpaired or natural flows be used as a base flow to provide good aquatic habitat conditions. Reclamation's Natural Flows provide a 51 year hypothetical record of the flows at Keno Dam under natural, unimpaired conditions. The mean annual flow using this hypothetical record is 1,810 cfs at Keno Dam. Accretions from the Keno gage to J.C. Boyle Dam and Copco 2 Dam were estimated from the actual 44 year gage records (Nancy Parker, pers. comm.) and added to this hypothetical mean annual flow, yielding an estimated mean annual flow at J.C. Boyle Dam of 1,844 cfs and 2,074 cfs at Copco 2 Dam. Our recommended minimum flows in these dewatered reaches are 34.7 percent and 35.2 percent of the mean annual unimpaired flows estimated in this way. These methods provide good validation of the minimum flows we selected.

Water Temperature Considerations: The Boyle dewatered reach currently has cool water temperatures due to a large volume (~220 cfs) of cold water springs that supply 11-12EC water combining with only 100 cfs of warmer water inflows. Increasing flows in this reach will warm water temperatures because the J.C. Boyle Reservoir releases are relatively warm. The thermal history of redband trout appears to influence thermal tolerances of local populations (Behnke 1992; Zoellick 1999). Redband trout have an enhanced capacity to function at warmer temperatures than most salmonids (24E C) (Rodnick et al. 2004). Because redband/rainbow trout are doing well at higher temperatures in the Keno reach, increased flows in the Boyle dewatered reach are not likely to result in adverse effects due to temperature on redband/rainbow trout.

Anadromous salmonids are more sensitive to warm water temperatures than redband/rainbow trout. Maximum recommended temperatures for salmonids are 16 – 18 EC depending on the life stage (EPA 2003). However, Torgersen et al. (Torgersen et al. 1999) showed that spring Chinook salmon can persist in rivers with high water temperatures (greater than 25EC) by seeking thermal refugia during warmer periods. Indeed, adult spring Chinook salmon migration in the Klamath River Basin was inhibited when mean daily river temperatures equaled or exceeded 22EC, at which time they would seek out and reside in thermal refugia (Strange 2003), and juvenile salmonids heavily utilize thermal refugial areas during July and August in the lower Klamath River (Belchik 1997; Belchik 2003). Belchik (2003) found that thermal refugia in the lower Klamath River varied greatly in size, and are significant components of anadromous fish restoration on the Klamath (also see NRC 2003). The springs in the Boyle Dewatered Reach will likely provide important thermal refugia for migrating anadromous salmonids when they are reintroduced.

The level of increased flows recommended here is not likely to adversely affect thermal conditions for reintroduced anadromous salmonids because results of the Applicant's water quality model indicate that water temperatures are only moderately increased with releases of 600 to 800 cfs in the J.C. Boyle Dewatered Reach (M. Deas presentation, PacifiCorp Water Quality Meeting, March 4, 2004). Temperature conditions are only critical in the months of July and August, when flows are unlikely to exceed 800 cfs in the Boyle Dewatered Reach under our flow recommendations. The addition of flows to this reach would improve food availability to this important thermal refugial area and increase habitat quantity available, and restoration of the natural hydrologic patterns will help to sustain native biodiversity and river ecosystem functioning as recommended by a variety of ecological researchers (National Research Council 1992, Poff et al. 1997).

Flow Recommendation for J.C. Boyle Peaking Reach: In the J.C. Boyle Peaking Reach, recommended flows equal 40 percent of the estimated mean annual flows entering the reach using a 44 year record of gage data and adjustments for accretions between gages (Nancy Parker pers. comm.). This percentage provides a continuity of minimum flows from reach to reach down the Klamath River through the Project. Flows in this reach above the recommendation are expected to approximate a natural pattern due to the run-of-river mode of operations recommended at this facility.

Project inflow is derived from a combination of natural flow, tributary inflow, spring accretion flow, irrigation return flows and releases made by Reclamation from its Klamath Irrigation Project. To date, PacifiCorp has been unclear and not entirely responsive in providing information on Project operations. However, it is clear from flow records that PacifiCorp uses storage to "shape" releases and has the ability to provide minimum flows, on a daily, weekly, or even monthly basis that differ from the real-time inflow from Link River dam. The recommended minimum flow releases in conjunction with run-of–river operations constitute a flow regime that 1) protects aquatic resources whenever PacifiCorp has operational discretion and 2) acknowledges that "fish flows" will not always be available for release by PacifiCorp.

The recommendations for minimum flow releases and operations at Iron Gate illustrate blending of natural resource requirements with existing hydrologic constraints. Given current conditions, inflow to Iron Gate reservoir often drops below the recommended minimum flow releases presented in Table One during the irrigation season. Once the "normal active storage" within Iron Gate reservoir is depleted and reservoir elevation drops to below 2,322 ft msl, PacifiCorp will begin to loose the ability to sustain releases in excess of inflow. Under these circumstances, PacifiCorp's operations at Iron Gate would convert to run-of-river, with outflow equal to the three day running average of inflow. Taken together, these recommendations address aquatic resource needs to the extent feasible while allowing flexibility to accommodate changing hydrologic or facility constraints.

Flow Recommendation for Downstream of Iron Gate Dam:

At Iron Gate Dam 100 percent of flows below 1,735 cfs go through penstocks and powerhouse. Flows in excess of 1,735 cfs are spilled. The FERC ramp rate is 250 cfs or 3 inches per hour whichever is less. More recently, the NMFS Biological Opinion for coho revised the ramp rates to 125 cfs per hour and 300 cfs per 24 hours when flows are greater than 1,750 cfs and 50 cfs per 2 hours and 150 cfs per 24 hours when flows are 1,750 cfs or less.

Project inflow is derived from a combination of natural flow, tributary inflow, spring accretion flow, irrigation return flows and releases made by Reclamation from its Klamath Irrigation Project. To date, PacifiCorp has been unclear and not entirely responsive in providing information on Project operations. However, it is clear from flow records that PacifiCorp uses storage to "shape" releases and has the ability to provide minimum flows, on a daily, weekly, or even monthly basis that differ from the real-time inflow from Link River dam. The recommended run-of–river operations constitute a flow regime that 1) protects aquatic resources whenever PacifiCorp has operational discretion and 2) acknowledges that "fish flows" will not always be available for release by PacifiCorp.

In considering flows in the future, NMFS suggestions differ from run-of-river flows under some water year types for August and September. In order to address the risk of disease to adult salmonids during the late-summer/early fall period, CDFG recommended in their 2004 report on the Klamath River 2002 Fish Die-Off a combined flow at the Orleans and Hoopa gages of 2200 CFS as a minimum to reduce the risk of a disease outbreak. Similarly, The Yurok Tribe recommended in their 2004 Die-Off report a minimum flow of 2500 CFS.

Impacts of Diversion of Instream Flows

PacifiCorp diverts a high proportion of the instream flow at each Project Facility (from PacifiCorp 2004):

- Link River: Diversions at Eastside and Westside appropriate up 1200 and 250 cfs, while the bypass flow is 90 cfs below Link River Dam. Since the USFWS Biological Opinion was adopted for federally listed suckers in 2001, the bypass flow recommendation was increased to at least 250 cfs from June to October when needed.
- Keno Reach: Flows generally range from as low as 200 cfs up to 1700 cfs during the summer although there is no generation at Keno dam. Flows at Keno Dam are regulated to maximize generating efficiency at J.C. Boyle and downstream peaking facilities and also to keep the Keno pool within one foot of the high water mark to allow irrigation pumping facilities to operate. PacifiCorp did not conduct an instream flow study in this reach.
- J.C. Boyle: Diversion at J.C. Boyle Dam appropriates up to 3,000 cfs while the bypass flow is 100 cfs below the Dam. Spring inflow approximately half way down the

dewatered reach adds an additional 220 cfs for a total discharge of approximately 320 cfs from the bypass reach.

- Copco 1: At Copco 1 Dam 100 percent of the instream flow below 3,200 cfs goes through the penstocks and powerhouse.
- Copco 2: Diversion at Copco 2 Dam is 97 percent of the instream flow below 3,200 cfs. The bypass flow is 5 to 10 cfs below Copco 2.
- Iron Gate: At Iron Gate Dam 100 percent of flows below 1,735 cfs go through penstocks and powerhouse. Flows in excess of 1,735 cfs are spilled.

PacifiCorp's Project substantially alters and reduces flow regimes within and downstream of the FERC Project boundary. Reduction of stream flows substantially reduces the quantity and quality of stream habitat for aquatic and riparian organisms and adversely affects fish resources. The Project has altered the natural flow regime in the dewatered reaches (PacifiCorp 2004) and current minimum flows do not provide adequate flows for fish and other aquatic organisms (see below). Both the project-affected bypass and peaking reaches flow regimes have been highly modified from their natural states which can have detrimental effects on native fish populations.

The literature consistently illustrates the adverse effect of inadequate flow on aquatic organisms (see (Annear et al. 2004)). Research also indicates that beyond prescribing a minimum flow, managers should determine an appropriate flow regime based on season and water year type (see Richter, B.D., et al, 1997 and Stanford, J.A., et al, 1996). The artificial manipulation of flow without reference to a baseline hydrograph can profoundly impact habitat and fish communities (Poff and Allan 1995). The flow regime proposed by the Applicant perpetuates significant peaking and dewatering operations and will not protect native salmonid habitat from future adverse impacts. Instream flows are recommended in all Project-affected reaches to protect and restore native fish species, move the reaches toward a more natural flow regime, and restore and reconnect riparian, wetland and aquatic species.

In addition to altering water quantity, the Project contributes to the degradation of water quality in the Klamath River. Preliminary water quality modeling results indicate that Project dams such as Keno, J.C. Boyle, Copco No. 1 and Iron Gate impact water quality by slowing and storing water, increasing retention time and solar exposure, and shifting thermal regimes and nutrient cycling. The Project facilities and operations exacerbate already significantly impaired water quality conditions in the Klamath River. Restoration of flows to more natural conditions will help to improve water quality conditions in each reach (see below).

Project Impacts in Link River Reach: The Link River is impacted by Project operations that chronically turn on and off East and West side diversions located at Link River Dam (see Figure 5, below). These fluctuations result in impacts to fish and aquatic resources similar to those described for hydroelectric peaking (see hydroelectric peaking effects, recommendation for run of river operations). The minimum flow requirement below Link River Dam is 90 cfs. During site visits in recent years, such as the PacifiCorp-led tour on September 26, 2000, barely an estimated 25-30 cfs was flowing downstream from the dam, primarily dam leakage and flow via the fish ladder.

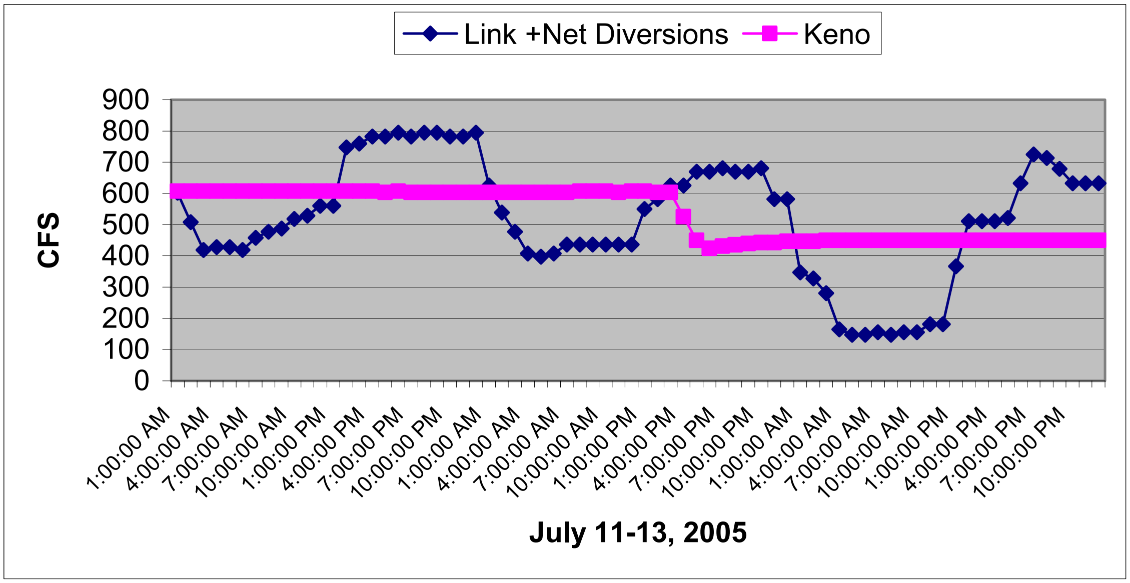


Figure 5. Comparison of flows in Link River, including net diversions from Reclamation Irrigation Project facilities, and below Keno Dam, during July 11-13, 2005.

Project Impacts in Keno Reach: The minimum flow requirement below Keno Dam, per FERC article 58 and ODFW agreement is 200 cfs. PacifiCorp states that flows below Keno Dam, in the Keno Reach are dependent entirely on what is delivered to the Keno Reservoir by Reclamation and other irrigation operations and that PacifiCorp has no discretion or control over flows in the Keno Reach. This is contradicted by the fact that 80 percent of the inflow to Lake Ewauna is from Link River while approximately 20 percent is from agricultural returns with a very small amount from municipal and industrial inputs (PacifiCorp 2004, FLA WTR). PacifiCorp can and does alter flows in the Link River and Keno Reach for hydroelectric Project purposes, including maintenance actions, and to maximize peaking at downstream Project peaking facilities.

