Section C: U.S. Department of the Interior Preliminary Section 18 Prescriptions, Klamath Hydroelectric Project - FERC No. 2082

Section C: U.S. Department of the Interior Preliminary Section 18 Prescriptions

I. INTRODUCTION, BACKGROUND, AND PROCEDURAL CONSIDERATIONS

The U.S. Fish and Wildlife Service and the 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]

II. 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.

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

[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 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., United States v. Adair, 723 F.2d 1394, 1408-15 (9th Cir. 1984), cert. denied, 467 U.S. 1252; Parravano v. Babbitt, 70 F.3d 539 (9th Cir. 1984), cert. denied, 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.

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

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:

- 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 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.

III. 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

[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)

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.

IV. 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	1.0 Foot	NMFS 2003, ODFW 2006b
Slope	~10%	NMFS 2003
Federally listed suckers		
Maximum vertical jump	No jump	ODFW 2006b
Slope	<4.0% (4.5%)	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

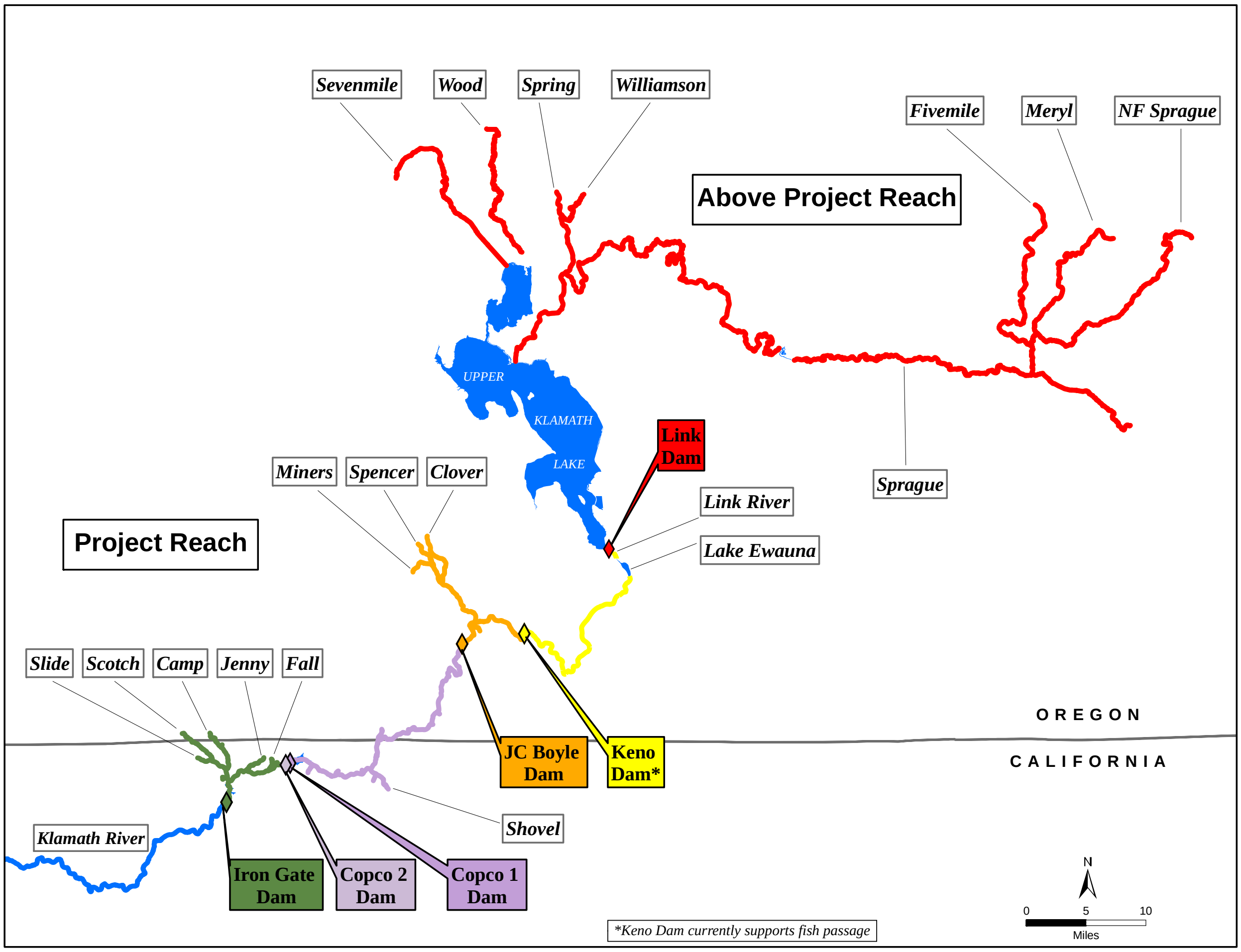

Figure 1. Project Reach and Above Project Reach (in red) designations for the Klamath River above Iron Gate Dam).

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

V. 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, 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.

Rationale for General Preliminary Prescriptions*:*

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.

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

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 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

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

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 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. Iron Gate 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 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:

Resident Trout: 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.

- Coho: 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.

2.1 Fall Creek Diversion Dam Upstream Fishway

2.1.1 Fall Creek Upstream Fishway: 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.

2.1.2 Design Consultation: 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.

2.1.3 Monitoring, Reporting, and Evaluation: 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:

- Resident Trout: 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.
- Coho: 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.

- Spring-run Chinook: 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).
- Fall Chinook: 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:

- Resident Trout: 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^{o}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°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.

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

8.2 Tailrace Barriers at Eastside and Westside Developments

8.2.1 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.

8.2.2 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.

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

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