4.6 Three Dam Removal Alternative

4.6.1 Introduction

4.6.1.1 Alternative Description

In the Three Dam Removal Alternative, the Copco No. 1, Copco No. 2, and Iron Gate dams and associated facilities would be fully removed, and J.C. Boyle dam and associated facilities would remain. The J.C. Boyle Dam facilities that would remain include (see also Figure 2.3-1):

1. A 2,629-acre-feet reservoir (J.C. Boyle Reservoir);
2. A 68-foot tall earthfill dam (J.C. Boyle Dam), concrete spillway, and three spill gates;
3. A concrete intake structure connecting to a 2.5-mile water conveyance system with an overflow forebay;
4. A 98-megawatt (MW) J.C. Boyle Powerhouse;
5. A switchyard with 2.8 miles of transmission lines; and
6. Ancillary buildings including an office building (known as the Red Barn), maintenance shop, fire protection building, communications building, two occupied residences, and a warehouse.

This alternative assumes that the J.C. Boyle Dam facilities would be relicensed by FERC for continued operations with changes to allow for upstream and downstream fish passage and updated flow requirements. More specifically, the Three Dam Removal Alternative assumes conditions described in the 2012 KHSA EIS/EIR *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*[215] for J.C. Boyle Dam. The primary conditions assumed for the Three Dam Removal Alternative are the following:

- *Fishway Prescriptions* – volitional year-round upstream and downstream fish passage at J.C. Boyle Dam consistent with the prescriptions from the DOI and U.S. Department of Commerce imposed during the FERC relicensing process (FERC 2007) and upheld in a trial-type administrative hearing, and specific fishway facility design and construction details included in the KHSA 2012 EIS/EIR *Fish Passage at Four Dams Alternative*[215], including fishway (i.e., fish ladder and screens) installation for both upstream and downstream migrations and barriers to prevent entrainment into turbines; and
- *Changes to J.C. Boyle Operations* – At least 40 percent of J.C. Boyle Reservoir inflow to be released downstream through the J.C. Boyle Bypass to increase minimum flows in the Bypass Reach (RM 225.2 to RM 229.8). J.C. Boyle hydroelectric peaking operations and/or recreation flows would not occur under the Three Dam Removal Alternative since Copco No. 1 and Iron Gate dams would not be present to reregulate flows downstream. Power generation would be suspended and all inflow to J.C. Boyle Reservoir would be released down the Bypass Reach under the seasonal high flow event that would occur for seven full

[215] The KHSA 2012 EIS/EIR's *Section 2.4.5 Fish Passage at Four Dams Alternative* and *Section 2.4.6 Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative* (included in Appendix U of this EIR) include fishway facility design and construction details beyond what are specifically required in the FERC prescriptions and that are based on designs of similar fishway facilities used at other hydroelectric facilities.

days in later winter/spring when inflows to J.C. Boyle first exceed 3,300 cfs (DOI 2007; NMFS 2007; FERC 2007).

The following conditions under the Three Dam Removal Alternative are modifications to the 2012 KHSA EIS/EIR *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*:

- Removal of Copco No. 2 facilities as described under the Proposed Project; and
- Flows specified in the NMFS and USFWS 2013 BiOp for the USBR Klamath Irrigation Project, which are currently being considered under reinitiated consultation (see also 3.1.6.1 *Klamath River Flows under the Klamath Irrigation Project's 2013 BiOp*).

As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing and emergency dilution flows are required to be released from Iron Gate Dam as part of re-initiation of consultation on the 2013 BiOp Flows, but they are not modeled as part of existing conditions hydrology. Potential new BiOp flow requirements under this alternative are speculative at this time, and it is not clear whether flushing and emergency dilution flow requirements would continue under the new BiOp during or after dam removal. However, the 2017 flow requirements are considered to be the most reasonable assumption for conditions until agency formal consultation is completed and a new BiOp is issued. For analysis of potential impacts related to fish disease, the Three Dam Removal Alternative considers conditions with and without 2017 court-ordered flushing flows.

Additionally, this section addresses the potential effects of using fishways other than the volitional ladders described in the 2012 KHSA EIS/EIR *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, and points out where such other fishways would result in different effects than fish ladders. Such fishway installation could include trap and haul facilities or a combination of these two approaches. Regardless of how fish passage is provided, this alternative assumes fish passage consistent with the general prescriptions (DOI 2007) that cover anadromous (fall- and spring-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey) and resident (rainbow and redband trout, shortnose and Lost River suckers) fish passage, and includes implementing operation and maintenance plans and prescribing attraction flows for upstream migrants (DOI 2007).

This alternative does not make any assumptions regarding conditions that could be imposed by the states of Oregon or California through water quality certification authority.

The aforementioned flow-related measures would reduce power generation at J.C. Boyle Dam. This alternative assumes that installation of fish passage facilities would follow the schedule described in *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*[216], which would install downstream passage facilities prior to

[216] Fishway feature design was provided in the 2012 KHSA EIS/EIR *Section 2.4.5 Fish Passage at Four Dams Alternative* and *Section 2.4.6 Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative* (Appendix U) and is used for this EIR to support the construction-related effects analysis. The KRRC would be required to obtain concurrence from USFWS and NMFS regarding fishway design and construction plans for each Lower Klamath Project facility prior to advancing to feasibility-level of design.

upstream passage facilities and would take place over a 4-month period (June through September of dam removal year 2) for J.C. Boyle Dam. The level of construction for fish passage at J.C. Boyle Dam would be consistent with that estimated for development of the 2012 KHSA EIS/EIR *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*[216], which includes removal of the existing J.C. Boyle fish ladder structure, construction of a new fishway at or near the same location as the existing fish ladder (Figure 2.3-1), and construction of downstream fish passage.

As neither the Fall Creek nor the Iron Gate hatchery facilities were built to address potential fisheries effects of J.C. Boyle Dam (Boyle 1976), this alternative assumes that hatchery operations would continue for eight years under the Three Dam Removal Alternative, with reduced production goals consistent with those described for the Proposed Project (see Section 2.7.6 *Hatchery Operations*).

Although leaving J.C. Boyle Dam in place, removing the existing fish ladder and installing a new fish ladder, would be less construction than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts to resources in California since J.C. Boyle is located in Oregon. California materials import for Copco No. 1, Copco No. 2, and Iron Gate facilities deconstruction would be the same as that described in Section 2.7.1 *Dam and Powerhouse Deconstruction,* and California waste disposal quantities, truck trips, and haul distances would be the same as presented in Table 2.7-3 (Copco No. 1 Dam), Table 2.7-5 (Copco No. 2 Dam), and Table 2.7-7 (Iron Gate Dam). Further, this alternative assumes that construction activities to meet FERC prescriptions for fish passage would occur at the J.C. Boyle Dam concurrent with activities for removal of the other Lower Klamath Project dams and associated facilities, such that any construction-related impacts would also occur concurrently and some of these (e.g., water quality) could result in downstream impacts in California. As described previously, fish passage under the Three Dam Removal Alternative would be provided by volitional fishways, trap and haul, or some combination. Overall, regardless of the method of fish passage, the level of construction activities in the Hydroelectric Reach in California under the Three Dam Removal Alternative would not be materially different than that described for the Proposed Project. California workforce projections under the Three Dam Removal Alternative also would be the same as those presented for the Proposed Project (Table 2.7-18).

If instead of a fish ladder, trap and haul or some combination of fish passage methods were used, there would be the potential for reduced construction compared to the aforementioned activities for a fish ladder. While trap and haul facilities differ by site, common features include a trap holding pool, diffusers or gates to guide fish into the trap, a channel or port for discharge of attraction flows, a lift mechanism for truck-loading fish, a truck loading station, and a discharge platform. Much of the trap and haul facility would be located in-stream, with only the truck loading station and discharge platform potentially requiring upland grading or other earthwork.

Because long-term land use under this alternative is currently unknown, this alternative does not assess the potential impacts of long-term use of the lands currently submerged under Iron Gate and Copco No. 1 reservoirs as that would require speculation.

4.6.1.2 Alternative Analysis Approach

The potential impacts of the Three Dam Removal Alternative are analyzed in comparison to existing conditions, with reference to impact analyses conducted for the No Project Alternative or the Proposed Project, where appropriate. Unless otherwise indicated, the significance criteria, area of analysis, environmental setting, and impact analysis approach, including consideration of existing local policies, for all environmental resource areas under the Three Dam Removal Alternative are the same as those described for the Proposed Project (see Section 3.1 *Introduction* and individual resource area subsections in Section 3 *Environmental Setting, Potential Impacts, and Mitigation Measures*). The potential impacts and impacts for each environmental resource area are analyzed both in the short term and the long term, and unless otherwise indicated, use the same definitions of short term and long term as described for each resource area analyzed for the Proposed Project. Unless otherwise indicated, the mitigation measures described in Section 3 *Environmental Setting, Potential Impacts, and Mitigation Measures* are similarly applicable. This section describes changes to mitigation measures in light of differing project impacts associated with this alternative.

4.6.2 Water Quality

Water quality modeling results applicable to the Three Dam Removal Alternative are not as extensive as results applicable to the Proposed Project or the No Project Alternative. The effects of Three Dam Removal Alternative can be assessed through a combination of modeling scenarios undertaken for the Proposed Project and other alternatives. Appendix D of this EIR summarizes the models used to evaluate potential water quality impacts, including identification of which model scenarios are directly applicable to the Three Dam Removal Alternative. The Klamath River Water Quality Model (KRWQM) developed by PacifiCorp and the River Basin Model 10 (RBM10) developed as part of the Klamath Dam Removal Secretarial Determination studies both include modeling scenarios that have J.C. Boyle remaining in place and Copco No. 1, Copco No. 2, and Iron Gate dams removed. An evaluation of model results from different reaches within the Klamath River also can be used to assess how J.C. Boyle remaining in place would impact water quality. The Klamath TMDL model includes a "TMDL dams-in" scenario (T4BSRN), which approximates the condition where the Lower Klamath Project dams remain in place, as well as the TOD2RN (Oregon reaches) and TCD2RN (California reaches) scenarios (together the "TMDL dams-out" scenario) that assume the removal of the Lower Klamath Project (see Appendix D for more detail). The Klamath TMDL model assumes full TMDL implementation for both "TMDL dams-in" and "TMDL dams-out" scenarios. While the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative, the Klamath TMDL model results are still informative with respect to the analysis of potential water quality impacts under this alternative for reasons described for the Proposed Project (see Section 3.2.4 *[Water Quality] Impact Analysis Approach*). For example, comparisons of the modeling scenarios "TMDL dams-in" Oregon reaches (TOD2RN) and "TMDL dams-out" (T4BSRN) for the reach between J.C. Boyle Dam and the upstream end of Copco No. 1 Reservoir document how the presence of J.C. Boyle Dam influences conditions in that portion of the Hydroelectric Reach. Similarly, comparison of the SRH-1 sediment modeling results downstream of J.C. Boyle Dam with the SRH-1 results downstream of Iron Gate Dam, and SRH-2D sediment modeling results showing the suspended sediment concentrations from removal of only Copco No. 1 Dam, provides significant insight into the similarities and differences between suspended sediment concentrations due to the

release of reservoir deposited sediments under the Three Dam Removal Alternative and under the Proposed Project. Overall, the available water quality modeling results provide sufficient information that the water quality impacts under the Three Dam Removal Alternative can be quantitatively or qualitatively assessed, as described below.

4.6.2.1 Water Temperature

In general, the Three Dam Removal Alternative would have the same or similar potential impacts on water temperature in California as those identified under the Proposed Project. The presence of the J.C. Boyle Reservoir on the Klamath River does not alter water temperatures in further downstream reaches because it has a shallow depth (8.3 feet average depth) and short hydraulic residence time (1.1 days) that does not support thermal stratification (FERC 2007). However, J.C. Boyle Dam operations do influence Klamath River water temperatures by releasing flow for peaking power generation and whitewater recreation. These releases cause water temperature variations in the J.C. Boyle Bypass and Peaking reaches, including from the Oregon-California state line to Copco No. 1 Reservoir, due to diversion of warmer reservoir discharges around the J.C. Boyle Bypass Reach, cold groundwater spring flows into the J.C. Boyle Bypass Reach, and the mixing of these flows when they rejoin in the J.C. Boyle Peaking Reach of the Klamath River. The combination of these flows produce an observed increase in daily water temperature range above the natural diel (24-hour) water temperature fluctuations in the J.C. Boyle Peaking Reach at the Oregon-California state line.

The Three Dam Removal Alternative would not include peaking power generation or whitewater recreation flows from J.C. Boyle Dam since the downstream dams would not be available to reregulate the peaking and recreation flows. Elimination of the peaking and recreation flows from J.C. Boyle Dam would likely result in J.C. Boyle operating in a run of the river manner and increases in the water temperature range associated with J.C. Boyle operations would no longer occur under both the Three Dam Removal Alternative and the Proposed Project (see also Section 3.2.2.2 *Water Temperature*).

Model results analyzed for the Proposed Project do not explicitly isolate the effects of the four individual Lower Klamath Project reservoirs on water temperatures, but the KRWQM includes a scenario in which only Iron Gate and Copco No. 1 dams are removed[217] with J.C. Boyle and Copco No. 2 remaining in place ("WIGC" PacifiCorp 2004a; Dunsmoor and Huntington 2006; see also Appendix D of this EIR). KRWQM WIGC results indicate that compared with removal of J.C. Boyle, Copco No. 1 and Iron Gate reservoirs ("WIGCJCB"), the long-term effects of removing Iron Gate, Copco No. 1, and Copco No. 2 reservoirs and converting the reservoir areas to a free-flowing river under the Three Dam Removal Alternative would be similar to effects on water temperature under the Proposed Project as illustrated in Figure 4.6-1.

[217] Copco No. 2 dam was not explicitly included in the model due to its negligible size and hydraulic residence time.

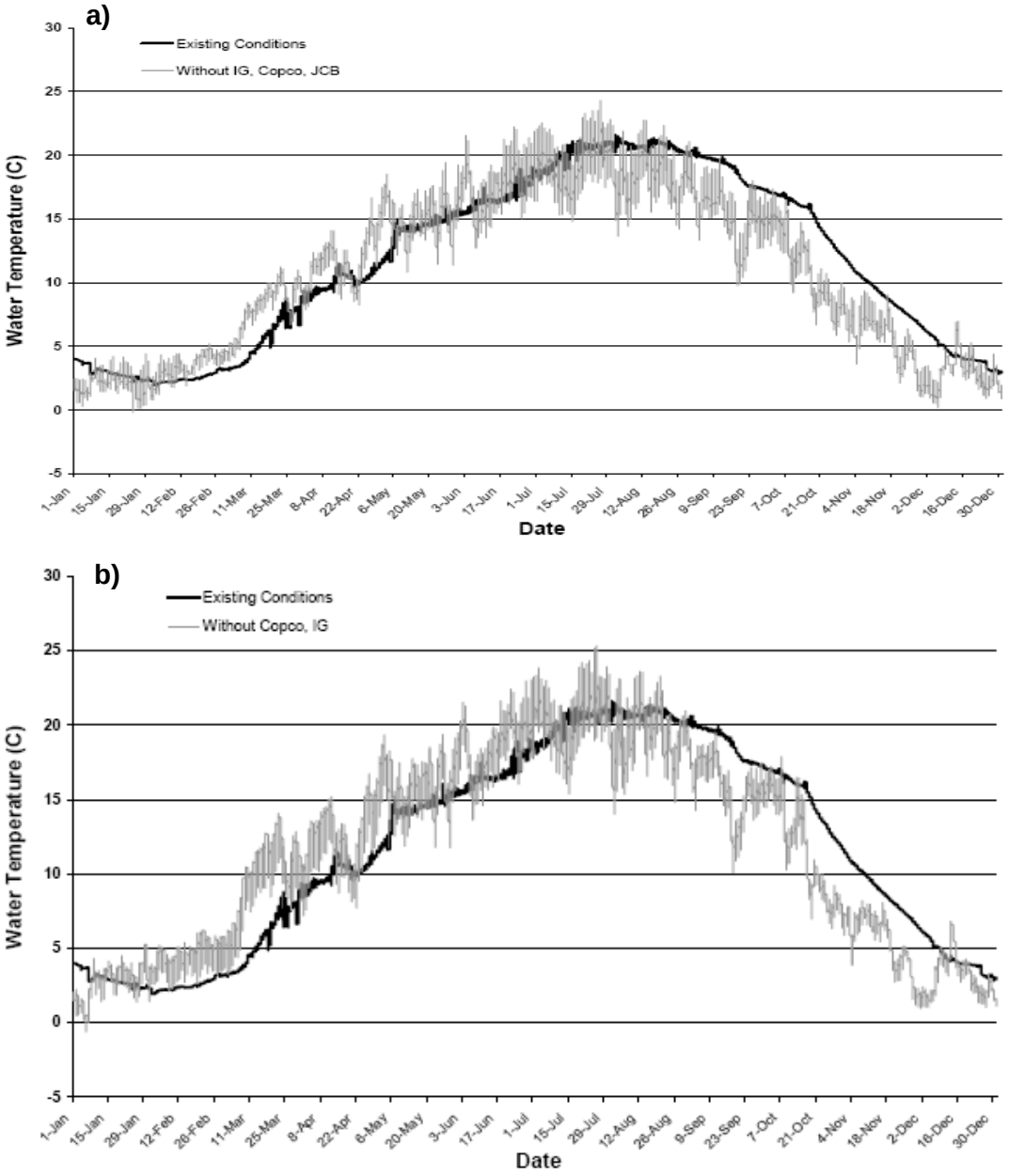

Figure 4.6-1. Simulated Hourly Water Temperature Downstream from Iron Gate Dam Based on Year 2004 for Current Conditions Compared to Hypothetical Conditions: (a) without Iron Gate (IG), Copco No. 1 and 2, and J.C. Boyle (JCB) Dams and (b) without Iron Gate (IG) and Copco No. 1 and 2 Dams. Source: PacifiCorp 2005.

