Appendix 2D

Attachment 1: Technical Memorandum: DRAFT Upstream Screening-Level Analysis for Fish and Aquatic Resources, Long-Term Operations of the State Water Project

Date:	May 2024
To:	California Department of Water Resources
From:	ICF
Subject:	**DRAFT Upstream Screening-Level Analysis for Fish and Aquatic Resources, Long-Term Operations of the State Water Project**

2D-1.1 Introduction

This technical memorandum provides a screening-level analysis of CalSim 3 results in the Feather River upstream of the Sacramento–San Joaquin Delta (Delta) for potential effects on fish and aquatic resources to support the scope of analysis used for Chapter 6, "Aquatic Biological Resources," in the Environmental Impact Report for Long-Term Operations of the State Water Project. General information about analysis methods is below, followed by a more detailed description of the analysis and analysis results.

2D-1.2 Modeling Approach

Outputs from the CalSim 3 operations model runs for Baseline Conditions and the Proposed Project were examined for instream flow in the Feather River Low Flow Channel (LFC) and High Flow Channel (HFC), as well as for end-of-May and end-of-September Oroville Reservoir storage. As discussed below in Section 2D-1.3, "Screening-Level Modeling Results," the results for the HFC indicated occasional larger differences (>5 percent), so further examination for potential effects on aquatic biological resources was conducted (see Attachment A, "Potential Flow Effects on Aquatic Biological Resources in the Feather River High Flow Channel").

2D-1.3 Screening-Level Modeling Results

There were predominantly negligible differences in instream flow and reservoir storage between the Proposed Project and Baseline Conditions, with the exception of some months in the HFC (Tables 2D-1-1, 2D-1-2, and 2D-1-3; Figures 2D-1-1 through 2D-1-26). Therefore, more detailed analyses of potential flow effects on aquatic biological resources in the HFC were conducted (see Attachment A). Although the analysis focused on instream flow and reservoir storage, it is important to note that the California Department of Water Resources is committed to meeting year-round water temperature targets in the Feather River LFC and HFC for salmonids as specified in the National Marine Fisheries Service Oroville Facilities Biological Opinion (National Marine Fisheries Service 2016). This applies to Baseline Conditions and the Proposed Project, so no differences in temperature-related effects on salmonids in the Feather River are expected under the Proposed Project relative to Baseline Conditions.

Table 2D-1-1. Mean Modeled Feather River Low Flow Channel Flow (cfs) under the Proposed Project and Baseline Conditions Modeling Scenarios, and Differences between the Scenarios (Proposed Project minus Baseline Conditions) Expressed as a Percentage Difference (parentheses), Grouped by Month and Water Year Type

Month	Water Year Type	Baseline Conditions	Proposed Project
October	Wet	800	800 (0%)
October	Above Normal	800	800 (0%)
October	Below Normal	800	800 (0%)
October	Dry	800	800 (0%)
October	Critically Dry	800	800 (0%)
November	Wet	800	800 (0%)
November	Above Normal	800	800 (0%)
November	Below Normal	800	800 (0%)
November	Dry	800	800 (0%)
November	Critically Dry	800	800 (0%)
December	Wet	1,239	1,252 (1%)
December	Above Normal	800	800 (0%)
December	Below Normal	800	800 (0%)
December	Dry	800	800 (0%)
December	Critically Dry	800	800 (0%)
January	Wet	2,128	2,128 (0%)
January	Above Normal	941	941 (0%)
January	Below Normal	800	800 (0%)
January	Dry	800	800 (0%)
January	Critically Dry	800	800 (0%)
February	Wet	2,290	2,287 (0%)
February	Above Normal	836	836 (0%)
February	Below Normal	800	800 (0%)

Month	Water Year Type	Baseline Conditions	Proposed Project
February	Dry	800	800 (0%)
February	Critically Dry	800	800 (0%)
March	Wet	2,445	2,445 (0%)
March	Above Normal	972	1,071 (10%)
March	Below Normal	800	800 (0%)
March	Dry	800	800 (0%)
March	Critically Dry	800	800 (0%)
April	Wet	954	954 (0%)
April	Above Normal	700	700 (0%)
April	Below Normal	700	700 (0%)
April	Dry	700	700 (0%)
April	Critically Dry	700	700 (0%)
May	Wet	1,130	1,130 (0%)
May	Above Normal	805	805 (0%)
May	Below Normal	700	700 (0%)
May	Dry	700	700 (0%)
May	Critically Dry	700	700 (0%)
June	Wet	702	702 (0%)
June	Above Normal	700	700 (0%)
June	Below Normal	700	700 (0%)
June	Dry	700	700 (0%)
June	Critically Dry	700	700 (0%)
July	Wet	700	700 (0%)
July	Above Normal	700	700 (0%)
July	Below Normal	700	700 (0%)
July	Dry	700	700 (0%)
July	Critically Dry	700	700 (0%)
August	Wet	700	700 (0%)
August	Above Normal	700	700 (0%)
August	Below Normal	700	700 (0%)
August	Dry	700	700 (0%)
August	Critically Dry	700	700 (0%)
September	Wet	773	773 (0%)
September	Above Normal	773	773 (0%)
September	Below Normal	773	773 (0%)
September	Dry	773	773 (0%)
September	Critically Dry	773	773 (0%)

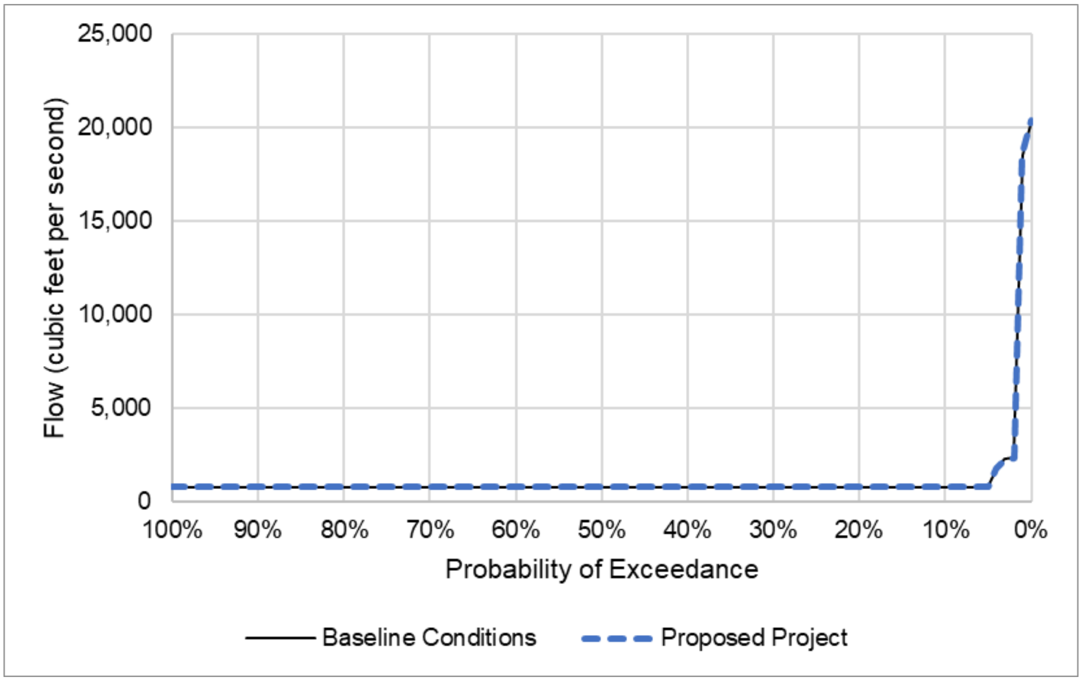
Table 2D-1-2. Mean Modeled Feather River High Flow Channel Flow (cfs) under the Proposed Project and Baseline Conditions Modeling Scenarios, and Differences between the Scenarios (Proposed Project minus Baseline Conditions) Expressed as a Percentage Difference (parentheses), Grouped by Month and Water Year Type

Month	Water Year Type	Baseline Conditions	Proposed Project
October	Wet	2,662	2,592 (-3%)
October	Above Normal	2,163	2,191 (1%)
October	Below Normal	2,790	2,677 (-4%)
October	Dry	2,329	2,326 (0%)
October	Critically Dry	1,590	1,613 (1%)
November	Wet	2,624	2,575 (-2%)
November	Above Normal	1,510	1,510 (0%)
November	Below Normal	1,721	1,649 (-4%)
November	Dry	1,537	1,548 (1%)
November	Critically Dry	1,073	1,085 (1%)
December	Wet	5,965	6,010 (1%)
December	Above Normal	1,943	1,943 (0%)
December	Below Normal	1,572	1,731 (10%)
December	Dry	1,782	1,615 (-9%)
December	Critically Dry	1,108	1,120 (1%)
January	Wet	8,835	8,834 (0%)
January	Above Normal	3,287	3,331 (1%)
January	Below Normal	1,997	1,990 (0%)
January	Dry	1,421	1,421 (0%)
January	Critically Dry	1,062	1,062 (0%)
February	Wet	12,624	12,631 (0%)
February	Above Normal	4,082	3,982 (-2%)
February	Below Normal	2,564	2,382 (-7%)
February	Dry	1,827	1,860 (2%)
February	Critically Dry	1,065	1,212 (14%)
March	Wet	13,035	13,043 (0%)
March	Above Normal	6,847	6,665 (-3%)
March	Below Normal	3,411	3,439 (1%)
March	Dry	1,447	1,447 (0%)
March	Critically Dry	1,064	1,063 (0%)
April	Wet	8,448	8,448 (0%)
April	Above Normal	3,127	3,220 (3%)
April	Below Normal	1,318	1,318 (0%)
April	Dry	1,326	1,326 (0%)
April	Critically Dry	1,719	1,694 (-1%)
May	Wet	8,440	8,440 (0%)
May	Above Normal	4,248	4,249 (0%)

Month	Water Year Type	Baseline Conditions	Proposed Project
May	Below Normal	1,932	1,645 (-15%)
May	Dry	1,565	1,567 (0%)
May	Critically Dry	979	1,017 (4%)
June	Wet	6,556	6,584 (0%)
June	Above Normal	4,885	4,775 (-2%)
June	Below Normal	3,383	3,299 (-2%)
June	Dry	4,610	4,344 (-6%)
June	Critically Dry	3,397	3,251 (-4%)
July	Wet	6,114	6,107 (0%)
July	Above Normal	8,699	8,642 (-1%)
July	Below Normal	8,904	8,768 (-2%)
July	Dry	8,388	8,349 (0%)
July	Critically Dry	3,530	3,537 (0%)
August	Wet	4,069	4,025 (-1%)
August	Above Normal	7,647	7,378 (-4%)
August	Below Normal	7,137	7,101 (-1%)
August	Dry	3,917	3,451 (-12%)
August	Critically Dry	2,335	2,369 (1%)
September	Wet	4,743	5,689 (20%)
September	Above Normal	5,859	7,267 (24%)
September	Below Normal	2,970	2,843 (-4%)
September	Dry	1,049	1,137 (8%)
September	Critically Dry	798	799 (0%)

Table 2D-1-3. Mean Modeled End-of-May and End-of-September Oroville Reservoir Storage (thousand acre-feet) under the Proposed Project and Baseline Conditions Modeling Scenarios, and Differences between the Scenarios (Proposed Project minus Baseline Conditions) Expressed as a Percentage Difference (parentheses), Grouped by Water Year Type

Month	Water Year Type	Baseline Conditions	Proposed Project
May	Wet	3,529	3,529 (0%)
May	Above Normal	3,505	3,500 (0%)
May	Below Normal	3,145	3,142 (0%)
May	Dry	2,596	2,583 (-1%)
May	Critically Dry	1,711	1,700 (-1%)
September	Wet	2,740	2,685 (-2%)
September	Above Normal	2,121	2,058 (-3%)
September	Below Normal	1,903	1,921 (1%)
September	Dry	1,511	1,539 (2%)
September	Critically Dry	1,029	1,027 (0%)



Source: <DRAFT_TrendReport_MultiCalSim_rev09_20230726.xlsx>

Figure 2D-1-1. Mean Modeled Feather River Low Flow Channel Flow, January

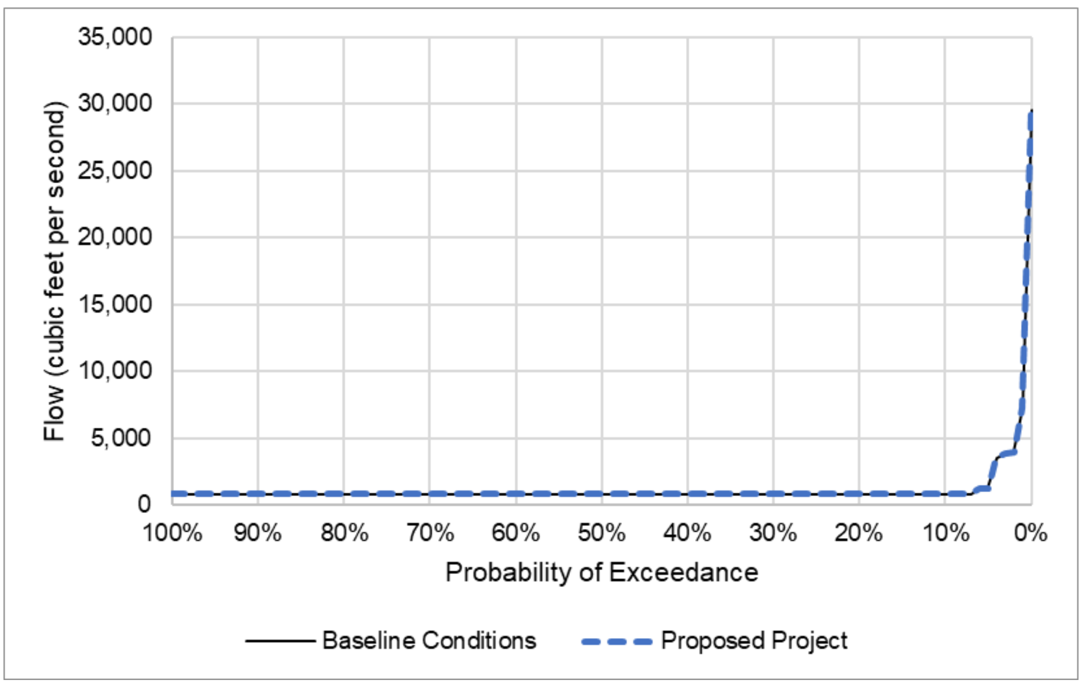


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Figure 2D-1-2. Mean Modeled Feather River Low Flow Channel Flow, February