Keno Dam is operated to maintain a constant water surface elevation of Keno Reservoir with fluctuations of only 0.5 foot (PacifiCorp 2004 FLA Water Res Rep). The steady reservoir elevation allows Reclamation to manage its irrigation water through its diversion channels from Keno reservoir, and enables PacifiCorp to more effectively plan downstream load following operations at the J.C. Boyle powerhouse (PacifiCorp 2004 FLA Water res rep). Flow fluctuations can vary greatly from hour to hour and day to day (see PacifiCorp 2004, Fig. 5.7-11).

While the Keno Reach is not as severely impacted as the dewatered or peaking reaches downstream, flows are ramped up and down to re-regulate flows to maximize peaking at downstream facilities and to regulate incoming flow from Reclamation irrigation. Flows generally range from as low as 200 cfs to over 1000 cfs during the summer although there is no generation at Keno dam (see Figure 6, below).

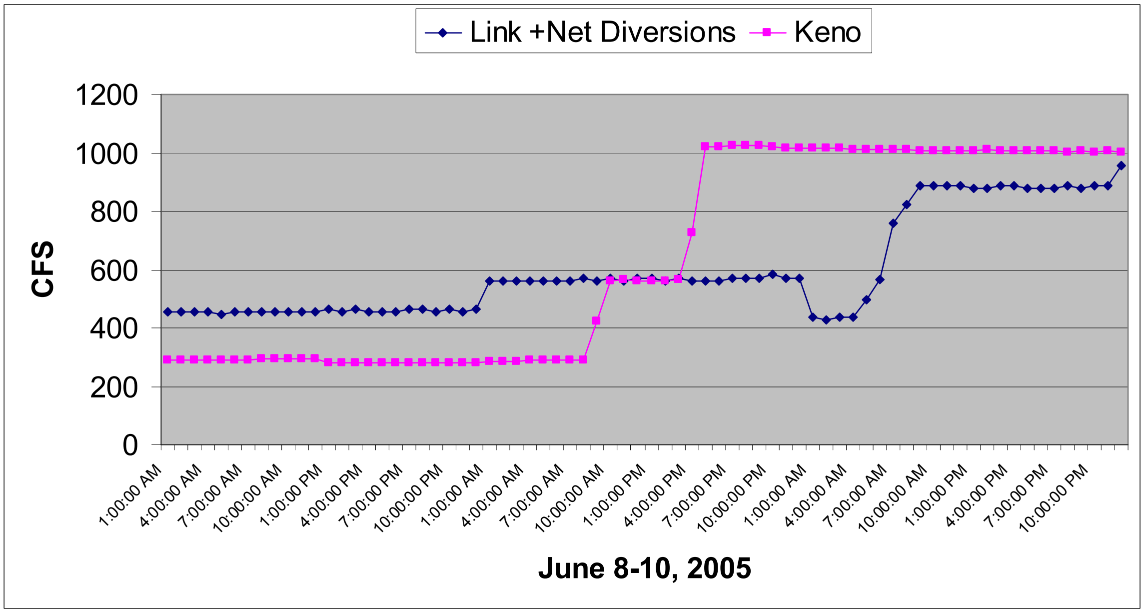


Figure 6. Comparison of flows in Link River, including net diversions from Reclamation Irrigation Project facilities, and below Keno Dam, during June 8-10, 2005.

The practice of using reservoir storage to follow short-term peaks in power demand – known as load following – results in rapid and significant changes in river flow and reservoir elevation. The larger storage at Keno Dam (than at J.C. Boyle Reservoir), with a 6 inch daily reservoir fluctuation, has given PacifiCorp more options to maximize peaking at the downstream J.C. Boyle and the Copco peaking facilities. The Applicant describes Keno Dam operation as: "The steady reservoir elevation allows Reclamation to manage its irrigation water through its diversion channels from Keno reservoir, and enables PacifiCorp to more effectively plan downstream load following operations at the J.C. Boyle powerhouse" (PacifiCorp 2004, FLA WTR).

Project impacts occur from a combination of periodic low flows in combination with a high ramp rate. Impacts are greatest during very high and cold water temperatures and often lead to fish die-offs. For example, in June 2003 flows in the Keno Reach were reduced by PacifiCorp in order to limit the amount of inflow to the J.C. Boyle Reservoir during a Project outage for maintenance at the J.C. Boyle Powerhouse. Due to both rapid declines in flow, the sustained low flow of 250 cfs and hot weather and water temperatures, a fish kill occurred in the Keno Reach. The large fish and macroinvertebrate die off occurred due to the rapid de-watering in combination with the high water temperatures of the Klamath River which stranded fish and caused stressful conditions. An unknown amount of macroinvertebrate abundance was lost but was significant considering abundance ranges from 11,000 to 21,000 m^2 in the Keno reach of the Klamath River.

A second large fish die off occurred later that summer in late July and early August and was caused by a combination of algae die off, very warm water, and low flows (flows in the Keno reach ranged from 413 cfs to 521 cfs during the die off), and resulting lack of dissolved oxygen for fish, that occurred the previous nights. The stressful conditions (low dissolved oxygen, warm water temperatures, and low flows) probably resulted in an epizootic of columnaris which appeared to be the immediate cause of death of most fish sampled. The factors that led to the

Keno and Topsy Reservoir die-off were the same combination of factors that caused the September 2002 fish adult Chinook salmon kill in the lower Klamath River – the combination of low flows, high water temperatures and increased incidence of disease in fish exposed to these conditions.

Many fish die-offs have occurred in the Keno Reach since ODFW staff began to keep records in their monthly reports. ODFW concludes that in most cases, when fish die-offs occur in the Keno Reach, that PacifiCorp, not Reclamation, alters flows in the Keno Reach, for Project purposes, which results in adverse impacts to fish and aquatic resources. Die-offs are more severe during episodes of very warm or cold water temperatures, in combination with low flows or cumulative down ramps that reduce the river to low flows (Bill Tinniswood, ODFW. pers comm.). For this reason, a minimum flow regime along with a reduced ramp rate needs to be established as part of the new license to protect fish and aquatic life from Project operational impacts.

Project Impacts in J.C. Boyle Dewatered Reach: Current operation of the Project provides approximately 100 cfs to the J.C. Boyle dewatered reach year-round. The exception to this flow occurs during spill events when river flows exceed 2,950 cfs and J.C. Boyle Reservoir is full (PacifiCorp 2004a, Exhibit E 3.1.5.3). As a result, flows that mimic seasonal high flows (peak flows) occur when there is a spill event. Flows in the downstream end of the dewatered reach are augmented by spring accretions. Springs contribute an average of 220 cfs, such that the total streamflow in the lower portion of the bypass reach is 320 cfs for most of the year (Water Resources FTR, pp. 5-38 to 5-39, 2004).

Project operations divert the majority of inflow available from the Klamath River above J.C. Boyle Reservoir. The magnitude of diversion from the J.C. Boyle Reservoir is 300 cfs to 2,850 cfs (Water Resources FTR, 5-42, 2004). Analysis of USGS gage data, with the assumption that flows are 100 cfs unless there is a spill, illustrates the reduction in flows in the J.C. Boyle dewatered reach, (USGS, #11510700). Flows are reduced by 75 percent to 97 percent on an annual basis in the J.C. Boyle dewatered reach. By diverting the majority of the inflow, the current water management of the Project optimizes flows for power generation but adversely impacts flows necessary to provide for aquatic and riparian resources in the Klamath River. Current operations provide 75 percent to 97 percent of flow to the J.C. Boyle Canal and 3 percent to 25 percent of flow to the Klamath River channel annually (USGS gage station #11510700). Since the majority of water available is diverted for power generation, only a small fraction of the inflow is available for fisheries and other aquatic species.

Reduced base and peak flows from Project operations have adversely affected the location and type of riparian vegetation in the J.C. Boyle bypass reach. Reduced flows create conditions suitable for the establishment and survival of undesirable riparian vegetation, and species such as reed canary grass encroach on the stream channel (PacifiCorp 2004a, Exhibit E 5-149). Reed canary grass is well-suited to survive in excessively coarse substrate (areas that lack gravel and smaller sized material.) Thus, it gains a competitive advantage over other native riparian species that do not establish in these conditions.

PacifiCorp developed habitat suitability criteria (HSC) and used the depth, velocity, and cover criteria to perform simulations of habitat area to produce habitat flow relationships (commonly referred to as WUA curves). The most recent WUA curves for the project were provided in the

Instream Flow Addendum Report by PacifiCorp (PacifiCorp AIR GN 2, 2005). The WUA relationships reflect adverse effects due to 50 years of sediment transport impairment and low, static flows for most of the year (see below). These relationships reflect changes in channel form and habitat quality including loss of gravel point bars, benches, and spawning areas; confinement due to side-cast material; more uniform bedforms; and reduced riparian width and vegetation encroachment on the channel due to largely static flow conditions.

Project operations including low and static flows have produced changes in the stream channel resulting from reductions in the supply of sediment and alteration of the frequency of flows capable of transporting sediment. Indeed, significant changes to geomorphology were observed in the J.C. Boyle bypass reach (Exhibit E, pp. 5-25, 2004). Geomorphic changes caused by current Project operations reduce the extent and quality of aquatic habitat and impair riparian ecological processes.

Project operations in the bypass reach negatively impact the redband trout fishery and habitat, including food availability (City of Klamath Falls, 1986), fish production, and overall fish size. Macroinvertebrate drift data show much lower drift density in the dewatered reach compared to the Keno reach above J.C. Boyle Dam. In the Keno reach, drift density was 11 times higher in July and 2.4 times higher in September than drift density in the bypass reach (Addley 2005 pp. 5). This difference in density does not include the much lower total productivity that results from less habitat area available due to lower base flow (approximately one sixth the flow in the bypass reach versus the Keno reach in June, July, and August.) The largely static flows in the dewatered reach may be a contributing factor to low drift density and may help explain the lower fish growth and survival observed relative to the Keno reach.

PacifiCorp's studies show that fish growth, fish survival of older age classes, and fish size-at-age in the bypass reach is less than observed in the Keno reach (PacifiCorp 2004, FLA Fish TR). The foraging model over-predicted observed growth in the J.C. Boyle dewatered reach. It would be necessary to decrease the temperature and/or observed drift density inputs to the model to match the slow growth observed in the J.C. Boyle bypass reach (Addley 2005). This suggests that static flows or some other habitat limitation may be affecting fish growth and survival. Similar patterns in fish population structure here were observed by Beak (1986). Trout age distributions (there are few trout over three years of age and they are of smaller size at age) and macroinvertebrate drift data suggest that existing flow conditions limit both habitat and forage productivity, thus affecting redband trout growth and productivity. The evidence from redband trout studies (Addley, 2005 and Oregon Department of Fish and Wildlife, 2003) suggests that the minimum flows of 100 cfs in the J.C. Boyle bypass reach do not adequately provide for a productive fish community in this reach.

Evidence provided in the FLA illustrates that project-related flow reductions affect fish movement and migration (Fish Resources FTR, page 5-36 and 37). Habitat fragmentation and degradation have been identified as limiting factors for native migratory redband trout (Oregon Department of Fish and Wildlife 1997, NRC 2004). With the exception of the J.C. Boyle Dam and Keno Dam, which have passage facilities with limited effectiveness, the five mainstem dams of the Project lack passage and have isolated native migratory fish populations, reduced native fish abundance within some segments, and disrupted fish movement between river segments.

*Project Impacts in Peaking Reach***:** The effects of hydroelectric peaking operations are described in NMFS's 10(j) Recommendation No. 6, Run of River Operations, above.

Project Impacts in Copco 2 Dewatered Reach: Copco 2 Dewatered Reach is approximately 1.4 miles long, and extends from Copco No. 2 Dam to Copco No. 2 powerhouse. The powerhouse discharges directly into Iron Gate Reservoir. The channel is in a deep, narrow canyon with a steep gradient, and consists of bedrock, boulders, large rocks, and occasional pool habitat. Water quality is likely poor in summer because its source, Copco No. 2 Reservoir, has high temperatures and blue green algal blooms in summer (PacifiCorp 2004 Fish Res Tech Rep).

Of all river reaches impacted by the Project, the Copco No. 2 Dewatered Reach is the most strongly affected. The Project's ability to divert up to 3,200 cfs, combined with decades of minimum flows in the bypass of 5-10 cfs, have resulted in the almost complete de-watering of this reach. Except during spill events, between 98 and 99.5 percent of the flow into this reach is diverted. As a result, riparian vegetation has encroached on the channel and adversely altered channel characteristics. PacifiCorp's instream flow habitat curves show this riparian encroachment and narrowing of the channel. As the water level is simulated to increase above a base flow, relatively large areas become flooded, resulting in a steep initial increase in simulated WUA for trout and suckers (PacifiCorp April 2005 HSC report).

The channel is expected to adjust significantly to the addition of flows to the levels recommended here. Riparian vegetation and associated sediment will be removed by the additional flows and deposited into Iron Gate Reservoir. Reservoir fisheries will likely improve due to the additional habitat surface area provided by large woody debris. Fisheries in the Copco No. 2 Dewatered Reach are expected to improve due to the significantly increased amount of habitat area and quality.