Relative to existing conditions, the potential impacts of the Three Dam Removal Alternative on water temperature would be the same as or similar to those described for the Proposed Project, except as follows:

- J.C. Boyle Reservoir would not alter water temperature in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir. J.C. Boyle Dam operations for peaking and recreation releases under existing conditions that cause increases in the water temperature range would be eliminated under both the Three Dam Removal Alternative and the Proposed Project. Short-term and long-term alterations in water temperatures in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir under the Three Dam Removal Alternative would result in water temperature effects similar to those of the Proposed Project (i.e., slightly lower maximum water temperatures and less artificial diel (24-hour) temperature variation during summer and early fall, see also Potential Impact 3.2-1) and would be beneficial.
- Short-term and long-term alterations in water temperatures due to conversion of the Copco No. 1 and Iron Gate reservoir areas to a free-flowing river (Potential Impact 3.2-1) would be the same as under the Proposed Project, and would be beneficial for the Hydroelectric Reach and the Middle Klamath River to the confluence with the Salmon River. As under the Proposed Project, there would be no significant impact for the Middle Klamath River downstream from the Salmon River, the Lower Klamath River, and the Klamath River Estuary.
- Sediment trapped by J.C. Boyle Dam would not be released under the Three Dam Removal Alternative, but the magnitude of the sediment releases from Copco No. 1 and Iron Gate reservoirs[219] would still be over 90 percent of the sediment releases under the Proposed Project (Table 2.7-11). Thus, the overall short-term and long-term alterations in seasonal water temperatures in the Klamath River Estuary due to potential morphological changes induced by sediment release from Copco No. 1 and Iron Gate reservoirs and subsequent deposition in the Klamath River Estuary would be similar under the Three Dam Removal Alternative and the Proposed Project (Potential Impact 3.2-2), and there would be no significant impact.

4.6.2.2 Suspended Sediments

As the Three Dam Removal Alternative does not include the removal of J.C. Boyle Dam, short-term mobilization of J.C. Boyle reservoir sediment deposits would not occur under this alternative and none of the associated 1,190,000 cubic yards of deposits estimated to occur in the reservoir in 2020[218] (i.e., eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-10 and 2.7-11) would be eroded or delivered to downstream reaches and the Pacific Ocean. The approximately 27 to 51 percent of the sediment trapped behind the J.C. Boyle Dam predicted to move downstream through the California reaches of the Klamath River and out into the Pacific Ocean under the Proposed Project (USBR 2012) would not be transported under the Three Dam Removal Alternative.

[218] Between 2020 and 2021 (i.e., dam removal year 2 when drawdown would primarily occur), the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012). The increase in sediment volume between 2020 and 2021 would be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable.

However, Copco No. 1 and Iron Gate reservoirs contain approximately 92 percent of the total estimated 2020 reservoir deposits (50 and 42 percent, respectively) such that approximately 92 to 94 percent of sediment anticipated to erode from these reservoirs[219] under the Proposed Project (Table 2.7-10 and Table 2.7-11) would still occur under the Three Dam Removal Alternative. Increases in suspended sediment concentrations (SSCs) in the Hydroelectric Reach upstream of Copco No. 1 Reservoir from removal of J.C. Boyle Reservoir would be eliminated under this alternative since reservoir deposited sediment would not be released from J.C. Boyle Reservoir. While there would be some reduction in SSCs downstream of Copco No. 1 due to no SSCs being released by J.C. Boyle Dam removal, the reduction of SSCs under the Three Dam Removal Alternative would not alter the overall impact of dam removal on SSCs compared to the Proposed Project in the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, or the nearshore marine environment. Modeling of SSCs downstream of Copco No. 1 Reservoir from release of only Copco No. 1 Reservoir sediment deposits across the wet, average, and dry water year types indicate SSCs, within the general uncertainty of the model, would peak at approximately 7,000 to 8,000 mg/L between Copco No. 1 Dam and Iron Gate Reservoir within one to two months of reservoir drawdown, then SSCs would decrease to generally less than 1,000 mg/L within approximately one more month (Figure 3.2-15; see Section 3.2.5.2 *Suspended Sediments*). Thus, SSCs in the Hydroelectric Reach between Copco No. 1 and Iron Gate reservoirs would still exceed the significance criteria for suspended sediment (SSCs greater than 100 mg/L over a continuous two-week exposure period) under the Three Dam Removal Alternative due to the overall magnitude of reservoir deposits still anticipated to erode from Copco No. 1 and Iron Gate reservoirs. Downstream of the Hydroelectric Reach, SSCs would also exceed the significance criteria for suspended sediment under the Three Dam Removal Alternative since over 90 percent of the reservoir deposited sediments anticipated to be transported under the Proposed Project would still occur. Thus, the overall short-term impact of increases in SSCs due release of sediments currently trapped behind Copco No. 1 and Iron Gate dams under the Three Dam Removal Alternative would be similar to impacts under the Proposed Project (see Section 3.2.5.2 *Suspended Sediments* for additional details).

Sediments and suspended materials (inorganic and organic) would continue to be intercepted and retained behind J.C. Boyle Dam in the long term under the Three Dam Removal Alternative since that dam would remain in place. While the amount of sediment supplied to the Klamath River on an annual basis from the watershed upstream of J.C. Boyle is a relatively small fraction of the total sediment (Stillwater Sciences 2010) (see also Section 3.11.2.4 *Sediment Load*), the long-term increase in mineral (inorganic) suspended material downstream of J.C. Boyle Dam under this alternative would be less than under the Proposed Project since J.C. Boyle Dam would continue to intercept upstream sediment. The majority of algal-derived (organic) suspended material from upstream sources (Upper Klamath Lake, Klamath Straights Drain, Lost River) is intercepted and retained by the Keno Impoundment/Lake Ewauna, but J.C. Boyle Dam does retain some algal-derived (organic) suspended material (see Appendix C, Section C.2.1 *Upper Klamath Basin* for more detail). Thus, the long-term

[219] Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir that would subsequently be released downstream once drawdown of Copco No. 2 Dam begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

increases in algal-derived (organic) suspended material downstream of J.C. Boyle Dam under this alternative would be less than under the Proposed Project.

Long-term interception and retention of sediments and suspended materials (inorganic and organic) would not occur behind Copco No. 1, Copco No. 2[220], and Iron Gate dams since they would be removed under the Three Dam Removal Alternative. Long-term increases in mineral (inorganic) and algal-derived (organic) suspended material under this alternative would be less than under the Proposed Project because J.C. Boyle Dam would continue to retain sediments and suspended materials from upstream of that dam. However, the overall long-term impact from changes in the interception of sediments due to retention of J.C. Boyle Dam and removal of Copco No. 1, Copco No. 2, and Iron Gate dams would be similar under both the Three Dam Removal Alternative and the Proposed Project. The long-term increases in mineral (inorganic) and algal-derived (organic) suspended material due to the lack of interception by the dams would be a less than significant impact under the Proposed Project since only a small amount of sediment and suspended material is delivered from upstream of J.C. Boyle Dam. Thus, a decrease in the amount of sediment transported downstream under the Three Dam Alternative due to the retention of J.C. Boyle Dam and removal of Copco No. 1, Copco No. 2, and Iron Gate dams would still be a less than significant impact.

Relative to existing conditions, the potential impacts of the Three Dam Removal Alternative on suspended sediments would be the same as or similar to those described for the Proposed Project, except as follows:

- As discussed in the first two paragraphs of this section, there would be no change in SSCs from the existing conditions in the Hydroelectric Reach between the Oregon-California state line and the upstream end of Copco No. 1 Reservoir since sediment deposits in J.C. Boyle Dam would remain in place. However, the increases in suspended sediment in the Hydroelectric Reach due to release of sediments currently trapped behind Copco No. 1 and Iron Gate Dams would remain a short-term significant and unavoidable impact for the Hydroelectric Reach, the Middle and Lower Klamath River, and the Klamath River Estuary (Potential Impact 3.2-3). The magnitude of suspended sediments increases in the Pacific Ocean nearshore environment due to release of sediments currently trapped behind Copco No. 1 and Iron Gate dams would be within the range of historical conditions, but the duration (i.e., weeks) of elevated suspended sediments still would be greater than historical conditions, thus there would be a short-term significant and unavoidable impact on suspended sediments in the Pacific Ocean nearshore environment (Potential Impact 3.2-3). Suspended sediments would resume modeled background levels by the end of Post-Dam removal year 1, so there would be no significant impact in the long term for the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment (Potential Impact 3.2-3). The short-term significant impact of increases SSCs due to dam removal in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment cannot be avoided or substantially decreased through reasonably feasible mitigation.

[220] Copco No. 2 Dam does not intercept or retain appreciable amounts of sediment (USBR 2011b).

- While there would not be potential construction-related short-term increases in suspended material from removal of J.C. Boyle Dam under the Three Dam Removal Alternative, there would be construction of new fish passage facilities at J.C. Boyle Dam that would potentially result short-term increases in suspended material downstream in California. Potential construction-related short-term increases in suspended material from pre-construction, dam removal, and restoration activities at Copco No. 1, Copco No. 2, and Iron Gate dams would be the same under the Three Dam Removal Alternative as under the Proposed Project since these activities would occur in both scenarios. Under the Three Dam Removal Alternative, short-term increases in suspended material from stormwater runoff due construction activities associated with new fish passage facilities at J.C. Boyle Dam and pre-construction, dam removal, and restoration activities at Copco No. 1, Copco No. 2, and Iron Gate dams would be potentially significant impacts without mitigation in the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam and in the Middle Klamath River immediately downstream of Iron Gate Dam (Potential Impact 3.2-4). Implementation of mitigation measures WQ-1, TER-1, and HZ-1 would reduce this potential impact under the Three Dam Removal Alternative to no significant impact, similar to the Proposed Project.
- As discussed earlier in this section, there would be no long-term change from existing conditions regarding the interception and retention of mineral (inorganic) (Potential Impact 3.2-5) or algal-derived (organic) (Potential Impact 3.2-6) suspended material by J.C. Boyle Dam in the Hydroelectric Reach between Oregon-California state line and the upstream end of Copco No. 1 Reservoir under the Three Dam Removal Alternative because J.C. Boyle Dam would remain in place and continue to intercept and retain mineral and algal-derived suspended material to the same extent that it currently does. However, similar to under the Proposed Project, there would be potential long-term increases in suspended material in the Hydroelectric Reach downstream of Copco No. 1 Reservoir because Copco No. 1, Copco No. 2, and Iron Gate dams would be removed under this alternative and they would no longer intercept and retain suspended material. While there would be no long-term change in the suspended material in the Hydroelectric Reach from the Oregon-California state line to Copco No. 1 Reservoir under the Three Dam Removal Alternative, the removal of Copco No. 1, Copco No. 2, and Iron Gate dams would result in this alternative having an overall similar long-term increase in suspended material due to lack of interception or retention by dams downstream of Copco No. 1 Dam as the Proposed Project. There would be no significant impact under the Three Dam Removal Alternative from long-term increases in suspended material due to the lack of continued interception and retention of mineral (inorganic) and algal-derived (organic) for the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam, the Middle Klamath River, Lower Klamath River, Klamath River Estuary, and the Pacific Ocean nearshore environment, similar to under the Proposed Project (Potential Impact 3.2-5 and 3.2-6).

4.6.2.3 Nutrients

Short-term or long-term increases in sediment-associated nutrients due to release of J.C. Boyle reservoir sediment deposits would not occur in the Hydroelectric Reach from the Oregon-California state line to the upstream end of Copco No. 1 Reservoir under the Three Dam Removal Alternative because none of the associated 1,190,000 cubic yards

of deposits estimated to occur in the reservoir in 2020[221] (i.e., eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-7 and 2.7-8) would be eroded or delivered to downstream reaches. As detailed in Section 4.6.2.2 *Suspended Sediments*, approximately 27 to 51 percent of the sediment trapped behind the J.C. Boyle Dam is predicted to be transported under the Proposed Project (USBR 2012), but this would not occur under the Three Dam Removal Alternative. Thus, nutrients associated with these sediments also would not be transported downstream and there would be no increase in sediment-associated nutrients from existing conditions in the Hydroelectric Reach between the Oregon-California state line and the upstream end of Copco No. 1 Reservoir associated with the Three Dam Removal Alternative.

However, approximately 92 to 94 percent of the sediment anticipated to erode from Copco No. 1 and Iron Gate reservoirs[222] under the Proposed Project (Table 2.7-11) would occur under the Three Dam Removal Alternative and mobilization of nutrients associated with these reservoir sediment deposits would occur. The majority of sediment-associated nutrients would be transported under both this alternative and the Proposed Project, but sediment-associated nutrients downstream of Copco No. 1 Dam would be slightly less under the Three Dam Removal Alternative than under the Proposed Project because nutrients associated with J.C. Boyle reservoir sediments would not contribute to nutrient concentrations. Thus, overall pattern and duration of short-term and long-term increases in sediment-associated nutrients due to release of sediments from behind the Copco No. 1 and Iron Gate dams under the Three Dam Removal Alternative would be similar to the Proposed Project in the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, or the nearshore marine environment, but the magnitude of nutrient concentrations would be slightly less. See Section 3.2.5.3 *Nutrients* for further details.

Since J.C. Boyle dam would remain in place, continuing interception and retention of sediment-associated nutrients and suspended materials would still occur behind J.C. Boyle Dam in the long term. However, TMDL modeling[223] and empirical data indicate that J.C. Boyle Dam does not retain high amounts of nutrients such that long-term effects of dam removal on nutrient levels in the Hydroelectric Reach under the Proposed Project would be primarily due to the removal of Copco No. 1 and Iron Gate dams (see also Section 3.2.2.4 *Nutrients* and Section 3.2.5.3 *Nutrients* for information on the existing conditions for nutrients in the reservoirs). More specifically, the "TMDL dams-in"

[221] Between 2020 and 2021 (i.e., dam removal year 2 when drawdown would primarily occur), the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012). The increase in sediment volume between 2020 and 2021 would be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable.

[222] Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir that would subsequently be released downstream once drawdown of Copco No. 2 Dam begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

[223] While the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative, the Klamath TMDL model results are still informative with respect to the analysis of potential water quality impacts under this alternative for reasons described for the Proposed Project (see Section 3.2.4 *[Water Quality] Impact Analysis Approach*).

Oregon reaches (TOD2RN) scenario indicates that Copco No. 1 retains approximately 10.0 percent of the annual total nitrogen and approximately 5.1 percent of the annual total phosphorus; and Iron Gate retains approximately 6.7 percent of the annual total nitrogen and approximately 3.3 percent of the annual total phosphorus (North Coast Regional Board 2010). The relative amounts of nutrient retention in each of the reservoirs without full TMDL implementation may be somewhat higher than the aforementioned estimates because the model mechanism increases the rate of retention as incoming nutrient concentrations increase; however, the model mechanism also indicates that the longer the retention time of water in the reservoir, the higher the nutrient retention. Copco No. 1 and Iron Gate reservoirs have average retention times of 11 days and 15 days, respectively, while J.C. Boyle Reservoir has a lower retention time of only approximately 1 day (Table 3.6-4) and thus allows most sediment-associated nutrients to pass through the reservoir and move downstream. Overall, under the Three Dam Removal Alternative, long-term interception and retention of sediments and suspended materials behind Copco No. 1 and Iron Gate dams would cease, since the facilities would be removed, and nutrient removal for the Hydroelectric Reach would be similar to that described for the Proposed Project.

Relative to existing conditions, the potential impacts of the Three Dam Removal Alternative on nutrients would be the same as or similar to those described for the Proposed Project, except as follows:

- There would be no short-term or long-term change to the existing condition with regard to sediment-associated nutrients in the Hydroelectric Reach between Oregon-California state line and the upstream end of Copco No. 1 Reservoir, since sediment deposits in J.C. Boyle Dam would remain in place and no sediment-associated nutrients would be transported due to the release of sediments trapped behind J.C. Boyle Dam. However, there would be short-term increases in sediment-associated nutrients due to release of sediments currently trapped behind Copco No. 1 and Iron Gate dams[224] as in the Proposed Project (Potential Impact 3.2-7). Potential short-term increases in suspended material from construction of a new fish ladder at J.C. Boyle would be not result in short-term increases in sediment-associated nutrients since potential construction sediments would only have the nutrient content of the soils surrounding J.C. Boyle with substantially less nutrients than reservoir sediment deposits. As described in Section 3.2.5.3 Nutrients, this would result in no significant impact in the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam, the Middle Klamath River, the Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment
- Under the Three Dam Removal Alternative, there would be no long-term change from existing nutrient levels due to interception of nutrients by J.C. Boyle Dam in the Hydroelectric Reach between Oregon-California state line and the upstream end of Copco No. 1 Reservoir since J.C. Boyle Dam would remain in place. However, Copco No. 1, Copco No. 2, and Iron Gate dams would be removed and replaced by a free-flowing river under this alternative, so these dams would no longer intercept and retain incoming nutrients. As under the Proposed Project, long-term increases in nutrient levels from the lack of continued interception by the

[224] Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir that would subsequently be released downstream once drawdown of Copco No. 2 Dam begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

Copco No. 1, Copco No. 2, and Iron Gate dams and conversion of the reservoir areas to a free-flowing river (Potential Impact 3.2-8) would result in no significant impact for the Hydroelectric Reach, Middle and Lower Klamath River, Klamath River Estuary, and the Pacific Ocean nearshore environment.

