Appendix 4A

Attachment 6: Scenario Related Changes to CalSim 3 and DSM2

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4A-6.1 Introduction

This document describes assumptions for scenario related changes to CalSim 3 and DSM2 utilized in this EIR. Scenario related changes include:

- CalSim 3 Artificial Neural Network
- Old and Middle River Flows

4A-6.2 CalSim 3 Artificial Neural Network

This section describes the method with which CalSim 3 estimates salinity in the Sacramento–San Joaquin Delta, and the update to the methodology for the application of the SMSCG operations detailed in the Summer-Fall Habitat Action of the Proposed Project.

4A-6.2.1 Description of the Artificial Neural Network

The representation of Delta hydrodynamics in CalSim 3 is simplified. Simulated Delta channel flows represent tidally averaged or freshwater flow averaged over a monthly timestep. Salinity in the Delta cannot be modeled accurately by the simple mass balance routing and coarse timestep used in CalSim 3. Salinity variation in the western Delta (represented by X2 location in the model) is affected by seawater intrusion. Delta salinity is also influenced by boundary inflows, operation of the DCC Gates, salinity of the San Joaquin River at Vernalis, export pumping, and SMSCG operations. Agricultural drainage and municipal and industrial wastewater discharges also can affect local salinity conditions. CalSim 3 uses an Artificial Neural Network (ANN) algorithm developed by DWR to translate water quality standards into flow equivalents that are to be met through SWP and CVP simulated operations (Sandhu et al. 1999). The ANN mimics the flow-salinity relationships as simulated in DSM2 and provides a rapid transformation of this information into a form usable by CalSim 3 operations. The ANN references DSM2 because it represents the best available planning model for Delta tidal hydraulic and salinity modeling. It is appropriate for describing the existing conditions in the Delta, as well as performing simulations for the assessment of incremental environmental impacts caused by future facilities and operations (U.S. Bureau of Reclamation 2015). It has been calibrated and validated to historical, observed flow, stage and EC data (California Department of Water Resources 2021).

A more detailed description of the use of ANNs in the CalSim model is provided in Wilbur and Munévar (2001). For more details regarding the implementation of the ANN in CalSim 3, please refer to Chapter 17, “Sacramento–San Joaquin Delta” in the CalSim 3 Report (California Department of Water Resources 2022).

4A-6.2.2 Update to ANN to Reflect the Summer/Fall SMSCG Operations in the Proposed Project

The SMSCG are located approximately 2 miles downstream from the confluence of the Sacramento and San Joaquin Rivers, on Montezuma Slough. The operation of the SMSCG aims to lower salinity in Montezuma Slough by restricting the flow of higher-salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower-salinity Sacramento River water from the previous ebb tide.

The Baseline Conditions and Proposed Project include measures to operate SMSCG in September through May to meet water quality objectives in the Marsh, and in June through October for the Summer-Fall Habitat Action (State Water Contractors 2017). Per the Summer-Fall Habitat Action in the Baseline Conditions and the Proposed Project, DWR will operate the SMSCG for up to 60 days in June–October of Above Normal years, Below Normal years, and Dry years following Wet, Above Normal, or Below Normal years. Instead of operating the SMSCG continuously (as done in the Baseline Conditions) for the Summer-Fall Habitat Action, the SMSCG cycle between tidal operations for seven days and remaining open for seven days, or a seven on, seven off schedule, in the Proposed Project. For more details regarding this action, see the Proposed Project description.

4A-6.2.2.1 Representation in CalSim 3

As described in Section 2.1, *Description of the Artificial Neural Network*, CalSim 3 uses an ANN to translate water quality standards into flow equivalents that are to be met through SWP and CVP simulated operations. The ANN is trained based on the flow-salinity relationships of DWR's hydrodynamic and water quality model, DSM2. To estimate the flow equivalents for the water quality standards, the ANN relies upon the seven inputs listed below:

1. Northern flow (Sacramento River, Yolo Bypass, Mokelumne River, Cosumnes River, and Calaveras River inflow)
2. San Joaquin River inflow
3. Exports (Banks, Jones, and Contra Costa Pumping Plants)
4. DCC gate operation
5. Net Delta channel depletion
6. Tidal energy (daily maximum – daily minimum of astronomical tides)
7. SMSCG gate operation (this modification was added to ANN after Jayasundara et al. 2020)

SMSCG operations reduce the effective Delta outflow through tidal pumping of Sacramento River waters through the Montezuma Slough. The degree to which effective Delta outflow changes is affected by the operational schedule of the SMSCG (continuous vs seven on, seven off). As such, the ANN was retrained to reflect the continuous and seven on, seven off operational schedules for the SMSCG.