Project Impacts Downstream of Iron Gate Dam: The Klamath Hydroelectric Project has significantly altered the natural hydrologic pattern and functioning of the Klamath River downstream from Iron Gate Dam. The ecological structure and functioning of aquatic, wetland, and riparian ecosystems depend largely on the hydrologic regime, or pattern and quantity of water flowing through the system (Gorman and Karr 1978; Junk et al. 1989; Poff and Ward 1990; National Research Council 1992; Sparks 1992; Mitsch and Gosselink 1993; Poff et al. 1997). Intra-annual variation in hydrologic conditions plays an essential role in the dynamics among species within such communities through influences on reproductive success, natural disturbance, and biotic interactions (Poff and Ward 1989). Modifications of hydrologic regimes can indirectly alter the composition, structure, and functioning of aquatic, riparian, and wetland ecosystems (Stanford and Ward 1979; Ward and Stanford 1983; Bain et al. 1988; Ward and Stanford 1989), Lillehammer and Saltveit 1984; (Dynesius and Nilsson 1994)). Project alterations to the hydrologic regime include the impacts associated with impounding waters at five dam sites, use of storage to change the timing of flows through hydroelectric dams and river reaches to maximize revenues, diverting the majority of flows from bypassed reaches of the Klamath River to maximize power production, and ramping river water surface elevation rapidly.

Though Iron Gate Reservoir allows high flows to pass, their magnitude is often decreased. The reduction of flood flows has resulted in changes in the distribution of riparian vegetation due to changes in the availability of sediments. Less active bed scour, erosion, deposition, and channel migration downstream results in less fresh sediment surfaces available for colonization by seedlings of riparian plants (Johnson 1992).

7. **Geomorphic and Juvenile Outmigrant Flows**

Recommendation:

At a minimum, once annually between February 1st and April 15th, diversion to the J.C. Boyle Power Canal should be suspended when inflow to JC Boyle reservoir first exceeds 3,300 cfs during this time period.

- Suspension of diversion shall be maintained for a minimum of seven days.
- The streamflow shall be measured from the Keno gage (#11509500) and Spencer Creek gage (#11510000) combined.
- The down ramp rate shall not exceed 300 cfs per 24 hours, measured at the gage below J.C. Boyle Dam at RM 225.

Justification:

Flood flows at bankful levels or above are needed to provide natural scour to the channel that serves to maintain natural levels of sediment transport, shallow aquatic habitats, and riparian vegetation. All of these features are important fish habitat components. High flows naturally occur from about December through June. However, due to the potential for salmonid eggs or alevins to be disturbed by high flows in December, January, and February, the flood flows should be implemented starting in March.

Impacts: The Project has altered the natural annual hydrograph of the J.C. Boyle bypassed and Copco 2 bypassed reaches by reducing the frequency and magnitude of flood flow events (see Figures E3.1-12 and 1-17 in PacifiCorp Exhibit E, Water Use and Quality, (PacifiCorp 2004b)). Reduced flows in the J.C. Boyle bypassed reach have resulted in channel constriction, elimination of riparian vegetation, and development of an island (PacifiCorp 2004d). During construction of the road and power canal in the J.C. Boyle bypassed reach significant amounts of sidecast material was deposited within the right bank of the river. Riparian vegetation has been reduced by the sidecast, aquatic habitats have been damaged, and fish passage constricted in some places. Extremely reduced flows in the Copco No. 2 bypassed reach has resulted in a significant degree of riparian encroachment into the active channel, a significantly reduced channel, and reduction in aquatic habitat availability (PacifiCorp 2004d).

Klamath Project reservoirs are relatively small, and are not operated for flood control. Though reservoirs allow high flows to pass, their magnitude is often decreased and the flood flows do not pass through the bypassed reaches. The reduction of flood flows has resulted in changes in the distribution of riparian vegetation due to changes in the availability of sediments. Less active bed scour, erosion, deposition, and channel migration can result in less fresh sediment surfaces available for colonization by seedlings of riparian plants (Johnson 1992).

For spawning, salmonids are dependent on the gravel sediments that are normally maintained by flood events, and riparian vegetation is important for providing stream edge habitats for juvenile rearing. Salmonid egg incubation and fry development occurs in the winter months in the Klamath River. These life stages can be adversely affected by high flow events that could wash the eggs or fry downstream prematurely (Jensen and Johnsen 1999). However, higher flows in spring appear to increase survival of spring out-migrants ((Kjelson and Brandes 1989; Kope and Botsford 1990; Cada and Sale 1993), but see (Williams and Matthews 1995)).

8. Gravel Augmentation

Recommendation:

Within one year of license issuance, the Licensee shall, for the conservation, development, and mitigation of damages to anadromous fish resources, file for FERC approval, a Gravel Augmentation Plan (GAP) for the Project reaches and Klamath River below Iron Gate Dam to improve habitat resources for anadromous salmonids. The GAP shall be completed in consultation with the Service, NMFS, CDFG, ODFW and the affected Tribes. The schedule for completing the plan shall accommodate a 30-day review period for agencies to submit comments. If the Licensee does not adopt agency recommendations a rationale for why these were not included should be included in the plan. The goal of the GAP shall be the development and implementation of a comprehensive management plan to provide spawning gravel in reaches of the Klamath River that have lost spawning gravel due to impoundments. The GAP shall include, but not be limited to, the following measures:

1. Identification of priority spawning and holding reaches
2. Assessment of flows needed to transport gravels and maintain holding habitats (pools)
3. Identification of areas for removal of deposits of large debris
4. Identification of priority areas for gravel augmentation, volumes of gravel, and flows to implement deposition of gravel in target areas and schedule for periodic replenishment of gravels.

The Licensee shall file the GAP with the Commission for approval, with copies to the agencies consulted. NMFS reserves the right to require modifications to the study plan. The Licensee shall implement gravel augmentation within three years of license issuance and results shall be monitored to develop future augmentation needs with continued consultation with the Service, NMFS, CDFG, ODFW, and the affected Tribes. Gravel augmentation needs shall be reviewed at least every five years for the duration of the license to provide for adaptive management and changing conditions.

Justification: Gravel augmentation will restore spawning gravel to portions of the Klamath River channel that have been deprived on any sediment inputs for decades. As a result, these portions of the channel now have few if any gravel necessary for the spawning life history stage of salmonids.

The development of the GAP will maximize the likelihood of success in restoring spawning habitat quantity and quality and at the same time minimize the potential damage to critical areas, such as the deep pools in the J.C. Boyle bypassed reach immediately below the input of 220 cfs of spring water. These areas were likely to have been used historically and have potential as holding areas for spring-run Chinook adults. This type of coolwater refugial habitat is necessary for this run of fish (McCullough 1999). Juvenile spring-run Chinook would rear in the cool water habitat adjacent to the springs in the J.C. Boyle bypass reach. Water temperatures in this spring influenced areas do not vary substantially from 50 to 55^{o}F throughout the year (USDI BLM 2003) and would also provide relatively warmer water during winter months, benefiting rearing spring-run Chinook by providing optimal temperatures for juvenile growth (McCullough 1999).

Impacts: Native species in the Klamath River evolved under the seasonal variability of an unregulated river, with a freely moving bedload. However, the Project's dams have been collecting and storing sediments for decades, while reaches below the dams have been deprived and scoured of gravel and finer sediments. PacifiCorp (PacifiCorp 2004d) reported that the Project impacts alluvial features (and therefore potential salmonid spawning material) from Iron Gate Dam to the confluence with Cottonwood Creek.

In most Project reaches, the river bed is coarsened as smaller gravels are transported downstream without being replaced, and larger gravels and cobbles that are unsuitable for use by spawning fish ((Kondolf and Matthews 1993; PacifiCorp 2004d). PacifiCorp's Water Resources Final Technical Report, dated February 2004, indicates that the Project causes a deficit of sediment for transport between dams and below the Project. The reach below J.C. Boyle Dam is especially sediment supply limited. Indeed, "pebble count results indicate potential bed coarsening immediately downstream of Project dams and in the J.C. Boyle peaking and bypass reaches" (PacifiCorp 2004d). In addition, the Project may have significantly coarsened the channel bed from downstream of Iron Gate Dam to the confluence with Cottonwood Creek (PacifiCorp 2004d).

A natural river transports sediment inputs from upstream to downstream reaches through flood flow events. Reservoirs trap gravels that would otherwise be supplied from upstream. In most Project reaches, the river bed is coarsened as smaller gravels are transported downstream without being replaced, and larger gravels and cobbles that are unsuitable for use by spawning fish dominate (Kondolf and Matthews 1993, PacifiCorp Water Resources Fish Technical Report, February 2004). This effect is especially important in the J.C. Boyle bypassed and peaking reaches and below Iron Gate Dam.

Changes in the flow and sediment regimes due to Project operations and facilities impact the potential establishment of desirable riparian vegetation. J.C. Boyle Dam reduces the input of gravel, sand, and silt to this reach ((PacifiCorp 2004b), Exhibit E 5-148). In addition, flow diversions and changes in the flow regime reduce the potential for scouring and sediment deposition of the limited material that is transported downstream of the dam (PacifiCorp 2004c, pp. 6-135). Further, since the streamflows, sediment supply, and bed mobility are reduced, the extent of substrate appropriate for establishment of willows and other native riparian plants is decreased.

According to PacifiCorp analysis, the Project contributes to the lack of willows in streamside areas ((PacifiCorp 2004b), Exhibit E 5-102). Riparian hardwoods typically germinate and establish on freshly deposited alluvium in channel positions low enough to provide adequate moisture but high enough to escape scour (Scott et al. 1993). The Project, however, maintains static hydrologic and geomorphic conditions that do not provide alluvium over a large portion of the area where willows have the best potential to establish.

In the upper portion of the J.C. Boyle bypassed reach the river is constrained by sidecast material present in the margins of the active stream channel. This material was generated during the construction of the J.C. Boyle canal and road and continues to impact 1.5 miles of the channel. The sidecast material has constricted the channel and altered the riparian vegetation along most of the reach ((PacifiCorp 2004b) Exhibit E, 5-25, 2004). Alteration of instream flows and changes in sediment regimes result in decreased bank stability and loss of riparian vegetation (Hill 1991, Rosgen 1996). Desirable riparian vegetation (e.g., willow) does not establish and survive in the conditions created by the boulder-sized rocks comprising the sidecast. Further, in some areas this material has entered the active channel and is causing accelerated bank erosion on the opposite bank (PacifiCorp 2004d).

9. Temperature Control Device Feasibility Study

Recommendation:

Within one year of license issuance, the Licensee shall, for the conservation, development, and mitigation of damages to anadromous fish resources, file for FERC approval, a Temperature Control Device Feasibility and Implementation Plan (TCD Plan) for the Project reaches and Klamath River below Iron Gate Dam to improve habitat resources for anadromous salmonids. The TCD Plan shall be completed in consultation with the Service, NMFS, CDFG, ODFW and the affected Tribes. The schedule for completing the plan shall accommodate a 30-day review period for agencies to submit comments. If the Licensee does not adopt agency recommendations a rationale for why these were not included should be included in the plan. The goal of the TCD Plan shall be the development and implementation of a comprehensive management plan to improve water temperature conditions below Iron Gate and Copco No. 1 Dams. The TCD Plan shall include, but not be limited to, the following measures:

1. The Licensee shall contract with an independent third party (to be approved by NMFS, the Service, ODFW, and CDFG) to conduct a feasibility study to determine the potential effectiveness of a Temperature Control Device for Iron Gate and Copco No. 1 dams.
2. The study methodology and results shall be subject to review and approval by the Service, NMFS, CDFG, and ODFW. If the feasibility study is favorable, licensee shall construct and/or operate Temperature Control Devices at Iron Gate and Copco No. 1 dams.
3. The TCD Plan shall fully model, compare and evaluate a variety of technologies, including but not limited to construction and operation of a multi-port selective withdrawal structure, and include an assessment of effectiveness, cost, and potential impacts.

Justification:

Deas (2003) (Klamath Water Quality Technical Memo #7) provides a water quality model and analysis of the potential benefits of a temperature control device indicating that modest benefits could be obtained by construction of new intake structures and choosing combinations of intake outflows to provide lower temperature releases from Iron Gate Reservoir. It does not appear that the optimum combination of water releases was identified by the analysis; however, a reduction in water temperature of 1.1 to 1.8 EC for a period of 1-1/2 months in August – September was modeled. PacifiCorp completed a Evaluation of temperature control alternatives (PacifiCorp 2005c) which concluded that temperature control options are not feasible. We disagree with this assessment because the analysis was unnecessarily limited. NMFS (National Marine Fisheries Service 2005) identified several improvements to the analysis conducted in Deas (2003) and PacifiCorp (PacifiCorp 2005c) that would improve the reliability of the determination of whether a temperature control device is feasible on Iron Gate and Copco 2 dams.

The U. S. Geological Survey in Fort Collins, Colorado has been asked to do an analysis of potential temperature control alternatives for Iron Gate and Copco 1 dams using their Systems Impact Assessment Model (SIAM). SIAM is a hydrology based model that includes water quality and salmon production components (for more information on the model, see Bartholow et al. 2005). Preliminary results of their analysis indicate that mixing flows from the upper outlet with a new lower outlet at Iron Gate Dam could result in significant cooling (2 to 3EC) throughout September, while maintaining a reduced thermocline at the end of September, allowing further cooling in October (Campbell and Heasley, pers comm.).

There are indications that even this modest cooling of water temperatures during the critical fall spawning period would have significant benefits in terms of anadromous fish production in the Klamath River below Iron Gate Dam. These benefits would be due primarily to the advantages of earlier fry emergence. SALMOD simulations showed that Chinook salmon spawning earlier, with at least 2^{o}C cooling, produced more juvenile fish than spawning during October (Sharon Campbell, USGS, pers. comm.). Predicted emergence times are on average four weeks earlier for the early spawning scenarios than for spawning in October. For years with warm fall stream temperatures, fry emergence occurred as much as eight weeks earlier. SALMOD predicted larger numbers of juvenile fish spread out over longer periods of time for the early spawning scenarios. Mortality for these fish was reduced by three to seven percent. Twenty nine percent of fish produced from October spawning were exposed to stream temperatures greater than 10C (temperature above which disease is more prevalent). This dropped to twelve and eight percent for progeny of adults that spawned two and three weeks early. The predicted number of Chinook presmolts exiting the study area was 38 percent higher for the early spawning scenarios. In addition, the average weight of migrating juveniles was predicted to be 13 percent to 22 percent greater for those fish produced from early spawning. (Sharon Campbell, USGS, pers. comm.). Larger fish may result in potentially higher downstream survival rates when smolts reach the ocean.