4.6.2.4 Dissolved Oxygen

J.C. Boyle Reservoir sediment deposits (approximately 1,190,000 cubic yards in 2020[225] or approximately eight percent of total sediment volume trapped behind the Lower Klamath Project dams, see also Tables 2.7-7 and 2.7-8) would be not mobilized in the Hydroelectric Reach from the Oregon-California state line to the upstream end of Copco No. 1 Reservoir under the Three Dam Removal Alternative since J.C. Boyle Dam would remain in place (see Section 4.6.2.2 *Suspended Sediments*). Thus, the short-term mobilization associated effects of these sediments on sediment-associated oxygen demand and dissolved oxygen (i.e., high content of organic carbon present in the reservoir sediments allows for the possibility of microbial oxidation of organic matter exposed to the water column from deep within the sediment profile and mobilized during dam removal), would also not occur in the Hydroelectric Reach from the Oregon-California state line to the upstream end of Copco No. 1 Reservoir under the Three Dam Removal Alternative. However, mobilization of approximately 92 to 94 percent the reservoir sediment deposits anticipated to erode under the Proposed Project due to transport of reservoir sediments from Copco No. 1 and Iron Gate reservoirs[224] would still occur in this alternative (see Section 4.6.2.2 *Suspended Sediments*). While there would be some reduction in SSCs downstream of Copco No. 1 due to no sediment being released by J.C. Boyle Dam removal, the overall short-term effects of sediment release and SSCs on sediment-associated oxygen demand and dissolved oxygen concentrations in the Hydroelectric Reach from downstream of Copco No. 1 Dam to Iron Gate Dam under the Three Dam Removal Alternative would still be similar to effects for the Hydroelectric Reach under the Proposed Project in that impact significance associated with SSCs, sediment-associated oxygen demand, and dissolved oxygen concentrations would be the same as the Proposed Project (see Potential Impact 3.2-9 for additional details).

Less sediment would be mobilized into the Middle Klamath River under the Three Dam Removal Alternative, so the extent of downstream increases in oxygen demand (Immediate Oxygen Demand [IOD] and Biological Oxygen Demand [BOD]) and reductions in dissolved oxygen in this reach under the Three Dam Removal Alternative would be somewhat less than those of the Proposed Project. Minimum dissolved oxygen values likely would occur slightly upstream compared the Proposed Project, but they would still generally occur near RM 191 to 193.1 (approximately 0 to 2 miles downstream from Iron Gate Dam) since the location of minimum dissolved oxygen concentrations does not change much with variations in SSCs (see Table 3.2-13). Similarly, the farthest distance downstream with dissolved oxygen less than 5 mg/L likely

[225] Between 2020 and 2021 (i.e., dam removal year 2 when drawdown would primarily occur), the sediment volume present behind the dams would increase by approximately 81,300 cubic yards in Copco No. 1 Reservoir and approximately 100,000 cubic yards in Iron Gate Reservoir based on estimates of annual sedimentation rates for each reservoir (USBR 2012). The increase in sediment volume between 2020 and 2021 would be an order of magnitude less than the uncertainty of the 2020 total sediment volume estimates, so model results using the 2020 sediment volumes would still be applicable.

would shift slightly upstream, but the distance would be similar to the Proposed Project (i.e., approximately RM 145 to 122 or within 48 to 71 miles downstream of Iron Gate Dam) since it does not change much with variations in SSCs. Minimum dissolved oxygen values would likely show a greater relative increase under the Two Dam Removal Alternative compared the Proposed Project, since the amount of IOD and BOD downstream of Iron Gate Dam is strongly influenced by variations in SSCs and there would be less sediment transported under this alternative.

Despite the potential for a slightly shorter distance of short-term impacts due to decreases in the sediment-associated oxygen demand and a reduction in the magnitude of the decrease in dissolved oxygen in the Middle Klamath River under the Three Dam Removal Alternative, the release of sediments trapped behind Copco No. 1 and Iron Gate Dam would decrease dissolved oxygen concentrations in the Klamath River below the Basin Plan water quality objective for dissolved oxygen (90 percent saturation) in the short term and constitute a significant impact. Additionally, since the location where the minimum and at least 5 mg/L dissolved oxygen concentrations occurred during modeling under the Proposed Project did not change much with variations in SSC, it is conservatively estimated that the distance that the significant impact from short-term increase in sediment-associated oxygen demand and reductions in dissolved oxygen under the Three Dam Removal Alternative occurs would be similar to that modeled under the Proposed Project (Potential Impact 3.2-9), so the short-term impact would remain significant in the Middle Klamath River from Iron Gate Dam to approximately the confluence with the Salmon River (RM 66).

Similarly, it is conservatively estimated that the distance where there would be no significant impact on dissolved oxygen from releases of reservoir deposited sediments under the Three Dam Removal Alternative would be similar to that modeled under the Proposed Project. Modeling under the Proposed Project indicates that downstream of the confluence with the Salmon River on the Middle Klamath River, as well as in the Lower Klamath River and the Klamath River Estuary, there would be no significant impact from the release of sediments trapped behind the Lower Klamath Project dams (see Section 3.2.5.4 *Dissolved Oxygen*). Thus, there also would be no significant impact under the Three Dam Removal Alternative downstream of the confluence with the Salmon River on the Middle Klamath River, as well as in the Lower Klamath River and the Klamath River Estuary.

In the long term, since J.C. Boyle Dam would remain in place, continuing summertime interception and retention of sediments and suspended materials from upstream sources containing high biological oxygen demand (see also 3.2.2.5 *Dissolved Oxygen*) would still occur in J.C. Boyle Reservoir under the Three Dam Removal Alternative. Accordingly, existing large summertime variations in dissolved oxygen in J.C. Boyle Reservoir, especially at depth, would still occur and could continue to influence dissolved oxygen concentrations in the California portion of the Hydroelectric Reach in the same manner as under existing conditions (see also 3.2.2.5 *Dissolved Oxygen*). Modeling of existing conditions indicates these summertime dissolved oxygen variations in J.C. Boyle increase the range of dissolved oxygen concentrations between the Oregon-California state line and the upstream end of Copco No. 1 Reservoir (North Coast Regional Board 2011), but aeration and fast water velocities within the free-flowing reach result in dissolved oxygen concentrations near or slightly greater than saturation upstream of Copco No. 1 Reservoir (FERC 2007; Raymond 2008). The Three Dam Removal Alternative would not include peaking power generation and release of flow for

recreation at J.C. Boyle Dam, but the dissolved oxygen at the Oregon-California state line would still likely have slightly greater daily variability than natural conditions (see also Potential Impact 3.2-10). While the degree of influence of peaking flows on daily variability in dissolved oxygen concentrations at the Oregon-California state line is not clearly defined by existing information, the daily variability is not currently adversely affecting beneficial uses. However, dissolved oxygen concentrations immediately downstream of J.C. Boyle would potentially fall below 85 percent saturation and 6.5 mg/L during summer similar to existing conditions. Thus, retaining J.C. Boyle with no peaking or recreation flows under the Three Dam Removal Alternative would have only a small influence on dissolved oxygen concentrations downstream of the Oregon-California state line compared to existing conditions and there would be no significant impact.

Within the Hydroelectric Reach downstream of Copco No. 1 Reservoir, the long-term effects of the Three Dam Removal Alternative on dissolved oxygen concentrations would be the same as effects described for the Proposed Project (Potential Impact 3.2-10) as conversion of Copco No. 1, Copco No. 2, and Iron Gate reservoirs to free-flowing riverine reaches with higher velocities and more turbulent mixing would increase aeration of Klamath River. Additionally, the extreme super-saturated surface water and oxygen-depleted hypolimnion conditions found in existing conditions in April/May to October/November would not occur under the Three Dam Removal Alternative as Copco No. 1 and Iron Gate reservoirs would be removed (see Section 3.2.5.4 *Dissolved Oxygen* for details). The long-term effects of dam removal on concentrations of dissolved oxygen in the Middle and Lower Klamath, the Klamath River Estuary, and the Pacific Ocean nearshore environment under the Three Dam Removal Alternative would also be the same as those described for the Proposed Project, where even assuming full TMDL compliance, modeling results[226] indicate that the conversion of Copco No. 1 and Iron Gate reservoirs to free-flowing river reaches would eliminate seasonal extremes in dissolved oxygen concentrations downstream of Iron Gate Dam (see Section 3.2.5.4 *Dissolved Oxygen* for details).

In summary, relative to existing conditions, the potential impacts of the Three Dam Removal Alternative on increased IOD and BOD and dissolved oxygen would be the same as or similar to those described for the Proposed Project, except as follows:

- There would be no short-term increases in IOD and BOD or reductions in dissolved oxygen in the Hydroelectric Reach between Oregon-California state line and the upstream end of Copco No. 1 Reservoir since sediment deposits in J.C. Boyle Dam would remain in place (Potential Impact 3.2-9). However, there would be no change from the Proposed Project downstream of Copco No. 1 Dam because short-term increases in IOD and BOD and reductions in dissolved oxygen due to release of sediments currently trapped behind Copco No. 1 and Iron Gate dams[220] (Potential Impact 3.2-9) would result in a significant and unavoidable impact in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle Klamath River from Iron Gate Dam to the confluence with the Salmon River (RM 66) under the Three Dam Removal Alternative. There would be no significant impact in the Middle Klamath River downstream from the Salmon River

[226] While the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative, the Klamath TMDL model results are still informative with respect to the analysis of potential water quality impacts under this alternative for reasons described for the Proposed Project (see Section 3.2.4 *[Water Quality] Impact Analysis Approach*).

confluence, Lower Klamath River, and the Klamath River Estuary under the Three Dam Removal Alternative, similar to the Proposed Project. The short-term significant impact of increases in IOD and BOD and reductions in dissolved oxygen due to release of sediments in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle and Lower Klamath River, and the Klamath River Estuary cannot be avoided or substantially decreased through reasonably feasible mitigation.

- Potential long-term alterations in daily variability of dissolved oxygen concentrations in the Hydroelectric Reach in California due to the elimination of hydropower peaking flows at J.C. Boyle Dam (Potential Impact 3.2-10) would result in no significant impact. However, long-term increases in dissolved oxygen, as well as increased daily variability in dissolved oxygen, due to conversion of the Copco No. 1 and Iron Gate reservoirs to a free-flowing river (Potential Impact 3.2-10) would be the same under the Three Dam Removal Alternative as under the Proposed Project. Thus, there would be no significant impact for daily fluctuations in the Hydroelectric Reach between Copco No. 1 and Iron Gate Dam and the Middle Klamath River immediately downstream of Iron Gate Dam, would be beneficial for elimination of summer and fall extremes in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam, and would result in no significant impact in the Lower Klamath River and Klamath River Estuary.

4.6.2.5 pH

In general, the Three Dam Removal Alternative would have the same or similar potential impacts on pH as those identified under the Proposed Project. Because J.C. Boyle Reservoir peaking power generation and whitewater recreation flows downstream of J.C. Boyle Dam do not substantially alter pH in the downstream river under existing conditions, leaving this dam in place and ceasing peaking and recreation flows would be unlikely to affect pH relative to existing conditions in either the short-term or long-term. Under the existing condition in Copco No. 1 and Iron Gate reservoirs, seasonal and daily pH is characterized by high pH (greater than 9 s.u.) and large (0.5 to 1.5 s.u.) daily fluctuations occurring in reservoir surface waters during periods of intense phytoplankton blooms (see Section 3.2.2.6 *pH*). Klamath River TMDL modeling[227] for the Proposed Project indicates that removal of these two reservoirs, which would occur under the Three Dam Removal Alternative, would eliminate the occurrences of high pH and large daily fluctuations in pH in these reaches, because the free-flowing reaches of the river replacing these reservoirs would not support the intense phytoplankton blooms that are driving the existing pH conditions (see Section 3.2.5.5 *pH*). The most significant action to achieve California TMDL compliance is the removal of Copco No. 1, Copco No. 2 and Iron Gate dams as their removal provides lasting long-term benefits to water quality in California. Similar to the Proposed Project, the Three Dam Removal Alternative leads to improved pH conditions and contributes to TMDL compliance on a shorter timeline scale than expected under existing conditions. Due its small size and low retention time, Copco No. 2 Reservoir does not affect pH under existing conditions and its removal under the Three Dam Removal Alternative also would not affect pH within the

[227] While the mechanisms for implementation and the timing required to achieve future TMDL compliance are currently speculative, the Klamath TMDL model results are still informative with respect to the analysis of potential water quality impacts under this alternative for reasons described for the Proposed Project (see Section 3.2.4 *[Water Quality] Impact Analysis Approach*).

Hydroelectric Reach or downstream reaches. In the Klamath River downstream from Iron Gate Dam, pH conditions under the Three Dam Removal Alternative would be the same as under the Proposed Project (Potential Impact 3.2-11).

In summary, relative to existing conditions, the potential impacts of the Three Dam Removal Alternative on pH would be the same as or similar to those as described for the Proposed Project (Potential Impact 3.2-11). Thus, there would be no significant impact in the short term or long-term to pH in the Hydroelectric Reach between J.C. Boyle Dam and the upstream end of Copco No. 1 Reservoir since J.C. Boyle Reservoir does not substantially alter pH in the river downstream from this dam under existing conditions (Potential Impact 3.2-11). Short-term and long-term decreases in summertime pH and daily pH fluctuations due to a conversion of the Copco No. 1 and Iron Gate reservoir areas to a free-flowing river (Potential Impact 3.2-11) would be beneficial for the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, and would have no significant impact for the Middle Klamath River, the Lower Klamath River, and the Klamath River Estuary.

4.6.2.6 Chlorophyll-a and algal toxins

In general, the Three Dam Removal Alternative would have the same or similar potential impacts on chlorophyll-*a* and algal toxins as those identified under the Proposed Project (see Section 3.2.5.6 *Chlorophyll-a and Algal Toxins*). The shallow depth (8.3 feet average depth) and short hydraulic residence time (1.1 days at average flows) of J.C. Boyle Reservoir does not promote the low mixing conditions or thermal stratification that create optimal habitat for phytoplankton growth, so the reservoir does not have large phytoplankton blooms (as measured by chlorophyll-*a*) under existing conditions (see Figure 3.2-5). Under existing conditions, peaking power generation flows occur in the late afternoons and early evenings to meet high power demand, and J.C. Boyle Reservoir refills during the night when power demand is minimal. Daily fluctuations in the reservoir water level under existing operations increases mixing in the reservoir, making the reservoir slightly less suitable habitat for phytoplankton during the season of maximum phytoplankton and cyanobacteria (blue-green-algae) growth in the system. Ceasing peaking power generation flows would reduce daily reservoir water level fluctuations in J.C. Boyle Reservoir because the facility would no longer be operated to draw on reservoir storage to support daily peaks in hydropower production when there is not sufficient river flow for peak production (3,000 cfs), as occurs during the summer and fall low flow period under existing conditions. However, the residence time of J.C. Boyle Reservoir without peaking operations would still be short (i.e., on the order of one to three days), so leaving this dam in place and ceasing peaking flows would be unlikely to create conditions that would support large seasonal phytoplankton blooms or increase chlorophyll-*a* concentrations relative to existing conditions. Concentrations of the algal toxin microcystin are generally low in J.C. Boyle Reservoir (Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*) and in the Hydroelectric Reach from J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir since the J.C. Boyle Reservoir does not support large blooms of toxigenic blue-green algae and springs downstream of J.C. Boyle Dam dilute any algal toxins that may be present within that reach. Thus, leaving J.C. Boyle Dam in place and ceasing peaking flows associated with the Three Dam Removal Alternative would not promote conditions that would support production of algal toxins.

In Copco No. 1 and Iron Gate reservoirs, existing conditions for chlorophyll-*a* levels in summer and early fall can be two to 10 times greater than those recorded in the

mainstem river upstream of Copco No. 1 Reservoir near Shovel Creek. High chlorophyll-*a* readings in the reservoirs as compared to the Klamath River are in part due to the lower mixing conditions and longer residence times of these reservoirs (10.7 days for Copco No. 1 and 14.8 days for Iron Gate at average flows) that promote the growth of phytoplankton and the associated production of chlorophyll-*a* within the reservoirs. Additionally, measurements of microcystin in Copco No. 1 and Iron Gate during summer months show high microcystin concentrations, especially during algal blooms when microcystin concentrations measured between 2006 and 2015 exceeded the State Water Board et al. (2010, updated 2016) 0.8 ug/L and peaked from 64 ug/L in Iron Gate Reservoir to 73,000 ug/L in Copco No. 1 Reservoir (Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*). Under the Three Dam Removal Alternative, elimination of Copco No.1 and Iron Gate reservoirs, which currently support growth conditions for toxin-producing nuisance algal species such as *Microcystis aeruginosa,* would result in decreases in high seasonal concentrations of chlorophyll-*a* and periodically high levels of algal toxins generated by suspended blue-green algae, consistent with the Proposed Project (see Section 3.2.5.6 *Chlorophyll-a and Algal Toxins*). The removal of Copco No. 1 and Iron Gate reservoirs also would eliminate the primary habitat for blue-green algae in the Hydroelectric Reach, reducing both the amount of blue-green algae present that could contribute to chlorophyll-*a* and algal toxins within this reach and the amount of blue-green algae that may be exported into the Klamath River downstream of Iron Gate Dam. Due its small size and low residence time (less than a day), Copco No. 2 Reservoir does not promote phytoplankton growth that would alter chlorophyll-*a* and algal toxins concentrations under existing conditions and its removal under the Three Dam Removal Alternative also would not affect chlorophyll-*a* and algal toxins within the Hydroelectric Reach or downstream reaches.

Because phytoplankton and the resulting chlorophyll-*a* and algal toxin levels (e.g., microcystin) are primarily internally generated in Copco No. 1 and Iron Gate reservoirs, removal of these reservoirs under the Three Dam Removal Alternative would also reduce the transport of chlorophyll-a and algal toxins to the Klamath River downstream of Iron Gate Dam in both the short-term and the long-term, consistent with the Proposed Project.