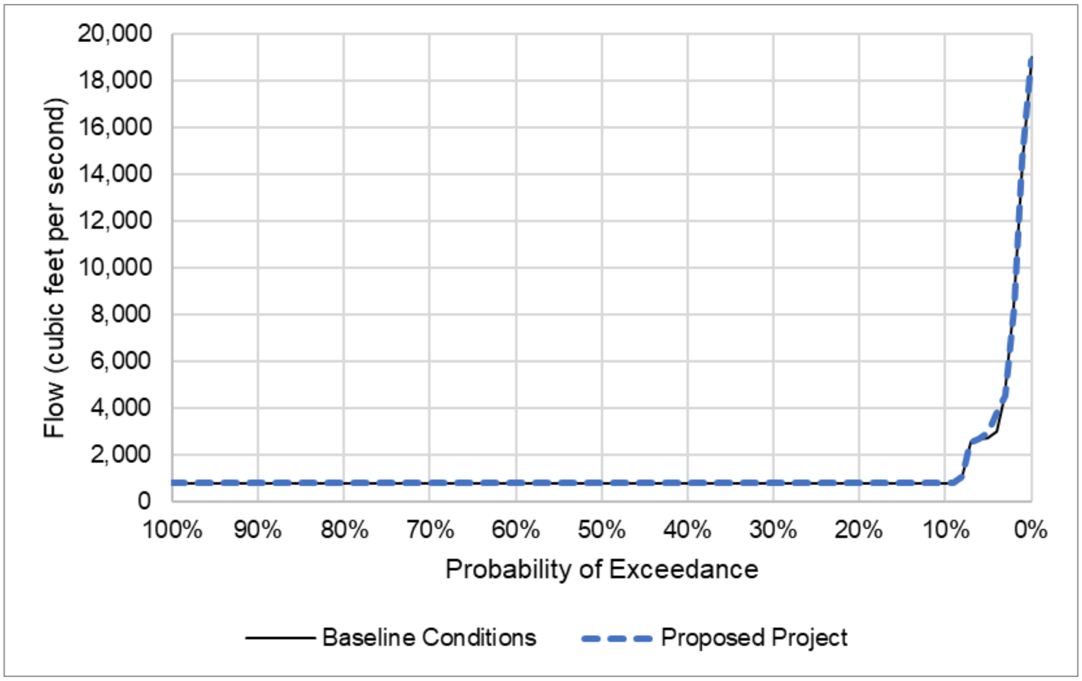

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Figure 2D-1-3. Mean Modeled Feather River Low Flow Channel Flow, March

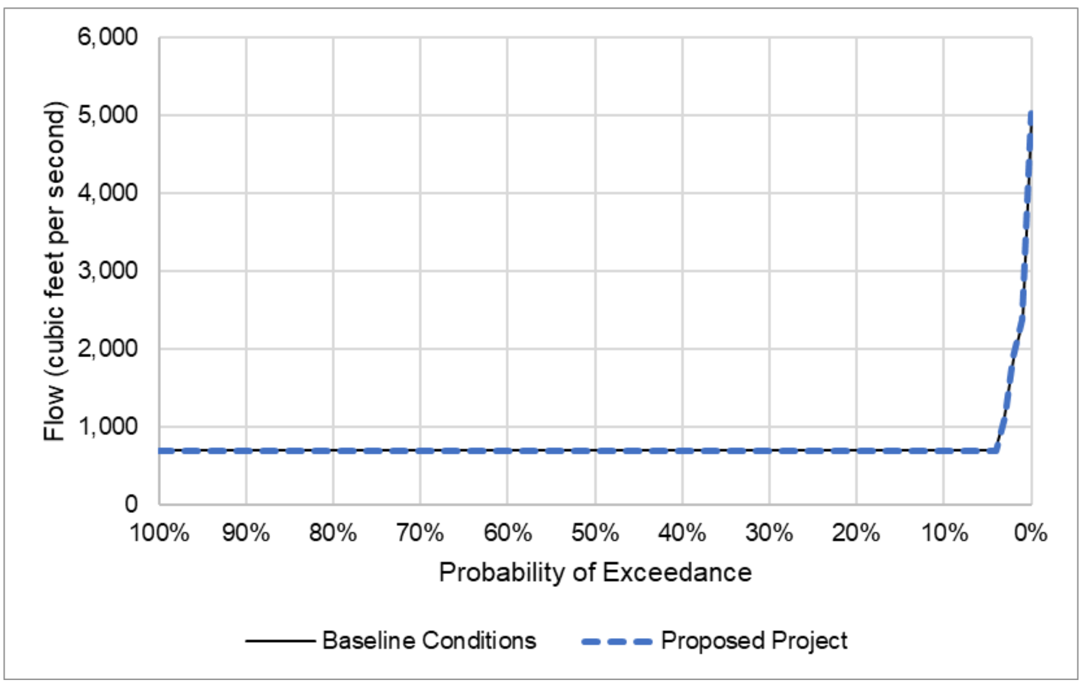

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Figure 2D-1-4. Mean Modeled Feather River Low Flow Channel Flow, April

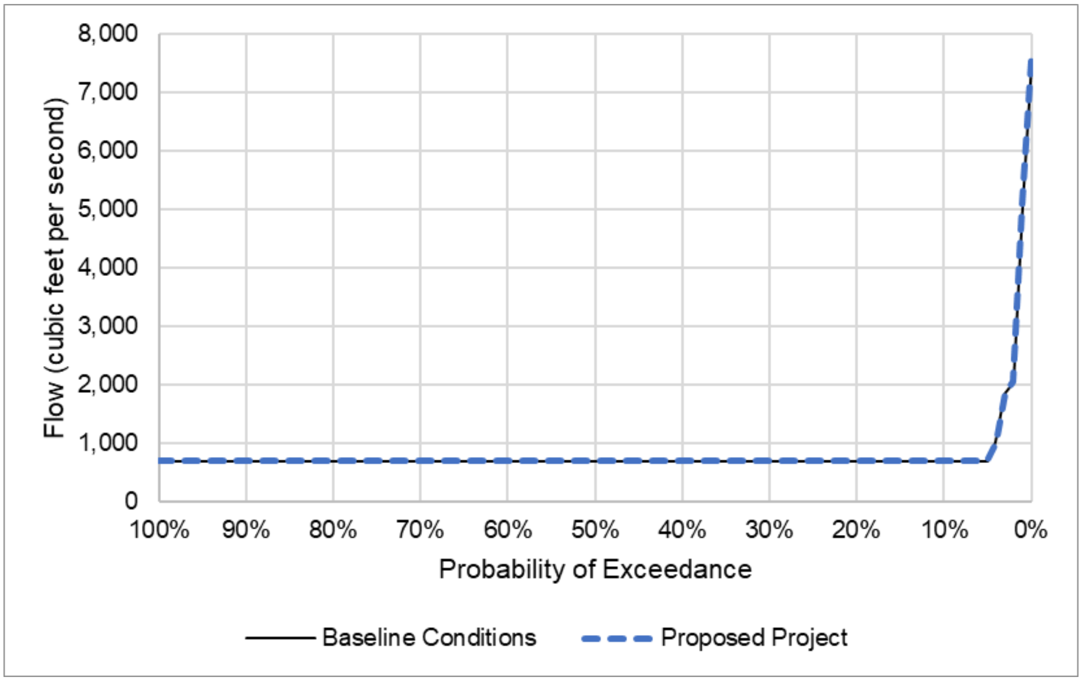

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Figure 2D-1-5. Mean Modeled Feather River Low Flow Channel Flow, May

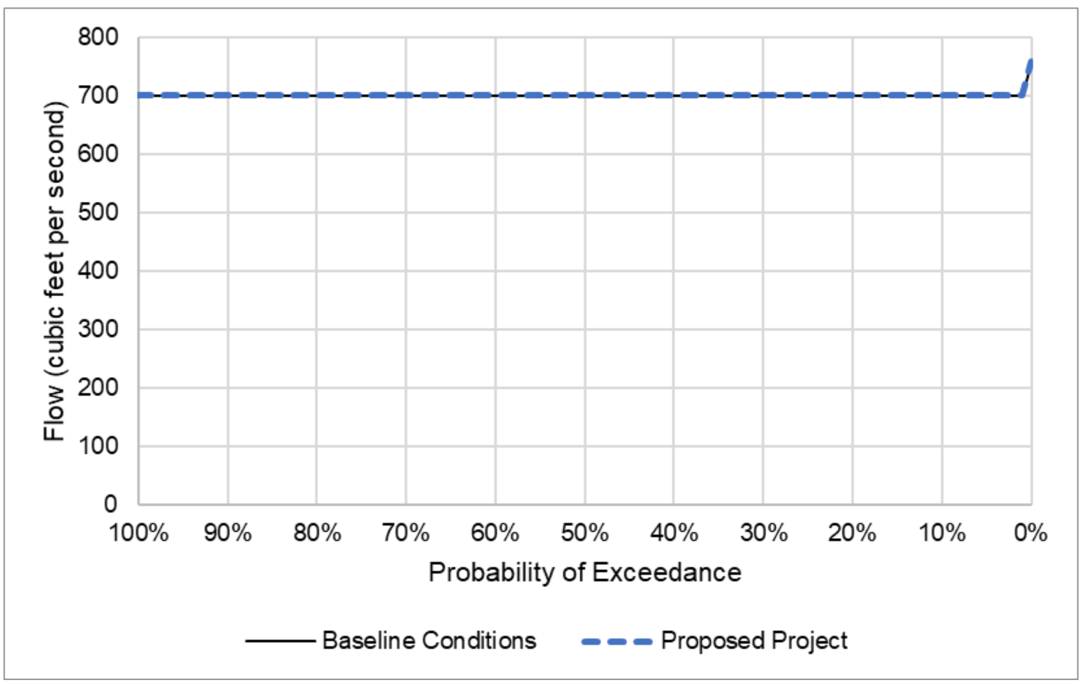

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Figure 2D-1-6. Mean Modeled Feather River Low Flow Channel Flow, June

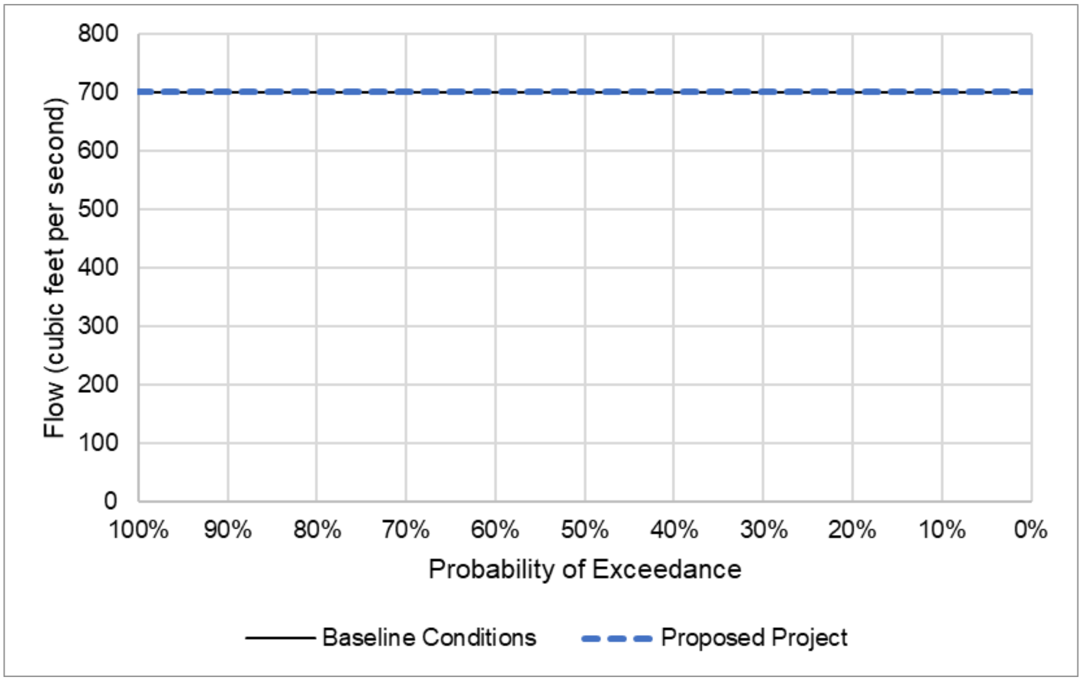

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Figure 2D-1-7. Mean Modeled Feather River Low Flow Channel Flow, July

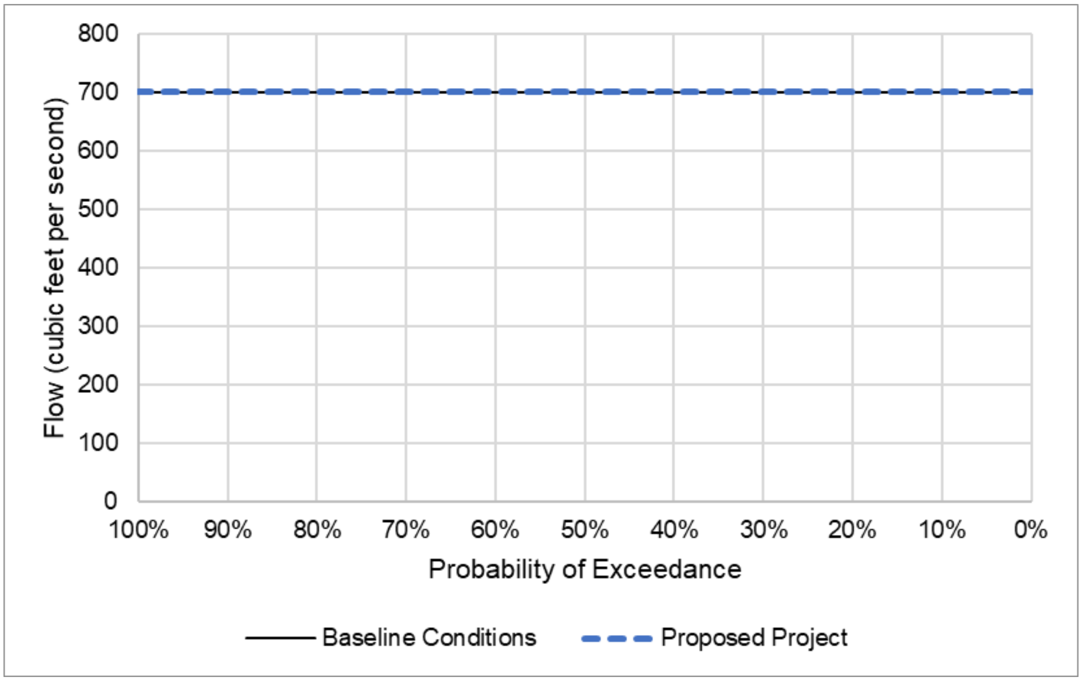

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Figure 2D-1-8. Mean Modeled Feather River Low Flow Channel Flow, August