Control of water temperature of downstream releases from the Klamath Hydroelectric Project would benefit anadromous fisheries because water temperatures below the Project (PacifiCorp 2004d) during summer months often exceed recommended criteria to protect coldwater salmonids (EPA 2003). The Project exacerbates the effects of high temperatures on downstream fisheries during late summer due to the thermal lag produced by the water impoundments (PacifiCorp 2005d). Due to the significance of potential benefits to aquatic resources, additional analysis on the practicability of temperature control devices is warranted.

Impacts: Changes in water temperature due to reservoir impoundments are well documented (Sylvester 1963; Jaske and Goebel 1967; Crisp 1977; Wunderlich and Shiao 1984). Reservoirs reduce annual and daily fluctuations in temperature and delay the warming and cooling periods by acting as thermal sinks. Bartholow et al. (2005) modeled the effect of hypothetical removal of the Klamath hydroelectric dams on thermal characteristics of the Klamath River. They found that dam removal would restore the timing of the river's seasonal thermal signature by shifting it approximately 18 days earlier in the year, resulting in river temperatures that more rapidly track ambient air temperatures. With dam removal, water temperatures would be cooler in the fall and winter (when temperatures are cooling) and warmer in spring and summer (when temperatures are warming).

PacifiCorp (2005, AR-2, September 2005) has modeled the expected thermal lag condition caused by reservoirs to assess temperature differences between existing conditions and hypothetical without project conditions. Model results show that river reaches cool and heat relatively quickly without the reservoir volumes (assuming no reservoirs). In general, water temperatures are cooler in the spring and warmer in the late summer and fall under existing conditions than most of the without dam alternatives. The Project dams appear to warm water temperatures by 1 to 5 EC during the months of August through November, and to cool water temperatures by 1 to 3 EC during the months of February through June (PacifiCorp 2005, Figures 1-1 through 1-5, Appendix B, AR-2).

Temperatures are critical for salmonids on the Klamath River at three times of the year. In the spring months of March through May, juvenile salmonids need temperatures above 10 to 13 EC for optimal growth (U. S. Environmental Protection Agency 2003). The Project significantly delays the onset of these temperatures in the spring according to AR-2, Appendix B, slowing salmonid juvenile growth rates. Outmigration of juvenile fall Chinook salmon normally occurs by the summer months of June and July, in part, to avoid warmer temperatures. Juvenile disease risk is elevated at 14 to 17 EC and is high at 18 to 20 EC (EPA 2003). By slowing juvenile growth rates, juvenile outmigration is likely delayed, subjecting juvenile Chinook to higher disease risk.

High water temperatures in the mainstem Klamath River during summer months are commonly cited as a cause of decline of anadromous fish runs in the Klamath River (Bartholow 1995; Campbell et al. 2001). Temperatures commonly reach levels that are lethal to salmonids and temperatures in the mainstem Klamath River get higher with a greater frequency, and stay higher for a longer time, than waters in adjacent coastal anadromous streams (Bartholow 1995). Spring-run Chinook, steelhead, and coho over-summer in the Klamath River as juveniles, making them especially vulnerable to these higher temperatures. Salmonid juveniles have been shown to use cool water areas to get by during these warm time periods, but these areas are limited on the Klamath River (Berman and Quinn 1991; Belchik 1997; Sutton et al. 2004).

Project dams exacerbate the effects of high water temperatures on salmonid juveniles because while they decrease maximum temperatures in June and July, they also elevate minimum temperatures at that time and slow the cooling of both daily maximum and minimum temperatures in August and September (2005, AR-2, Sept). The elevation of minimum daily temperatures in June and July is likely to impact fish by removing the effectiveness of important thermal refugial areas (National Research Council 2004). The elevation of water temperatures in August and September prolongs the exposure of juvenile salmonids to high temperatures with impaired thermal refugia, which very likely increases mortality rates. Indeed, mortality of over 240,000 juvenile Chinook salmon in the Trinity and Klamath rivers was associated with water temperatures in excess of 20 EC in June, July, and August (Williamson and Foott 1998). As stated earlier, juvenile disease risk is high at 18 to 20 EC and temperatures are lethal above 23 EC (EPA 2003).

Adult salmonids entering the river to spawn are likely impacted by the temperature effects of Project dams. Spring-run Chinook salmon enter the river in May and June and fall-run Chinook enter in August and September. Upstream migration appears to be delayed when temperatures equal or exceed 22 EC, at which point adult Chinook seek out and reside in thermal refuges or stay in the estuary where temperatures are much cooler (Strange 2005). Thermal tolerances for adults are similar to those for juveniles identified above (EPA 2003). Therefore, the elevation of minimum daily temperatures in June and July caused by Project dams likely impacts adult Chinook trying to hold in thermal refugia, and may lead to premature mortality. The elevation of water temperatures in August and September due to Project dams likely postpones spawning migration, leading to delayed spawning and egg development. In addition, elevated water temperatures in August and September increase adult mortality by causing salmonids to hold in poor quality habitat becoming stressed and crowded (Schreck and Li 1991; Matthews and Berg 1997). Such conditions are known to lead to outbreaks of diseases such as *Flexibacter colunmaris* (Holt et al. 1975; Wakabayashi 1991) and *Ichthyophthirius multifiliis* (Bodensteiner et al. 2000). Such an outbreak resulted in over 30,000 adult Chinook deaths in the Klamath River during September of 2002 (USFWS 2003a, USFWS 2003b, CDFG 2004).

10. Dissolved Oxygen Enhancement Feasibility Study

Recommendation:

Within one year of license issuance, the Licensee shall, for the conservation, development, and mitigation of damages to anadromous fish resources, file for FERC approval, a dissolved oxygen (DO) enhancement plan (DO Plan) for the Project reaches and Klamath River below Iron Gate Dam to improve habitat resources for anadromous salmonids. The DO Plan shall be completed in consultation with the Service, NMFS, CDFG, ODFW and the affected Tribes. The schedule for completing the plan shall accommodate a 30-day review period for agencies to submit comments. If the Licensee does not adopt agency recommendations a rationale for why these were not included should be included in the plan. The goal of the DO Plan shall be the development and implementation of a comprehensive management plan to improve DO conditions below Iron Gate Dam. The DO Plan shall include, but not be limited to, the following measures:

1. The dissolve oxygen (DO) content of release water from Iron Gate Dam should be controlled to meet salmonid requirements for the geographic extent of Project DO effect;
2. The Licensee’s proposal to install a hypolimnetic oxygenation system in Iron Gate reservoir should be studied further to demonstrate downstream effectiveness and the potential for adverse effects on nutrient levels and thermal stratification; and

4. DO Plan shall fully model, compare and evaluate a variety of technologies, including but not limited to: liquid oxygen injection (intake and draft tube), gaseous oxygen injection (intake and draft tube), construction and operation of a multi-port selective withdrawal structure, and turbine venting and include an assessment of effectiveness, cost, and potential impacts.

Justification:

In the Final License Application, PacifiCorp indicated that DO levels in water releases from Iron Gate Dam do not meet the objectives of the Water Quality Control Plan for the North Coast Region (Basin Plan) (NCRWQCB 1996) during certain periods. To mitigate for this impact, PacifiCorp is proposing to install a hypolimnetic oxygenation system that will improve dissolved oxygen levels below Iron Gate dam (PC 2005 AR-1a and PC AR-1b). However, the effectiveness of the system and potential effects of the system were not adequately studied by PacifiCorp. The extent down the Klamath River to which benefits would occur was not analyzed. In addition, the potential for increased DO levels in the hypolimnion to alter chemistry of the lake and cause a release of nutrients need further study. Deas (2003) found that "forced reaeration slightly decreased ammonia, noticeably decreased ortho-phosphate, slightly increased algae, and significantly increased nitrate in the outflow between mid-July and Mid-October". These changes may affect other conditions including algal dynamics and impact water temperatures. The oxygenation system could also impact water temperatures in the reservoir by breaking up the stratification, which would also impact water temperatures downstream and the effectiveness of any temperature control alternatives that may be considered.

Impacts:

Basin Plan objective for the river below Iron Gate is a minimum of 8 mg/l DO and a 50% lower limit of 10 mg/l. During fish spawning and egg incubation periods the minimum allowable DO is 9 mg/l. Iron Gate and Copco Reservoirs are stratified in the summer with extremely low DO levels in the hypolimnion (PacifiCorp 2005, Water FTR). Dissolved oxygen concentration of water releases from Iron Gate are well below objectives for salmon in the summer and early fall, but levels are well elevated through mixing by the time waters reach the Shasta River (PacifiCorp 2005, Water FTR). Simulated DO levels downstream of Iron Gate Dam were 2-4 mg/l less under existing conditions than under the without Project scenario (PacifiCorp 2005 Draft AR-2 Sept 2005). Directly downstream of Iron Gate Dam, simulated DO levels under the without Project scenario approximated the minimum level of 8 mg/l, while DO levels were significantly below 8 mg/l under the existing conditions (PacifiCorp 2005 Draft AR-2 Sept 2005). The next location studied downstream was the Shasta River, where impacts to DO of the Project appear to be absent. It is unknown how far downstream of Iron Gate Dam DO effects of the Project extend.

11. Management Plan for Keno Reservoir to Improve Water Quality

Recommendation: Within one year of license issuance, the Licensee shall, for the conservation, development, and mitigation of damages to anadromous fish resources, file for FERC approval, a Plan to manage Keno Reservoir to improve water quality for fish habitat and meet water quality standards (as measured immediately below Keno Dam). The Plan to manage Keno Reservoir to improve water quality (Keeno Plan) shall be completed in consultation with Reclamation, the Klamath Tribes, NMFS, the Service, BLM, USGS, ODFW, ODEQ, and Upper Klamath Basin water users. The schedule for completing the Keeno Plan shall accommodate a 30-day review period for agencies to submit comments. If the Licensee does not adopt agency recommendations a rationale for why these were not included should be included in the Keeno Plan. Possible actions to improve water quality include restoration of wetlands, treatment wetlands, mechanical aeration, and/or mechanical removal of algae. The Licensee shall comply with all terms of the Oregon Department of Environmental Quality and Tribal Clean Water Act section 401 Water Quality Certificates. Should Reclamation first develop such a Plan for Keno reservoir, the Licensee shall incorporate Reclamation's Plan into the Licensee's Keeno Plan. The Licensee shall file the Keeno Plan, with the Commission for approval, with copies to the agencies consulted.

Justification: The Keeno Plan needs to take into account the results of the Reclamation study, contract No. 05PG250026, awarded February 7, 2005, which will be completed by January 2006. Restoration of wetlands, treatment wetlands, mechanical aeration, and/or mechanical removal of algae provide great benefits to degraded water quality in reservoirs elsewhere. Restoring water quality in Lake Ewauna will have far reaching benefits to federally listed suckers and habitat downstream for anadromous salmonids.

Impacts: As mentioned above, in Recommendation No. 9, changes in water temperature due to reservoir impoundments are well documented (Sylvester 1963, Jaske and Goebel 1967, Crisp 1977, Wunderlich and Shiao 1984). Between October and June, water quality conditions in the Keno impoundment are typically within acceptable limits for native fishes. However, Keno reservoir has extreme temperature and other water quality problems that contribute to extensive habitat degradation within the reservoir. During most years, the Lake Ewauna reach of the Klamath River (Link River Dam to Keno Dam) has dissolved oxygen concentrations less than 6 mg/L and temperatures greater than 20^{o}C from mid-June through mid-November (Jason Cameron, BOR, pers. comm.). These conditions are not within criteria for migrating anadromous salmonids (USEPA 2003). These impacts extend downstream during some years.

12. Monitoring and Evaluation

Project impacts in regard to fish disease, predation, and reintroduction need to be better monitored. Corresponding remedial measures need to be undertaken to mitigate for any potential impacts.

A. Fish Disease Risk Monitoring and Evaluation

Recommendation:

Juvenile Disease Risk - The Licensee shall, file for FERC approval, a Juvenile Fish Disease Risk Monitoring and Management Plan (JDRP) to reduce the disease risk for juvenile anadromous salmonids in the Klamath River to a level comparable to the disease risk in healthy river systems. The JDRP shall be developed in consultation with affected Tribes, NMFS, the Service, ODFW, and CDFG The JDPR shall include:

1. An identification of key factors controlling disease risk and pathogen abundance;
2. a comprehensive explanation of pathogen ecology;
3. recommended measures for controlling, managing, or removing pathogens, hosts, and vectors; and
4. An assessment of the benefits through restoration using geomorphic processes, management of flows, physical removal or treatment of pathogens, vectors, hosts or their habitats, and water quality to minimize disease risk.