In summary, relative to existing conditions, the potential impacts and impacts of the Three Dam Removal Alternative on chlorophyll-*a* and algal toxins would be the same as or similar to those described for the Proposed Project, except as follows:

- There would be no short-term or long-term alterations in chlorophyll-a and algal toxins in the Hydroelectric Reach between J.C. Boyle Dam and the upstream end of Copco No. 1 Reservoir since J.C. Boyle Reservoir would remain in place, but it does not support conditions promoting large phytoplankton blooms and associated chlorophyll-a and algal toxins under existing conditions (Potential Impact 3.2-12). However, short-term and long-term reduction of chlorophyll-a and algal toxin levels due to a conversion of the reservoir areas to a free-flowing river (Potential Impact 3.2-12) under the Three Dam Removal Alternative would be beneficial for the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, the Middle Klamath River, Lower Klamath River, and Klamath River Estuary, similar to the Proposed Project.

4.6.2.7 Inorganic and Organic Contaminants

Short-term mobilization of J.C. Boyle reservoir sediment deposits would not occur under the Three Dam Removal Alternative and none of the associated 1,190,000 cubic yards of deposits (i.e., eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-7 and 2.7-8) would be eroded or delivered to downstream reaches. However, mobilization of reservoir sediment deposits in the much larger Copco No. 1 and Iron Gate reservoirs[228] would still occur such that the short-term potential for mobilization of inorganic and organic contaminants in the Hydroelectric Reach from downstream of Copco No. 1 Dam to Iron Gate Dam under the Three Dam Removal Alternative would be similar to effects for the Hydroelectric Reach under the Proposed Project (Section 3.2.5.7 *Inorganic and Organic Contaminants*).

Though toxicity testing of sediments from J.C. Boyle Resources suggested potential for toxicity to freshwater benthic organisms (when compared to Copco No 1 and Iron Gate reservoir sediments), dilution and dispersals of sediments as expected in the Proposed Project were anticipated to not result in a significant impact to benthic organism survival (Section 3.2.5.7 *Inorganic and Organic Contaminants*). The Three Dam Removal Alternative does not involve the release of J.C. Boyle reservoir sediment deposits thus the potential for toxicity to freshwater benthic organisms may be relatively slightly less under the Three Dam Removal Alternative than that of the Proposed Project due to no sediment from J.C. Boyle Reservoir being transported downstream. However, the overall impact of the release of sediments trapped behind Lower Klamath Project dams, including J.C. Boyle Dam, under the Three Dam Removal Alternative and under the Proposed Project are expected to be similar. The Proposed Project analysis assumes mixing of sediment deposits from all three reservoirs as they move downstream and exposure of downstream aquatic biota to an "average" sediment composition, rather than a reservoir-specific composition (Section 3.2.5.7 *Inorganic and Organic Contaminants*), so overall water column toxicity due to the concentration of inorganic or organic substances under the Proposed Project is unlikely. As such, there would be a less than significant impact due to the release of sediments trapped behind Lower Klamath Project dams, including J.C. Boyle Dam, under the Proposed Project. While leaving J.C. Boyle Dam in place and not releasing J.C. Boyle reservoir deposited sediments would potentially slightly reduce toxicity to benthic freshwater organisms, the overall impact from the release of Copco No. 1 and Iron Gate reservoir deposited sediments and the sediment-associated inorganic and organic contaminants would be a less than significant impact in the short term under the Three Dam Removal Alternative, similar to the Proposed Project.

Although leaving J.C. Boyle Dam in place, removing the existing fish ladder and installing a new fish ladder, would be less construction than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts to resources in California since J.C. Boyle is located in Oregon. Thus, short-term increases in inorganic and organic contaminants from hazardous materials associated with construction and restoration activities under the Three Dam Removal Alternative would also be the same as or similar to those described for the Proposed Project.

[228] Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir that would subsequently be released downstream once drawdown begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

In the long term, existing inorganic and organic contaminant data characterizing J.C. Boyle Reservoir sediment deposits indicate that a relatively small number of chemicals (i.e., mercury, DDTs, and possibly dioxin-like chemicals) are present at levels that have the potential to cause minor or limited adverse effects (i.e., toxicity or bioaccumulation) to freshwater aquatic species remaining in this reservoir under the Three Dam Removal Alternative. Elutriate sediment sample bioassay results from J.C. Boyle Reservoir indicate that no further dilution would be required to prevent water column toxicity to freshwater fish. Relative to existing condition, there would be no change. Conversely, long-term retention of inorganic and organic contaminants contained within existing sediment deposits behind Copco No. 1 and Iron Gate dams and their potential to cause minor or limited adverse effects (i.e., toxicity or bioaccumulation) would not occur since they would be removed under the Three Dam Removal Alternative, which would be beneficial.

In summary, relative to existing conditions the potential impacts of the Three Dam Removal Alternative on inorganic and organic contaminants would be the same as or similar to those described for the Proposed Project, except as noted below:

- J.C. Boyle Reservoir sediment deposits and its sediment-associated inorganic and organic contaminants would not be released downstream, but the short-term and long-term human exposure to inorganic and organic contaminants due to release of sediments currently trapped behind the Lower Klamath Project dams (Potential Impact 3.2-13) would result in a potentially significant impact for the Hydroelectric Reach, Middle Klamath River, Lower Klamath River, and Klamath River Estuary. Implementation of mitigation measures WQ-2 and WQ-3 would result in no significant impact.
- While J.C. Boyle Reservoir sediment deposits and its sediment-associated inorganic and organic contaminants would not be released downstream, the short-term and long-term freshwater aquatic species' exposure to inorganic and organic contaminants due to release of sediments currently trapped behind the Copco No. 1 and Iron Gate dams (Potential Impact 3.2-14) would result in no significant impact for the Hydroelectric Reach, Middle Klamath River, Lower Klamath River, Klamath River Estuary, and Pacific Ocean nearshore environment based on sediment screening and/or laboratory toxicity results after consideration of dilution conditions under the Proposed Project.
- Short-term increases in inorganic and organic contaminants from hazardous materials associated with construction and restoration activities (Potential Impact 3.2-15) in the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam would be potentially significant without mitigation. Implementation of mitigation measures WQ-1, TER-1, and HZ-1 would result in no significant impact.
- Short-term impacts to aquatic biota from herbicide application during restoration of the reservoir footprint area (Potential Impact 3.2-16) would be potentially significant without mitigation. Implementation of Mitigation Measure WQ-4 would result in no significant impact.
- Long-term freshwater aquatic species' exposure to inorganic and organic contaminants contained within J.C. Boyle Reservoir sediment deposits would continue to have the potential to cause minor or limited adverse effects (i.e., toxicity or bioaccumulation) to some freshwater aquatic species in the reservoir

(Potential Impact 4.2.2-8), which would be no significant impact (no change from existing adverse conditions).

4.6.2.8 General Water Quality

Iron Gate Hatchery operations would continue, and Fall Creek Hatchery would reopen, for eight years under the Three Dam Removal Alternative. The potential short-term and long-term impacts of these operations on the Klamath River, Bogus Creek, and Fall Creek water quality would be the same as described for the Proposed Project (Potential Impact 3.2-17).

4.6.3 Aquatic Resources

4.6.3.1 Suspended Sediment

As discussed in Section 4.6.2.2 *Suspended Sediments*, while there would be some reduction in SSCs downstream of Copco No. 1 due to no SSCs being released by J.C. Boyle Dam removal, the reduction of SSCs under the Three Dam Removal Alternative would not alter the overall impact of dam removal on SSCs compared to the Proposed Project in the Hydroelectric Reach, the Middle and Lower Klamath River, the Klamath River Estuary, or the nearshore marine environment. Thus, the potential impacts of suspended sediment on aquatic resources in California would be the same under the Three Dam Removal Alternative as those described under the Proposed Project (see also Section 3.3.5.1 *Suspended Sediment*).

4.6.3.2 Bed Elevation and Grain Size Distribution

Because the volume of stored sediment in J.C. Boyle Reservoir is relatively small compared with the volume of stored sediment in Copco No. 1 and Iron Gate reservoirs, the potential for alterations in bed elevation and grain size distribution and the associated effects on aquatic resources in California would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (see also Section 3.3.5.2 *Bed Elevation and Grain Size Distribution*). Thus, downstream impacts to aquatic species due to bed elevation and grain size distribution would be very similar to those described for the Proposed Project.

4.6.3.3 Water Quality

California would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (see also Section 3.3.5.3 *Water Quality*). As Copco No. 1 and Iron Gate reservoirs are the largest of the four Lower Klamath Project reservoirs, they have the greatest impact on water quality (FERC 2007), and their removal would result in water quality conditions similar to those of the Proposed Project. Because of its small size and short residence time, continuing to store water within J.C. Boyle Reservoir would generally not result in the same poor water temperature conditions that occur downstream of the larger Lower Klamath Project reservoirs under existing conditions. Section 4.6.2 discusses the impacts of the Three Dam Removal Alternative with an emphasis on similarities and differences with the potential impacts of the Proposed Project.

The Three Dam Removal Alternative includes no peaking power generation or release of flow for recreation at J.C. Boyle Dam. As described in Section 3.2.2.2 *Water Temperature*, daily peaking operations at J.C. Boyle Powerhouse (RM 225.2) result in an increase in the daily water temperature range in the Bypass Reach because warmer reservoir discharges are diverted around this reach and cold groundwater springs enter the river and dominate remaining flows. The temperature effects of altering the flow regime under the Three Dam Removal Alternative (while keeping J.C. Boyle Dam in place) would be a reduction in diel (24-hour) temperature variation and overall warmer water temperatures in the Bypass Reach during summer and early fall. In the Peaking Reach, water temperature effects would be the same as under the Proposed Project (i.e., slightly lower maximum water temperatures and less artificial diel [24-hour] temperature variation during summer and early fall) since no peaking flows would occur and the effect of J.C. Boyle thermal mass on water temperatures does not extend this far downstream (see also Section 4.6.2.1 *Water Temperature*).

In the Hydroelectric Reach from the upstream end of Copco No. 1 Reservoir to Iron Gate Dam, removing Iron Gate, Copco No. 1, and Copco No. 2 reservoirs and converting the reservoir areas to a free-flowing river under this alternative would result in the same effects on water temperatures in the Middle Klamath River immediately downstream from Iron Gate Dam as described for the Proposed Project (i.e., long-term increases in spring water temperatures and decreases in late summer/fall water temperatures) (see Section 3.3.5.3 *Water Quality*).

4.6.3.4 Fish Disease and Parasites

For the reasons discussed below, potential impacts of fish disease and parasites on aquatic resources in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.5 *Fish Disease and Parasites*). The main factors contributing to risk of juvenile salmonid infection by *C. shasta* and *P. minibicornis* include availability of habitat (pools, eddies, and sediment) for the polychaete intermediate host; microhabitat characteristics (static flows and low velocities); congregations of spawned adult salmon with high spore; polychaete proximity to spawning areas; planktonic food sources from Lower Klamath Project reservoirs; and water temperatures greater than 59°F (Bartholomew and Foott 2010). The current reach with highest infectivity (nidus) for *C. shasta* and *P. minibicornis* is located in the Klamath River downstream of Iron Gate Dam, where returning adult spawners congregate. For adult salmon, Ich and columnaris have occasionally resulted in substantial mortality, particularly when habitat conditions include exceptionally low flows, high water temperatures, and high densities of fish (such as adult Chinook salmon migrating upstream in the fall and holding at high densities in pools). This section addresses differences between these disease factors anticipated under the Three Dam Removal Alternative in comparison with the Proposed Project, and implications for effects on juvenile and adult salmonid life stages.

The availability of habitat for the polychaete worm intermediate host is driven by sediment transport and hydrologic dynamics that as described in sections above would be nearly the same as the Proposed Project. The relatively low volume of sediment in J.C. Boyle Reservoir would not appreciably affect habitat for the polychaete host relative to the Proposed Project, and thus the hydrology affecting microhabitat characteristics would be the same as that described for the Proposed Project. The reduction in congregations of spawned adults with proximity to polychaetes would be similar to the

Proposed Project, since anadromous salmonids would have upstream migratory access past Iron Gate Dam, including provision of improved fish passage at J.B. Boyle Dam, and would be as widely distributed. As described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing and emergency dilution flows are required to be released from Iron Gate Dam prior to reconsultation on the 2013 BiOp Flows, but they are not modeled as part of existing conditions hydrology. Under the Three Dam Removal Alternative, it is anticipated that the nidus would no longer form downstream of Iron Gate Dam, and the risk of a new nidus forming upstream is low, even in the absence of the 2017 flow requirements (see also Section 3.3.5.5 *Fish Disease and Parasites*). Although the conditions leading to a reach that would exhibit the highest infectivity (nidus) for *C. shasta* and *P. minibicornis* downstream of Iron Gate Dam would be ameliorated once Copco No. 1, Copco No. 2, and Iron Gate dams are removed, some disease factors would continue under the Three Dam Removal Alternative, including eight years of additional Iron Gate Hatchery operations potentially resulting in continued (through post-dam removal year 10) congregations of mostly adult fall-run Chinook salmon in the reach from Iron Gate Dam to Seiad Valley (see also Section 3.3.5.6 *Fish Hatcheries*). Under the Three Dam Removal Alternative, if a nidus were to remain in the vicinity of Iron Gate Hatchery, or theoretically were to form within newly accessible upstream habitat such as the reach immediately downstream of J.C. Boyle Dam where a future fish passage facility entrance would be located, flushing and emergency dilution flows as required by the 2017 court order may be required from a new upstream location to achieve the same ecological benefits (i.e., disruption of nidus).

Under the Three Dam Removal Alternative, planktonic (e.g., floating organisms such as algae) food sources would be reduced relative to existing conditions with elimination of reservoir habitats, similar to conditions under the Proposed Project. However, because J.C. Boyle Reservoir would remain it would continue to provide a source of planktonic food for the polychaete host of *C. shasta* and *P. minibicornis*. Therefore, while planktonic food sources would be reduced under the Three Dam Removal Alternative relative to existing conditions, slightly more reservoir (and thus planktonic food source) would be removed under the Proposed Project.

Conditions resulting in water temperatures greater than 59°F downstream of Iron Gate Dam under the Three Dam Removal Alternative would be the same as those identified under the Proposed Project. As described in Section 4.6.2.1 *Water Temperature*, the presence of the J.C. Boyle Reservoir on the Klamath River does not alter water temperatures in further downstream reaches because it has a shallow depth (8.3 feet average depth) and short hydraulic residence time (1.1 days) that does not support thermal stratification (FERC 2007).

Under the Three Dam Removal Alternative, the conditions that can support Ich and columnaris outbreaks among adult salmonids (i.e., exceptionally low flows, high water temperatures, and high densities of fish), would be similar to those identified under the Proposed Project, especially within the Lower Klamath River where Ich and columnaris have caused substantial mortality under existing conditions. Downstream of the confluence with the Salmon River neither the Proposed Project or the Three Dam Removal Alternative would have a pronounced effect on instream flows, water temperatures, or congregations of fish, due to the contributions of several large tributaries (notably the Trinity River). Overall, impacts to aquatic species due to fish disease and parasites would improve relative to existing conditions under the Three

Dam Removal Alternative and they would be very similar to those described for the Proposed Project.

4.6.3.5 Fish Hatcheries

The potential impacts of fish hatcheries on aquatic resources in the California portions of the Klamath River would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.6 *Fish Hatcheries*). As neither the Fall Creek nor the Iron Gate hatchery facilities were built to address potential fisheries effects of J.C. Boyle Dam, and this alternative includes volitional fish passage at J.C. Boyle consistent with mandatory conditions issued for relicensing of the Klamath Hydroelectric Project, thereby eliminating J.C. Boyle Dam as a fish barrier, this alternative assumes that hatchery operations would continue for eight years under the Three Dam Removal Alternative and then the hatcheries would be removed. During the eight years following removal of Copco No. 1, Copco No. 2, and Iron Gate dams, the hatcheries would operate with reduced production goals consistent with those described for the Proposed Project (see Section 2.7.6 *Hatchery Operations*).

4.6.3.6 Algal Toxins

Potential impacts of algal toxins on aquatic resources in the California portions of the Klamath River would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.7 *Algal Toxins*). Removal of the larger Copco No. 1 and Iron Gate reservoirs would decrease or eliminate support for excessive growth of phytoplankton, including seasonal blue-green algae blooms and associated algal toxins (e.g., microcystin), by eliminating large areas of quiescent habitat where these phytoplankton species currently thrive. While J.C. Boyle Reservoir would remain, because of its small size (2,267 acre-feet, Table 2.3-1) and short hydraulic residence time (approximately 1 day, Table 3.6-4), it would not support substantial blooms and thus the expected decrease in algal toxins anticipated under the Proposed Project would be the same under the Three Dam Removal Alternative. Additionally, potential for bioaccumulation of algal toxins in freshwater mollusk and fish tissue under the Three Dam Removal Alternative would be expected to decrease in the mainstem Klamath River from Hydroelectric Reach to the Klamath River Estuary as described for the Proposed Project.

4.6.3.7 Aquatic Habitat

For the reasons discussed below, potential impacts of aquatic habitat on aquatic resources in California portions of the Klamath River would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.8 *Aquatic Habitat*). Improvements in aquatic habitat conditions resulting from increased minimum flows and ending peaking operations downstream of J.C. Boyle Dam based on federal mandatory conditions in the PacifiCorp hydroelectric relicensing process would occur under the Three Dam Removal Alternative as described for the Proposed Project. As described in sections above, changes sediment dynamics would also be similar to those described under the Proposed Project. Access to additional aquatic habitat upstream of Iron Gate Dam would be the same under the Three Dam Removal Alternative as described for the Proposed Project, since fish passage would be provided at J.C. Boyle Dam (see also Section 4.6.3.8 *Fish Passage*). The primary difference under the Three Dam Removal Alternative is that aquatic habitat within J.C. Boyle

Reservoir would remain lentic rather than reverting to the riverine conditions described for the Proposed Project. Based on the estimates of Cunanan (2009), there would be approximately 3.5 fewer miles of additional riverine habitat (currently inundated by J.C. Boyle Reservoir) that would become available under this alternative compared to the Proposed Project. However, J.C. Boyle Reservoir inundation is a small proportion (approximately 16 percent) of the 22 miles of Lower Klamath Project reservoir habitat that would be restored to riverine habitat under the Proposed Project. In addition, J.C. Boyle would continue to provide reservoir habitat to support aquatic resources (including shortnose and Lost River suckers), discussed in Potential Impact 3.3-13. Under the Three Dam Removal Alternative, the three lower reservoirs would be removed as described for the Proposed Project, restoring approximately 18.5 miles of mainstem river that previously exhibited high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009).