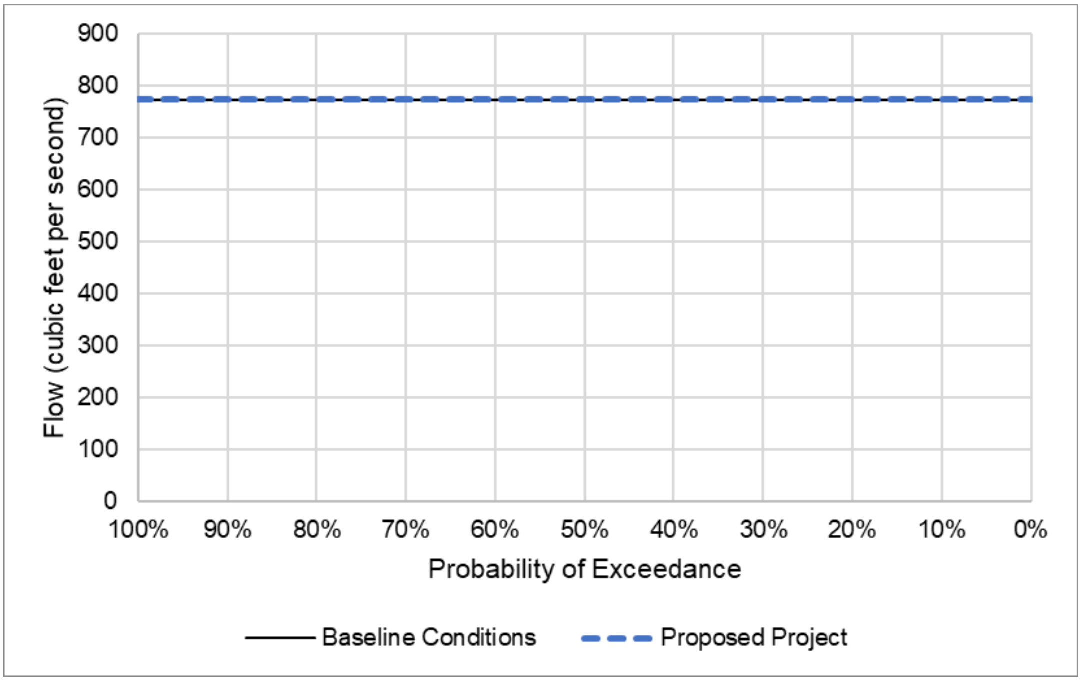

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Figure 2D-1-9. Mean Modeled Feather River Low Flow Channel Flow, September

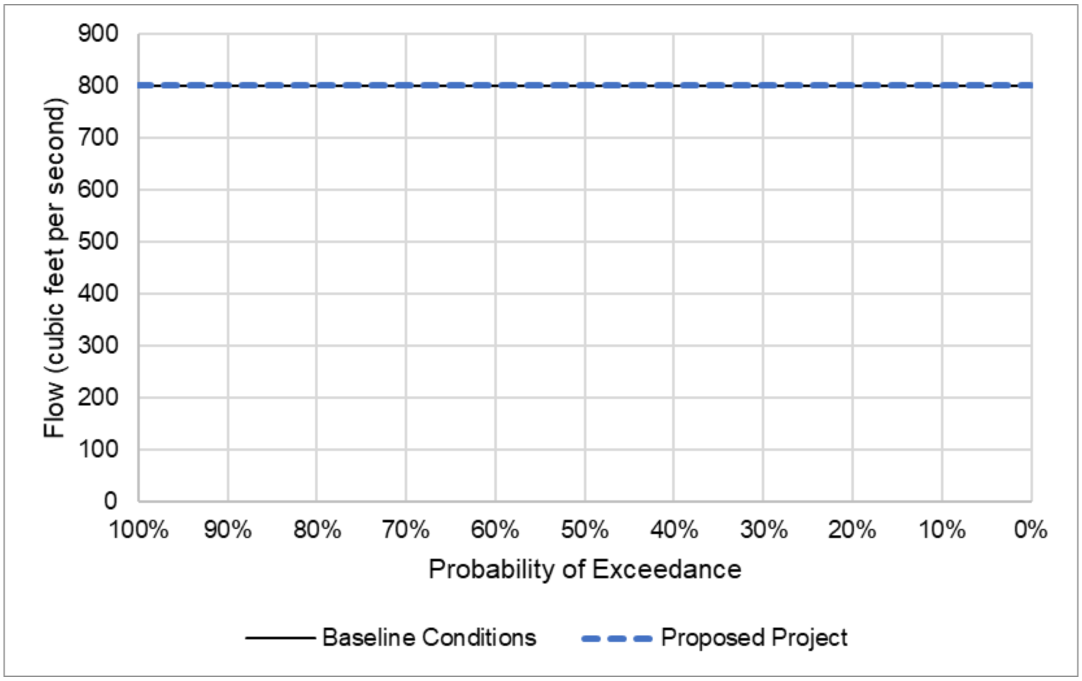

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Figure 2D-1-10. Mean Modeled Feather River Low Flow Channel Flow, October

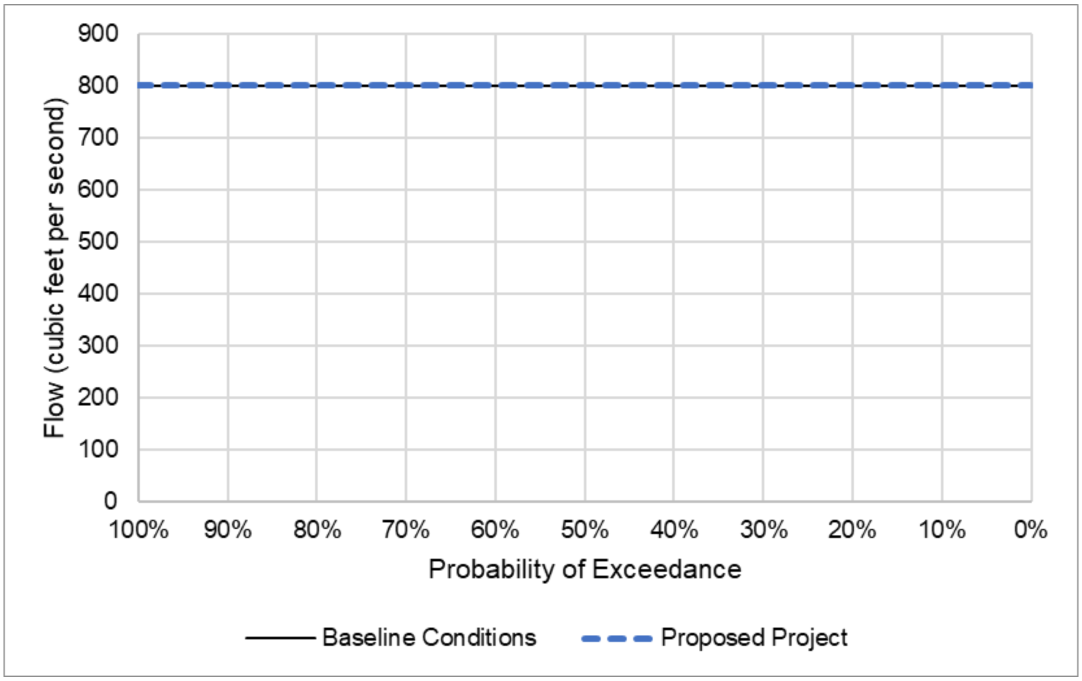

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Figure 2D-1-11. Mean Modeled Feather River Low Flow Channel Flow, November

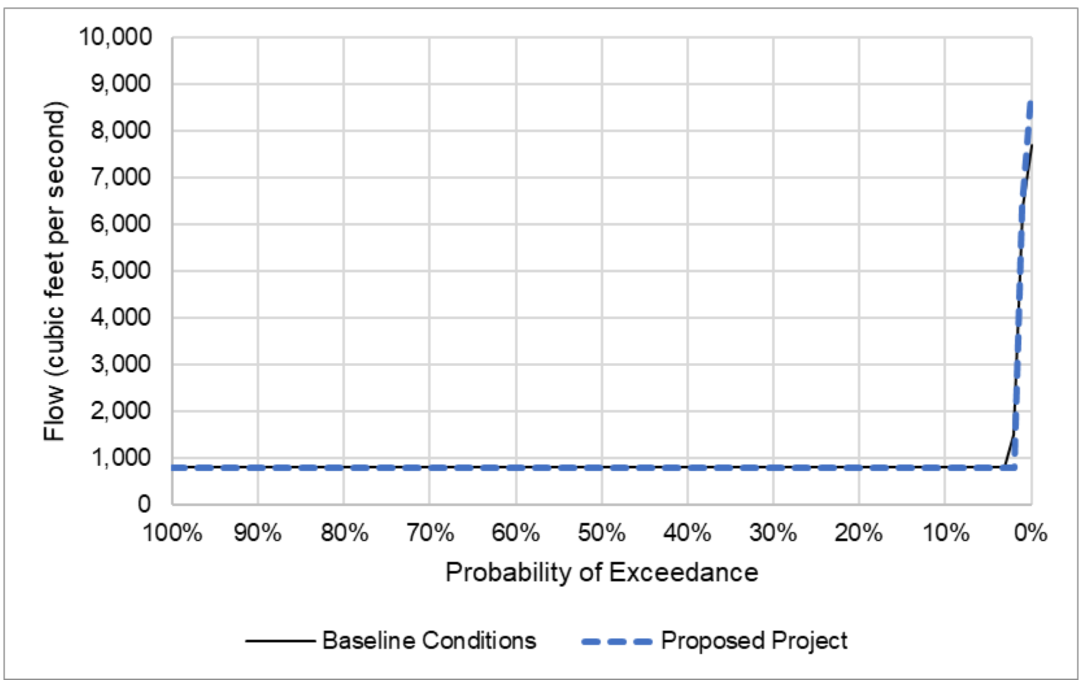

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Figure 2D-1-12. Mean Modeled Feather River Low Flow Channel Flow, December

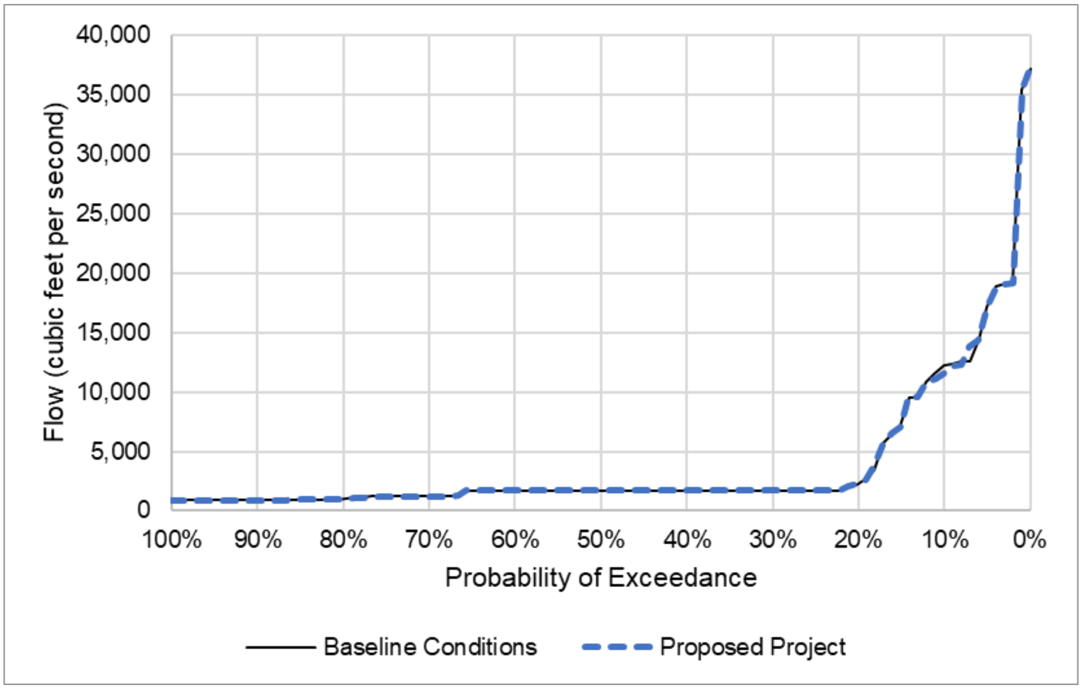

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Figure 2D-1-13. Mean Modeled Feather River High Flow Channel Flow, January

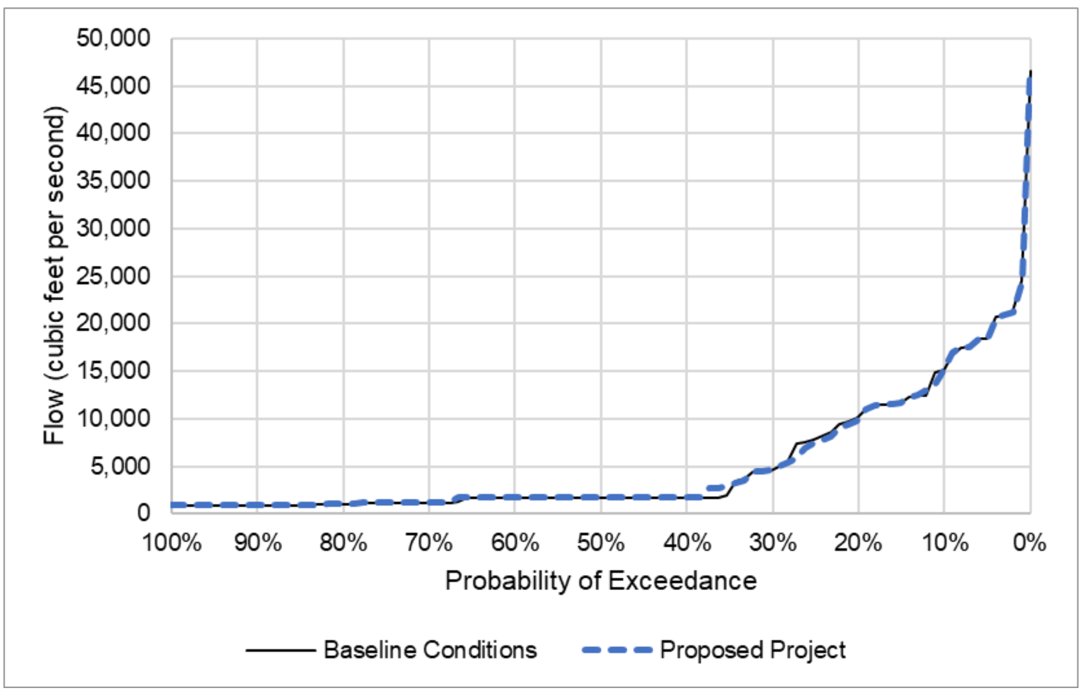

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Figure 2D-1-14. Mean Modeled Feather River High Flow Channel Flow, February