Adult Disease Risk - The Licensee shall file, for FERC approval, an Adult Fish Disease Risk Monitoring and Management Plan (ADRP) to reduce disease risk for adult anadromous salmonids in the Klamath River below Iron Gate Dam to a level comparable to the disease risk in the Trinity River. The ADRP shall be developed in consultation with the affected Tribes, NMFS, the Service, ODFW, and CDFG. The ADRP shall include:

1. recommendations for the management of flows and water quality to minimize disease risk;
2. mitigation steps to be taken to minimize disease risk to reintroduced anadromous species above Iron Gate Dam, to resident species, and to fish production from Iron Gate Hatchery;
3. studies to assess the role of seasonal flow reductions in increasing habitat and pulse flows in decreasing habitat for the intermediate host, *Manayunkia speciosa,* of the anadromous fish parasite, *Ceratomyxa shasta*. In order to assess this issue, test freshets of varying extent could be created to determine sufficient mobilization of the bed that results in scour of the algae mats and then subsequent testing of both the polychaete and myxozoan abundance; and
4. an assessment of the benefits through restoration using geomorphic processes, management of flows, physical removal or treatment of pathogens, vectors, hosts or their habitats, and water quality to minimize disease risk.

Emergency Response Pulse Flow Plan (ERP) – The Licensee shall file, for FERC approval, a plan to provide temporarily enhanced flows on an emergency basis utilizing the estimated active storage at Iron Gate and Copco reservoirs of 52,000 acre feet (AF). The ERP shall be developed in consultation with the affected Tribes, NMFS, Reclamation, the Service, ODFW, and CDFG. These flows would be provided when an interagency Fish Health Assessment Team determines that enhanced flows are necessary to decrease the impacts of an impending juvenile or adult fish die-off. Adaptive Management reports shall be provided by the Licensee summarizing the successes and failures of such attempts and recommendations for future enhanced flow management.

The schedule for completing the plans shall accommodate a 30-day review period for agencies to submit comments. If the Licensee does not adopt agency recommendations, a rationale for why these were not included should be included in the plans. Within two years of the development of disease risk Monitoring and Plans and agency approval, the Licensee shall fully implement the Plans.

An interagency team of fisheries experts (Klamath Fish Health Assessment Team, KFHAT) has formed to provide an emergency plan and process to respond to potential fish kill events in their early stages (Klamath Fish Health Assessment Team 2005). Many of the individuals in this team were involved with fish kill responses on the Klamath River in the past few years and continue to monitor fish health conditions at critical time periods in the life cycles of anadromous salmonids. The Licensee should assemble a similar team to develop their ERP.

Justification: Disease of fish and die-offs in the lower Klamath River downstream from the Project are a serious management concern. On September 27 of the 2002 Fish Die-Off, the Project increased flows from Iron Gate dam that helped trigger upstream migration and alleviated additional mortality due to disease (USDI Fish and Wildlife Service 2003a, McCracken 2002). Flows were ramped up from 767 cfs to 1,350 cfs over a 2 day period. This discharge was maintained through October 9, 2002, after which discharges declined to 885 cfs by October 13, 2002. 36,000 acre-feet of additional water was provided over a 2-week period. While it is unclear if the Project alone has enough storage to provide these flows, at least 12,000 AF of storage is available in Project reservoirs and management of this water would have the potential to prevent or mitigate future fish kills.

The Applicant has not proposed any measures to better understand die offs in the Klamath River or to manage to minimize disease outbreaks. The development of JDRP, ADRP, and ERP plans for adult and juvenile salmonids will help ensure that agencies, Tribes, and the Klamath River Basin Fisheries Task Force will explore all options for minimizing future fish die-offs and meet their management goals and objectives.

Impacts: Outmigrating juvenile Chinook (*Oncorhynchus tshawytscha)* and steelhead (*O. mykiss*) within the Lower Klamath River Basin experience significant mortality from infectious disease, with recent estimates of disease-related mortality in downstream migrants as high as 90 percent (Foott, personal communication). The primary pathogens implicated in this mortality are the myxozoan parasites *Ceratomyxa shasta* and *Parvicapsulum minibicornis* (Williamson and Foott 1998; Foott et al. 1999; Foott et al. 2002; Foott et al. 2003).

The life cycles of the parasites are complex and require development in both a vertebrate and invertebrate host. For *C. shasta*, the invertebrate host is the freshwater polychaete *Manayunkia speciosa* (Bartholomew et al. 1997). Fish become infected by contact with actinospores that are produced within *Manayunkia*. Following fish mortality, myxospores are released into the water where they are then taken up by the polychaete. The invertebrate host for *Parvicapsulum minibicornis* has not yet been identified, but new information suggests that its host may also be *Manayunkia* (Hendrickson, personal communication).

Algal buildup on substrate in the Klamath River is believed to contribute to increasing habitat suitable for the polychaete worm that is the alternate host for *Ceratomyxa shasta* (Stocking and Bartholomew 2004). Increases in habitat can increase production of the polychaete and subsequently the number of myxozoan spores in the water column that infect fish. In addition to high nutrient levels, reductions in the magnitude and extent of peak flows resulting from hydroelectric operations has likely contributed to increasing the amount of stable habitat for the polychaetes downstream of the Project (McKinney et al. 1999). PacifiCorp (2005 – AR-2) considered only temperature as an indicator and determinant of parasite load.

The Project contributes to higher water temperatures and elevated water temperatures increase disease risk. Fish disease among anadromous fish has increased in recent years in both adults and outmigrating juveniles in the lower Klamath River (Williamson and Foott 1998; Foott et al. 1999, 2002, 2003, Nichols and Foott 2005). The September 2002 fish die-off killed at least 33,000 adult fish, mostly Chinook salmon from infection by two pathogens (*Ichthyophthirius multifiliis* and *Flavobacterium columnare*) (USDI Fish and Wildlife Service 2003b). In 2004, juvenile outmigrating salmon were estimated to be 94 percent infected by myxozoan parasites (*Ceratomyxa shasta and Parvicapsula minibicornis)* on the Klamath River, which may have rivaled the loss of 33,000 adult fish two years earlier in impact to the population of Chinook salmon (Nichols and Foott 2005). Myxozoan parasitic infections in juvenile anadromous salmonids appear to be focused in the mainstem Klamath River as opposed to tributaries, and the duration of exposure to the mainstem river may be a major determinant in the disease (Nichols and Foott 2005). Higher spring flows would likely benefit survival probabilities of juvenile outmigrating salmonids by reducing their time spent in the mainstem river with associated disease infection risk.

Project reservoir related degradation of water quality contributes to fish stress and conditions conducive to disease related die-offs. Project reservoirs result in higher water temperatures in the downstream receiving river in the fall (Bartholow et al. 2005) that elevate the risk of disease to adult fish at least to the Seiad Valley. Both juvenile and adult die offs have been documented in the Klamath River since at least the 1990's. Juvenile die offs have been chronic in the mainstem Klamath River and undoubtedly are a contributor to the low (~0.18 percent) smolt to adult returns for production from Iron Gate Hatchery. In September 2002, the adult die-off in the lower river resulted in the loss of more than 30,000 fish (USDI Fish and Wildlife Service 2003b; California Department of Fish and Game 2004). The majority (98 percent) of fish killed in the September 2002 event were adult anadromous salmonids. Low river discharges apparently did not provide suitable attraction flows for migrating adult salmon, resulting in large numbers of fish congregating in the warm waters of the lower river (USDI Fish and Wildlife Service 2003a). The high density of fish, low discharges, warm water temperatures, and possible extended residence time of salmon created optimal conditions for disease (USDI Fish and Wildlife Service 2003a).

Our estimate of active storage for these reservoirs is different from the amount reported in Applicants documents because they report the active storage that is available during normal operations. We asked Sharon Campbell and John Heasley, U.S. Geological Survey, to estimate full active storage in Copco and Iron Gate Reservoirs. They used a procedure outlined in the September 27, 2005, memo attachment to the Service's November 17, 2005, letter commenting on PacifiCorp's response to information request AR-1a, dated September 2005. Although both Copco and Iron Gate Reservoirs are usually operated in near-full condition, each reservoir can be drawn down to the level of the outlet for the hydropower plant. In Copco, the outlet is located at 2,571 ft MSL, with water storage of 17,488 AF below this level. Maximum elevation is 2,607.5 ft MSL, with total water storage of 46,867 AF. Total active storage has been estimated as 29,379 AF for Copco Reservoir. Iron Gate Dam outlet is located at 2,299 ft MSL, with water storage of

35,533 AF below this level. The maximum storage elevation is 2,328 ft MSL, with maximum water storage of 58,794 AF. Total active storage has been estimated as 23,261 AF for Iron Gate Reservoir. Total active storage in both reservoirs is estimated at approximately 52,000 AF (52,640 AF). To translate that into discharge, 52,000 AF would provide approximately 875.4 cfs per day for a 30 day month (Campbell USGS pers. comm. Feb 1, 2006).

An interagency team of fisheries experts (Klamath Fish Health Assessment Team, KFHAT) has formed to provide an emergency plan and process to respond to potential fish kill events in their early stages (Klamath Fish Health Assessment Team 2005). Many of the individuals in this team were involved with fish kill responses on the Klamath River in the past few years and continue to monitor fish health conditions at critical time periods in the life cycles of anadromous salmonids. PacifiCorp should assemble a similar team to develop their ERP.

B. Anadromous Fish Monitoring and Evaluation

Recommendation:

1. Anadromous Fish - The Licensee shall file, for FERC approval, an Anadromous Fish Monitoring Plan (AFMP) that meets the approval of the Service and NMFS. The AFMP shall be developed in consultation with the Service, NMFS, affected Tribes, ODFW, and CDFG. The AFMP will describe the protocol for:

> A. Estimating the number, size, sex; and determine; using a combination of PIT tag technology and analysis of returning fish marked in other ways; the timing, survival, and origin of anadromous fish returning to Iron Gate Dam.
>
> B. Estimating the spawning populations of each species of anadromous fish in important Klamath River tributaries in the Project reach (Scotch, Camp, Jenny, Fall, Shovel, Long Prairie, and Spencer Creeks). This estimate will be at three-year intervals for the duration of the license.
>
> C. Estimating the numbers of juvenile outmigrant Chinook salmon originating from important Klamath River tributaries in the Project reach (Scotch, Camp, Jenny, Fall, Shovel, Long Prairie, and Spencer Creeks). This estimate will be at three-year intervals for the duration of the license.
>
> D. Implementing measures recommended by the Service, NMFS, ODFW, CDFG, and Tribes to meet project passage goals.

Justification:

The goals and objectives of the Klamath River Fisheries Task Force (USDI Klamath River Basin Fisheries Task Force 2001), agencies, and Tribes in relicensing of the Project include the successful restoration of anadromous salmonids to their historical habitats. The Project blocks access to historical mainstream and tributary habitat. Project facilities, even with ladders screens and bypasses, will impact survival of migrating fish produced above the Project as part of these restoration goals. Iron Gate Hatchery under its current management regime produces fish that will need to be distinguished from reintroduced, wild spawning fish for the purposes of managing successful reintroduction. If Project facilities remain in place, Project impacts will need to be offset by another method of guaranteeing that fish spawned above the Project are able to be distinguished and reach their natal area in sufficient numbers, and that Project impacts on the survival of migrating fish are identified and corrected.

Determining timing and survival of outmigrating fish from above Iron Gate Dam using juvenile collection, PIT tagging, and downstream tracking; and the assessment of their returns as adults to the Klamath River will be used to evaluate progress towards NMFS' management goals and objectives. Full Duplex tagging and detection technology is necessary to track small fish (≥60mm in fork length) of interest to agencies. This is particularly important for the estimation of survival of outmigrant Chinook salmon.

Assessment and monitoring of anadromous spawning is necessary to understand the contribution of important Klamath River tributaries in the Project reach (Scotch, Camp, Jenny, Fall, Shovel, Long Prairie, and Spencer Creeks). This capability to identify adults (in particular adult Chinook salmon) from above Iron Gate Dam (including areas above Upper Klamath Lake) is necessary to assess progress towards restoration goals and to implement measures to achieve these goals and objectives. It gives agencies the ability to manage the return of adults to their natal areas and establish new populations to pass genetic adaptations of successfully surviving a full life cycle on to the next generation, thereby maximizing the rate of adaptation to the reintroduction environment.

Recording the timing of movements of anadromous fish is necessary to understand migration and manage project operations and flow to minimize Project related mortality to migrating fish. Survival estimates are necessary to identify reaches where passage problems may exist and diagnose potential bottlenecks to the production of anadromous fish.

Coho salmon - Coho salmon, a federally listed species, have a three year peak in abundance. Assessment of restoration of the entire population is often based on how well the largest cohort performs. Surveys should be conducted for the term of the new license at three-year intervals, with the first year of evaluation being the peak abundance year.

Anadromous Fish - Chinook salmon and/or steelhead migrated to Scotch, Camp, Jenny, Fall, Shovel, and Spencer Creeks and well into the upper basin before dams blocked access (Hamilton et al. 2005). From 1950 to 1960 (prior to the construction of Iron Gate Dam) CDFG records indicate that between 344 and 2,496 Chinook salmon returned to spawn in Fall Creek. During this same period, an estimated 25 to 400 Chinook spawned in Jenny Creek (Coots and Wales 1952; Wales and Coots 1954; Coots 1957; Coots 1962). Steelhead also spawned in Shovel Creek (Coots 1965).

Coho salmon were present in Fall Creek prior to dam construction (Coots 1957; Coots 1962). Hamilton et al. (2005) concluded this species migrated to at least Spencer Creek. Pacific lamprey were present in Fall and Spencer Creeks as well (Coots 1957; U.S. BLM et al. 1995). There is evidence that steelhead used Long Prairie Creek (Coots 1965).

These tributaries and mainstem reaches in the Project area continue to provide suitable habitat (Beyer 1984; Weyerhaeuser Company 1994) U.S. BLM et al. 1995; ODFW 1997, CDFG 2005; (USDI Bureau of Land Management 2005). Comprehensive plans have been approved or proposed to manage reaches of Scotch, Camp, Fall, and Jenny Creeks (ODFW 1997; U.S. BLM 2005), Shovel Creek (CDFG 2005), Spencer Creek (U.S. BLM et al. 1995; ODFW 1997), and mainstem Klamath River in Oregon (ODFW 1997) for their continued provision of fish and aquatic habitat.