4.6.3.8 Fish Passage

The current upstream fishway at J.C. Boyle Dam is obsolete and does not meet NMFS (2011) design criteria (U.S. Department of Interior, DOI 2007). Under the Three Dam Removal Alternative, fish would have access beyond the location of Copco No. 1, Copco No. 2, and Iron Gate dams, as described for the Proposed Project (Section 3.3.5.8 *Aquatic Habitat*). However, whereas under the Proposed Project fish would have volitional unimpeded access past J.C. Boyle Dam, under the Three Dam Removal Alternative fish migrating upstream and downstream past J.C. Boyle Dam would access upstream habitat via fishways. DOI (2007) included a prescription for a NMFS-criteria volitional year-round fish ladder 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. In addition, DOI (2007) prescribed a new year-round NMFS criteria fish screen and a bypass facility at J.C. Boyle Dam (and modifications to spillway) to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, redband trout, and listed sucker species. Under the Three Dam Removal Alternative, fishways would be consistent with the prescriptions from the DOI and U.S. Department of Commerce imposed during the FERC relicensing process (FERC 2007), and specific fishway facility design and construction details included in the KHSA 2012 EIS/EIR *Fish Passage at Four Dams Alternative*[215], including fishway (i.e., fish ladder and screens) installation for both upstream and downstream migrations and barriers to prevent juvenile salmonid entrainment into turbines. Trap and haul would involve design assumptions described in the Section 4.4. *Continued Operations with Fish Passage Alternative,* but the assumptions would only be applied to J.C. Boyle Dam. In this EIR, it is assumed that for application at one dam (J.C. Boyle Dam), if alternative passage facilities were designed and constructed, they would necessarily meet agency criteria and thus would have an equivalent level of mortality as volitional fishways.

In their preliminary fishway prescriptions for the Lower Klamath Project dams, NMFS (2006) recommended dam removal to FERC under FPA S10(a)and(j) as the environmentally preferred alternative to provide the least mortality and injury to migrating fish. The associated NMFS fishway prescription (DOI 2007) is a mandatory conditioning authority that was submitted during the hydropower relicensing process at the time, in case FERC chose to reject NMFS' strong recommendation to removal all of the Lower Klamath Project mainstem dams. While unimpeded volitional fish passage is assumed to have higher survival and lower injury than fishways, no data or analyses are available

to accurately compare the effectiveness of unimpeded fish passage under the Proposed Project with volitional fishways under the Three Dam Removal Alternative. NMFS does not provide an expected level of mortality or injury in association with fishways constructed to their criteria, and performance would depend on many site-specific factors that would be considered in the design phase of new fishways. Based on the measured effectiveness of fishways constructed to NMFS criteria at other dams (DWR 2013), this EIR assumes at least 98 percent survival (or less than 2 percent mortality) of upstream and downstream migrating aquatic species in recognition that while survival could be high at properly constructed facilities, it is unlikely to be as high as survival would be with dams removed (i.e., 100 percent). Regardless of how fish passage is provided, this alternative assumes fish passage consistent with the general prescriptions (DOI 2007) that cover anadromous (fall- and spring-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey) and resident (rainbow and redband trout, shortnose and Lost River suckers) fish passage, and includes implementing operation and maintenance plans and prescribing attraction flows for upstream migrants (DOI 2007). This EIR also assumes that effects of passage through volitional fishways would be equivalent for other migratory species, which appears to be a reasonable assumption based on available data (DWR 2013) for fishways designed and constructed to modern agency criteria as required by DOI (2007).

Based on the similarities between the Three Dam Removal Alternative and the Proposed Project for several of the key ecological attributes discussed above, the potential impacts of the Three Dam Removal Alternative would be the same as those described under the Proposed Project for several potential impacts (Potential Impacts 3.3-2, 3.3-3, 3.3-5, 3.3-6, 3.3-12, 3.3-15, 3.3-16, 3.3-18, 3.3-20, 3.3-21, 3.3-22, 3.3-23, and 3.3-24). The potential impacts of the Three Dam Removal Alternative that could result in different effects than those already discussed under the Proposed Project are discussed below.

Potential Impact 3.3-1 Effects on coho salmon critical habitat quality and quantity due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on coho salmon critical habitat in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-1), with a few subtle differences. For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on critical habitat from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion expected under the Proposed Project would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles. Habitat in the J.C. Boyle Bypass and Peaking Reaches would be improved through elimination of peaking operations and higher baseflows. Therefore, although upstream of current designated critical habitat, the Three Dam Removal Alternative would expand the geographic extent of habitat available to coho salmon in a similar manner to the Proposed Project.

The short-term impacts on coho salmon critical habitat from sediment releases would be the same under the Three Dam Removal Alternative as those described for the

Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-1), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. Based on the substantial short-term decrease in quality of the features of critical habitat and PCEs supporting SONCC coho salmon, there would be a significant impact to coho salmon critical habitat under the Three Dam Removal Alternative in the short term.

However, as described for the Proposed Project, the Three Dam Removal Alternative includes aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) to reduce the short-term effects of SSCs on coho salmon PCEs of critical habitat. In addition, mitigation measures AQR-1 and AQR-2 (described in Section 3.3.5.9 *Aquatic Resource Impacts*), would be implemented to increase certainty of the effectiveness of the aquatic resource measures AR-1 and AR-2 and reduce the short-term significant adverse impacts of the Three Dam Removal Alternative on coho salmon critical habitat. Consistent with the Proposed Project, based on the wide distribution of coho salmon critical habitat within tributaries, aquatic resource measures, and mitigation measures designed to offset short-term impacts to PCEs of critical habitat, there would not be a substantial decrease in the quality of a substantial proportion of habitat for coho salmon critical habitat in the short term. Therefore, the Three Dam Removal Alternative would have no significant impact on coho salmon critical habitat in the short term.

For the reasons described in Section 4.6.3.7 *Aquatic Habitat*, in the long term the Three Dam Removal Alternative would increase the amount of habitat available to coho salmon upstream of currently designated critical habitat and improve water quality and bedload characteristics in the mainstem Klamath River within current critical habitat in the same manner as the Proposed Project. Overall, these changes would be a substantial increase in the quality and quantity of coho salmon critical habitat in the long term as compared to existing conditions. Therefore, the Three Dam Removal Alternative would be beneficial for coho salmon critical habitat in the long term.

Significance

No significant impact with mitigation to coho salmon critical habitat in the short term

Beneficial for coho salmon critical habitat in the long term

Potential Impact 3.3-4 Effects on Chinook and coho salmon Essential Fish Habitat (EFH) quality and quantity due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on Chinook and coho salmon EFH in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-4), with a few subtle differences. For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on EFH from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion expected under the Proposed Project would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles.

The short-term impacts on Chinook and coho salmon EFH from sediment releases would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-4), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. Based on the substantial short-term decrease in quality of EFH for Chinook and coho salmon, there would be a significant impact to Chinook and coho salmon EFH under the Three Dam Removal Alternative in the short term.

However, as described for the Proposed Project, the Three Dam Removal Alternative includes aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) to reduce the short-term effects of SSCs on Chinook and coho salmon EFH. In addition, mitigation measures AQR-1 and AQR-2 (described in Section 3.3.5.9), would be implemented to increase certainty of the effectiveness of the aquatic resource measures AR-1 and AR-2 and reduce the short-term significant adverse impacts of the Three Dam Removal Alternative on Chinook and coho salmon EFH. Consistent with the Proposed Project, based on the wide distribution and use of tributaries by both juvenile and adult Chinook and coho salmon, aquatic resource measures (AR-1 and AR-2), and mitigation measures (AQR-1 and AQR-2), designed to offset short-term impacts to Chinook and coho salmon EFH, there would not be a substantial decrease in the quality of a large proportion of Chinook and coho salmon EFH in the short term. Therefore, the Three Dam Removal Alternative would have no significant impact, with mitigation, on Chinook and coho salmon EFH in the short term.

For the reasons described above in Section 4.6.3.7 *Aquatic Habitat*, in the long term the Three Dam Removal Alternative would increase habitat for Chinook and coho salmon (upstream of currently designated EFH) by providing access to habitats upstream of Iron Gate Dam in the same manner as the Proposed Project. Overall, these changes would be a substantial increase in the quality and quantity of Chinook and coho salmon EFH in the long term. Therefore, the Three Dam Removal Alternative would be beneficial for Chinook and coho salmon EFH in the long term.

Significance

No significant impact with mitigation to Chinook and coho salmon EFH in the short term

Beneficial for Chinook and coho salmon EFH in the long term

Potential Impact 3.3-7 Effects on the fall-run Chinook salmon population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

Potential impacts on fall-run Chinook salmon in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-7), with a few subtle differences. As described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on fall-run Chinook salmon from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion expected under the Proposed Project would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. Based

on the 440 miles of fall-run Chinook salmon habitat estimated upstream of Iron Gate Dam (Section 3.3.5.8 *Aquatic Habitat*), the 3.5 miles that would remain inundated by J.C. Boyle Reservoir rather than reverting to riverine habitat under the Three Dam Removal Alternative is not substantial (< 1 percent of newly accessible habitat). Juvenile Chinook salmon would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles. Therefore, due to loss in fish passage facilities and migration through reservoir habitat, the estimated increases in fall-run Chinook salmon abundance predicted to occur under the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-7), would be less under the Three Dam Removal Alternative.

The short-term impacts on fall-run Chinook salmon from sediment releases would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-7), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. As described for the Proposed Project (Potential Impact 3.3-7), because there would be no substantial short-term decrease in fall-run Chinook salmon abundance of a year class, and no substantial decrease in habitat quality or quantity, there would not be a significant impact to fall-run Chinook salmon under the Three Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on fall-run Chinook salmon In the short term, aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) would occur under the Three Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including fall-run Chinook salmon. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Three Dam Removal Alternative on fall-run Chinook salmon by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, in the long term the Three Dam Removal Alternative would increase habitat availability, restore a more natural flow regime and seasonal water temperature variation, improve water quality, and reduce the likelihood of fish disease and algal toxins, all of which would be beneficial for fall-run Chinook salmon in the same manner as the Proposed Project. Overall, the multiple benefits of the Three Dam Removal Alternative would be beneficial for fall-run Chinook salmon in the long term.

Significance
No significant impact for fall-run Chinook salmon populations in the short term

Beneficial for fall-run Chinook salmon populations in the long term

Potential Impact 3.3-8 Effects on the spring-run Chinook salmon population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.
Potential impacts on spring-run Chinook salmon in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-8), with a few subtle differences. As described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on spring-run Chinook salmon from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion expected under the Proposed Project would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. Based on the 440 miles of spring-run Chinook salmon habitat estimated upstream of Iron Gate Dam (Section 3.3.5.8 *Aquatic Habitat*), the 3.5 miles that would remain inundated by J.C. Boyle Reservoir rather than revert to riverine habitat under the Three Dam Removal Alternative is unsubstantial (< 1 percent of newly accessible habitat). Juvenile Chinook salmon would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles.

The short-term impacts on spring-run Chinook salmon from sediment releases would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-8), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. As described for the Proposed Project (Potential Impact 3.3-8), because there would not be a substantial short-term decrease in spring-run Chinook salmon abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to spring-run Chinook salmon under the Three Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on fall-run Chinook salmon In the short term, aquatic resource measure AR-2 (Juvenile Outmigration) would occur under the Three Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including spring-run Chinook salmon. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measure AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the

potential for short-term effects of the Three Dam Removal Alternative on spring-run Chinook salmon by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, in the long term the Three Dam Removal Alternative would increase habitat availability, restore a more natural flow regime and seasonal water temperature variation, improve water quality, and reduce the likelihood of fish disease and algal toxins, all of which would be beneficial for spring-run Chinook salmon in the same manner as the Proposed Project. Overall, the multiple benefits of the Three Dam Removal Alternative would be beneficial for spring-run Chinook salmon in the long term.

Significance

No significant impact for spring-run Chinook salmon populations in the short term

Beneficial for spring-run Chinook salmon populations in the long term

Potential Impact 3.3-9 Effects on coho salmon populations due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

Potential impacts on coho salmon in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-9), with a few subtle differences. As described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on coho salmon from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion (approximately 80 miles) expected under the Proposed Project (as described in Section 3.3.5.8 *Aquatic Habitat*) would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. Juvenile coho salmon would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles. Habitat in the J.C. Boyle Bypass and Peaking Reaches would be improved through elimination of peaking operations and higher baseflows. Therefore, the Three Dam Removal Alternative would expand the geographic extent of habitat available to coho salmon in a similar manner to the Proposed Project; albeit with higher migration mortality in fishways and reservoirs.

The short-term impacts on coho salmon from sediment releases would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-9), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. Because there would not be a substantial short-term decrease in coho salmon abundance of a year class or a substantial decrease in habitat

quality or quantity, there would not be a significant impact to coho salmon under the Three Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on coho salmon In the short term, aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) would occur under the Three Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including coho salmon. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Three Dam Removal Alternative on coho salmon by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, in the long term the Three Dam Removal Alternative would increase the amount of habitat available to coho salmon and improve water quality and bedload characteristics in the mainstem Klamath River in the same manner as the Proposed Project. Overall, these changes could result in a substantial increase the abundance of coho salmon populations in the long term. Therefore, the Three Dam Removal Alternative would be beneficial for coho salmon in the long term.

Significance

No significant impact for coho salmon populations in the short term

Beneficial for coho salmon populations in the long term

Potential Impact 3.3-10 Effects on the steelhead population due to short-term sediment releases and long-term changes in habitat quality, habitat quantity, and hatchery operations due to dam removal.

Potential impacts on steelhead in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-10), with a few subtle differences. As described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on steelhead from sediment releases would be similar to the Proposed Project, as well as water quality, fish disease and parasites, fish hatcheries, and algal toxins. The same habitat expansion (approximately 440 miles) expected under the Proposed Project (as described in Section 3.3.5.8 *Aquatic Habitat*) would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would be accessible but would continue to be inundated by J.C. Boyle Reservoir. Juvenile steelhead would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles.

The short-term impacts on steelhead from sediment releases would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-10), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. Because there would not be a substantial short-term decrease in steelhead abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to steelhead under the Three Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on steelhead In the short term, aquatic resource measures AR-1 (Mainstem Spawning) and AR-2 (Juvenile Outmigration) would occur under the Three Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on salmonid juveniles, smolts, and eggs, including steelhead. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measures AQR-1 and AQR-2, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Three Dam Removal Alternative on steelhead by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, in the long term the Three Dam Removal Alternative would increase the amount of habitat available to steelhead and improve water quality and bedload characteristics in the mainstem Klamath River in the same manner as the Proposed Project. Overall, these changes could result in a substantial increase the abundance of steelhead populations in the long term. Therefore, the Three Dam Removal Alternative would be beneficial for steelhead in the long term.

Significance

No significant impact for steelhead populations in the short term

Beneficial for steelhead populations in the long term

Potential Impact 3.3-11 Effects on the Pacific lamprey population due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on Pacific lamprey in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-11), with a few subtle differences. As described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on Pacific lamprey from sediment releases would be similar to the Proposed Project, as well as water quality, and algal toxins. The same habitat expansion (approximately 80 miles) expected under the Proposed Project (as described in Section 3.3.5.8 *Aquatic Habitat*) would occur, with the exception of habitat under J.C. Boyle Reservoir (approximately 3.3 miles; Cunanan 2009) and the downstream portion of Spencer Creek (approximately 0.2 miles; Cunanan 2009), which would continue to be inundated by J.C. Boyle Reservoir and unlikely to be used by Pacific Lamprey. Based on the 80 miles of Pacific lamprey habitat estimated upstream of Iron Gate Dam (Section 3.3.5.8 *Aquatic Habitat*), the 3.5 miles that would

remain inundated by J.C. Boyle Reservoir rather than revert to riverine habitat under the Three Dam Removal Alternative is unsubstantial (< 5 percent of newly accessible habitat). Juvenile lamprey would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018).

As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles.

The short-term impacts on Pacific lamprey from sediment releases would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-11), for the reasons described in Section 4.6.3.1 *Suspended Sediment* and Section 4.6.3.2 *Bed Elevation and Grain Size Distribution*. Because there would not be a substantial short-term decrease in Pacific lamprey abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to Pacific lamprey under the Three Dam Removal Alternative in the short term.

In addition, and as described for the Proposed Project, although this EIR finds no significant impact on Pacific lamprey In the short term, aquatic resource measure AR-1 (Mainstem Spawning) would occur under the Three Dam Removal Alternative, which would further reduce the potential for short-term effects of SSCs on Pacific lamprey. In addition, although CEQA Guidelines Section 15126.4(a)(3) states that mitigation measures are not required for effects which are not found to be significant, mitigation measure AQR-1, which would be implemented as a result of significant adverse impacts described for Potential Impact 3.3-1 and Potential Impact 3.3-4, would even further reduce the potential for short-term effects of the Three Dam Removal Alternative on Pacific lamprey by increasing certainty regarding the effectiveness of the proposed aquatic resource measures.

For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, in the long term the Three Dam Removal Alternative would increase the amount of habitat available to Pacific lamprey and improve water quality and bedload characteristics in the mainstem Klamath River in the same manner as the Proposed Project. Overall, these changes could result in a substantial increase the abundance of Pacific lamprey populations in the long term. Therefore, the Three Dam Removal Alternative would be beneficial for Pacific lamprey in the long term.

Significance

No significant impact for Pacific lamprey in the short term

Beneficial for Pacific lamprey in the long term

Potential Impact 3.3-12 Effects on the green sturgeon population due to short-term sediment releases and long-term changes in habitat quality due to dam removal.