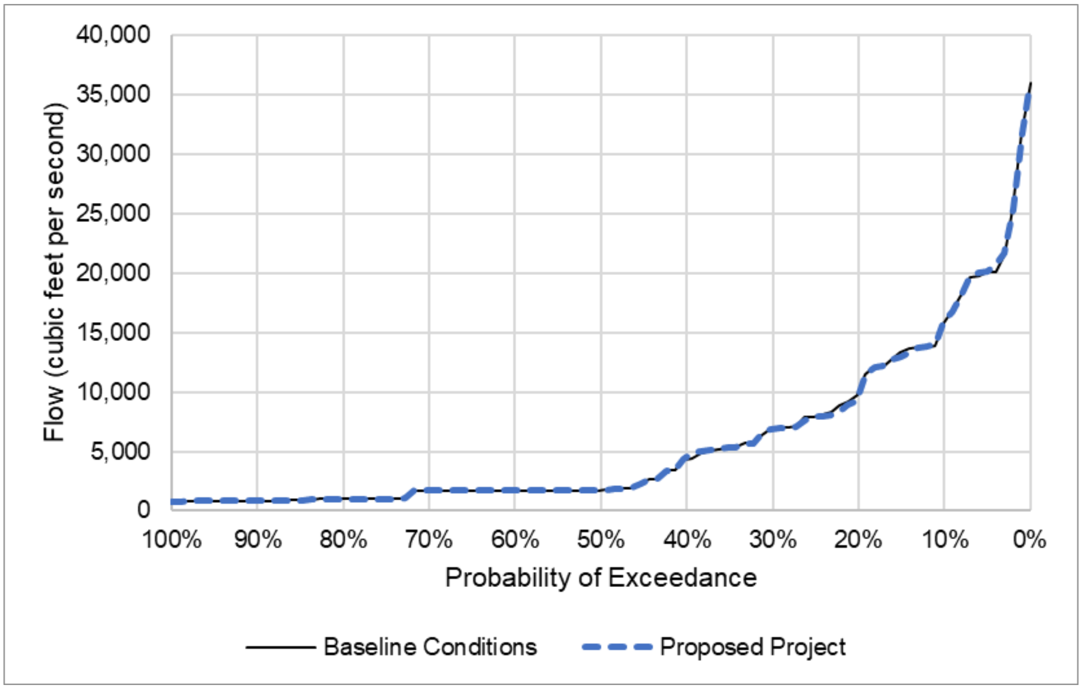

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Figure 2D-1-15. Mean Modeled Feather River High Flow Channel Flow, March

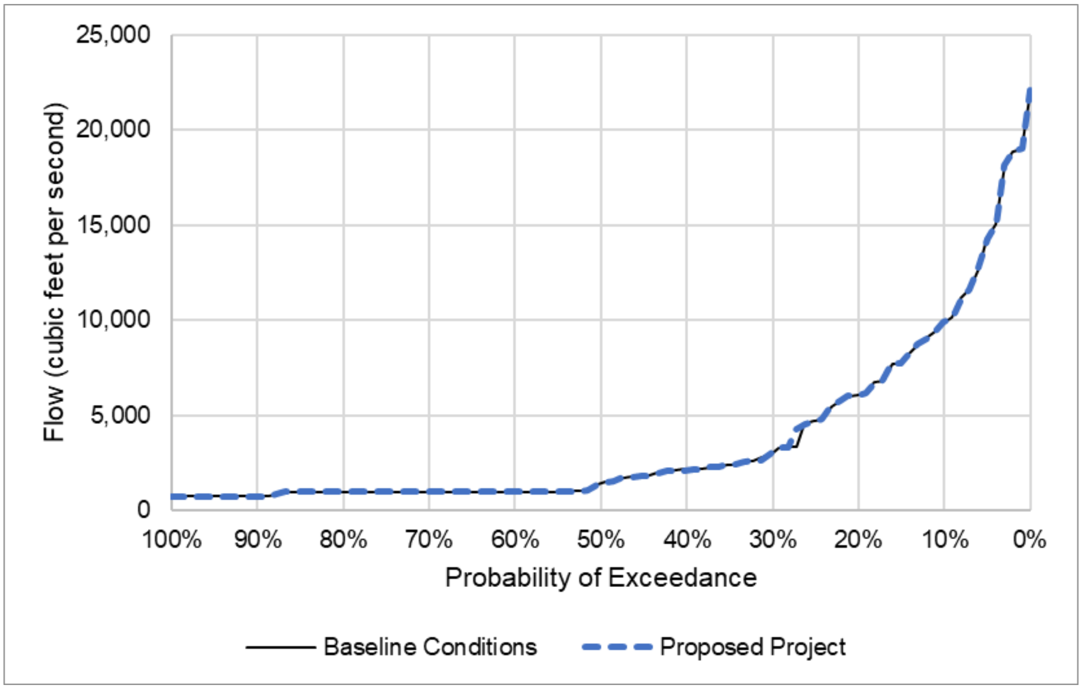

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Figure 2D-1-16. Mean Modeled Feather River High Flow Channel Flow, April

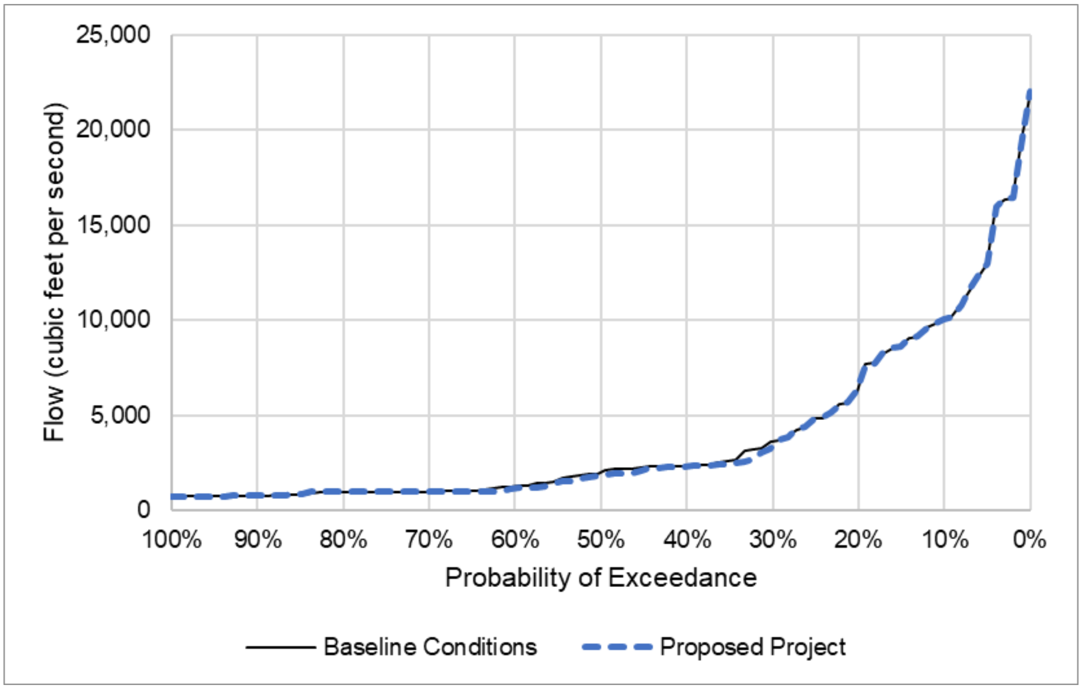

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Figure 2D-1-17. Mean Modeled Feather River High Flow Channel Flow, May

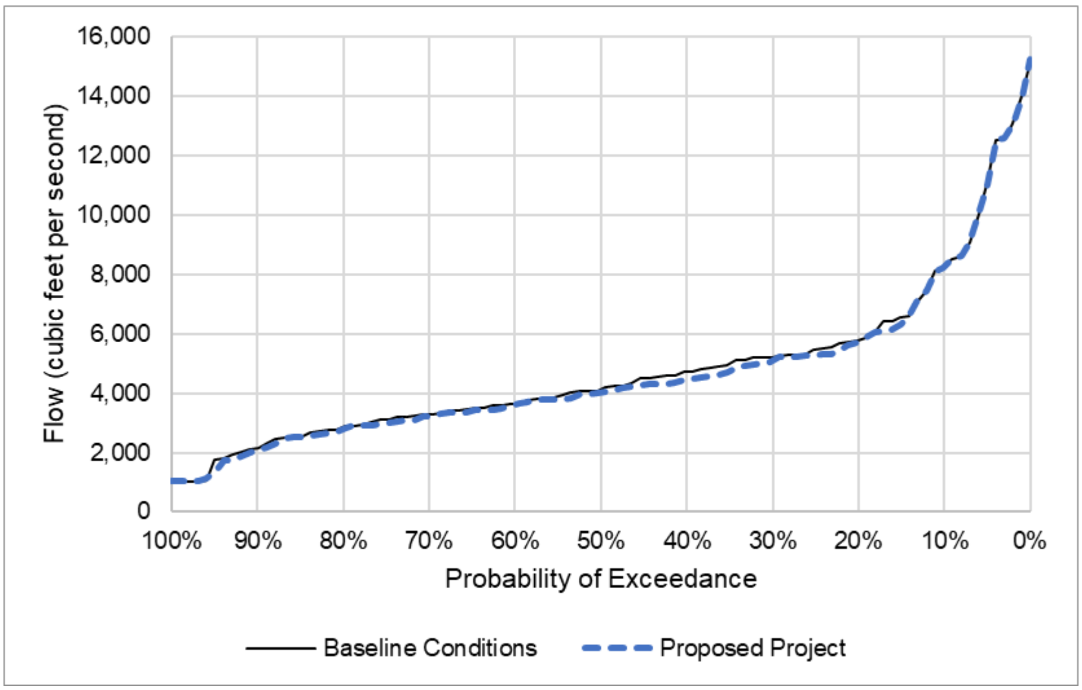

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Figure 2D-1-18. Mean Modeled Feather River High Flow Channel Flow, June

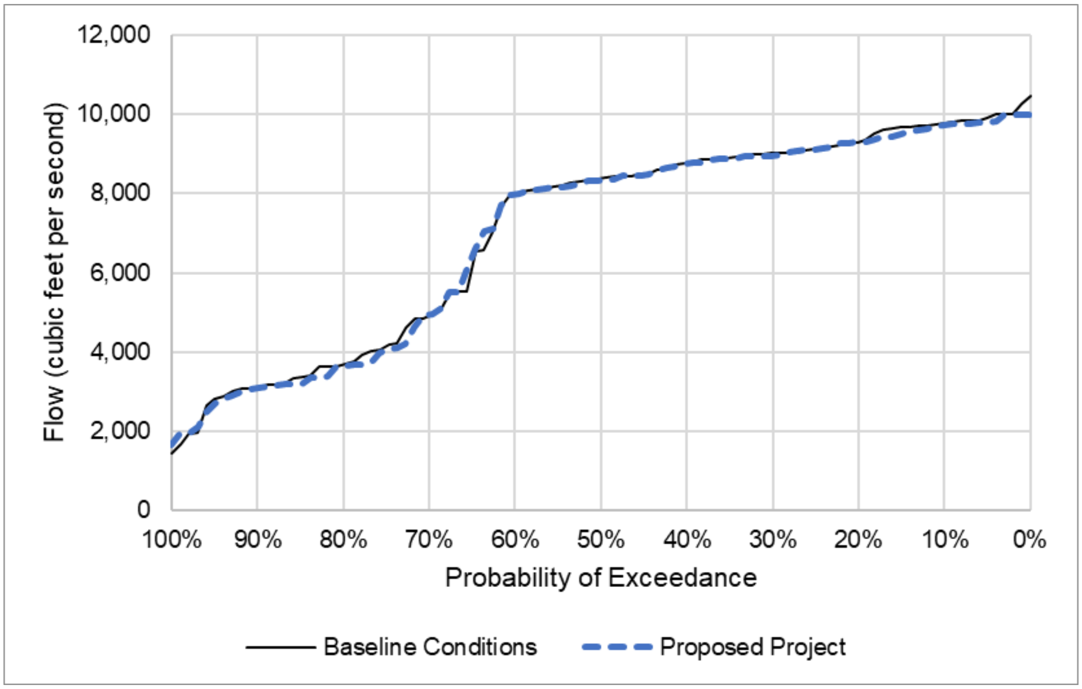

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Figure 2D-1-19. Mean Modeled Feather River High Flow Channel Flow, July

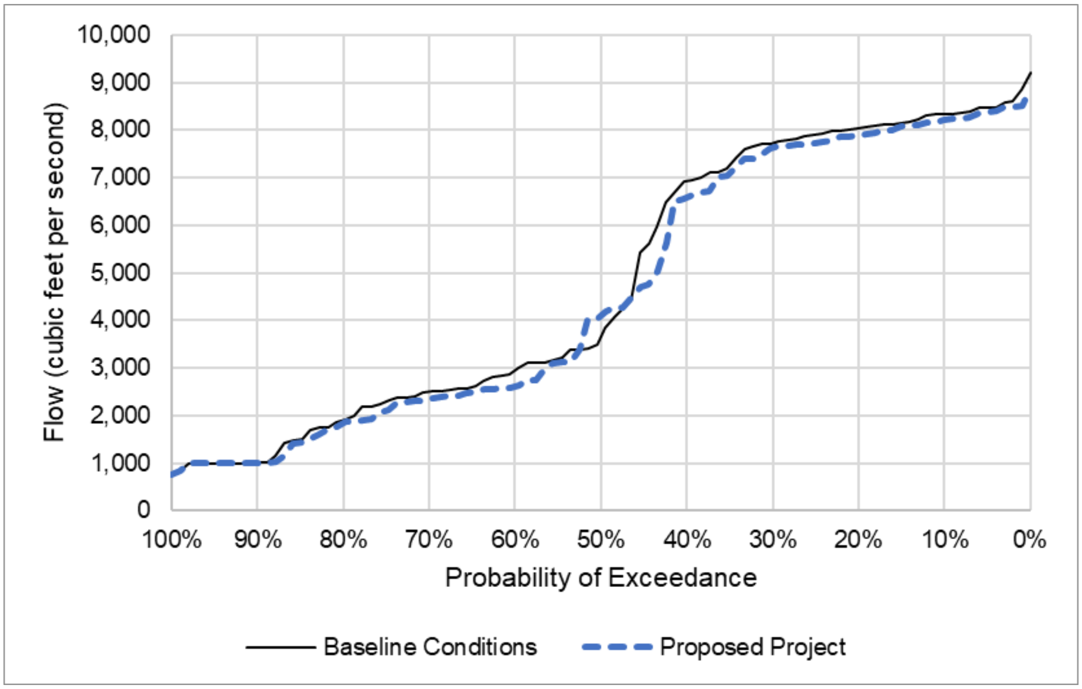

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Figure 2D-1-20. Mean Modeled Feather River High Flow Channel Flow, August