Impacts: The Project will continue to block access of anadromous fish to considerable quantity and quality of habitat above the dams. Over 360 miles of anadromous fish habitat exists in and above the Project Reach (Huntington 2006).

13. Iron Gate Hatchery Operations

Recommendation:

a. The Licensee shall fully fund and continue hatchery operations at Iron Gate Hatchery to meet hatchery target goals for fall-run Chinook, spring-run Chinook, coho and steelhead. The hatchery target goals for each species will be adjustable and developed by the Service, CDFG, ODFW, NMFS, and the Tribes. Target goals will be approved by the Service, NMFS, and CDFG. The hatchery will provide mitigation as well as facilitate implementation of fish passage measures to restore/reconnect wild runs of anadromous and resident fish above and below the Project. The hatchery target goals will be adjusted by CDFG, NMFS, and the Service in response to ongoing impacts of the Project and implementation of the passage conditions.

b. Marking of all Iron Gate hatchery (IGH) Chinook salmon releases shall be 100 percent to develop a time series of accurate estimates of hatchery contribution and distinguish returning adult Chinook salmon that are the progeny of reintroduced fish above Iron Gate Dam.

c. Development of a Hatchery and Genetics Management Plan (HGMP) for IGH operations including, but not limited to: 1) an accurate adult census of natural salmonids; 2) the rate and contribution of hatchery strays to natural spawning stocks; 3) determining the rate of competition between hatchery and natural salmonids; 4) determining genetic characteristics of natural and hatchery coho salmon and steelhead stocks; 5) determining out-migration timing of hatchery and natural stocks; 6) maintaining Tribal trust and Resource Trustee obligations to mitigate for lost habitat; 7) developing conservation hatchery techniques; and 8) minimizing any negative effects from fish husbandry or juvenile release on native, naturally occurring populations of listed salmonids. This plan will be subject to review by the appropriate resource agencies (the Service, CDFG, NMFS, ODFW, and the Tribes).

d. Fund 100 percent of hatchery operations and maintenance which are necessary to provide protection, mitigation and/or enhancement to the fishery resources impacted by the Project. This would include:

- 100 percent of any improvements to existing facilities
- 100 percent of any new construction
- 100 percent of the annual operating costs
- 100 percent of the fish marking, monitoring and recovery costs
- 100 percent of any permits and/or plans required by the State and/or Federal governments to operate existing or new facilities.

Justification:

a. The future role of Iron Gate Hatchery will be to compensate for ongoing and continuous impacts of irretrievable productivity lost due to the inundated Klamath River and blocked passage into historical habitats. The Iron Gate Hatchery provides a harvestable fishery. Until wild populations in the upper basin can provide sufficient, harvestable, self-sustaining runs, a hatchery program will be needed to supplement natural production in the upper basin.

b. The Licensee needs to fully fund mitigation for Project impacts and mark fish resulting from mitigation to ensure that agencies and Tribes can assess reintroduction efforts above the dam. The progress towards reintroduction goals cannot be adequately assessed without being able to distinguish IGH fish from fish originating above Iron Gate Dam.

c. Requirements for future operation of IGH and any other hatchery facilities mitigating Project impacts should include a goal of designing future hatchery activities to complement the recovery of natural stocks in the Klamath River. To achieve this goal will require comprehensive monitoring and assessment of hatchery impacts. HGMP must also be in place that ensures that the fish used to reestablish fall-run Chinook, spring-fun Chinook, steelhead, and Pacific lamprey are genetically appropriate and genetically robust. If they are not, it could impact the likelihood of success of reintroduction.

d. An effective and responsive mitigation hatchery program will require a substantial financial commitment. Because the hatchery is operated as direct mitigation for on-going Project impacts, the Licensee should bear the cost of any measures necessary to mitigate Project impacts on fish and wildlife resources. NMFS recommends that the FERC address this issue by requiring the Licensee:

> Fund 100 percent of IGH operations and maintenance which are necessary to provide protection, mitigation and/or enhancement to the fishery resources impacted by the Project. This would include:

- 100 percent of any improvements to existing facilities
- 100 percent of any new construction
- 100 percent of the annual operating costs

- 100 percent of the fish marking, monitoring and recovery costs
- 100 percent of any permits and/or plans required by the State and/or Federal governments to operate existing or new facilities.

The lack of fish passage has prevented management agencies, the Tribes, and the Klamath River Basin Fisheries Task Force from meeting their goals and objectives. To ensure that mitigation for Project impacts is consistent with the goals and objectives of management agencies, the Tribes, and the Klamath River Basin Fisheries Task Force, the above anadromous fish hatchery operations are critical. Because of its location in the watershed and production capacity, the hatchery is also key to facilitate implementation of measures to restore wild runs of anadromous fish above the Project.

Impacts: The Project will continue to block access by anadromous fish to considerable quantity and quality of habitat above the dams. Approximately 360 miles of current (if sea run fish could access these areas) anadromous fish habitat exists in the Above Project Reach (Huntington 2006). This figure would be increased to 420 miles of habitat following restoration (Huntington 2006). Potential returns based upon historical habitat are about 111,000 Chinook adults and 6,900 to 20,000 steelhead (Fortune et al. 1966; Chapman 1981; Huntington 2004) and Huntington 2006).

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Attachment C

National Marine Fisheries Service 10(a) Recommendations

March 27, 2006

TABLE OF CONTENTS

I. INTRODUCTION

In issuing a new license or re-license, FERC must ensure that the Project is best adapted to a comprehensive plan for, among other considerations, the adequate protection, mitigation and enhancement of fish and wildlife, including related spawning grounds and habitat, under section 10(a) of the FPA.[1] 16 U.S.C. § 803(a). Relicensing provides an opportunity to completely reevaluate the best use of the river resource upon license expiration and under the FPA is considered "substantially equivalent" to issuing an original license. *Confederated Tribes and Bands of Yakima Indian Nation v. Federal Energy Regulatory Commission,* 746 F.2d 466, 475 -476 (9th Cir. 1984).

In fulfilling the balancing provisions of section 10(a) of the FPA, FERC guidance states that it must consider the economics of hydropower projects in terms of a project's current operating costs as compared to likely alternative power.[2] The project's power benefits are to be evaluated as previously licensed, and under the amended license with the mitigation and enhancement measures set forth in the recommendations, prescriptions and conditions under FPA sections 10(j) and section 18.[3]

As a Federal Agency responsible for managing anadromous salmonids and steelhead in the Klamath River, the National Marine Fisheries Service (NMFS) recommends that FERC fully consider the substantial resource benefits that would accrue from restoring the aquatic resources of the Klamath River impacted by the operation of the hydroelectric Project. These impacts occur in the Klamath River, which was historically the third

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[1] Section 10(a)(1) of the FPA (16 U.S.C. § 803(a)(1)) states: *"That the project adopted...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 waterpower development, for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat), and for other beneficial uses, including irrigation, flood control, water supply, and recreational and other purposes referred to in section 4(e) [; and] if necessary in order to secure such plan the Commission shall have authority to require the modification of any project and of the plans and specifications of the project works before approval".*
".

[2] 72 FERC ¶ 61,027 (1995). Under FERC analysis, future inflation is assumed to be zero, the annual cost of money and discount rate is assumed to be 8 percent, and the present value and levelized cost calculations are based on the first 30 years of license term.

[3] In the Edwards Dam proceeding, FERC found that fish protection devices at the project were economically infeasible and thus inconsistent with the obligation "to make licensing decisions that represent the best comprehensive use of the waterway". Accordingly, FERC ordered the project decommissioned and the structures removed. 65 FERC 64,083.

largest producer of salmon on the west coast. The Klamath River watershed once produced large runs of Chinook salmon (Oncorhynchus tshawytscha) and steelhead (Oncorhynchus mykiss) and also supported significant runs of other anadromous fish, including coho salmon (Oncorhynchus kisutch), green sturgeon (Acipenser medirostris), eulachon (Thaleichthys pacificus), coastal cutthroat trout (Oncorhynchus clarki clarki), and Pacific lamprey (Lampetra tridentata). One estimate (Radtke, pers. comm. cited in Gresh et al. 2000) put the historical range of salmon abundance for the Klamath-Trinity River system at 650,000-1 million fish.

These runs contributed to substantial commercial, recreational, subsistence, and Tribal harvests (Snyder 1931; Lane and Lane Associates 1981; USDI 1985; USDI Fish and Wildlife Service 1991; Gresh et al. 2000). In particular, the Upper Klamath River above Iron Gate Dam once supported the spawning and rearing of large populations of anadromous salmon and steelhead (Lane and Lane Associates 1981, Hamilton et al. 2005, FERC 1990).

Anadromous production within the Klamath River has been in general decline throughout the 20th century. The Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program (Long Range Plan) clearly identifies the lack of passage through and beyond the Project Area as a significant impact to the Klamath River anadromous fishery. Significant and un-utilized anadromous habitat exists upstream of Iron Gate Reservoir. Existing dams prevent access to historically productive low-gradient wetland habitat in the Upper Klamath Basin. Summer steelhead and spring-run Chinook are largely extirpated from their historical range in the upper mid-Klamath region and associated tributaries. Iron Gate Dam and Copco Dam prevent access to cold-water spring habitat in the Klamath River, located in the reach between JC Boyle Dam and the upper end of Copco Reservoir, which would function as suitable summer holding habitat to sustain these fish in the upper Klamath system.

In contrast, the supplemental contribution of generating capacity provided through continued Project operations is nominal (total capacity of 163 MW) relative to the watershed level benefits to aquatic resources and regional and National priorities for restoring anadromous salmonids. As part of the FERC relicensing process, the California Resources Agency and the California State Water Resources Control Board requested that the California Energy Commission (CEC) staff review the energy effects of full or partial decommissioning (CEC 2004). Based upon a comprehensive analysis of regional generating capacity and economics CEC staff concluded that decommissioning is a feasible alternative from the perspective of impacts to the statewide electricity resource adequacy and that replacement energy is available in the near term (D-32). In coming to this conclusion CEC staff reasoned: “Because of the small capacity of the Klamath hydro units, staff concluded that removal of these units “will not have a significant reliability impact on a larger regional scale” (D-31). Further, CEC staff identified a total of 721 MW of new generation or power purchase contracts in the immediate project vicinity, plus another 1,692 MW of proposed generation in the same area (D-32). Accordingly, a decision to remove the lower 4 Project dams and provide efficient fish passage at remaining Project facilities would fulfill FERC's mandate under the FPA to ensure the best comprehensive use of the waterway.

RECOMMENDATIONS

1. Removal of Lower Four Dams on the Klamath River

Recommendation: The Licensee shall develop and implement a plan to remove the lower four Project dams (Iron Gate, Copco 2, Copco 1, and J.C. Boyle dams), restore the riverine corridor, and bring upstream and downstream fish passage facilities at Keno dam into compliance with NMFS guidelines and criteria within ten years of license issuance, expiration or surrender.

Justification:

While NMFS is prescribing preliminary fishways under its authority in Federal Power Act section 18, NMFS believes that within this relicensing process the best alternative to contribute to restoration of all fish species of concern in the Klamath watershed is the decommissioning and subsequent removal of the four lower Project dams (Iron Gate, Copco 1 & 2, and J.C. Boyle), combined with improvements in fish passage at Keno Dam. The dam removal alternative is a superior alternative from a fish passage, water quality, and habitat restoration standpoint. Without man-made barriers to blockade essential fish movements, all fish may move freely and naturally, according to their life history adaptations for fulfilling their biological requirements. This is the basis of our section 10(a) recommendations. Implementing this dam decommissioning and dam removal alternative would go a long way toward resolving decades of degradation where Klamath River salmon stocks are concerned. NMFS and several key participating stakeholder groups are in full agreement with this important principle. The Applicant does not propose modifications of existing facilities that would provide for passage of anadromous fish through Project facilities. Upgrades are proposed for the J.C. Boyle facility, where existing passage structures required by the current license are not functioning for resident trout. However, needed upgrades at Keno Dam are not proposed, and no passage facilities are proposed for Iron Gate, Copco 1, or Copco 2 dams, where resident species are isolated by lack of passage. Thus, the passage needs of anadromous and resident fish have not been adequately addressed.

Removal of the four lower dams on the Klamath River will, in general, remove the following impacts due to these dams:

Dam Impacts:

Anadromous Fish - Habitat Loss: Lack of fish passage at the Klamath Project facilities blocks access to more than 410 miles of migration, spawning, and rearing habitat for salmon, steelhead, and Pacific lamprey. All anadromous species in the Klamath River Basin have declined significantly in the years since initiation of the Klamath Project.

Anadromous Fish - Thermal Refugia: The Applicant does not propose reintroducing anadromous fishes into or above the Project area. However, thermal refugia present within the Project area are important to the survival of anadromous species with life histories that include holding in the mainstem Klamath River during the warmer months. In particular, spring Chinook salmon, coho, and summer steelhead require cool water during this period.

Thermal refugial areas downstream of Iron Gate dam, such as Elk Creek and Blue Creek, have been inventoried (Belchik 1997) and shown to be heavily used by anadromous salmonids in the Klamath River when water temperatures elevate (Sutton et al. 2004). Historically, significant refugial areas existed just downstream from J.C. Boyle Dam, underneath Iron Gate Reservoir, and at Jenny, Fall, Shovel, and Spencer creeks. Springs that would have provided thermal benefits are also described in the Copco area prior to the completion of Copco 1 dam (Boyle 1976).