Southern DPS Green Sturgeon may enter the Klamath River Estuary to forage during the summer months. They would not be present when the most severe effects of dam removal are occurring and are not expected to be affected by the Three Dam Removal

Alternative. The remainder of this section focuses on the effects of the Three Dam Removal Alternative on the Northern Green Sturgeon DPS. Northern Green Sturgeon do not occur upstream of Ishi Pishi Falls and would not be affected by Three Dam Removal Alternative impacts that do not extend downstream past these falls. Potential impacts on green sturgeon in California would be the same under the Three Dam Removal Alternative as those described for the Proposed Project in the short term (Potential Impact 3.3-12).

For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, in the long term the Three Dam Removal Alternative would result in the same improvements in flow regime, water quality, temperature variation, and algal toxins as described for the Proposed Project (Potential Impact 3.3-12). Because there would not be a substantial short- or long-term decrease in green sturgeon abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to the green sturgeon population under the Three Dam Removal Alternative in the short or long term.

Significance
No significant impact for green sturgeon in the short or long term

Potential Impact 3.3-13 Effects on Lost River and shortnose sucker populations due to short- and long-term changes in habitat quality and quantity due to dam removal.
Potential impacts on Lost River and shortnose suckers in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-13), with a few notable differences. For reasons described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6. *Algal Toxins*, impacts on Lost River and shortnose suckers in Upper Klamath Lake, interactions with anadromous fish, and from conversion of Lower Klamath Project reservoir habitat to riverine habitat would be similar to the Proposed Project. Lost River and shortnose suckers currently occur within all Lower Klamath Project reservoirs, including J.C. Boyle Reservoir (Desjardins and Markle 1999). Therefore, while under the Proposed Project all Lower Klamath Project reservoir habitat (2,347 acres) currently supporting Lost River and shortnose suckers would be removed, under the Three Dam Removal Alternative habitat would remain in J.C. Boyle Reservoir (420 acres). Most of the reservoir habitat (82 percent), and the preponderance of the Lost River and shortnose sucker populations in the Hydroelectric Reach is within Iron Gate and Copco reservoirs.

Overall, the short-term impact of the Three Dam Removal Alternative would be very similar to the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-13), with the exception of those Lost River and shortnose sucker individuals that are able to remain within J.C. Boyle Reservoir habitat. All individual suckers occurring within the lower three Lower Klamath Project reservoirs would likely be lost within dam removal year 2; however, these individuals are not considered to substantially contribute to the achievement of conservation goals or recovery, since little or no reproduction occurs downstream from Keno Dam (Buettner et al. 2006), and there is no potential for interaction with upstream populations (Hamilton et al. 2011). Based on the best available estimates of Lost River and shortnose sucker abundance in the Lower Klamath Project excluding J.C. Boyle Reservoir, there are likely fewer than 1,000 adult suckers of both species (USFWS 2012, Desjardins and Markle 1999), with a

combined suitable sucker area of less than 2,500 acres. The populations in Upper Klamath Lake are estimated at 50,000 to 100,000 Lost River sucker (USFWS 2013b), and up to 25,000 shortnose suckers (USFWS 2013c), within around 79,000 acres of suitable habitat in Upper Klamath Lake and connected water bodies. Therefore, a loss of the suckers in Lower Klamath Project reservoirs (excluding J.C. Boyle Reservoir) represents around less than 1.5 percent of the total sucker population, and a loss of less than 3.5 percent of the total suitable sucker habitat. Based on no predicted substantial (< 1.5 percent) short-term decrease in Lost River and shortnose suckers' abundance of a year class, or substantial decrease in habitat quality or quantity (<1.5 percent), the Three Dam Removal Alternative would not cause a significant impact to the Lost River and shortnose sucker populations in the short term.

For the reasons described above in Section 4.6.3.7 *Aquatic Habitat*, in the long term reservoir removal associated with dam removal under the Three Dam Removal Alternative would eliminate habitat availability and affect Lost River and shortnose suckers in Iron Gate and Copco reservoirs. All individual suckers occurring within these reservoirs would likely be lost within the short term and would not be replaced in the long term. However, as described above, these individuals are not considered to substantially contribute to the achievement of conservation goals or recovery of the populations (Hamilton et al. 2011). Because there would not be a substantial long-term decrease in Lost River and shortnose suckers abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to the Lost River and shortnose sucker populations under the Three Dam Removal Alternative in the long term.

In addition, and as described for the Proposed Project (Section 3.3.5.9 *Aquatic Resource Impacts*, Potential Impact 3.3-13), although this EIR finds no significant impact on Lost River and shortnose suckers in the short term or long term, aquatic resource measure AR-6 (Suckers) would occur under the Three Dam Removal Alternative, which would further reduce the potential for effects of reservoir removal.

Significance

No significant impact for Lost River and shortnose sucker populations in the short term

No significant impact for Lost River and shortnose sucker populations in the long term

Potential Impact 3.3-14 Effects on the redband trout population due to short-term sediment releases and long-term changes in habitat quality and quantity due to dam removal.

Potential impacts on redband trout in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impact 3.3-14), with a few notable differences. As described in Section 4.6.3.1 *Suspended Sediment* through Section 4.6.3.6 *Algal Toxins*, impacts on redband trout from water quality would be similar to the Proposed Project, as well as algal toxins. Redband trout would also be affected by the reintroduction of anadromous fish, including the potential for competition, predation, and exposure to disease in the same manner as described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14), since these result from restored habitat access of anadromous salmonids that would not differ between the Proposed Project and the Three Dam Removal Alternative.

Suspended and bedload sediment effects would differ from those described for the Proposed Project. Redband trout are distributed upstream of Iron Gate and Copco reservoirs, and therefore under the Proposed Project the impacts these individuals would experience from sediment releases would be downstream of J.C. Boyle and downstream of Copco No. 1 and Copco No. 2. Therefore, for those individuals upstream of Copco No. 1, despite the relatively small volume of sediment stored in J.C. Boyle Reservoir, impacts of sediment release on redband trout that would occur under the Three Dam Removal Alternative would be substantially less under the Proposed Project. For those individuals downstream of Copco No. 2 the impacts of sediment release would be indistinguishable from the Proposed Project, due to the relatively large contribution from sediment stored in Copco No. 1 Reservoir.

As described in Section 4.6.3.7 *Aquatic Habitat*, conversion of Lower Klamath Project reservoir habitat to riverine habitat would be similar to the Proposed Project, with the exception of J.C. Boyle Reservoir. Under the Three Dam Removal Alternative redband trout would benefit from changes in hydropower operations, and from the conversation of 17.7 miles of reservoir habitat to riverine habitat, in the same manner as for the Proposed Project. However, 3.5 miles of mainstem and tributary habitat would continue to be inundated by J.C. Boyle Reservoir. It is anticipated that under the Three Dam Removal Alternative this habitat would continue to support an adfluvial redband trout population. As described in Section 4.6.3.8 *Fish Passage*, mortality within fishways (i.e., volitional facilities, trap and haul) at J.C. Boyle Dam is predicted to be less than 2 percent for upstream and downstream migrating adults and juveniles.

Because there would not be a substantial short-term decrease in redband trout abundance of a year class or a substantial decrease in habitat quality or quantity, there would not be a significant impact to the redband trout population under the Three Dam Removal Alternative in the short term. Based on a long-term substantial increase in redband trout habitat quality and quantity, the Three Dam Removal Alternative would be beneficial for redband trout in the long term.

Significance

No significant impact for redband trout in the short term

Beneficial for redband trout in the long term

Potential Impact 3.3-17 Effects on species interactions between introduced resident fish species and native aquatic species due to short- and long-term changes in habitat quality and quantity due to dam removal.

Introduced fish species threaten the diversity and abundance of native fish species through competition for resources, predation, interbreeding with native populations, and causing potential physical changes to the invaded habitat (Moyle 2002). Potential impacts on species interactions between introduced resident fish species and native aquatic species ("species interactions") in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14), with a few notable differences. As described for the Proposed Project, implementation of the Three Dam Removal Alternative would eliminate reservoir habitat associated with three Lower Klamath Project reservoirs, and thus the abundance of introduced resident species would decline substantially (Buchanan et al. 2011a), providing a benefit to native aquatic species. However, the Three Dam Removal Alternative would retain the habitat supporting non-native fish species associated with

J.C. Boyle Reservoir. As described in Section 3.3.2.1 *Aquatic Species [non-native fish species]*, non-native fish species would continue to occur in J.C. Boyle Reservoir, including yellow perch and bass species. Juvenile salmonids and lamprey would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle Reservoir, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018). However, in restoration efforts elsewhere in the Pacific Northwest, anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (NMFS 2006a). In addition, the majority of the non-native species are within Iron Gate and Copco No. 1 reservoirs, which support popular recreational fisheries for yellow perch and bass. Therefore, species interactions under the Three Dam Removal Alternative would be substantially improved relative to existing conditions, albeit to a lesser degree than under the Proposed Project. This effect would be beneficial for native aquatic species in the short and long term.

Significance

Beneficial for the effects of introduced resident fish species on aquatic species in the short term and long term

Potential Impact 3.3-19 Effects on freshwater mollusks populations due to short-term sediment releases and long-term changes in habitat quality due to dam removal.

Potential impacts on freshwater mollusks in California would be similar under the Three Dam Removal Alternative as those described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-19), with a few subtle differences. As described in Section 4.6.3.1 *Suspended Sediment*, impacts on freshwater mollusks from sediment releases would be similar to the Proposed Project. Based on the distribution of freshwater mollusks primarily downstream of Iron Gate dam (summarized in Section 3.3.5.9, Potential Impact 3.3-14), the impacts of the Three Dam Removal Alternative would be the same as those described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14) with one exception. The Proposed Project would have the most substantial impact on the floater mussels (*Anodata spp*.) which occur in the mainstem Klamath River in the Hydroelectric Reach, within Lower Klamath Project reservoirs, in a reach (<15 miles) directly downstream of Iron Gate Dam, and within the Upper Shasta River. *Anodata spp*. have been found in high abundance within J.C. Boyle Reservoir as recently as summer 2018 (Troy Brandt, River Design Group, pers. comm., November 2018). Therefore, under the Three Dam Removal Alternative the *Anodata spp.* would remain unaffected within a portion of their range in J.C. Boyle Reservoir and Upper Shasta River. Therefore, while the impacts to other species of freshwater mollusks would be the same under the Proposed Project (not significant), impacts to the *Anodata spp*. would be less substantial under the Three Dam Removal Alternative than under the Proposed Project. However, impacts the Anodata spp. would still occur under the Three Dam Removal Alternative in the mainstem Klamath River (primarily downstream of Iron Gate Dam) as described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14), and based on predicted substantial short-term decrease in *Anodonta spp.* abundance of a year class, there would be a significant impact to the *Anodonta spp.* population under the Proposed Project in the short term.

However, the Three Dam Removal Alternative includes aquatic resource measure AR-7 (Freshwater Mussels) to reduce the short-term effects of sediment transport during dam

removal on *Anodonta spp.*, as described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-14). Under the Proposed Project this salvage and relocation plan would consider sites for translocation downstream from the Trinity River confluence (RM 43.4), and between J.C. Boyle Dam (RM 230.6) and Copco Reservoir (RM 209.0). These areas would have less impact from increased SSCs but would not be completely protected from short-term effects. The areas downstream of the Trinity River confluence do not currently support *Anodonta spp*. and are unlikely to in the future (Davis et al. 2013). However, under the Three Dam Removal Alternative *Anodonta spp*. could be salvaged from the reach downstream of Iron Gate Dam and relocated to J.C. Boyle Reservoir, which does support suitable *Anodonta spp*. habitat. Therefore, with aquatic resource measure AR-7, there would likely not be a substantial reduction in the abundance of *Anodonta spp.* species in the short term, and impacts would be not significant with for *Anodonta spp.* in the short term.

Significance

No significant impact for *M. falcata, G. angulate, or Anodonta spp.* in the short or long term

No significant impact for freshwater clams in the short or long term

4.6.4 Phytoplankton and Periphyton

4.6.4.1 Phytoplankton

Short-term mobilization of J.C. Boyle Reservoir sediment deposits would not occur under the Three Dam Removal Alternative (see Section 4.6.2.2 *Suspended Sediments*), thus there would be no short-term increase in sediment-associated nutrients downstream of J.C Boyle Dam (see Section 4.6.2.3 *Nutrients*). While there would be a short-term increase in sediment-associated nutrients between Copco No. 1 Reservoir and Iron Gate Dam in the Hydroelectric Reach, as well as in the Middle Klamath River, Lower Klamath River, and Klamath River Estuary during reservoir drawdown (see Section 4.6.2.3 *Nutrients*), minimal deposition of fine suspended sediments, including the associated nutrients, would occur in the river channel and the estuary (Stillwater Sciences 2008; USBR 2012). Thus, the short-term increase in nutrients would be limited to the time period when sediment deposits are being transported through the Klamath River. The drawdown of Copco No. 1 and Iron Gate reservoirs and release of these nutrients also would occur during winter months when the rates of phytoplankton growth and reproduction along with the rates of nutrient transformations by microbes (e.g., nitrification and denitrification) are relatively low, so the ability of phytoplankton to use sediment-associated nutrients mobilized during reservoir drawdown would be low (see Potential Impact 3.4-1). Sediment released during reservoir drawdown under the Three Dam Removal Alternative also would increase suspended sediment concentrations and water turbidity (see also Potential Impact 3.2-3), limiting light availability for phytoplankton photosynthesis and further reducing the potential for additional phytoplankton growth and reproduction. Under the Three Dam Removal Alternative, the sediment-associated nutrients would be less than under the Proposed Project since no J.C. Boyle sediment-associated nutrients would be released, but the overall impact would be the same in both the Three Dam Removal Alternative and the Proposed Project. The sediment-associated nutrients would not be likely to stimulate phytoplankton growth or reproduction that would lead to an increase spatial extent,

temporal duration, toxicity, or concentration of nuisance and/or noxious phytoplankton, so there would be no significant impact.

With respect to potential long-term impacts, J.C. Boyle Reservoir does not support low mixing conditions or thermal stratification that create optimal habitat for phytoplankton growth or reproduction under existing conditions due to its shallow depth (8.3 feet average depth) and short hydraulic residence time (approximately 1 day at average flows, Table 3.6-4) and it would not do so under the Three Dam Removal Alternative. Peaking power generation flows are released in the late afternoons and early evenings to meet high power demand, and J.C. Boyle Reservoir refills during the night when power demand is minimal. Daily fluctuations in the reservoir water level under existing operations increases mixing in the reservoir, making the reservoir slightly less suitable habitat for phytoplankton during the season of maximum phytoplankton and cyanobacteria (blue-green-algae) growth in the system. Ceasing peaking power generation flows would reduce daily reservoir water level fluctuations in J.C. Boyle Reservoir because the facility would no longer be operated to draw on reservoir storage to support daily peaks in hydropower production when there is not sufficient river flow for peak production (3,000 cfs), as occurs during the summer and fall low flow period under existing conditions. However, the residence time of J.C. Boyle Reservoir without peaking operations would still be short (i.e., on the order of one to three days), so leaving this dam in place and ceasing peaking flows would not change long-term phytoplankton growth or reproduction and thus it would not change the spatial extent, temporal duration, or concentration of nuisance and/or noxious phytoplankton blooms, including blue-green algae, to the degree that new or further impairment of designated beneficial uses would occur.

Copco No. 1 and Iron Gate reservoirs currently support growth conditions for toxin-producing nuisance phytoplankton species such as *Microcystis aeruginosa*, with these two reservoirs serving as the primary habitat for blue-green algae in the Hydroelectric Reach. Thus, the removal of Copco No. 1 and Iron Gate reservoirs under the Three Dam Removal Alternative would eliminate the main habitat toxin-producing nuisance phytoplankton and reduce the long-term spatial extent, temporal duration, and concentration of nuisance and/or noxious phytoplankton species relative to existing conditions, consistent with the Proposed Project. The elimination of Copco No. 1 and Iron Gate reservoirs would be beneficial in the Hydroelectric Reach downstream of Copco No. 1 Reservoir. Due its small size and low residence time (less than a day), Copco No. 2 Reservoir does not promote phytoplankton growth under existing conditions and its removal under the Three Dam Removal Alternative also would not affect the spatial extent, temporal duration, and concentration of nuisance and/or noxious phytoplankton species within the Hydroelectric Reach or downstream reaches.

Because seasonal phytoplankton blooms are primarily internally generated in Copco No. 1 and Iron Gate reservoirs, removal of these reservoirs under the Three Dam Removal Alternative would also decrease or eliminate the long-term downstream transport of nuisance and/or noxious phytoplankton species and their associated toxins from Copco No. 1 and Iron Gate reservoirs into the Middle and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment. The decrease or elimination of long-term downstream transport of phytoplankton cells from Copco No. 1 and Iron Gate reservoirs would also reduce the seasonal (i.e., summer and fall) downstream transport of nutrients contained in those phytoplankton cells that potentially promote seasonal increases in phytoplankton and/or periphyton growth in the Middle

and Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment.