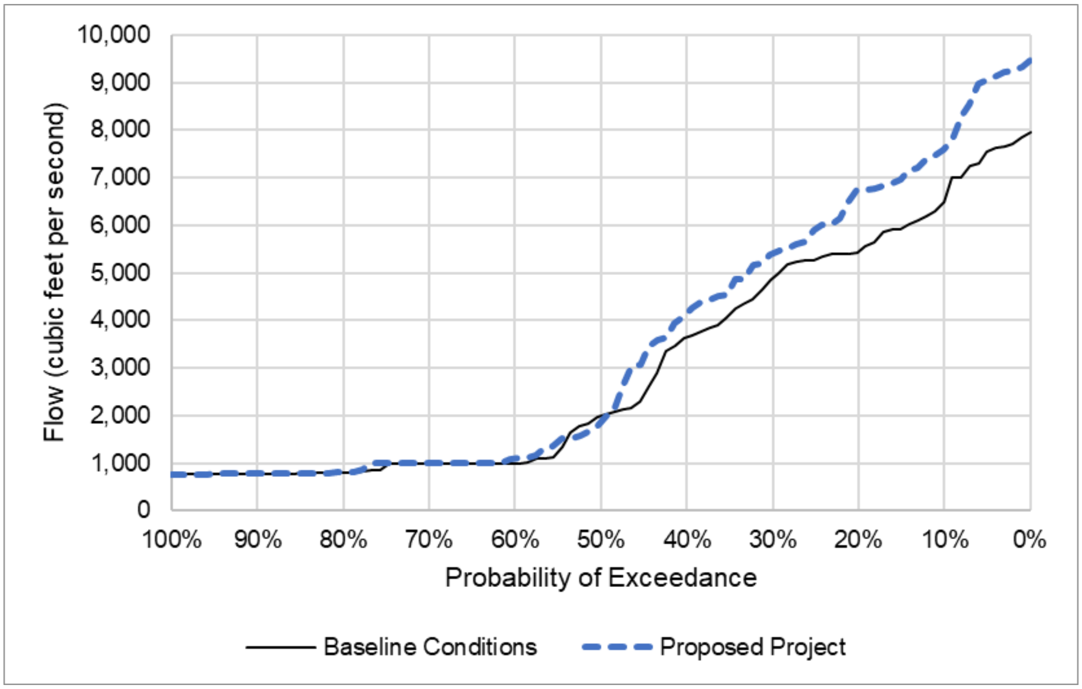

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Figure 2D-1-21. Mean Modeled Feather River High Flow Channel Flow, September

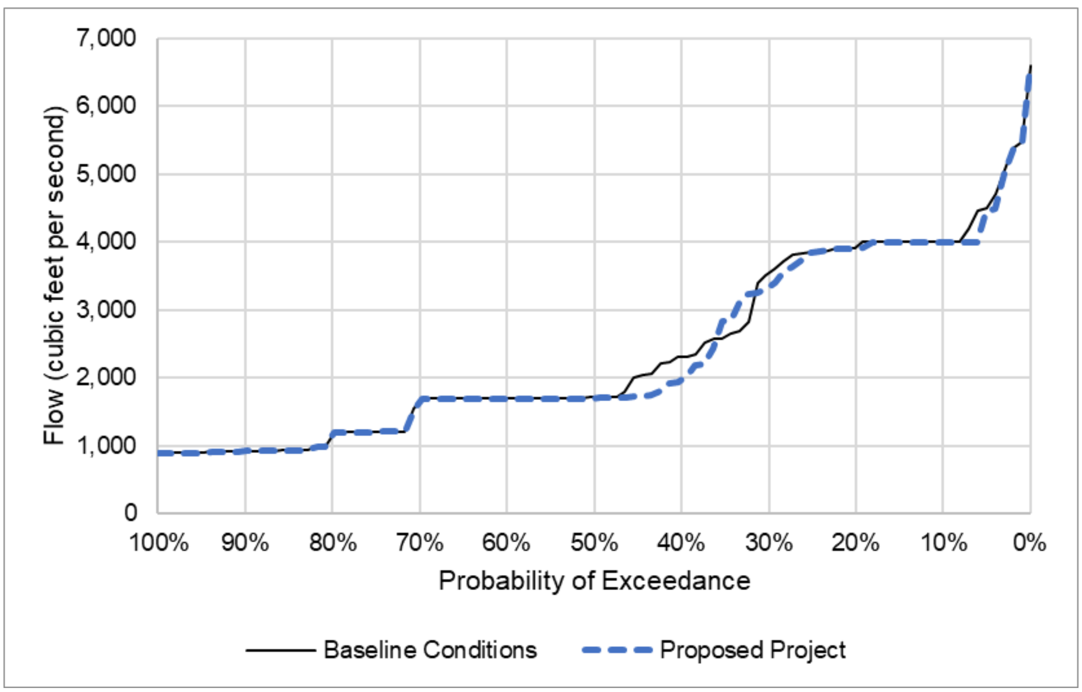

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Figure 2D-1-22. Mean Modeled Feather River High Flow Channel Flow, October

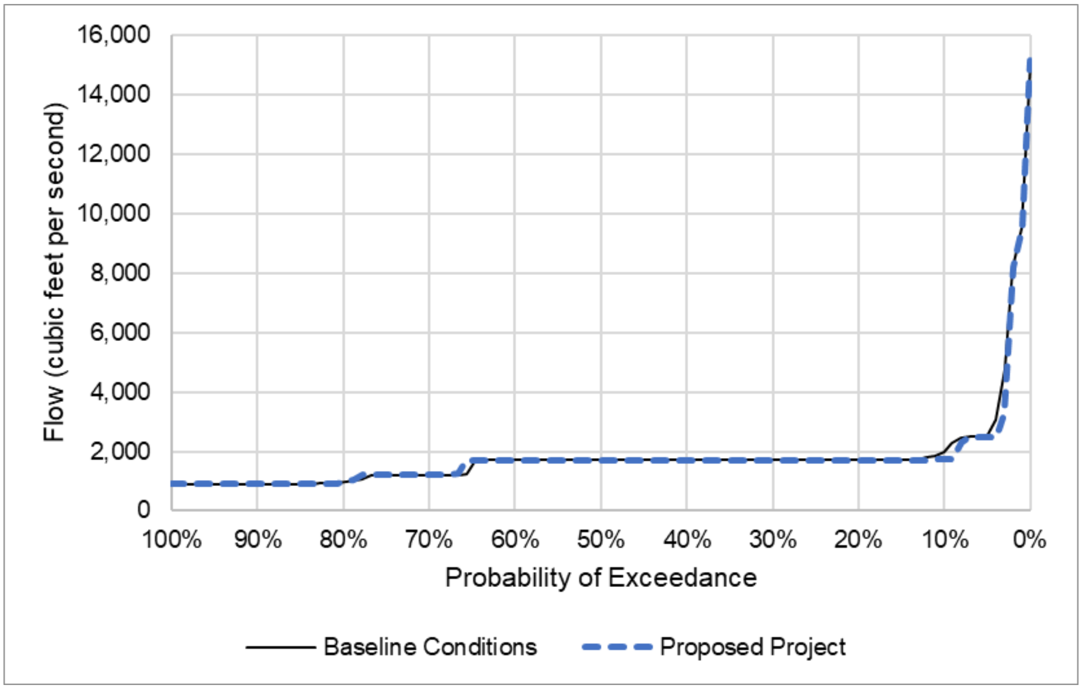

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Figure 2D-1-23. Mean Modeled Feather River High Flow Channel Flow, November

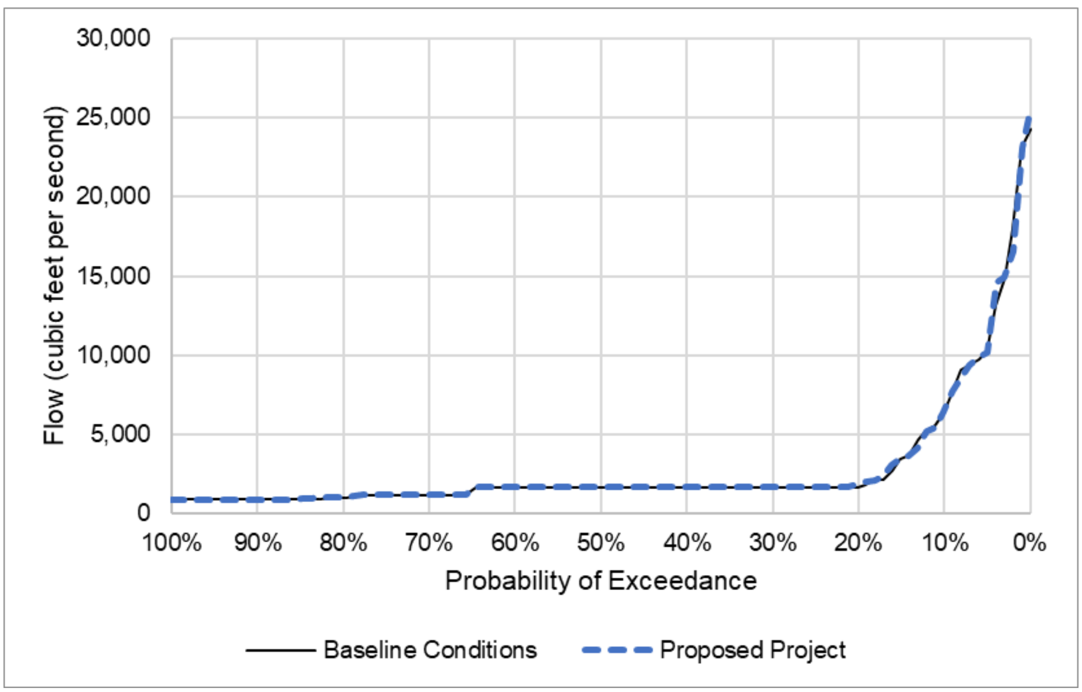

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Figure 2D-1-24. Mean Modeled Feather River High Flow Channel Flow, December

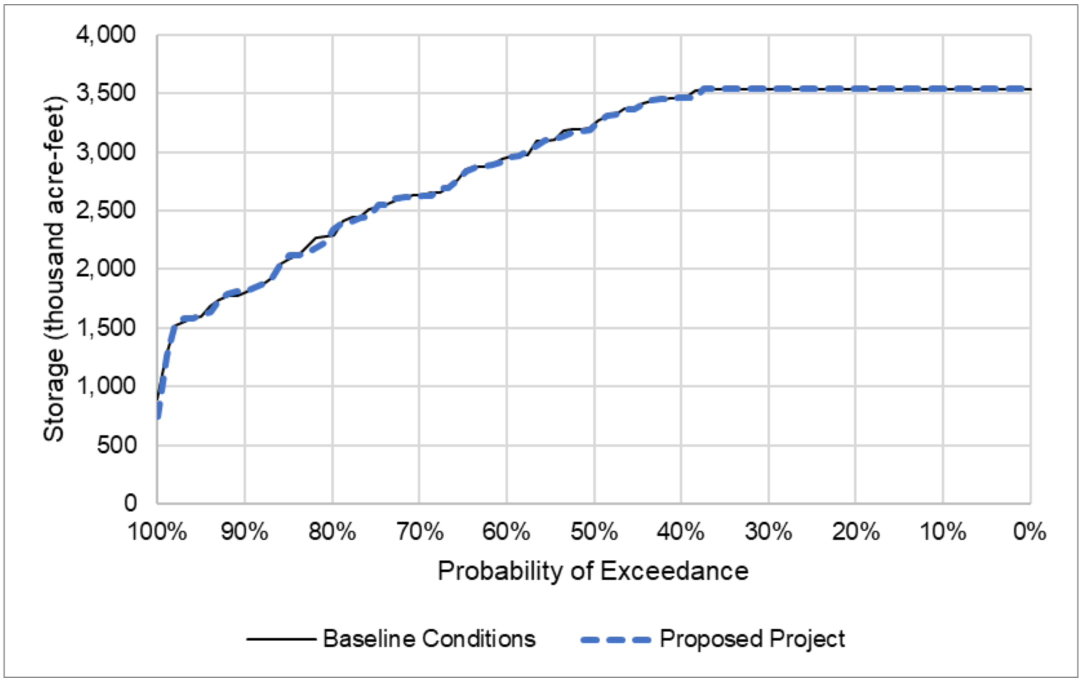

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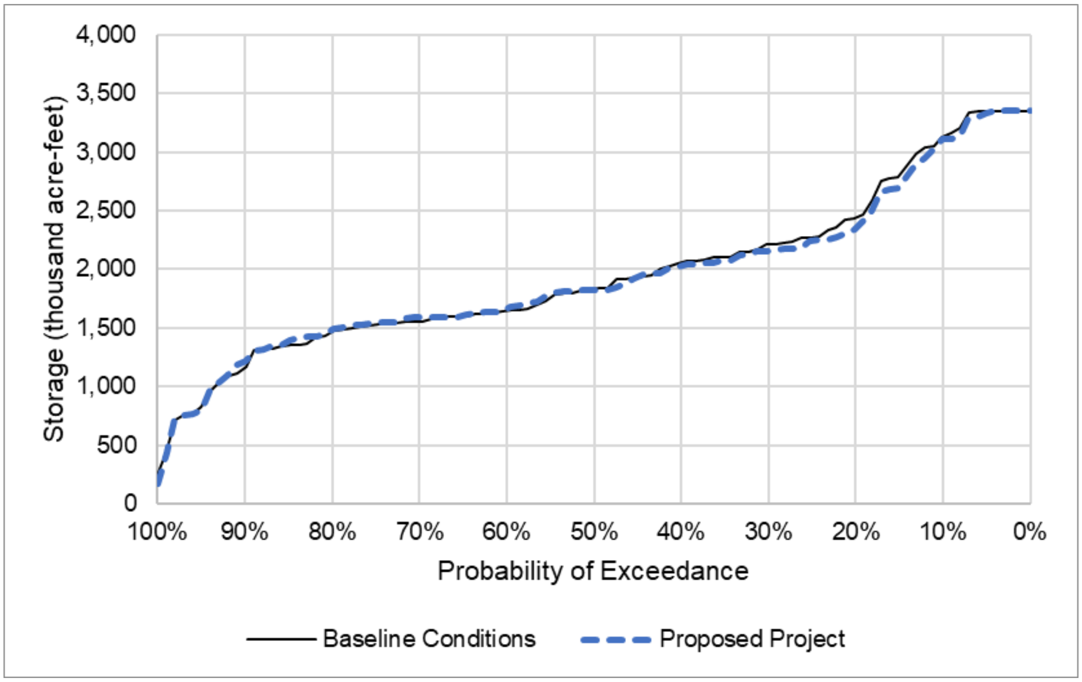
Figure 2D-1-25. End-of-May Oroville Reservoir Storage



Source: <DRAFT_TrendReport_MultiCalSim_rev09_20230726.xlsx>

Figure 2D-1-26. End-of-September Oroville Reservoir Storage

2D-1.4 Conclusion

On the basis of the limited overall differences between the Proposed Project and Baseline Conditions described above in Section 2D-1.3 and in Attachment A, it is concluded that the geographic scope of the study area for the Environmental Impact Report for Long-Term Operations of the State Water Project does not need to include the Feather River.