Project facilities have blocked access to these thermal refugia within and above the Project. Once Iron Gate dam (river mile 190) was completed in 1962, access to important thermal refugia was blocked. The spring run Chinook salmon population below the dam, with no large cold water refugial areas downstream to Beaver Creek (river mile 162) (Belchik 1997) has been declining ever since. Today, the Salmon River and its Wooley Creek Tributary (over 130 miles downstream from Iron Gate Dam) mark the upper limit of the remnant Klamath River spring run Chinook salmon (USDI Fish and Wildlife Service 1991). The absence of cold water pools for use by both adults and juveniles has been identified as an important factor limiting the spring Chinook salmon population on the Trinity River (Olson 1996, Hillemeier 1999). The health of the spring Chinook salmon population on the Klamath River is likely dependent upon opening up the coldwater refugial areas upstream of Iron Gate Dam.

Anadromous Fish - Ecosystem Function: Anadromous fish play a key role in ecosystem function. They are an important source of energy and nutrients for subsequent generations of salmon and to maintain proper ecological function (Stockner 2003). When salmon return from the ocean to spawn, they bring vital nutrients with them to the watershed. In addition to elemental nutrients, salmon carcasses contain minerals, amino acids, proteins, fats, carbohydrates, and other biochemicals essential for living organisms (Wipfli *et al.* 2003). The significance of these biochemicals and their availability to the food web may be more important than nitrogen, phosphorous, or other nutrients (Wipfli *et al.* 2003). In the Klamath River above Iron Gate Dam, anadromous fish previously provided nutrient input from the marine environment that is no longer occurring due to this Project.

It is likely that marine-derived nutrients from salmon carcasses would have an important effect on the recovery of riparian ecosystems in the Klamath River Basin and provide associated benefits to other species, including federally listed suckers and terrestrial wildlife. Decomposing carcasses provide a vital source of food and nutrients, not just for other fish species and wildlife, but for a host of organisms in the watershed vital to ecosystem health.

Alteration of the Natural Hydrologic Regime: The Klamath Hydroelectric Project has significantly altered the natural hydrologic pattern of the Klamath River within the project reaches and downstream. The ecological structure and functioning of aquatic, wetland, and riparian ecosystems depends largely on the hydrologic regime (Gorman and Karr 1978, Junk et al. 1989, Poff and Ward 1990, National Research Council 1992, Sparks 1992, Mitsch and Gosselink 1993, Poff et al. 1997). Intra-annual variation in hydrologic conditions plays an essential role in the dynamics among species within such communities through influences on reproductive success, natural disturbance, and biotic interactions (Poff and Ward 1989). Modifications of hydrologic regimes can indirectly alter the composition, structure, and functioning of aquatic, riparian, and wetland ecosystems (Stanford and Ward 1979; Ward and Stanford 1983, 1989; Bain et al. 1988; Dynesius and Nilsson 1994). Project alterations to the hydrologic regime include impounding waters at five dam sites, use of storage for peaking, diverting the majority of flows from bypassed Project reaches, and rapidly fluctuating flow rates due to ramping. These effects are discussed below.

Impoundment Effects - Habitat Loss: A total of 38.7 miles of riverine channel that has been inundated by Project reservoirs (6.1 miles for Iron Gate reservoir, 4.4 miles for Copco reservoirs; 3.7 miles for J.C. Boyle reservoir; and 23 miles for Keno reservoir) (PacifiCorp 2004a). Project reservoir environments now favor mostly non-native species and impair native species (Moyle 2002). Non-native species compete with and prey on native species, limiting the productive potential of native fish populations in Project reservoirs.

Impoundment Effects - Water Temperature: Implementing effective fish passage will allow anadromous fish access to tributary and mainstem habitats upstream of Iron Gate Dam. However, fish passage alone will not address water temperature impacts downstream of Iron Gate Dam. Changes in water temperature due to reservoir impoundments are well documented (Sylvester 1963, Jaske and Goebel 1967, Crisp 1977, Wunderlich and Shiao 1984). Reservoirs reduce annual and daily fluctuations in temperature and delay the warming and cooling periods by acting as thermal sinks. Bartholow et al. (2005) modeled the effect of hypothetical removal of the Klamath hydroelectric dams on thermal characteristics of the Klamath River downstream of Iron Gate Dam. They found that dam removal would "restore the timing of the river's seasonal thermal signature by shifting it approximately 18 days earlier in the year, resulting in river temperatures that more rapidly track ambient air temperatures". With dam removal, water temperatures would be cooler in the fall and winter (when temperatures are cooling) and warmer in spring and summer (when temperatures are warming).

The Applicant (PacifiCorp 2005d) modeled thermal lag conditions caused by Project reservoirs to assess temperature differences between existing conditions and hypothetical without project conditions. Model results show that river reaches cool and heat relatively quickly without the reservoir volumes (assuming no reservoirs). Water temperatures are cooler in the spring and warmer in the late summer and fall under existing conditions than most of the without dam alternatives. The Project dams appear to warm water temperatures by 1 to 5 EC during the months of August through November, and to cool water temperatures by 1 to 3 EC during the months of February through June (PacifiCorp 2005d, Figures 1-1 through 1-5, Appendix B).

Temperatures are critical for salmonids on the Klamath River. In the spring months of March through May, juvenile salmonids need temperatures above 10 to 13EC for optimal growth (United States Environmental Protection Agency 2003). The Project significantly delays the onset of these temperatures (PacifiCorp 2005d) and likely slows salmonid juvenile growth. Juvenile disease risk is elevated at 14 to 17 EC and is high at 18 to 20 EC (United States Environmental Protection Agency 2003). By slowing juvenile growth rates, juvenile outmigration is likely delayed, subjecting juvenile Chinook to higher temperatures and increased disease risk.

During summer months, high water temperatures in the mainstem Klamath River downstream of Iron Gate Dam are commonly cited as a cause of decline of anadromous fish runs in the Klamath River (Bartholow 1995, Campbell et al. 2001). Temperatures commonly reach levels that are lethal to salmonids and temperatures in the mainstem Klamath River "get higher with a greater frequency and stay higher for a longer time, than waters in adjacent coastal anadromous streams" (Bartholow 1995). Spring Chinook, steelhead, and coho over-summer in the Klamath River as juveniles, making them especially vulnerable to these elevated temperatures. Salmonid juveniles have been shown to use cool water areas to get by during these warm time periods, but these areas are limited on the Klamath River (Berman and Quinn 1991, Belchik 1997, Sutton et al. 2004).

Project dams likely exacerbate the effects of high water temperatures on salmonid juveniles because while they decrease maximum temperatures in June and July, they also elevate minimum temperatures at that time and slow the cooling of both daily maximum and minimum temperatures in August and September (PacifiCorp 2005d). As stated earlier, juvenile disease risk is high at 18 to 20 EC and temperatures are lethal above 23EC. The elevation of minimum daily temperatures in June and July is likely to impact fish by removing the effectiveness of important thermal refugial areas (NRC 2004). The elevation of water temperatures in August and September prolongs the exposure of juvenile salmonids to high temperatures with impaired thermal refugia, which very likely increases mortality rates. Indeed, juvenile fish die-offs in the Klamath River are not uncommon. Mortality of over 240,000 juvenile Chinook salmon in the Trinity and Klamath rivers was associated with water temperatures in excess of 20 EC in June, July, and August (Williamson and Foott 1998).

Adult salmonids entering the river to spawn are likely impacted by the temperature effects of Project dams. Spring-run Chinook salmon enter the river in May and June and fall-run Chinook enter in August and September. Upstream migration appears to be delayed when temperatures equal or exceed 22 EC, at which point adult Chinook seek out and reside in thermal refuges or stay in the estuary where temperatures are much cooler (Strange 2005). Thermal tolerances for adults are similar to those for juveniles identified above (United States Environmental Protection Agency 2003). Therefore, the elevation of minimum daily temperatures in June and July caused by Project dams likely impacts Chinook trying to hold in thermal refugia, and may lead to premature mortality. The elevation of water temperatures in August and September due to Project dams likely postpones spawning migration, leading to delayed spawning and egg development and subsequent reduced survival. In addition, elevated water temperatures in August and September increase adult mortality by causing salmonids to crowd in poor quality habitat (Schreck and Li 1991, Matthews and Berg 1997). Such conditions are known to lead to outbreaks of diseases such as *Flexibacter colunmaris* (Holt et al. 1975, Wakabayashi 1991) and *Ichthyophthirius multifiliis* (Bodensteiner et al. 2000). Such an outbreak resulted in over 30,000 adult Chinook deaths in the Klamath River during September of 2002 (USFWS 2003a, USFWS 2003b, CDFG 2004).

Impoundment Effects - Dissolved Oxygen**:** Dissolved oxygen (DO) levels in the upper portion of the J.C. Boyle bypass reach are impaired by J.C. Boyle Reservoir (PacifiCorp 2004b, 4-41 and 4-53). Median and minimum DO levels are decreased by the Project during the summer months. The Project reduces DO levels at the upstream end of the bypass reach by as much as 4 to 5 mg/L during the June to August period, and occasionally causes DO levels to approach zero (PacifiCorp 2004b, 4-53).

DO is also very low from below Copco 1 to below Iron Gate dam (PacifiCorp 2005b); therefore, fish in the Copco bypassed reach and Iron Gate Reservoir will be adversely affected due to inadequate DO levels. In the FLA, the Applicant acknowledges that as a consequence of temperature stratification and high nutrient loading in Iron Gate reservoir, the hypolimnetic water is deficient in oxygen during the summer and fall. The Applicant has proposed installation of a hypolimnetic oxygenation system that will improve dissolved oxygen levels below Iron Gate dam (PacifiCorp 2005b and PacifiCorp 2005c).

Impoundment Effects - Nutrient Loads: The Applicant has argued that Project reservoirs decrease nutrient loads and algal growth in the Klamath River below Iron Gate dam by allowing organic matter from Upper Klamath Lake to settle in the reservoirs (PacifiCorp 2005d). However, this statement is not supported by analysis. Studies have shown that the reservoirs either do not trap or generate nutrients (U. S. EPA 1978, Campbell 1999). A recent nutrient budget analysis of Copco and Iron Gate reservoirs demonstrates that both reservoirs act as a source of nitrogen and phosphorus periodically, especially during the critical period of July through September (Kann 2005a).

Impoundment Effects - Disease: Outmigrating juvenile Chinook (*Oncorhynchus tshawytscha)* and steelhead (*O. mykiss*) within the Lower Klamath River Basin experience significant mortality from infectious disease, with recent estimates of disease-related mortality in downstream migrants as high as 90 percent (Foott et al 2003). The primary pathogens implicated in this mortality are the myxozoan parasites *Ceratomyxa* *shasta* and *Parvicapsulum minibicornis* (Williamson and Foott 1998, Foott et al. 1999, 2002, 2003).

The life cycles of the parasites are complex and require development in both a vertebrate and invertebrate host. For *C. shasta*, the invertebrate host is the freshwater polychaete *Manayunkia speciosa* (Bartholomew et al. 1997). Fish become infected by contact with actinospores that are produced within *Manayunkia*. Following fish mortality, myxospores are released into the water where they are then taken up by the polychaete.

Little is known of the life history, ecology, and distribution of *Manayunkia*. Within the Klamath River, *Manayunkia* has been collected from several locations above and below Iron Gate Dam, often in association with mats of the filamentous green alga *Cladophora* (Pacificorp 2004a, Stocking and Bartholomew 2004). The polychaete inhabits a tube built of fine organic and/or inorganic particles, and its distribution may be restricted to locations where these particle sizes are readily available.

Researchers at Oregon State University are considering a hypothesis that algae buildup on substrate in the Klamath River contributes to increasing habitat suitable for the polychaete worm that is the alternate host for *Ceratomyxa shasta* (Stocking and Bartholomew 2004). Increases in habitat can increase production of the polychaete and subsequently the number of myxozoan spores in the water column that may infect fish. In addition to high nutrient levels, reductions in the magnitude and extent of peak flows resulting from hydroelectric operations has likely contributed to increasing the amount of stable habitat for the polychaetes downstream of the Project (McKinney et al. 1999). The Applicant (PacifiCorp 2005d) considered only temperature as an indicator and determinant of parasite load. The Applicant did not consider the roles of seasonal flow reductions and stagnancy in increasing habitat for the intermediate host and increasing abundance of *C. shasta*.

Impoundment Effects - Toxic Algae Blooms: Blooms of *Microcystis aeruginosa*, a blue green alga (cyanobacteria), have recently been reported in Iron Gate and Copco Reservoirs (Kann 2005b). *M. aeruginosa* is a microscopic organism that is found naturally at low concentrations in lakes and streams. Occasionally, it forms a harmful bloom, a dense aggregation of cells that float on the water surface. This species forms a toxin (microcystin) that is a strong hepatotoxin, causing liver disease in fish (Carmichael 1988, Andersen et al. 1993, Sahin et al. 1995, Watanabe et al. 1996).

M. aeruginosa is commonly found in water bodies that are eutrophic and hypereutrophic (Watanabe et al. 1996). Excessive nutrients, poor water flow (stagnant conditions), and alterations of lake conditions such as land clearing, agricultural development, and water management have been associated with cyanobacteria blooms (Hallegraeff 1993, Florida Fish and Wildlife Research Institute 2005). Research on the lower Neuse River of North Carolina indicated that blooms of *M. aeruginosa* were triggered by high levels of nutrients and periods of low flows and decreased turbulence (Pearl 1987). The reservoirs of the Klamath Hydroelectric Project have created large areas with ideal conditions for the development of toxic blue green algae blooms. *M. aeruginosa* may naturally exist in small concentrations along the margins of the Klamath River, but it would likely be far less abundant if the reservoirs were restored to free-flowing river reaches. The Applicant states that "the risk of blue-green algae blooms in the Project area is less under the without-dams scenarios" (PC 2005d). Monitoring for the presence of *M. aeruginosa* and its effects on Klamath River biota are needed.