In summary, relative to existing conditions, the potential impacts and impacts of the Three Dam Removal Alternative on phytoplankton would be the same as or similar to those described for the Proposed Project, as follows:

- There would be no short-term change in phytoplankton growth and reproduction from existing conditions in the Hydroelectric Reach from J.C. Boyle Dam to the upstream end of Copco No. 1 Reservoir due to mobilization of sediment-associated nutrients from J.C. Boyle Reservoir because this reservoir and its sediment deposits would remain in place (Potential Impact 3.4-1).
- While there would be short-term increases in sediment-associated nutrients downstream of Copco No. 1 Dam due to the release of sediments currently trapped behind the Copco No. 1 and Iron Gate dams, there would not be an increase in the spatial extent, temporal duration, toxicity, or concentration of nuisance and/or noxious phytoplankton species, including blue-green algae, in the Hydroelectric Reach downstream of Copco No. 1 Dam, the Middle and Lower Klamath River, and the Klamath River Estuary that results in new or further impairment of designated beneficial uses; therefore, there would be no significant impact in the short term (Potential Impact 3.4-1).
- There would be no significant impact in the long term from J.C. Boyle Dam remaining in place and ceasing peaking power generation flows on the spatial extent, temporal duration, transport, and/or concentration of nuisance and/or noxious phytoplankton species and concentrations of algal toxins because J.C. Boyle Reservoir would not support habitat that would promote phytoplankton blooms under the Three Dam Removal Alternative, similar to under existing conditions (Potential Impact 3.4-2).
- Long-term reduction in the spatial extent, temporal duration, transport, and/or concentration of nuisance and/or noxious phytoplankton species and concentrations of algal toxins due to elimination of Copco No. 1 and Iron Gate reservoir habitats would be beneficial for the Hydroelectric Reach, Middle and Lower Klamath River, and Klamath River Estuary (Potential Impact 3.4-2). There would be no significant impact for the Pacific Ocean nearshore environment (Potential Impact 3.4-2).

4.6.4.2 Periphyton

Short-term mobilization of J.C. Boyle Reservoir sediment deposits would not occur under the Three Dam Removal Alternative, thus there would be no short-term increase in sediment-associated nutrients downstream of J.C Boyle Dam. While there would be a short-term increase in sediment-associated nutrients between Copco No. 1 Reservoir and Iron Gate Dam in the Hydroelectric Reach, as well as in the Middle Klamath River, Lower Klamath River, and Klamath River Estuary during reservoir drawdown, minimal deposition of fine suspended sediments, including the associated nutrients, would occur in the river channel and the estuary (Stillwater Sciences 2008; USBR 2012). Thus, the short-term increase in nutrients would be limited to the time period when sediment deposits are being transported through the Klamath River. The drawdown of Copco No. 1 and Iron Gate reservoirs and release of these nutrients would occur during winter months when the rates of periphyton growth and reproduction along with the rates of nutrient transformations by microbes (e.g., nitrification and denitrification) are relatively

low due to less light availability for photosynthesis and lower water temperatures. As a result, the ability of periphyton to use sediment-associated nutrients would be limited and there would not be an increase in periphyton growth or reproduction during this period, even though additional nutrients would be available due to the release of sediments trapped behind the Lower Klamath Project dams. Light limitation from high concentrations of suspended sediments in the water (Potential Impact 3.2-3) would also reduce any potential for nuisance levels of periphyton growth during reservoir drawdown. Additionally, high river flows during the winter drawdown period and late spring storm events would result in greater sediment movement and scouring, which would greatly limit, if not eliminate, the area of the streambed that periphyton can establish to grow during this period. Thus, the Three Dam Removal Alternative would not be likely to stimulate an increase in periphyton growth or reproduction and result in an increase in the spatial extent, temporal duration, or biomass of nuisance periphyton species that causes a new or further impairment of designated beneficial uses, similar to the Proposed Project.

Under the Three Dam Removal Alternative, J.C. Boyle Reservoir would remain in place and peaking power generation and release of recreation flows would cease from J.C. Boyle Dam, so there would be less artificial diel (24-hour) temperature variation during summer and early fall in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir similar to the Proposed Project (see also Potential Impact 3.2-1). J.C. Boyle retains relatively little nutrients under existing conditions (see Appendix C, Section C.3.1.1 *Hydroelectric Reach*), and therefore nutrient conditions in this reach would be the same under the Three Dam Removal Alternative as under existing conditions since there would be no change in nutrient interception or retention with J.C. Boyle Dam remaining in place. The less diel (24-hour) temperature variations and slight decrease in the maximum water temperature in this reach is not anticipated to affect periphyton colonization. Additionally, the generally high gradient and velocity in the J.C. Boyle Peaking Reach does not currently support excessive periphyton mats and it is not anticipated this reach would support excessive periphyton mats under lower flows once peaking and recreation flows cease. In the short term and long term, increases in periphyton biomass from elimination of peaking and recreation flows along with the change in water temperature in this reach are expected to be limited under the Three Dam Removal Alternative and any potential increase in periphyton would not result in new or further impairment of designated beneficial uses.

Further downstream in the Hydroelectric Reach, periphyton growth in low-gradient channel margin areas in the footprints of Copco No. 1 and Iron Gate reservoirs could increase on a seasonal basis following dam removal because removal of the reservoirs would provide additional low-gradient habitat suitable for periphyton assemblages. Dam removal construction and restoration activities in dam removal year 2 and additional sediment transport and scour during winter post-dam removal year 1 may inhibit some periphyton growth in the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, but, overall, periphyton would be expected to begin colonizing the newly created suitable habitat within the short term and would continue in the long term. Similar to the Proposed Project (Potential Impact 3.4-4), conservatively this would be a significant impact with respect to periphyton growth. The response of periphyton in the river is subject to many competing processes that could either accelerate or hinder periphyton growth and potential increases in nuisance periphyton (i.e., *Cladophora* sp.) extent, duration, and biomass. In the long term, improvements (i.e., reductions in biomass) are expected from several processes such as scour and in-stream retention processes,

whereas improvements could be diminished by processes such as reduced nutrient retention from the reservoirs or climate change. While the growth of nuisance periphyton along channel margin areas is not expected to contribute algal toxins that would impair water quality, the degree to which designated beneficial uses would be impaired due to an increase in nuisance periphyton species (i.e., *Cladophora* sp.) in the newly formed low-gradient channel margin areas of the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam is not fully understood. The implications of potential changes in periphyton biomass and community composition on dissolved oxygen and the spread of fish disease under the Three Dam Removal Alternative would be similar to those described in Section 3.2.5.4 *Dissolved Oxygen* and Section 4.6.3.4 *Fish Disease and Parasites*, respectively, for the reach between Copco No. 1 Reservoir and Iron Gate Dam.

In summary, relative to existing conditions, the potential impacts of the Three Dam Removal Alternative on periphyton would be the same as or similar to those described for the Proposed Project, as follows:

- There would be no significant impact in the short term from changes in periphyton growth compared to existing conditions due to mobilization of sediment-associated nutrients from J.C. Boyle Reservoir (Potential Impact 3.4-3) because this reservoir and its sediment deposits would remain in place.
- Mobilization of sediment-associated nutrients from Copco No. 1 and Iron Gate reservoirs would occur under the Three Dam Removal Alternative, but usage of these nutrients would be limited due to lower light levels reducing photosynthesis for periphyton growth and higher flows scouring periphyton from the streambed during winter and early spring. Thus, there would not be an increase in the spatial extent, temporal duration, or biomass of nuisance periphyton species in the Hydroelectric Reach downstream of Copco No. 1, the Middle and Lower Klamath River, or the Klamath River Estuary that would result in a new or further impairment of designated beneficial uses (Potential Impact 3.4-3), and there would be no significant impact.
- There would be no short-term or long-term increase in nuisance periphyton growth that results in new or further impairment of designated beneficial uses in the Hydroelectric Reach from J.C. Boyle Dam to Copco No. 1 Reservoir, including the Oregon-California state line, due to increased nutrients or ceasing of peaking flows at J.C. Boyle (Potential Impact 3.4-4), so there would be no significant impact.
- There could be a short-term and/or long-term increase in nuisance periphyton growth that would result in new or further impairment of designated beneficial uses in the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam due to an increase in nutrients and available low-gradient channel margin habitat from conversion of the Copco No. 1 and Iron Gate reservoir areas to a free-flowing river (Potential Impact 3.4-4) and if this increase were to occur, it would be a significant and unavoidable impact.
- There would be no long-term increase in biomass of nuisance periphyton that would result in new or further impairment of designated beneficial uses in the Middle Klamath River, Lower Klamath River, and Klamath River Estuary due to increased nutrient availability from upstream dam removal under the Three Dam Removal Alternative similar to the Proposed Project (Potential Impact 3.4-5), so there would be no significant impact.

4.6.5 Terrestrial Resources

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes construction of a new fish ladder at J.C. Boyle Dam (and removal of the existing one within a similar footprint to the existing ladder). While there would potentially be less construction activities resulting in noise or habitat removal under this alternative than under the Proposed Project, the relative decrease in construction activities under the Three Dam Removal Alternative would not change the level of impacts to terrestrial resources in California since J.C. Boyle is located in Oregon. Thus, potential impacts on sensitive habitats (wetlands and riparian habitat), rare natural communities, culturally significant species, special-status species, wildlife corridors and habitat connectivity within the Primary Area of Analysis for terrestrial resources would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impacts 3.5-1 through 3.5-31).

4.6.6 Flood Hydrology

For the reasons discussed below, potential impacts on flood hydrology resources in California would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impacts 3.6-1 through 3.6-6). J.C. Boyle Reservoir has a relatively small storage capacity (2,267 acre-feet total storage; 1,724 acre-feet active storage; see Table 3.6-4) and is not operated by PacifiCorp as a flood control reservoir. Thus, leaving J.C. Boyle Dam in place under the Three Dam Removal Alternative would not affect the FEMA 100-year floodplain nor risks related to flooding during reservoir drawdown downstream from the Oregon-California state line relative to the Proposed Project. Ceasing peaking power generation or release of flow for recreation at J.C. Boyle Dam would reduce daily reservoir level variability, as well as flow variability in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir, relative to existing conditions. However, because the reservoir active storage is relatively small, these changes would not affect flood hydrology. Therefore, the flood hydrology impacts of the Three Dam Removal Alternative would be the same as those described for the Proposed Project and there would be no significant impacts for Potential Impacts 3.6-1, 3.6-2, and 3.6-4 through 3.6-6. There would be significant and unavoidable impacts related to exposing structure to a substantial risk of damage due to flooding downstream of the location of Iron Gate Dam (Potential Impact 3.6-3).

4.6.7 Groundwater

would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impacts 3.7-1 and 3.7-2). The Klamath River within the Hydroelectric reach is a gaining reach (i.e., regional groundwater discharges to the river). Groundwater contributions from the Lower Klamath Project reservoirs to surrounding aquifers likely only extends to the immediate vicinity of the reservoirs (i.e., less than approximately 2 miles) (USBR 2012). J.C. Boyle Reservoir is located more than 20 river miles upstream of the other Lower Klamath Project reservoirs, and thus leaving it in place under the Three Dam Removal Alternative would not influence groundwater wells located in the vicinity of Copco No. 1 and Iron Gate reservoirs. Removal of Copco No. 1 and Iron Gate reservoirs under the Three Dam Removal Alternative would result in the same effects on groundwater as described for the

Proposed Project (Section 3.7 *Groundwater*). For the reasons described in Potential Impacts 3.7-1 and 3.7-2, and there would be no significant impacts.

4.6.8 Water Supply/Water Rights

For the reasons discussed below, the water supply and water rights impacts of the Three Dam Removal Alternative would be the same as those analyzed under the Proposed Project (Potential Impacts 3.8-1 through 3.8-5). As discussed in Section 3.8 *Water Supply/Water Rights*, under existing conditions none of the Lower Klamath Project facilities are water supply facilities. Thus, the same set of influences that currently dictate water availability in California would continue to do so regardless of whether J.C. Boyle Dam is removed (as under the Proposed Project) or remains (as under the Three Dam Removal Alternative).

The Lower Klamath Project reservoir that would remain under the Three Dam Removal Alternative, J.C. Boyle, has a relatively small storage capacity (2,267 acre-feet total storage; 1,724 acre-feet active storage; see Table 3.6-4) and, like other Lower Klamath Project facilities, is not a water supply facility for consumptive use in Oregon or California. Ceasing peaking power generation and recreation flow releases at J.C. Boyle Dam would reduce daily reservoir level variability, as well as flow variability downstream from J.C. Boyle Dam, relative to existing conditions. Minimum flows in California under the Three Dam Removal Alternative would be the same as those analyzed under the Proposed Project because minimum instream flows would still be mandated by BiOp requirements. As under the Proposed Project, reducing riverine flow fluctuation in the Hydroelectric Reach and removing the California reservoirs would not reduce the amount of water available or impact diversion facilities for the three diversions identified from the Oregon-California state line to Copco No. 1 Reservoir. Thus, Potential Impacts 3.8-1, 3.8-2, and 3.8-5 under the Proposed Project would be the same under the Three Dam Removal Alternative, and there would be no significant impacts.

Short-term mobilization of J.C. Boyle Reservoir sediment deposits would not occur under the Three Dam Removal Alternative and none of the associated 1,190,000 cubic yards of deposits (i.e., eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-7 and 2.7-8) would be eroded or delivered to downstream reaches, although little to no sediment deposition would be expected in the reach between J.C. Boyle and Copco No. 1 (USBR 2012). However, mobilization of reservoir sediment deposits in the much larger Copco No. 1 and Iron Gate reservoirs[229] would still occur such that release of stored sediment during reservoir drawdown could still impact water intake pumps downstream from Iron Gate Dam (Potential Impact 3.8-3). Implementation of Mitigation Measure WSWR-1 would be required to result in no significant impact.

The City of Yreka's municipal water supply pipeline would still need to be relocated following drawdown of Iron Gate Reservoir, and there would still be potential for disruption to the City's water supply. Implementation of Mitigation Measure WSWR-2 would reduce this potential impact to less than significant.

[229] Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1 Reservoir that would subsequently be released downstream once drawdown begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

4.6.9 Air Quality

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes removing the existing fish ladder and installing a new fish ladder. Although this would be less construction than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts to air quality in California. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. Like the Proposed Project, due to the potential for the emissions generated from construction activity in Oregon to have air quality impacts in Siskiyou County, California, the emissions from construction activity in Oregon are conservatively included in the estimate of total emissions due to construction activity under this alternative. In California, construction activities at Copco No. 1, Copco No. 2, and Iron Gate dams would occur under the Three Dam Removal Alternative in the same manner as under the Proposed Project. Thus, overall the detailed discussion of impacts to air quality provided in the Proposed Project also applies to this alternative (see also Appendix N). Note that the magnitude of estimated emissions due to J.C. Boyle Dam and Powerhouse deconstruction is relatively low compared with the other three dam complexes, such that reducing this estimate for a lesser degree of construction under the Three Dam Removal Alternative would not change the expectation that emissions would exceed the Siskiyou County Air Pollution Control District emissions thresholds (see Table 3.9-5). Thus, potential air quality impacts due to construction activities under the Three Dam Removal Alternative would be the same as those described for the Proposed Project (Potential Impacts 3.9-1 through 3.9-5). Like the Proposed Project, construction activities occurring under the Three Dam Removal Alternative would exceed the Siskiyou County Air Pollution Control District emissions thresholds for NO_x, PM_{10}, and $PM_{2.5}$ and would result in a significant and unavoidable impact.

4.6.10 Greenhouse Gas Emissions

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes removing the existing fish ladder and installing a new fish ladder. Although this would be less construction than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts due to GHG emissions in California. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. As with the Proposed Project, due to the cumulative nature of GHG emissions, the emissions from construction activity in Oregon are conservatively included in the estimate of total emissions due to construction activity under this alternative. In California, construction activities at Copco No. 1, Copco No. 2, and Iron Gate dams would still occur and this, combined with lesser degree of construction activities in Oregon, means that the detailed discussion of impacts to greenhouse gases provided in the Proposed Project (Potential Impact 3.10-1) also applies to this alternative, albeit with slightly lower overall GHG emissions. Leaving J.C. Boyle Dam in place and lowering overall construction-related emissions relative to the Proposed Project would not change the potential for a conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse

gases (Potential Impact 3.10-2). Overall, Three Dam Removal Alternative would result in no significant impacts due to greenhouse gas emissions.

4.6.11 Geology, Soils, and Mineral Resources

For the reasons discussed below, the Three Dam Removal Alternative would have similar effects on geology, soils, and mineral resources in California as would the Proposed Project (Section 3.11 *Geology, Soils, and Mineral Resources*), with minor differences discussed at the end of this section. Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes construction of a new fish ladder at J.C. Boyle Dam (and removal of the existing one within a similar footprint to the existing ladder). If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. While there would potentially be less construction activities resulting in short-term soil disturbance under this alternative than under the Proposed Project, the relative decrease in construction activities under the Three Dam Removal Alternative would not change the potential for impacts due to geologic hazards, short-term soil disturbance, hillslope instability, earthen dam embankment instability, or loss of mineral resources in California since J.C. Boyle is located in Oregon.

In California, potential impacts under the Three Dam Removal Alternative would be due to removal and reservoir drawdown activities at Copco No. 1, Copco No. 2, and Iron Gate dams and associated facilities in California. Thus, there would be no significant impacts due to potential for changes to geologic hazards, short-term soil disturbance, earthen dam embankment instability, and mineral resource availability under the Three Dam Removal Alternative for the reasons described for the Proposed Project (Potential Impacts 3.11-1, 3.11-2, 3.11-4 and 3.11-8).

For the reasons described for the Proposed Project, Implementation of Mitigation Measure GEO-1 would be necessary to reduce the potential impacts resulting from slope failure in reservoir rim areas at Copco No. 1 Reservoir (see Potential Impact 3.11-3). With implementation of Mitigation Measure GEO-1, there would be no significant impacts due to the potential for hillslope instability at Copco No. 1 Reservoir during drawdown and the year following drawdown.