2D-1.5 References

National Marine Fisheries Service. 2016. *Oroville Facilities Biological Opinion.* West Coast Region, Central Valley Office. Sacramento, CA.

Appendix 2D, Attachment 1

Attachment A: Potential Flow Effects on Aquatic Biological Resources in the Feather River High Flow Channel

2D-1-A.1 Introduction

This attachment analyzes potential effects on covered fish species in the High Flow Channel (HFC) of the Feather River as a result of differences in instream flow under the Proposed Project relative to Baseline Conditions. The effects analysis is based on flows and related metrics in the HFC below the Thermalito Afterbay (CalSim 3 Channel C-FTR059). Results of escapement surveys conducted since 2000 (Kindopp pers. comm. 2021a) show that the Low Flow Channel (LFC) is preferred over the HFC for spawning of Chinook Salmon and steelhead and that this preference has increased over time (Figure 2D-1-A-1); therefore, quantitative analyses on these species in the HFC were not conducted and the analysis was qualitative, considering CalSim 3 outputs. Qualitative analyses based on CalSim 3 outputs were generally undertaken for other species as well, with some quantitative analyses as described in Section 2D-1-A.2, "Methods," of this attachment.

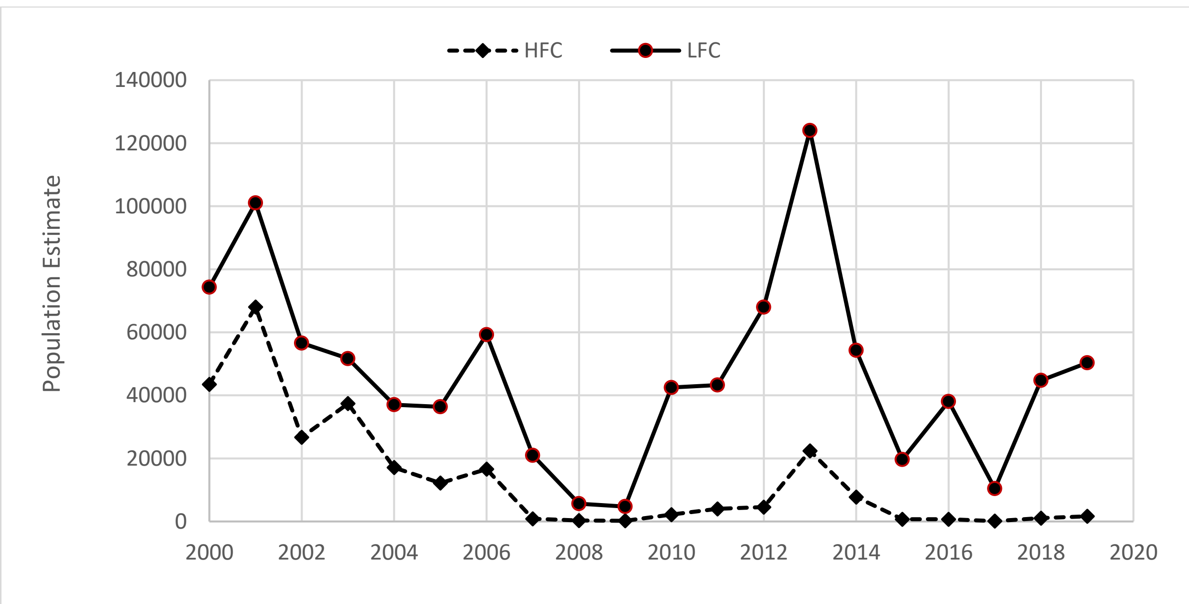


Figure 2D-1-A-1. Escapement Population Estimates for Fall-run Chinook Salmon in the Low Flow Channel (LFC) and High Flow Channel (HFC) of the Feather River from 2000 through 2019, from Escapement Surveys of DWR.

2D-1-A.2 Methods

The species of management concern included in this effects analysis for the Feather River HFC regularly occur in the Feather River (Table 2D-1-A-1). The potential effects of the Proposed Project were evaluated by comparing flows between Baseline Conditions and the Proposed Project during months when key life stages are generally present. For many of the species, the CalSim 3 monthly flow estimates computed from the 100-year output period are the primary metric used for the analyses (see Table 2D-1-2 in the main memorandum text above). Quantitative analyses for obstruction and stranding are described in Sections 2D-1-A.2.1, “Low-Flow Obstruction of Upstream Passage for Salmonid and Sturgeon Adults,” and 2D-1-A.2.2, “Stranding of Lamprey and Other Species.”

Table 2D-1-A-1. Feather River Fish Species of Management Concern

Species and *ESU/DPS*	Federal Status	State Status	Tribal[a], Commercial, or Recreational Importance
Spring-run Chinook Salmon *Central Valley ESU*	Threatened	Threatened	Yes[b]
Fall-run Chinook Salmon *Central Valley ESU*	Species of Concern	Species of Special Concern	Yes[b]
Steelhead *Central Valley DPS*	Threatened	None	Yes
Green Sturgeon *Southern DPS*	Threatened	Species of Special Concern	Yes
White Sturgeon	None	Species of Special Concern	Yes
Pacific Lamprey	Species of Concern	Species of Special Concern	Yes
Western River Lamprey	None	Species of Special Concern	Yes
Sacramento Hitch	None	Species of Special Concern	Yes
Sacramento Splittail	None	Species of Special Concern	Yes
Hardhead	None	Species of Special Concern	Yes
Striped Bass	None	None	Yes
American Shad	None	None	Yes
Black Bass (Largemouth Bass, Smallmouth Bass, Spotted Bass)	None	None	Yes

Notes:

ESU = evolutionarily significant unit; DPS = distinct population segment.

[a] Tribal importance was noted based on Shilling et al. 2014:15–46.

[b] Commercially important species with essential fish habitat under the Magnuson-Stevens Fishery Conservation and Management Act.

2D-1-A.2.1 Low-Flow Obstruction of Upstream Passage for Salmonid and Sturgeon Adults

Low flow can interfere with passage of upstream migrating adult salmon or sturgeon because of inadequate water depth or flow over natural or artificial barriers. If periods of low flow last only a few days and are infrequent, they probably have little effect on the fish because the fish can hold in deeper water until passage conditions improve. The primary Feather River passage obstruction is a boulder weir at the Sunset Pumps at Live Oak (National Marine Fisheries Service 2018; Seesholtz pers. comm. 2022). This weir creates a partial barrier to the only confirmed spawning location of Green Sturgeon in the Feather River (Seesholtz et al. 2015). The U.S. Fish and Wildlife Service (USFWS) (2016) indicates that the boulder weir is a barrier to upstream passage of Green Sturgeon when Feather River flow is less than 6,000 cubic feet per second (cfs). Given the absence of information indicating passage at lower flows, 6,000 cfs was selected as the threshold flow for upstream passage of sturgeon in the Feather River. Adult salmonids can pass above the Sunset Pumps weir at 1,500 cfs or slightly less (Kindopp pers. comm. 2021b), so 1,500 cfs was selected as the threshold flow for upstream passage of salmonids. The recovery plan for the southern distinct population segment of Green Sturgeon lists removal or modification of the Sunset Pumps boulder weir as a high-priority recovery action (National Marine Fisheries Service 2018), but it is not clear when such measures would be implemented (Seesholtz pers. comm. 2021).

2D-1-A.2.2 Stranding of Lamprey and Other Species

Potential flow-related effects on Pacific and Western River Lamprey ammocoetes were evaluated by estimating dewatering of ammocoete rearing habitat resulting from differences in river stage as estimated from flow for the Proposed Project and Baseline Conditions. An ammocoete is the filter-feeding larval stage of lamprey. It remains relatively immobile in the sediment at the same location for several years (Moyle et al. 2015), after which it migrates downstream. During the rearing period there is potential for dewatering of ammocoete rearing habitat, also referred to as ammocoete stranding, from rapid reductions in flow, leading to mortality (U.S. Fish and Wildlife Service 2012). Suitable habitat for ammocoetes is often at stream margins in areas of low velocity with fine substrate, which are the first areas dewatered when stream flows drop. Ammocoetes do not segregate themselves by age; therefore, a single event can affect multiple year classes, significantly affecting a local lamprey population (U.S. Fish and Wildlife Service 2012).

Rearing habitat dewatering risks were analyzed for ammocoetes under the Proposed Project and Baseline Conditions in the Feather River HFC. Data from several studies conducted in Northern California and the Pacific Northwest indicate that Pacific Lamprey ammocoetes are roughly uniformly distributed over depths from near surface to about 8 feet deep (Claire et al. 2007; David Evans and Associates, Inc. et al. 2007; Stone and Barndt 2005; Winkowski and Kendall 2018). Western River Lamprey ammocoetes are assumed to have a similar depth distribution. The relationship between river flow and depth was determined using stage-discharge tables for the Gridley gauge on the Feather River (California Data Exchange Center: https://cdec.water.ca.gov/rtables/). This gauge is 7 miles downstream of the Thermalito Afterbay outlet location, the closest CalSim 3 node to Gridley. Despite the distance, the CalSim 3 flow estimates for the Thermalito Afterbay outlet are expected to provide a reasonable approximation of flows at the Gridley gauge because there are no major diversions or inflows on the Feather River between the Thermalito Afterbay outlet and the Gridley gauge. Changes in water levels typically vary somewhat among different locations in the river, including the gauge, but they are generally similar if the flows are similar (Gordon et al. 1992). Using the stage-discharge tables for the Gridley gauge, changes in river stage were determined from the CalSim 3 monthly flow outputs at the Thermalito Afterbay outlet for the Proposed Project and Baseline Conditions to estimate differences in river stage attributable to the Proposed Project.

A cohort of ammocoetes was assumed to begin every month during the spawning period (April through July for Pacific Lamprey and February through May for Western River Lamprey) and spend five years rearing upstream, although rearing periods as short as three years have been reported for more southerly streams (Moyle 2002; U.S. Fish and Wildlife Service 2012; Goodman and Reid 2022). Eggs hatch in about a month, and ammocoetes quickly disperse to their rearing habitat (Moyle et al. 2015), so initiation of an ammocoete cohort was assumed to occur each month of spawning over the 100-year CalSim 3 modeling period. The stage of the river, estimated from the CalSim 3 and the stage vs. flow table for Gridley, was tracked for each cohort from the month of spawning through five years of ammocoete rearing. The greatest reduction in stage from the month of spawning during the following five-year period was used to determine, from the depth distribution of ammocoetes, the percentage of the ammocoete cohort stranded. For instance, a stage reduction of 4 feet was estimated to result in the stranding of 50 percent of the cohort and a stage reduction of 8 feet was estimated to result in a 100 percent stranding. This procedure assumes that the ammocoetes do not change location during their rearing period, which is not necessarily the case (U.S. Fish and Wildlife Service 2012), but any error associated with this assumption is likely to be roughly equal for Baseline Conditions and the Proposed Project.

The potential risk of redd dewatering was evaluated for Pacific and Western River Lamprey from the month-to-month flow reduction data. Greater mean month-to-month flow reductions during the months of spawning were considered to have a greater risk of redd dewatering. The results of this analysis were also used to evaluate the potential for stranding and dewatering of early life stages of other species, including black bass, Hardhead, and Sacramento Hitch.

2D-1-A.3 Results

2D-1-A.3.1 Spring-Run Chinook Salmon

Spring-run Chinook Salmon in the Feather River typically spawn from September through November. The fry begin to emerge in November or December. The juveniles rear through the spring with some juveniles emigrating from the river shortly after emerging. Adult spring-run return to the Feather River in March or April and hold in the river until they are ready to spawn (Bilski and Kindopp 2009).

The HFC is an important migration corridor for adults migrating to their upstream spawning areas. Effects of reduced flows on Feather River migration cues are unknown, but except for the boulder weir at the Sunset Pumps at very low flows, passage is not considered to be an issue for adult salmonids at any of the flows normally encountered in the HFC (National Marine Fisheries Service 2016). During the March through June period of upstream migration, flows in the HFC below the Thermalito Afterbay outlet are generally similar between Baseline Conditions and the Proposed Project, with limited instances of negative differences greater than 5 percent (see Table 2D-1-2 and Figures 2D-1-15 through 2D-1-18 in the main memorandum text). The frequency of flow below the

1,500-cfs passage threshold (see Section 2D-1-A.2.1) during the March through June immigration period for spring-run Chinook Salmon adults in the HFC of the Feather River was very similar between the Proposed Project and Baseline Conditions (Table 2D-1-A-2).

Table 2D-1-A-2. Estimated Percentage of Months with Mean Flows below the Low-Flow Threshold for Passage of Migrating Adult Salmonids (1,500 cfs) and Green Sturgeon (6,000 cfs) in the Feather River below Thermalito Afterbay Outlet and Differences in Percentages (in parentheses) for Baseline Conditions and the Proposed Project

Species	Immigration Period	Baseline Conditions	Proposed Project
Spring-run Chinook Salmon	March–June	32.3%	32.5% (0.25%)
Fall-run Chinook Salmon	August–December	32.0%	31.8% (-0.2%)
Steelhead	August–March	32.0%	31.8% (-0.25%)
Green Sturgeon	February–June	75.6%	75.8% (0.2%)

During the adult holding period for spring-run, from spring to early fall (i.e., approximately March/April to September/October), flows are generally similar between the Proposed Project and Baseline Conditions, with some differences (e.g., over 20 percent greater September flow under the Proposed Project in Wet and Above Normal years, 12 percent lower flow in August of Dry years; see Table 2D-1-2 and Figures 2D-1-15 through 2D-1-22 in the main memorandum text above). Adults hold in pools and therefore are unlikely to be much affected by such moderate differences in flow.

After emerging from their redds, spring-run Chinook Salmon fry rear in near-shore, inundated side-channel, and floodplain habitat in both the LFC and the HFC. Older juveniles also use habitats of greater depths. The relationship between flow and juvenile rearing habitat in the Feather River is uncertain. The available rearing Weighted Usable Area (WUA) curves for the Feather River have low certainty and are difficult to employ (Payne 2005). There are limited differences in HFC flow between the Proposed Project and Baseline Conditions for most of the November through June rearing period in most water year types, with differences generally between 0 and 5 percent, with a range from around 14 percent more under the Proposed Project to 15 percent more under Baseline Conditions in some months/water year types (see Table 2D-1-2 and Figures 2D-1-13 through 2D-1-18, 2D-1-23, and 2D-1-24 in the main memorandum text).