Impoundment Effects - Gravel Depletion: Native species in the Klamath River evolved under the seasonal variability of an unregulated river, with a freely moving sediment bedload. However, the Project's dams have been collecting and storing sediments for decades, while reaches below the dams have been deprived and scoured of gravel and finer sediments. The Applicant (PacifiCorp 2004a) reported that the Project impacts alluvial features (and therefore potential salmonid spawning material) from Iron Gate Dam to the confluence with Cottonwood Creek.

In most Project reaches, the river bed is coarsened as smaller gravels are transported downstream without being replaced, and larger gravels and cobbles that are unsuitable for use by spawning fish dominate (Kondolf and Matthews 1993, PacifiCorp 2004b). The Applicant states that the Project causes a deficit of sediment for transport between dams and below the Project. The reach below J.C. Boyle Dam is especially sediment supply limited. Indeed, "pebble count results indicate potential bed coarsening immediately downstream of Project dams and in the J.C. Boyle peaking and bypass reaches" (PacifiCorp 2004b). In addition, the Project may have significantly coarsened the channel bed from downstream of Iron Gate Dam to the confluence with Cottonwood Creek (PacifiCorp 2004b).

Impoundment Effects - Reduced Flood Flows: Klamath Project reservoirs are relatively small, and are not operated for flood control. Though reservoirs allow high flows to pass, their magnitude is often decreased. The reduction of flood flows has resulted in changes in the distribution of riparian vegetation due to changes in the availability of sediments. Salmonids are dependent on the gravel sediments for spawning that are normally maintained by flood events, and riparian vegetation is important for providing stream edge habitats for juvenile rearing.

Reduced flows in the J.C. Boyle bypassed reach have resulted in channel constriction, elimination of riparian vegetation, and development of an island (PacifiCorp 2004b). During construction of the road and power canal in the J.C. Boyle bypassed reach significant amounts of sidecast material was deposited within the right bank of the river. Riparian vegetation has been reduced by the sidecast, aquatic habitats have been damaged, and fish passage constricted in some places.

Extremely reduced flows in the Copco No. 2 bypassed reach has resulted in a significant degree of riparian encroachment into the active channel, a significantly reduced channel, and reduction in aquatic habitat availability (PacifiCorp 2004b).

Effects of Hydroelectric Peaking Operations: Hydroelectric peaking operations are used to maximize hydroelectric revenues by maximizing power generation when demand is greatest. Storage at J. C. Boyle and Copco reservoirs is used to manipulate flows through the powerhouses to a constant, elevated level during the afternoon and early evening and to minimum levels at night and in the morning. Such operations at the J.C. Boyle Powerhouse result in large, artificial, daily fluctuations in flows in the J. C. Boyle peaking reach, but flows exiting the Copco Powerhouse enter Iron Gate Reservoir directly, avoiding river reach flow fluctuations. Such large flow fluctuations result in high mortalities of many aquatic populations from physiological stress, wash-out during high flows, and stranding during rapid dewatering (Cushman 1985, Petts 1984). Frequent dewatering can result in massive mortality of bottom-dwelling organisms and subsequent severe reductions in biological productivity (Weisberg et al. 1990). Frequent flow fluctuations severely impair the rearing and refuge functions of shallow shoreline or backwater areas for small fish species or young life stages of larger fish (Bain et al. 1988, Stanford 1994).

Effects of Hydroelectric Peaking Operations - Reduced Flows in Bypassed Reaches: Most of the water that would enter the J. C. Boyle bypassed and Copco 2 bypassed reaches of the Klamath River is diverted for power generation. Only 100 cfs normally is released in the J.C. Boyle bypassed reach and only 5 cfs normally is released in the Copco 2 bypassed reach. Table 1 provides an exceedance table of the monthly flows at the J.C. Boyle Powerhouse gage using a period of record from October 1, 1959 to September 30, 2004. These flows represent the flows that would exit the J.C. Boyle bypassed reach without hydroelectric peaking operations. Subtracting these amounts by 220 cfs (spring accretions in the bypassed reach) gives an approximation of the flows that would enter the J.C. Boyle bypassed reach without hydroelectric peaking operations. The exceedance percentages equate to water year types. A 10 percent exceedance year is an extremely wet year, a 30 percent exceedance year is a wet year, a 50 percent exceedance year is an average year, a 70 percent year is a dry year, and a 90 percent year is a critically dry year.

Table 1. Monthly exceedance flows at the J. C. Boyle Powerhouse gage, period of record October 1, 1959 through September 30, 2004.

J.C. Boyle monthly exceedance flows

Exceedance	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
10%	2430	2831	3460	3760	4875	6070	4810	3770	1890	975	1170	1600
30%	1630	2292	2730	2680	2760	2907	2870	2220	1070	772	1010	1330
50%	1420	1560	2030	1880	2006	2240	1983	1420	749	671	940	1190
70%	1210	1240	1460	1430	1260	1470	1354	942	630	573	785	996
90%	859	862	904	833	676	714	767	638	506	392	514	706

A similar table is not available for the Copco 2 bypassed reach, but flows in the Copco 2 bypassed reach exceed those shown in Table 1 due to variable but small accretions between the powerhouse and Copco 2 dam.

Numerous studies demonstrate that departure from the natural flow regime leads to significant reductions in the functioning of river ecosystems (Poff et al. 1997). To avoid this, significant components of the natural variability of river flow must be retained. Flows in the J.C. Boyle and Copco bypassed reaches have been severely altered from the natural flow regime. Most of the aquatic habitat that was present before the Project was constructed is now gone.

In order to restore aquatic resources in these reaches, including anadromous salmonids, it is necessary to return flows in a natural pattern to these reaches. In addition to restoring natural patterns of variability, flows in the bypassed reaches should optimize habitat availability, habitat quality (mostly temperature), and food availability. Increased flows in a pattern that mimics the natural flow regime would benefit salmonid productivity in the bypassed reaches.

Effects of Hydroelectric Peaking Operations - Effects of Large Flow Fluctuations in the Peaking Reaches: Comparison of the Keno, J.C. Boyle bypassed, and J.C. Boyle peaking reaches provides an indication of the impacts of the large flow fluctuations caused by the Applicant's hydroelectric peaking operations. Oregon Department of Fish and Wildlife's Fish Management Plan (Oregon Department of Fish and Wildlife 1997) identifies the primary objective for these Klamath River reaches as wild trout management for the native redband/rainbow trout. Creel census information from Toman (1983) show that numbers of trout in the J.C. Boyle bypassed and J.C. Boyle peaking reaches were slightly less than in the Keno reach and the size of fish was significantly larger in the Keno reach. The Applicants studies (PacifiCorp 2005a, section 3.9.3) also showed that trout are significantly larger in the Keno reach. Further analysis indicates that the larger size of trout in the Keno reach is due to greater numbers of older fish and higher growth rates in older fish (Addley et al. 2005). Trout growth in the bypassed reach is impaired by the removal of most of the flows from that reach and growth in the peaking reach is impaired by the adverse effects of artificial flow fluctuations.

Effects of Hydroelectric Peaking Operations - Abundance of Macroinvertebrates: Artificial flow fluctuations create a varial zone on the streambed that experiences alternating desiccation and rewetting. The Applicant did an analysis that estimated that peaking operations reduce the wetted perimeter of the peaking reach by 10 to 25 percent (PacifiCorp 2005a). The extreme fluctuations in the varial zone significantly reduce the biomass of algae and macroinvertebrates. The Applicant found a distinctly lower abundance and diversity of macroinvertebrates in the varial zone of the peaking reach than in adjacent constantly wetted sites (Addley et al. 2005). This effect strongly reduces food availability to fish in the peaking reach, leading to smaller size fish than those found in the Keno Reach (Addley et al. 2005).

Macroinvertebrate drift density, a measure of food availability to trout, was measured in the three reaches and reported in the Bioenergetics Study (Addley et al. 2005). Drift density was high in the Keno reach and low in the J. C. Boyle bypassed and peaking reaches. The Keno reach receives high amounts of nutrients that support primary and secondary production, yielding high macroinvertebrate densities. The J.C. Boyle bypassed reach receives few nutrients because the flows received from upstream are very low and the spring accretions are low in nutrients, yielding low rates of primary and secondary production. The J.C. Boyle peaking reach receives high amounts of nutrients from upstream (the hydroelectric flows are returned to this reach), but the effects of peaking on the varial zone reduce the ability of this reach to assimilate nutrients, limiting primary and secondary production.

The Applicant provided a Bioenergetics Report (Addley et al. 2005) that analyzed the impacts of hydroelectric peaking on trout growth by comparing growth in different reaches of the Klamath River and by comparing growth with macroinvertebrate prey densities. The growth model accurately predicts existing condition growth in the peaking reach assuming observed drift density and no spawning. The analysis indicates that the higher drift density of invertebrate prey likely is responsible for some of the higher growth rates in the Keno reach, and suggests that trout may be switching to more abundant or higher energy prey and/or migrating and modifying their temperature regime in later growth stages.

Effects of Hydroelectric Peaking Operations - Fish Movement: Increased energetic costs of movement due to artificial flow fluctuations in the peaking reach are not modeled or considered as an explanation of differences between the Keno and peaking reaches in the Bioenergetics Report (Addley et al. 2005). However, it is likely that trout have significantly increased energetic costs due to movements required to adjust to extreme flow fluctuations from hydroelectric peaking operations. Extensive studies of trout activity patterns related to hydroelectric peaking operations indicate that significant movements are undertaken by fish (Pert and Erman 1994) that are likely to be energetically costly (Rincon and Lobon-Cervia 1993). NMFS disagrees with the Applicant's characterization of the Pert and Erman (1994) study. While some individual fish exhibited strong general site fidelity, all individuals shifted their habitat preferences to deeper and faster water as discharge increased, with associated increasing energy costs.

Effects of Hydroelectric Peaking Operations - Water Quality: The large flow fluctuations associated with peaking hydropower operations limit the assimilative capacity of the river to remove hypereutrophic components of the water entering the system. Highly variable flow regimes limit the success of benthic algae due to repeated desiccation and rewetting (PacifiCorp 2005f). Benthic algae are responsible for the removal of nutrients from the water column through assimilation. Without peaking operations, the Project reaches would provide stronger assimilation and removal of nutrients (PacifiCorp 2005f). The Klamath River below Iron Gate dam assimilates and removes nutrients due to uptake by algae and dilution from tributary streams (PacifiCorp 2005f).

Another effect of peaking operations is that water temperatures likely exhibit greater diurnal fluctuations than they would without peaking. The Applicant provided water quality modeling results showing that, in the peaking reach, a steady flow alternative would provide slightly lower daily maximums and higher minimums, and a without project alternative would provide even lower daily maximums and similar minimums, in comparison to the existing condition (PacifiCorp 2005a, Addley et al. 2005). Research on rainbow trout has shown that large daily fluctuations in temperature compromise growth and survival rates (Hokanson et al. 1977). Thermal effects of peaking are a concern because temperatures in the summer months are at or above thermal tolerances for salmonids in the Project area, and the increase in diurnal fluctuations likely negatively impacts growth and survival.

Effects of Hydroelectric Peaking Operations – Fish Stranding: Hydropower peaking generally causes significant salmonid losses due to stranding (Anglin et al. 2005) and is likely causing stranding mortality of fry and juvenile fish in the J.C. Boyle peaking reach. This may be contributing to the disparate age structure in the peaking reach versus similar redband trout populations (Oregon Department of Fish and Wildlife 2003).

The extent and cumulative impacts of stranding have not been previously studied in J.C. Boyle peaking reach (California Department of Fish and Game 2000). The most common habitat types in the J.C. Boyle peaking reach are shallow rapids, riffles, and runs. Channels with an abundance of shallow habitat are more likely to have larger areas exposed during down ramping where fish could become separated from the main river flow due to declines in stage (Hunter 1992).

2. 30 Year New License Term

<u>Recommendation</u>: If the Services' fishway prescriptions will be incorporated into the new license and the lower four Project dams will not be decommissioned and removed, the new license term shall be limited to 30 years.

<u>Justification:</u>

If the Services' fishway prescriptions will be incorporated into the new license and the lower four Project dams will not be decommissioned and removed, the new license term shall be limited to 30 years in order to minimize existing Project effects on anadromous fish. Anadromous fish species in the Klamath River Basin have exhibited significant declines in the years since initiation of the Klamath Project (Busby et al 2000, Myers et al 1998). Project impacts on anadromous fish include, but are not limited to, elimination of anadromous habitat within and above the Project, alteration of the riverine temperature, hydrology, and water quality below Iron Gate Dam, submersion and elimination of cold water refugia beneath Project reservoirs, gravel depletion below Iron Gate Dam, and disease impacts below Iron Gate Dam. With anadromous fish reintroduction into and above the Project, and significant environmental improvements in progress in the upper Klamath basin, it is important to limit the term of the license to 30 years to facilitate timely evaluation and modification of the terms and conditions of the license.

3. Decommissioning Fund

Recommendation:

The Licensee should be required to establish and maintain a decommissioning fund to finance potential future decommissioning of the project[4].

Justification:

This requirement is necessary to ensure that adequate funding is available to implement Project decommissioning should FERC or other duly authorized federal entities determine decommissioning to be required by law or otherwise in the best public interest.

[4] See FERC Policy Statement on Decommissioning, RM-93-23-000.

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