Under the Three Dam Removal Alternative, J.C. Boyle Dam would remain in place and none of the associated 1,190,000 cubic yards of reservoir sediment deposits (eight percent of total volume for the Lower Klamath Project reservoirs, see also Tables 2.7-7 and 2.7-8) would be eroded or delivered to downstream reaches. The latter would reduce associated short-term erosion and sediment delivery impacts (i.e., sedimentation and bank erosion downstream of Iron Gate Reservoir) that would occur under the Proposed Project, given the relatively smaller volume of sediments in J.C. Boyle Reservoir compared with Copco No. 1 and Iron Gate reservoirs. However, the effect would be relatively small since mobilization of reservoir sediment deposits in the much larger Copco No. 1 and Iron Gate reservoirs[230] would still occur. Therefore, potential

[230] Copco No. 2 Dam does not retain appreciable amounts of sediment (USBR 2011b), nor is it likely to accumulate large sediment deposits during drawdown of the upstream Copco No. 1

short-term erosion and sediment delivery impacts under the Three Dam Removal Alternative would be the same as those described for the Proposed Project (Potential Impacts 3.11-5 through 3.11-7) and there would be no significant impacts, with the exception of the Middle Klamath River between Iron Gate Dam and Cottonwood Creek where there would be a significant and unavoidable impact (see Potential Impact 3.11-5). In the long term, J.C. Boyle Reservoir would continue accumulating sediment at approximately the rate that it does under existing conditions, which is generally low (see Table 3.11-6).

4.6.12 Historical Resources and Tribal Cultural Resources

Leaving the J.C. Boyle Dam and associated facilities in place would reduce construction activities related to dam removal relative to the Proposed Project; however, it would not decrease the degree of construction activities or the associated impacts to historical and tribal cultural resources in California since J.C. Boyle is located in Oregon. Unlike under the Proposed Project, reservoir drawdown associated with the removal of J.C. Boyle Dam would not occur under the Three Dam Removal Alternative. However, as discussed in Potential Impact 3.12-3, drawdown releases from J.C. Boyle Dam under the Proposed Project would not cause flooding of the river between the dam and Copco No. 1 Reservoir and would not result in short-term erosion or flood disturbance to the numerous prehistoric archaeological riverside sites with habitation debris, house pits and rock features and cemeteries; as well as ethnographic places and other features of the cultural landscape that have been identified as TCRs along this reach of the Klamath River (PacifiCorp 2004, Daniels 2006). Therefore, leaving J.C. Boyle Dam in place under the Three Dam Removal Alternative would have no bearing on the potential for impacts to known or unknown historical and/or tribal cultural resources within this reach and, like the Proposed Project, there would be no significant impact. The potential for flood disturbance further downstream along the Klamath River would not be different under this alternative from that described for the Proposed Project (Potential Impact 3.12-3) since Copco No. 1, Copco No. 2, and Iron Gate dams would still be removed.

As Copco No. 1, Copco No. 2, and Iron Gate dams would be removed under this alternative as described for the Proposed Project, other potential impacts to tribal cultural resources (Potential Impacts 3.12-1, 3.12-2, 3.12-4 through 3.12-8) and the built environment and historic-period archaeological resources (Potential Impacts 3.12-11 through 3.12-16) and would be the same as those described for the Proposed Project. Implementation of Mitigation Measures TCR-1 through TCR-8 would be required to reduce impacts to tribal cultural resources, but the impacts would remain significant and unavoidable.

There would be approximately 18.5 miles of additional riverine habitat that would become available for salmonids under this alternative (not including 3.5 miles of riverine habitat that would remain inundated by J.C. Boyle Reservoir). The additional habitat, combined with a reduced incidence of fish disease and parasites in the Klamath River under this alternative (see Section 4.6.3.4 *Fish Disease and Parasites*), would improve conditions for the Klamath Cultural Riverscape related to fisheries (Potential Impact 3.12-9) relative to existing conditions. This would be a beneficial effect. Reductions in blue-green algae concentrations under this alternative (see Section 4.6.2.6 *Chlorophyll-a*

Reservoir that would subsequently be released downstream once drawdown begins (see also Section 2.7.3 *Reservoir Sediment Deposits and Erosion During Drawdown*).

and Algal Toxins) would support Cultural Use of Klamath River waters without risk of adverse health effects, which would improve tribal members' access to the river above levels occurring under existing conditions (Potential Impact 3.12-10) and would be a beneficial effect.

4.6.13 Paleontologic Resources

For the reasons described under Proposed Project, there could be instances of bank erosion and slope failures in the Middle Klamath River due to changes in river discharge should the Copco No. 1, Copco No. 2, and Iron Gate dams be removed (Potential Impact 3.13-1). However, the magnitude of this bank erosion would not be substantial compared to existing conditions and there would be a low likelihood that downcutting or erosion of the Hornbrook Formation located downstream of Iron Gate Dam would occur to a greater degree than existing conditions. Because of its small size (2,267 acre-feet total storage; see Table 3.6-4) and because it is not operated by PacifiCorp as a flood control reservoir, retaining J.C. Boyle Reservoir under this alternative would not affect the likelihood of downcutting or erosion relative to existing conditions or the Proposed Project. For these reasons, and given the formation's Low Paleontologic Potential (Potential Impact 3.13-1), there would be no significant impact to paleontologic resources under the Three Dam Removal Alternative.

4.6.14 Land Use and Planning

Under the Three Dam Removal Alternative, the impacts on land use and planning in California would be the same as those described for the Proposed Project in Section 3.14.5 *[Land use and Planning] Potential Impacts and Mitigation*. Because long-term land use under this alternative is currently unknown, this alternative does not assess the potential impacts of long-term use of the lands currently submerged under Iron Gate and Copco No. 1 reservoirs as that would require speculation. The California dam removal actions would occur in the same manner under both the Three Dam Removal Alternative and under the Proposed Project. Maintaining or removing J.C. Boyle Dam 20 miles upstream in Oregon would not have an impact on California land use or planning.

4.6.15 Agriculture and Forestry Resources

The potential for impacts on agriculture and forestry resources in California under the Three Dam Removal Alternative would be the same as described for the Proposed Project because retaining J.C. Boyle Dam would not change or result in the conversion of any California land use relating to agriculture or forestry. In addition, the issues relating to agricultural water in the Lower Klamath Project area would be the same regardless of whether J.C. Boyle Dam remains in place or is removed. Therefore, under the Three Dam Removal Alternative, potential impacts on agriculture and forestry resources would be the same as those of the Proposed Project and there would be no significant impacts (Potential Impacts 3.15-1 through 3.15-3).

4.6.16 Population and Housing

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes removing the existing fish ladder and installing a new fish ladder. If instead of fish ladders, trap and haul or some combination

of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. Although there would be less construction for fish passage than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated California impacts to population and housing that are described for the Proposed Project (Potential Impacts 3.16-1 and 3.16-2). Like the Proposed Project, the Three Dam Removal Alternative would not result in a substantial influx of population (Potential Impact 3.16-1), nor would there be a need to displace existing residents or build replacement housing elsewhere (Potential Impact 3.16-2), and there would be no significant population and housing impacts.

4.6.17 Public Services

Overall, under the Three Dam Removal Alternative, potential impacts on public services in California would be the same as those described for the Proposed Project. The California dam removal actions would occur in the same manner under both the Three Dam Removal Alternative and under the Proposed Project. Thus, for reasons described in Section 3.17.5 *[Public Services] Potential Impacts and Mitigation*, impacts and associated mitigation measures from increased public service response times for emergency fire, police, and medical services due to construction and demolition activities, elimination of a long-term water source for wildfire services substantially increasing the response time for suppressing wildfires, and potential effects on schools services and facilities would be the same under the Three Dam Removal Alternative as those described for the Proposed Project (Potential Impacts 3.5-1 through 3.5-3).

4.6.18 Utilities and Service Systems

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes removing the existing fish ladder and installing a new fish ladder. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. Although there would be less construction for fish passage than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts to public services in California since J.C. Boyle is in Oregon. Thus, potential construction-related impacts to utilities and service systems would be the same as described for the Proposed Project (Potential Impacts 3.18-1 through 3.18-4). There would be no significant impacts on utilities and service systems related to this degree of construction for the Proposed Project, and construction is the only part of the proposed activities that merits analysis for potential impacts on utilities and service systems. Construction-related activity in California would still require the need for onsite wastewater treatment, stormwater drainage, and/or solid waste disposal facilities at the same level as the Proposed Project (Potential Impacts 3.18-1 through 3.18-4) and would result in no significant impacts.

4.6.19 Aesthetics

Under the Three Dam Removal Alternative, the aesthetic impacts would be the same as described for the Proposed Project (Section 3.19). The California dam removal actions would occur in the same manner under both the Three Dam Removal Alternative and

the Proposed Project. Although the level of overall construction activities due to dam deconstruction in California and construction of upstream and downstream fish passage in Oregon under the Three Dam Removal Alternative would be less than that of the Proposed Project, construction-related activities at J.C. Boyle Dam, which is located 20 miles upstream of the Oregon-California state line, would not affect California aesthetics.

For the reasons described in Section 3.19.5 *[Aesthetics] Potential Impacts and Mitigation*, under the Three Dam Removal Alternative, short-term and long-term impacts on aesthetic resources in California, including a loss of open water and lake vistas in favor of more natural river, canyon, and valley vistas (Potential Impact 3.19-1) and changes in river flows, channel morphology, and visual water quality (Potential Impacts 3.19-2 and 3.19-3) would be the same as those of the Proposed Project, since Copco No. 1, Copco No. 2, and Iron Gate reservoirs would be removed, and there would be no significant impacts. Visual changes resulting from drawdown of Copco No.1, Copco No. 2 and Iron Gate reservoirs would be significant and unavoidable in the short term and would have no significant impact in the long term (Potential Impact 3.19-4). Visual changes due to removal of the California dams and facilities and improvements to or construction of new infrastructure (Potential Impact 3.19-5), and construction activities (Potential Impact 3.19-6) would also be the same as those of the Proposed Project since the manner of dam deconstruction would be the same under the Three Dam Removal Alternative. Impacts from construction lighting would still be significant and unavoidable as under the Proposed Project (Potential Impact 3.19-7).

4.6.20 Recreation

Under the Three Dam Removal Alternative, short-term construction-related activities would occur at Copco No. 1, Copco No. 2 and Iron Gate dams and associated facilities and would be lower than those described for the Proposed Project (Potential Impact 3.20-1). For the reasons described in Potential Impact 3.20-1, there would be no significant impact on recreation from the Three Dam Removal Alternative. Recreational facilities associated with Copco No. 1 and Iron Gate reservoirs would still be subject to closure and reservoir-related recreation would still increase the use of other regional recreational facilities and/or would be replaced with river-related recreation; however as with the Proposed Project there would be no significant impacts (Potential Impacts 3.20-2 and 3.20-3). Under the Three Dam Removal Alternative, all portions of the existing recreational facilities at J.C. Boyle Reservoir (Pioneer Park, Topsy Campground, Spring Island River Access) would remain in place under this alternative, offering more regional boating and fishing recreational opportunities relative to the Proposed Project. Elimination of peaking operations and higher baseflows under this alternative may increase the appeal of J.C. Boyle Reservoir recreational sites due to elimination of regular reservoir water level fluctuations and increased low flows in the Hydroelectric Reach.

While the Three Dam Removal Alternative would not remove J.C. Boyle Reservoir, it also would increase minimum flows in the Bypass Reach and would not include peaking power generation or release of flows for recreation at J.C. Boyle Dam. Since there would be no recreational flows in the Hydroelectric Reach under this alternative, and flows in the Hydroelectric Reach would be similar to those under the Proposed Project, the loss of whitewater boating opportunities in the Hell's Corner Reach (within the upper portion of the Hydroelectric Reach) would be the same as the Proposed Project

(Potential Impact 3.20-5) and would be significant and unavoidable. There would be no significant impact in the Middle and Lower Klamath River.

Under the Three Dam Removal Alternative, removal of Copco No. 1, Copco No. 2 and Iron Gate dams and construction of upstream and downstream fish passage at J.C. Boyle Dam would beneficially affect recreational fishing of anadromous fish (Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout) throughout the Hydroelectric Reach in California, as described for the Proposed Project (Potential Impact 3.20-6). The primary difference under the Three Dam Removal Alternative is that approximately 3.5 miles of aquatic habitat within J.C. Boyle Reservoir would remain lentic rather than reverting to the riverine conditions described for the Proposed Project; however, this would occur in Oregon and so would not affect California recreational fishing.

The Three Dam Removal Alternative would result in the same impacts to river-based recreational facilities in the Middle Klamath River and Lower Klamath River as the Proposed Project (Potential Impact 3.20-6). Water quality improvements would be beneficial for the Hydroelectric Reach, the Middle Klamath River downstream of Humbug Creek (RM 174.3), and the Lower Klamath River. With respect to potential flooding impacts to existing river-based recreational facilities, maintaining J.C. Boyle Reservoir would not affect flood hydrology, relative to Proposed Project or to existing conditions, in the Hydroelectric Reach or further downstream Middle Klamath River and Lower Klamath River (see also Section 4.6.6 *Flood Hydrology*). As under the Proposed Project, there would be little to no change to the 100-year floodplain extent in the Klamath River and Lower Klamath River, with the exception of the reach along the Middle Klamath River from Iron Gate Dam (RM 193.1) to the confluence with Humbug Creek (RM 174.0), where the 100-year floodplain extent would change slightly due to removal of the California Lower Klamath Project dams. However, the slightly increased potential for flooding in this reach would not represent a change or loss of a rare or unique river-based recreational facility affecting a large area or substantial number of people and therefore impacts to recreation under the Three Dam Removal Alternative would be the same as those described for the Proposed Project (Potential Impact 3.20-6) and would be less than significant.

4.6.21 Hazards and Hazardous Materials

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes removing the existing fish ladder and installing a new fish ladder. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. Although there would be less construction for fish passage than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts due to hazards and hazardous materials since J.C. Boyle is in Oregon. Construction activities in Oregon under this alternative would not change the hazards and hazardous materials analysis for California because the transport, use, and disposal of general construction waste materials (e.g., concrete, rebar, building waste, power lines) associated with J.C. Boyle Dam removal and fish passage construction, as well as construction-related activities that could result in the accidental release of hazardous materials to the environment, would occur in Oregon. Potential construction-

related impacts would be the same as those of the Proposed Project (Potential Impacts 3.21-1, 3.21-2, 3.21-4, and 3.21-7) and would be significant. Implementation of Mitigation Measure HZ-1 would result in no significant impacts for these construction-related impacts. With respect to removal of the Lower Klamath Project reservoirs as a readily available source of water for helicopter fire suppression crews fighting local fires, the two largest reservoirs (Copco No. 1 and Iron Gate) would still be removed under this alternative, which would substantially increase the public's risk of loss, injury or death associated with wildfires as described for the Proposed Project (Potential Impact 3.21-8). J.C. Boyle Reservoir would remain in place and would continue to serve as a relatively accessible water surface for helicopter fire suppression crews compared to the mainstem Klamath River. However, because J.C. Boyle Reservoir is approximately 20 river miles upstream of Copco No. 1 Reservoir and has a relatively small surface area (approximately 350 acres versus 942 acres [Iron Gate Reservoir] and 972 acres [Copco No. 1 Reservoir], see also Table 2.3-1), response and travel times between water fills would still be increased over existing conditions and the Proposed Project for helicopter crews to fly to J.C. Boyle Reservoir for water pick up. Thus, the Three Dam Removal Alternative would result in a substantial increased public risk of loss, injury, or death involving wildland fires due to increased response and travel times relative to existing conditions and would be a significant impact.

4.6.22 Transportation and Traffic

Relative to the Proposed Project, leaving the J.C. Boyle Dam and associated facilities in place would reduce overall construction activities related to dam removal. However, the Three Dam Removal Alternative also includes removing the existing fish ladder and installing a new fish ladder. If instead of fish ladders, trap and haul or some combination of fish passage methods were used, the level of construction activities at J.C. Boyle would be further reduced relative to the Proposed Project. Although there would be less construction for fish passage than removing the dam and associated facilities, this difference would not meaningfully decrease the degree of construction activities or the associated impacts to traffic and transportation since J.C. Boyle is in Oregon. Note that J.C. Boyle Dam-associated vehicle trips are included in the analysis of the Proposed Project as some of the construction-related traffic flow may use roads in California (e.g., I-5 to OR 66). As described in Section 3.22.5 *[Transportation and Traffic] Potential Impacts and Mitigation*, the Proposed Project would result in significant and unavoidable short-term impacts to traffic flow, road safety, road conditions, emergency access, public transit, and non-motorized transportation, unless and until KRRC reaches enforceable 'good citizen' agreements that are finalized and implemented through the FERC process and that include proposed items for the final TMP and Emergency Response Plan (Appendix B: *Definite Plan − Appendices O1 through O4*), as well as the additional components included in Recommended Measure TR-1 (Potential Impacts 3.22-1 through 3.22-5). As described for the Proposed Project, the Lower Klamath Project dams are not located within two miles of an airport nor would their removal result in a change in air traffic patterns that would result in a substantial safety risks, regardless of whether J.C. Boyle Dam remains place, and there would be no significant impact (Potential Impact 3.22-6).

4.6.23 Noise

The level of overall construction activities due to dam deconstruction in California and construction of upstream and downstream fish passage in Oregon under the Three Dam Removal Alternative would be the same as those described for the Proposed Project. Whether J.C. Boyle Dam remains or is removed would not affect noise impacts within the Proposed Project Area of Analysis due to J.C. Boyle Dam's location in Oregon, approximately 20 miles upstream of the Oregon-California state line. For the reasons described in Section 3.23.5 *[Noise] Potential Impacts and Mitigation Measures*, removal of Copco No. 1, Copco No. 2, and Iron Gate dams would result in noise and vibration that will affect sensitive receptors and exceed Siskiyou County General Plan standards under this alternative. Significant and unavoidable adverse environmental impacts would result from: construction equipment exceeding maximum allowable noise levels (Potential Impact 3.23-1); noise disturbance to residents from construction-generated noise at Copco No. 1 and Iron Gate dams (Potential Impacts 3.23-2 and 3.23-4), reservoir restoration at Copco No.1 and Iron Gate dams (Potential Impact 3.23-5); and vibration disturbance from blasting activities at Copco No. 1, Copco No. 2, and Iron Gate dams (Potential Impact 3.23-6). Other noise and vibration generation from the Three Dam Removal Alternative would not have a significant adverse impact (Section 3.23-5 *[Noise] Potential Impacts and Mitigation*).