Juvenile spring-run Chinook Salmon emigrate from the Feather River from about November to June (Bilski and Kindopp 2009). There are no published relationships between juvenile emigration survival and flow. Large changes in flow affect survival of emigrating salmon in the Sacramento River (Michel et al. 2021), but no such relationship has been demonstrated for the Feather River (Bilski and Kindopp 2009). As previously discussed for fry and juvenile rearing, there are generally limited differences in HFC flows during November through June (see Table 2D-1-2 and Figures 2D-1-13 through 2D-1-18, 2D-1-23, and 2D-1-24 in the main memorandum text).

Considering the generally limited differences in flow in the HFC between the Proposed Project and Baseline Conditions, with some modest positive and negative differences depending on water year type and month, the Proposed Project would have limited potential for different effects on spring-run Chinook Salmon than would occur under Baseline Conditions.

2D-1-A.3.2 Fall-Run Chinook Salmon

Fall-run Chinook Salmon in the Feather River typically spawn from October through December. The fry begin to emerge in December or January. The juveniles rear through the spring, with some juveniles emigrating from the river shortly after emerging. Emigration continues until about May. The adults return to the Feather River in August through December.

Effects of reduced flows on Feather River migration cues are unknown, but except for the boulder weir at the Sunset Pumps at very low flows, passage is not considered to be an issue for adult salmonids at any of the flows normally encountered in the HFC (National Marine Fisheries Service 2016). During the August through December period of upstream migration, flows in the HFC below the Thermalito Afterbay outlet are generally similar between Baseline Conditions and the Proposed Project, except for modest differences of around 8 to 12 percent in August (Dry years), September (Dry years), and December (Below Normal and Dry Years) (see Table 2D-1-2 and Figures 2D-1-20 through 2D-1-24 in the main memorandum text). The largest differences were 20 to 24 percent more flow under the Proposed Project in September of Wet and Above Normal years. The frequency of flow below the 1,500-cfs passage threshold (see Section 2D-1-A.2.1) during the August through December immigration period for fall-run Chinook Salmon adults in the HFC of the Feather River was very similar between the Proposed Project and Baseline Conditions (Table 2D-1-A-2).

After emerging from their redds, Feather River fry and older juvenile fall-run Chinook Salmon rear in near-shore, inundated side-channel, and floodplain habitat in both the LFC and the HFC. The relationship between flow and juvenile rearing habitat in the Feather River is uncertain. The available rearing WUA curves for the Feather River have low certainty and are difficult to employ (Payne 2005). There are limited differences in HFC flow between the Proposed Project and Baseline Conditions for most of the December through April rearing period in most water year types, with differences generally between 0 and 5 percent, with a range from around 14 percent more under the Proposed Project to 9 percent more under Baseline Conditions in some months/water year types (see Table 2D-1-2 and Figures 2D-1-13 through 2D-1-17 and 2D-1-24 in the main memorandum text).

Juvenile fall-run Chinook Salmon emigrate from the Feather River from about December to May (Bilski and Kindopp 2009). As previously described for spring-run Chinook Salmon in Section 2D-1-A.3.1, “Spring-Run Chinook Salmon,” there are no published relationships between juvenile emigration survival and flow. Large changes in flow affect survival of emigrating salmon in the Sacramento River (Michel et al. 2021), but no such relationship has been demonstrated for the Feather River (Bilski and Kindopp 2009). Similar to the rearing period, there are limited differences in HFC flow between the Proposed Project and Baseline Conditions for most of the December through May emigration period in most water year types, with differences generally between 0 and 5 percent, with a range from around 14 percent more under the Proposed Project to 15 percent more under Baseline Conditions in some months/water year types (see Table 2D-1-2 and Figures 2D-1-13 through 2D-1-18 and 2D-1-24 in the main memorandum text).

Considering the limited differences in flow in the HFC between the Proposed Project and Baseline Conditions, with some modest positive and negative differences depending on water year type/month, the Proposed Project would have limited potential for different effects on fall-run Chinook Salmon than would occur under Baseline Conditions.

2D-1-A.3.3 Steelhead

Steelhead in the Feather River typically spawn from December through March. The fry begin to emerge around February. Some juvenile steelhead rear in the river throughout the year, but many emigrate as young-of-the year during March through May (Seesholtz et al. 2004). Adult steelhead return to the Feather River in August through March.

Effects of reduced flows on Feather River migration cues are unknown, but except for the boulder weir at the Sunset Pumps at very low flows, passage is not considered to be an issue for adult steelhead at any of the flows normally encountered in the HFC (National Marine Fisheries Service 2016). During the August through March period of upstream migration, flows in the HFC below the Thermalito Afterbay outlet are generally similar between Baseline Conditions and the Proposed Project, with limited instances of negative differences greater than 5 percent and the largest differences consisting of 20 to 24 percent more flow under the Proposed Project in Wet and Above Normal years (see Table 2D-1-2 and Figures 2D-1-13 through 2D-1-16 and Figures 2D-1-20 through 2D-1-24 in the main memorandum text). The frequency of flow below the 1,500-cfs passage threshold (see Section 2D-1-A.2.1) during the August through March immigration period for spring-run Chinook Salmon adults in the HFC of the Feather River was very similar between the Proposed Project and Baseline Conditions (Table 2D-1-A-2).

After emerging from their redds, Feather River fry and older juvenile steelhead rear in near-shore, inundated side-channel, and floodplain habitat in both the LFC and HFC. Juvenile rearing occurs throughout the year and is therefore affected by changes in flow in any month. However, the juveniles are likely to be most susceptible to effects of flow changes in the months right after they emerge from their redds as fry, from midwinter through late spring. The relationship between flow and juvenile rearing habitat is uncertain. The available rearing WUA curves for the Feather River were not used for this report because they have low certainty and are difficult to employ (Payne 2005). As discussed for spring-run and fall-run Chinook Salmon in Sections 2D-1-A.3.1 and 2D-1-A.3.2, "Fall-Run Chinook Salmon," there are limited differences in flow between the Proposed Project and Baseline Conditions during winter/spring months.

Juvenile steelhead emigrate from the Feather River primarily from about March through May (Seesholtz et al. 2004; Bilski and Kindopp 2009). There are no published relationships between juvenile emigration survival and flow (Seesholtz et al. 2004; Bilski and Kindopp 2009), although large changes in flow have been shown to correlate with survival of emigrating salmon in the Sacramento River (Michel et al. 2021). During March through May, flow in the Feather River under the Proposed Project is generally similar to flow under Baseline Conditions, with an exception being in May of Below Normal years (15 percent lower flow; see Table 2D-1-2 and Figures 2D-1-15 through 2D-1-17 in the main memorandum text). Therefore, the Proposed Project is not expected to negatively affect steelhead juveniles during the months of emigration.

Considering the limited differences in flow in the HFC between the Proposed Project and Baseline Conditions, with some modest positive and negative differences depending on water year type/month, the Proposed Project would have limited potential for different effects on steelhead than would occur under Baseline Conditions.

2D-1-A.3.4 Green Sturgeon

Green Sturgeon irregularly spawn in the Feather River. Spawning was documented in 2011 at the Thermalito Afterbay outlet and in 2017 below the Fish Barrier Dam (National Marine Fisheries Service 2018; Seesholtz et al. 2015). In both 2011 and 2017, water temperature was notably cooler than average, likely due to the above average flow that occurred in the spring (Heublein et al. 2017). Green Sturgeon may spawn in the Feather River only during wet, high flow years (Heublein et al. 2017; Seesholtz et al. 2015). In most years, water temperatures downstream of the Thermalito Afterbay outlet are too warm for normal egg incubation by late May (Heublein et al. 2017). When Green Sturgeon spawn in the Feather River, spawning occurs only in spring (Heublein et al. 2017; Seesholtz et al. 2015); water temperatures in the river are generally too warm for a late summer and fall spawning period such as that documented for Sacramento River Green Sturgeon (National Marine Fisheries Service 2018). Larvae and juveniles most likely are present and dispersing downstream from early spring to early autumn.

The frequencies of flows in the HFC of the Feather River below the 6,000-cfs passage threshold for Green Sturgeon (see Section 2D-1-A.2.1) during the February through June immigration period were very similar between the Proposed Project and Baseline Conditions (Table 2D-1-A-2). This indicates that the Proposed Project would not result in differing passage conditions for upstream migrating adult Green Sturgeon than Baseline Conditions.

Green Sturgeon irregularly spawn in the Feather River. When spawning occurs, it is only in spring and early summer because in most years water temperatures downstream of the Thermalito Afterbay outlet are too warm for normal egg incubation by late May (Seesholtz pers. comm. 2021). Mean monthly flow under the Proposed Project during the late spring and early summer, when most Green Sturgeon spawning and egg incubation has occurred in the past, is generally similar or slightly lower than flow under Baseline Conditions (see Table 2D-1-2 and Figures 2D-1-17 through 2D-1-19 in the main memorandum text). The limited differences would not be expected to result in appreciable differences in water temperature between the Proposed Project and Baseline Conditions.

Distribution and timing of Green Sturgeon larvae or juveniles in the Feather River is uncertain. Assuming that development times and behaviors for Green Sturgeon larvae and juveniles in the Feather River are like those in the Sacramento River, larvae would most likely be present from early spring to early autumn and from the Fish Barrier Dam to the confluence with the Sacramento River. Feather River juveniles would be present from May through December and from the Fish Barrier Dam to the Delta. During May through December, HFC flow is generally similar between the Proposed Project and Baseline Conditions, with several somewhat larger positive and negative differences depending on month and water year type (see Table 2D-1-2 and Figures 2D-1-17 through 2D-1-24 in the main memorandum text). Green sturgeon larvae and juveniles are likely present in the Feather River only during Wet and Above Normal water years because spawning is believed to occur only in years of high flows (Heublein et al. 2017; Seesholtz et al. 2015); in Wet and Above Normal water years, there generally is little difference in HFC channel flow between the Proposed Project and Baseline Conditions, except for a 20 to 24 percent greater flow in September under the Proposed Project.

The effects of flow on Green Sturgeon larvae and juveniles are poorly understood. In the Sacramento River, there appears to be a positive relationship between annual outflow and abundance of Green Sturgeon larvae and juveniles in rotary screw traps at Red Bluff Diversion Dam (Heublein et al. 2017). The mechanisms behind this relationship are unknown and it is unknown if there is a similar relationship in the Feather River. The generally limited differences in flow described above suggest there would be little flow-related difference in Green Sturgeon population performance in the Feather River between the Proposed Project and Baseline Conditions.

2D-1-A.3.5 White Sturgeon

White Sturgeon occasionally use the lower Feather River for spawning, embryo development, and early rearing, although no definitive evidence of spawning has been documented in recent years (Moyle et al. 2015; Heublein et al. 2017; Seesholtz pers. comm. 2022). Upstream spawning migrations by White Sturgeon adults generally occur from late winter to late spring and may coincide with higher flows (Schaffter 1997; Moyle et al. 2015). Spawning occurs in deep water from late February to early June, but primarily during March and April. The larvae and juveniles emigrate from approximately April to July (Moyle et al. 2015; Heublein et al. 2017).

The frequencies of flows in the HFC of the Feather River below the 6,000-cfs passage threshold for sturgeon (see Section 2D-1-A.2.1) during the February through June immigration period were very similar between the Proposed Project and Baseline Conditions (Table 2D-1-A-2), with flows generally similar during this period as well (see Table 2D-1-2 and Figures 2D-1-14 through 2D-1-18 in the main memorandum text). This indicates that the Proposed Project would not result in differing passage conditions for upstream migrating adult White Sturgeon than Baseline Conditions.

Spawning of White Sturgeon in the Feather River may be limited to high flow years as described above for Green Sturgeon. Year-class recruitment of White Sturgeon is positively correlated with high late-winter to early-summer Delta outflow (Fish 2010[1]). Spawning migrations may be reduced under lower-flow conditions (Schaffter 1997). Mean monthly flow during March and April, when most White Sturgeon spawning and egg incubation occurs in the Sacramento River, is similar between the Proposed Project and Baseline Conditions (see Table 2D-1-2 and Figures 2D-1-16 and 2D-1-17 in the main memorandum text).

White sturgeon larvae and juveniles emigrate from approximately April to July (Moyle et al. 2015; Heublein et al. 2017). Flows below the Thermalito Afterbay outlet during this period are generally similar between the Proposed Project and Baseline Conditions, so no substantial difference between the Proposed Project and Baseline Conditions in flow effects on larvae or juveniles is expected (see Table 2D-1-2 and Figures 2D-1-16 through 2D-1-19 in the main memorandum text).

Considering all potential Feather River flow effects, the Proposed Project is not expected to substantially affect White Sturgeon in the Feather River relative to Baseline Conditions.

[1] See Chapter 6 in the Environmental Impact Report for Long-Term Operations of the State Water Project for the analysis of potential Delta outflow-related effects on year-class recruitment, for which it was concluded that there would be a less-than-significant impact of the Proposed Project.

2D-1-A.3.6 Pacific and River Lamprey

Pacific Lamprey spawn from April to July (U.S. Fish and Wildlife Service 2012), and Western River Lamprey spawn from February to May (Moyle 2002). Pacific Lamprey eggs and pro-larvae incubate in their redds for about a month (U.S. Fish and Wildlife Service 2012). Incubation times for Western River Lamprey are unknown but assumed to be similar. Redds are often found in low-gradient stream reaches, in gravel, and at the tailouts of pools and riffles, areas that are vulnerable to dewatering when flows drop (U.S. Fish and Wildlife Service 2012). After the larvae (ammocoetes) emerge from their redds, they drift downstream and burrow into fine sediments primarily in off-channel habitats, where they rear (Schultz et al. 2014; Moyle et al. 2015). Ammocoetes on average spend about five years rearing before they metamorphose to the juvenile stage and migrate downstream, although rearing periods as short as three years have been reported for more southerly streams (U.S. Fish and Wildlife Service 2012; Goodman and Reid 2022). Adults return to the river from the ocean and Delta about March through June and hold in the river for about a year prior to spawning (Moyle et al. 2015).

As discussed in Section 2D-1-A.2.2, the potential risk of redd dewatering was evaluated for Pacific and Western River Lamprey from the month-to-month flow reduction data derived from the CalSim 3 modeling. There were limited differences in flow reductions between the Proposed Project and Baseline Conditions during either the Pacific Lamprey (April through July) or the Western River Lamprey (February through May) spawning periods (Table 2D-1-A-3). There were also limited differences between the Proposed Project and Baseline Conditions for the potential of ammocoete stranding during the five-year rearing period (Table 2D-1-A-4). Therefore, the Proposed Project is not expected to have a substantial effect on spawning, egg incubation, or rearing for Feather River Pacific and Western River Lamprey in the HFC. As discussed for other species, there are limited differences in HFC flow between the Proposed Project and Baseline Conditions, indicating that any differences in biological effects on the two lamprey species also would be limited.

Table 2D-1-A-3. Mean Month-to-Month Percentage Reduction of CalSim 3 Monthly Average Flows by Month and Water Year Type in the Feather River Downstream of the Thermalito Afterbay Outlet and Differences in the Percentages (Proposed Project minus Baseline Conditions, in parentheses) for Baseline Conditions and the Proposed Project

Month	Water Year Type	Baseline Conditions	Proposed Project
January	Wet	13.2	13.2 (0.0)
January	Above Normal	9.9	9.9 (0.0)
January	Below Normal	3.0	3.0 (0.0)
January	Dry	0.1	0.1 (0.0)
January	Critically Dry	0.6	0.6 (0.0)
February	Wet	25.5	25.3 (-0.2)
February	Above Normal	8.3	7.6 (-0.8)
February	Below Normal	9.9	9.5 (-0.4)
February	Dry	10.4	12.8 (2.4)
February	Critically Dry	8.1	11.6 (3.4)
March	Wet	41.6	41.7 (0.0)
March	Above Normal	42.0	40.2 (-1.8)

Month	Water Year Type	Baseline Conditions	Proposed Project
March	Below Normal	40.9	41.1 (0.2)
March	Dry	24.2	24.3 (0.2)
March	Critically Dry	11.3	11.3 (0.0)
April	Wet	17.3	17.3 (0.0)
April	Above Normal	19.3	21.4 (2.1)
April	Below Normal	7.0	6.9 (-0.1)
April	Dry	9.7	10.0 (0.3)
April	Critically Dry	38.4	37.8 (-0.6)
May	Wet	24.0	23.3 (-0.7)
May	Above Normal	8.5	8.6 (0.0)
May	Below Normal	5.6	3.5 (-2.1)
May	Dry	0.7	0.8 (0.1)
May	Critically Dry	0.0	0.0 (0.0)
June	Wet	23.7	23.7 (0.0)
June	Above Normal	1.0	1.0 (0.0)
June	Below Normal	0.3	2.5 (2.2)
June	Dry	3.8	3.2 (-0.6)
June	Critically Dry	11.1	6.5 (-4.6)
July	Wet	41.3	41.7 (0.4)
July	Above Normal	11.9	14.6 (2.7)
July	Below Normal	20.4	19.2 (-1.2)
July	Dry	50.7	58.0 (7.2)
July	Critically Dry	32.3	32.2 (-0.1)
August	Wet	9.5	5.8 (-3.7)
August	Above Normal	25.7	14.3 (-11.4)
August	Below Normal	59.0	61.3 (2.3)
August	Dry	65.7	57.0 (-8.7)
August	Critically Dry	62.4	62.8 (0.4)
September	Wet	27.3	34.7 (7.4)
September	Above Normal	41.2	51.6 (10.4)
September	Below Normal	28.4	25.6 (-2.8)
September	Dry	2.6	5.1 (2.4)
September	Critically Dry	0.0	0.0 (0.0)
October	Wet	17.0	14.8 (-2.2)
October	Above Normal	20.7	21.5 (0.8)
October	Below Normal	28.9	27.6 (-1.4)
October	Dry	22.9	21.9 (-1.0)
October	Critically Dry	17.1	17.2 (0.1)

Month	Water Year Type	Baseline Conditions	Proposed Project
November	Wet	4.0	3.1 (-0.9)
November	Above Normal	0.0	0.0 (0.0)
November	Below Normal	6.1	5.5 (-0.6)
November	Dry	1.4	2.4 (1.0)
November	Critically Dry	1.5	2.3 (0.8)
December	Wet	7.9	8.1 (0.3)
December	Above Normal	0.0	0.0 (0.0)
December	Below Normal	2.7	5.1 (2.4)
December	Dry	8.0	6.3 (-1.8)
December	Critically Dry	4.7	5.8 (1.1)

Table 2D-1-A-4. Estimated Percent of Pacific Lamprey (April–July) and Western River Lamprey (February–June) Ammocoetes Stranded During 5-Year Rearing Period in the Feather River at Gridley Gauge and Differences in the Percentages (Proposed Project minus Baseline Conditions, in parentheses) for Baseline Conditions and the Proposed Project

Month	Water Year Type	Baseline Conditions	Proposed Project
February	Wet	69.0	69.0 (0.0)
February	Above Normal	23.5	22.9 (-0.7)
February	Below Normal	16.8	15.0 (-1.7)
February	Dry	10.4	10.9 (0.5)
February	Critically Dry	2.6	4.2 (1.6)
March	Wet	68.3	68.4 (0.0)
March	Above Normal	43.5	42.1 (-1.4)
March	Below Normal	19.0	19.2 (0.2)
March	Dry	7.4	7.4 (0.0)
March	Critically Dry	3.4	3.4 (0.0)
April	Wet	49.6	49.6 (0.0)
April	Above Normal	20.1	20.8 (0.8)
April	Below Normal	4.2	4.2 (0.0)
April	Dry	5.8	5.8 (0.1)
April	Critically Dry	10.7	10.7 (0.0)
May	Wet	54.0	54.0 (0.0)
May	Above Normal	26.8	26.8 (0.0)
May	Below Normal	12.7	9.3 (-3.3)
May	Dry	9.1	9.2 (0.1)
May	Critically Dry	2.2	3.0 (0.7)
June	Wet	46.2	46.6 (0.4)
June	Above Normal	36.1	35.3 (-0.8)
June	Below Normal	25.7	25.0 (-0.7)

Month	Water Year Type	Baseline Conditions	Proposed Project
June	Dry	35.6	33.8 (-1.9)
June	Critically Dry	27.9	26.6 (-1.3)
July	Wet	44.7	44.6 (-0.1)
July	Above Normal	60.5	60.3 (-0.2)
July	Below Normal	62.7	61.6 (-1.1)
July	Dry	58.6	58.7 (0.1)
July	Critically Dry	28.2	28.2 (0.0)

2D-1-A.3.7 Native Minnows (Sacramento Hitch, Sacramento Splittail, Hardhead)

Native minnows of management concern that reside in the Feather River include Hardhead, Sacramento Splittail, and Sacramento Hitch (Seesholtz et al. 2004). Central California Roach are not included in this analysis because although they may inhabit Feather River tributaries, there is no evidence that they inhabit the HFC (Seesholtz et al. 2004).

Hardhead are fairly common in the lower reaches of the Feather River and are considered a resident species with all life stages present (Moyle et al. 2015). Hardhead spawn mainly in April and May, but some may spawn as late as August (Moyle 2002; Wang 2010). They migrate upstream and into tributary streams to spawning sites, usually in April to May. They typically spawn in these months over gravel-bottomed riffles, runs, and at the head of pools (Moyle et al. 1995). A large portion of Hardhead spawning occurs in tributary streams and is therefore unaffected by flow changes resulting from the Proposed Project, but some Hardhead may spawn in the Feather River as well. Feather River HFC flows below the Thermalito Afterbay outlet are generally similar between Baseline Conditions and the Proposed Project during April and May (see Table 2D-1-2 and Figures 2D-1-16 and 2D-1-17 in the main memorandum text). Hardhead larvae and juveniles remain along stream edges with dense cover and move into deeper water as they grow, drifting downstream with the current (Moyle 2002). Flow during the summer/fall (July through November) is generally similar between the Proposed Project and Baseline Conditions, with a few somewhat larger positive and negative differences depending on month and water year type (see Table 2D-1-2 and Figures 2D-1-19 through 2D-1-23 in the main memorandum text). The month-to-month flow reduction results in Table 2D-1-A-3 provide a measure of potential stranding. The largest differences in month-to-month flow reductions occur during September/October (Table 2D-1-A-3), which is several months after the year's Hardhead cohort has hatched. Older Hardhead primarily inhabit pools and therefore are likely to be less affected by reductions in flow than younger life stages (Moyle et al. 2015). In general, the Proposed Project may have limited positive and negative flow effects on Hardhead relative to Baseline Conditions.

Adult Sacramento Splittail typically migrate upstream from the Delta in January and February and spawn in fresh water, particularly on inundated floodplains and side channels, during March and April (Sommer et al. 1997, 2008; Moyle et al. 2004). The eggs hatch in about a week and the larvae rear in inundated terrestrial habitat for about a month before developing into juveniles, which migrate back to the Delta (Sommer et al. 2008). Sacramento Splittail may use the lower Feather River during high flow years for spawning, egg incubation, and larval rearing from February through May. They utilize shallow flooded vegetation for spawning. Most spawning is thought to occur below the Yuba River confluence. During the winter and spring months that Sacramento Splittail occur in the Feather River, flows under the Proposed Project are generally similar to flows under Baseline Conditions (see Table 2D-1-2 and Figures 2D-1-13 through 2D-1-17 in the main memorandum text). Therefore, the Proposed Project is not expected to have a substantial effect on Sacramento Splittail in the lower Feather River relative to Baseline Conditions.

Sacramento Hitch are frequently observed in the Feather River from the Thermalito Afterbay outlet to the confluence with the Sacramento River (California Department of Water Resources 2003), although Seesholtz et al. (2004) found them to be rare in a four-year study of lower Feather River fishes. Sacramento Hitch are similar to Hardhead, spawning mainly in riffles of streams tributary to rivers, lakes, and reservoirs after flows increase in response to spring rains (Moyle et al. 2015). They spawn from April through June, when flows in the HFC below the Thermalito Afterbay outlet are generally similar between Baseline Conditions and the Proposed Project (see Table 2D-1-2 and Figures 2D-1-16 through 2D-1-18 in the main memorandum text). Young Sacramento Hitch spend the two months after hatching (i.e., in summer) shoaling in shallow water or staying close to areas of dense aquatic vegetation for cover before moving out into more open water. Under such conditions, flow reductions could force them from the cover, increasing their exposure to predation. However, the results of the month-to-month flow reduction analysis indicate that differences in flow reductions during summer (July/August) generally are limited (Table 2D-1-A-3).

Considering all potential Feather River flow effects, the Proposed Project is not expected to substantially affect the native minnow species in the Feather River relative to Baseline Conditions.

2D-1-A.3.8 Striped Bass

Striped Bass migrate into the Feather River to spawn when water temperatures reach at least 14 degrees Celsius (°C) and cease spawning runs when temperatures reach 21 °C (Moyle 2002). Water temperatures generally reach 14 °C during spring months, usually in late April through early June. Striped Bass are broadcast spawners with eggs that are free-floating and negatively buoyant. The eggs hatch as they drift downstream, with larvae occurring in shallow and open waters of the lower reaches of the Sacramento and San Joaquin rivers, and the Delta. Higher flows are thought to benefit conditions for migration of Striped Bass adults and the downstream dispersal of their eggs. Flows in the HFC below the Thermalito Afterbay outlet during the late April to June upstream migration period are generally similar between Baseline Conditions and Proposed Project (see Table 2D-1-2 and Figures 2D-1-16 through 2D-1-18 in the main memorandum text).

Considering all potential Feather River flow effects, the Proposed Project is not expected to substantially affect Striped Bass in the Feather River relative to Baseline Conditions.

2D-1-A.3.9 American Shad

American Shad migrate upstream in the Feather River starting in March, and typically spawn from April to June. American Shad eggs settle to the river bottom and drift downstream from spawning areas and hatch in about 2.5 days at 77 degrees Fahrenheit (°F) to about 8.5 days at 59 °F (Marschall et al. 2020). Larval American Shad are planktonic for about four weeks, after which they metamorphose to actively swimming juveniles. During the spring period of upstream migration, spawning, and development of the larvae, flows at the Thermalito Afterbay outlet are generally similar under the Proposed Project compared to Baseline Conditions (see Table 2D-1-2 and Figures 2D-1-15 through 2D-1-18 in the main memorandum text).

Juvenile American Shad rear in the lower Feather River below the Yuba River (Stevens et al. 1987) before moving downstream and entering saltwater during September through November. Although the importance of various potential mechanisms is unknown, the fall midwater trawl abundance index of juvenile American Shad in the Delta has been shown to be positively correlated with Delta inflow or outflow during the April through June spawning and nursery periods (Stevens et al. 1987; Moyle 2002; Kimmerer et al. 2009).[2] During the summer and fall juvenile rearing period, flows are generally similar between the Proposed Project and Baseline Conditions, with some positive and negative differences, the largest being up to 24 percent greater mean flow under the Proposed Project in September of Wet years (see Table 2D-1-2 and Figures 2D-1-19 through 2D-1-23 in the main memorandum text).

Considering all potential Feather River flow effects, the Proposed Project is not expected to substantially affect American Shad in the Feather River relative to Baseline Conditions.

2D-1-A.3.10 Black Bass

Three species of black bass (Largemouth Bass, Spotted Bass, and Smallmouth Bass) are among the resident fish species inhabiting Thermalito Afterbay and the Feather River HFC, although they are uncommon in the river (Seesholtz et al. 2004). In the Feather River, black bass are known to spawn in April through June with peak spawning by all species in May (California Department of Water Resources 2005). Black bass are nest builders that build their nests in littoral habitat, so the nests are vulnerable to effects of flow fluctuations, including dewatering when the flows fall. The month-to-month flow reduction results in Table 2D-1-A-3 show little difference between Baseline Conditions and the Proposed Project in flow reductions during the April through June spawning period. There are generally limited differences in flow between the Proposed Project and Baseline Conditions during other months as well, with somewhat larger differences in a limited number of water year type/month combinations (see Table 2D-1-2 and Figures 2D-1-13 through 2D-1-24 in the main memorandum text). During August, when black bass are rearing and foraging in the river and adjoining pools and backwaters (Moyle 2002), the flows are generally similar, with Dry year differences being larger (12 percent lower mean flow under the Proposed Project). Larger differences occur in September of Wet and Above Normal years (20 to 24 percent higher under the Proposed Project). Largemouth Bass and Spotted Bass generally prefer habitats with lower flow velocity, so positive and negative differences in flows could potentially negatively or positively negatively affect these species in the Feather River to some modest degree. However, the effects would be limited.

Considering all potential Feather River flow effects, the Proposed Project is not expected to substantially affect black bass in the Feather River relative to Baseline Conditions.

[2] See Chapter 6 in the Environmental Impact Report for Long-Term Operations of the State Water Project for the analysis of potential Delta outflow-related effects on American Shad, for which it was concluded that there would be a less-than-significant impact of the Proposed Project.

2D-1-A.4 References

2D-1-A.4.1 Printed References

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2D-1-A.4.2 Personal Communications

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Seesholtz A. 2021. Senior environmental scientist. California Department of Water Resources. April 14, 2021—Email to Sophie Unger, Senior Fish Biologist, ICF, Sacramento, CA.

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