4A-6.2.2.2 ANN Performance

After retraining the ANN to reflect the continuous and seven on, seven off operational schedules for the SMSCG, a CalSim 3 simulation was run with this new ANN. DSM2 HYDRO and QUAL were run with outputs from this CalSim 3 simulation. Then, monthly averaged EC results from the DSM2 QUAL simulation were compared against estimated EC values from the CalSim 3 simulation. A series of plots, comparing CalSim 3 EC estimates to DSM2 EC estimates at ANN output locations (Emmaton, Jersey Point, Collinsville, and X2) are provided below.

Both EC and X2 predictions from the ANN within CalSim 3 match DSM2 calculated EC values. EC scatter plot comparisons for Emmaton, Jersey Point, and Collinsville are shown in Figures 4A-6-1, 4A-6-2, and 4A-6-3, respectively. Figure 4A-6-4 shows a scatter plot comparison of ANN and DSM2 estimated X2. Each scatter plot includes a linear-regressed trend line, the slope of the trend line, and the fit (R-squared) of the trend line. Based on the slope of the trend line, the ANN estimate of EC falls within 2% of the DSM2 estimate of EC. Additionally, as displayed by the R-squared values that are all very close to 1, the scatter is very narrow throughout the simulations.

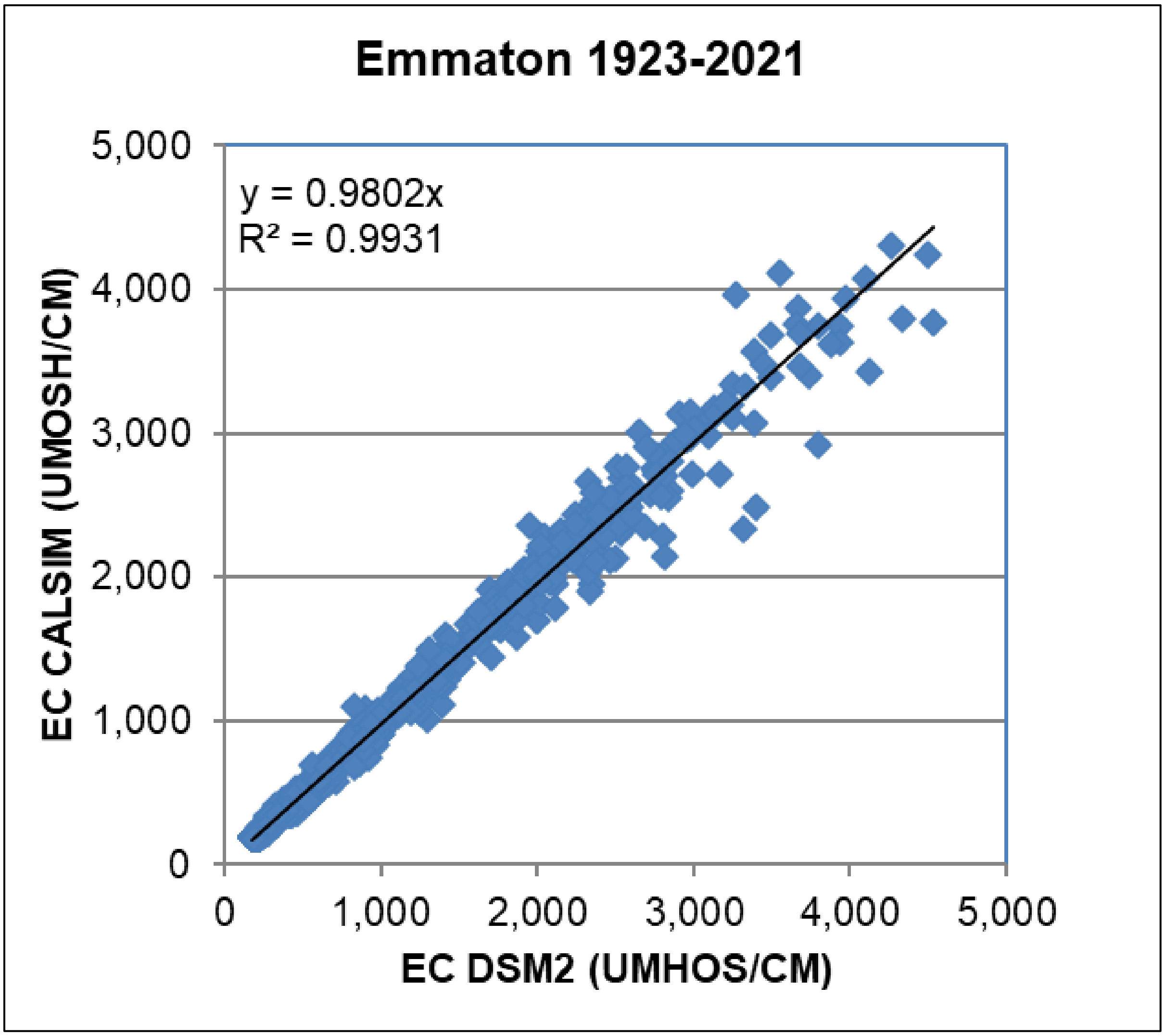

Figure 4A-6-1. Emmaton EC comparison for CalSim3 (ANN) vs DSM2

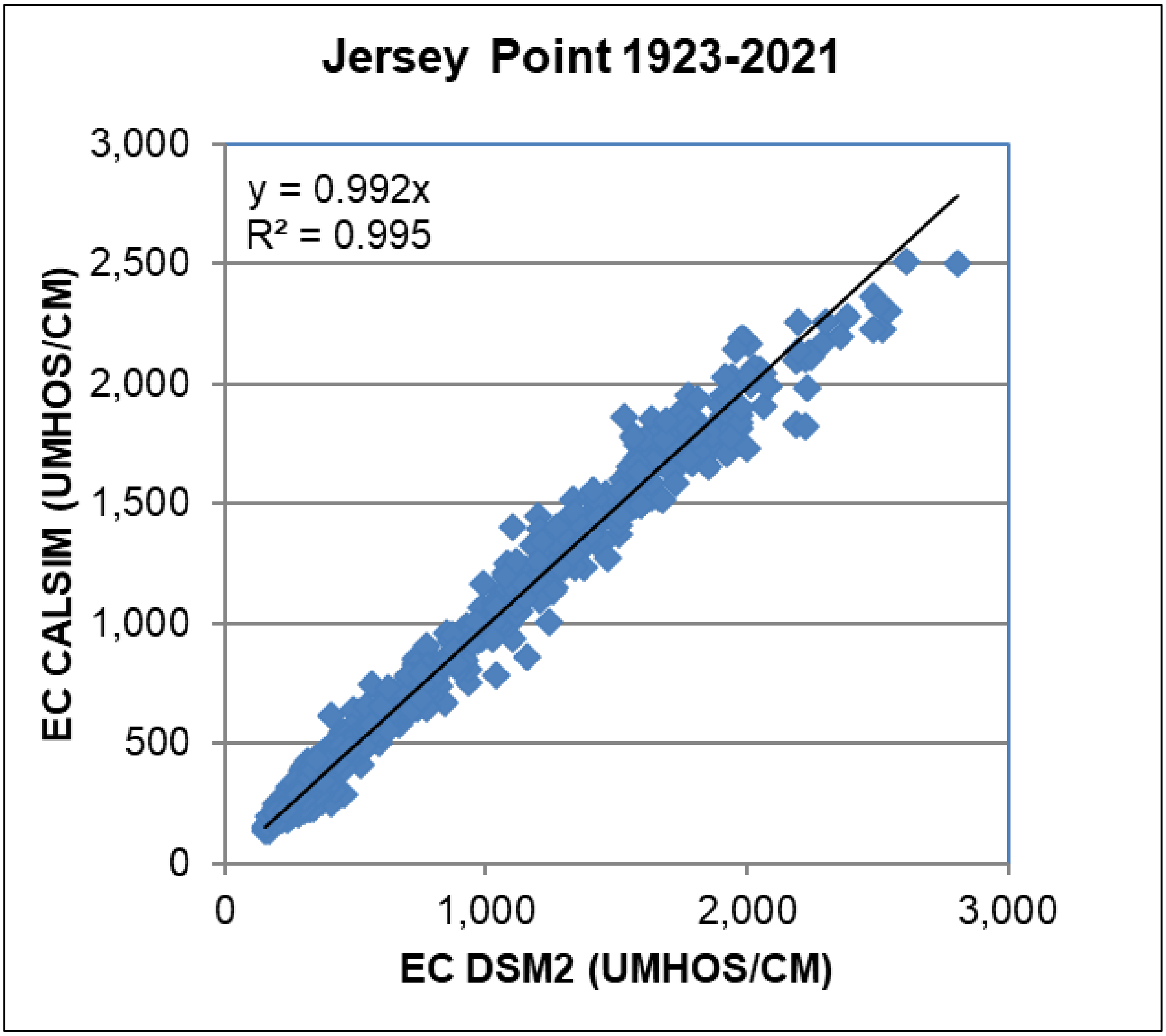

Figure 4A-6-2. Jersey Point EC comparison for CalSim3 (ANN) vs DSM2

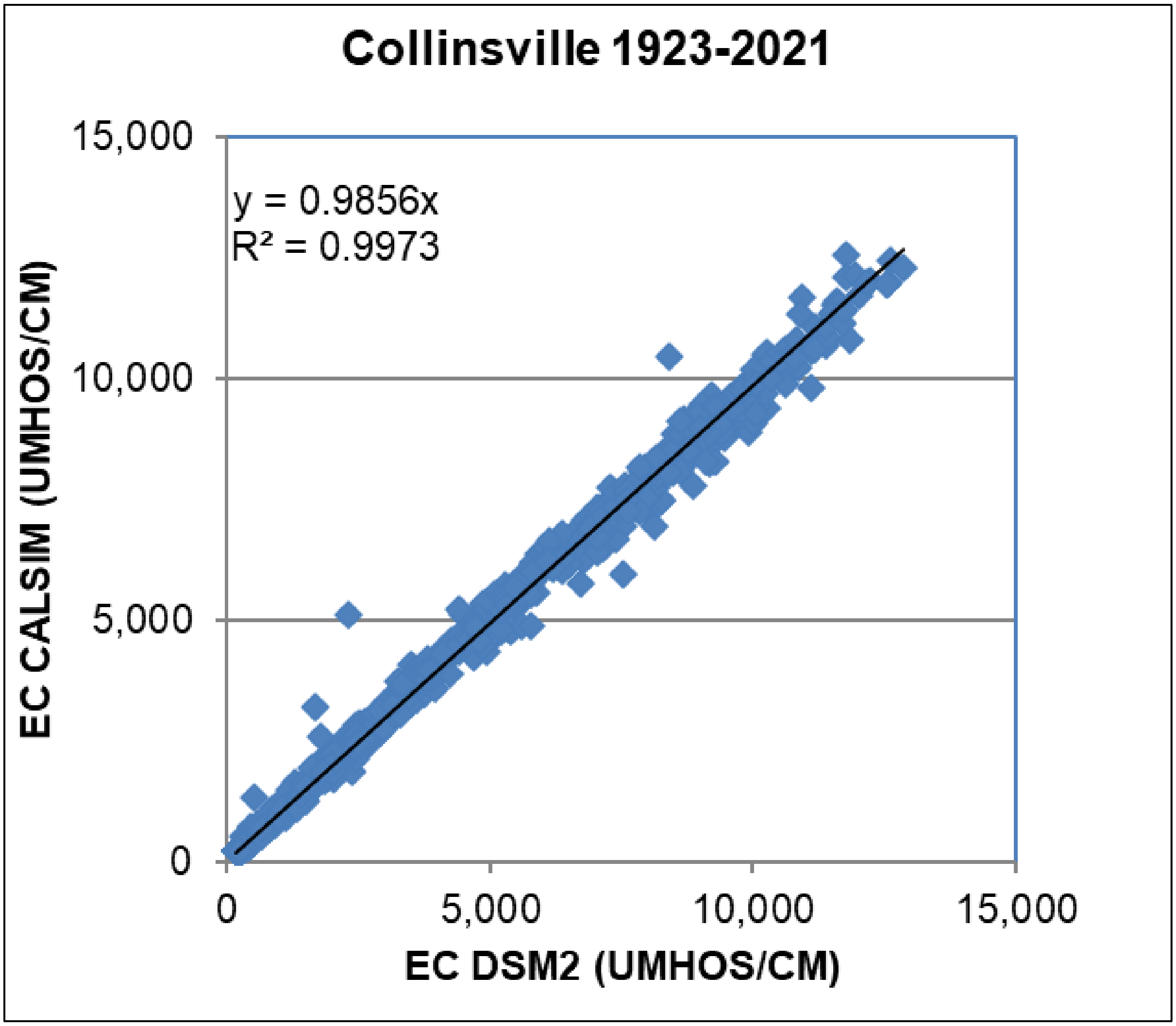

Figure 4A-6-3. Collinsville EC comparison for CalSim3 (ANN) vs DSM2

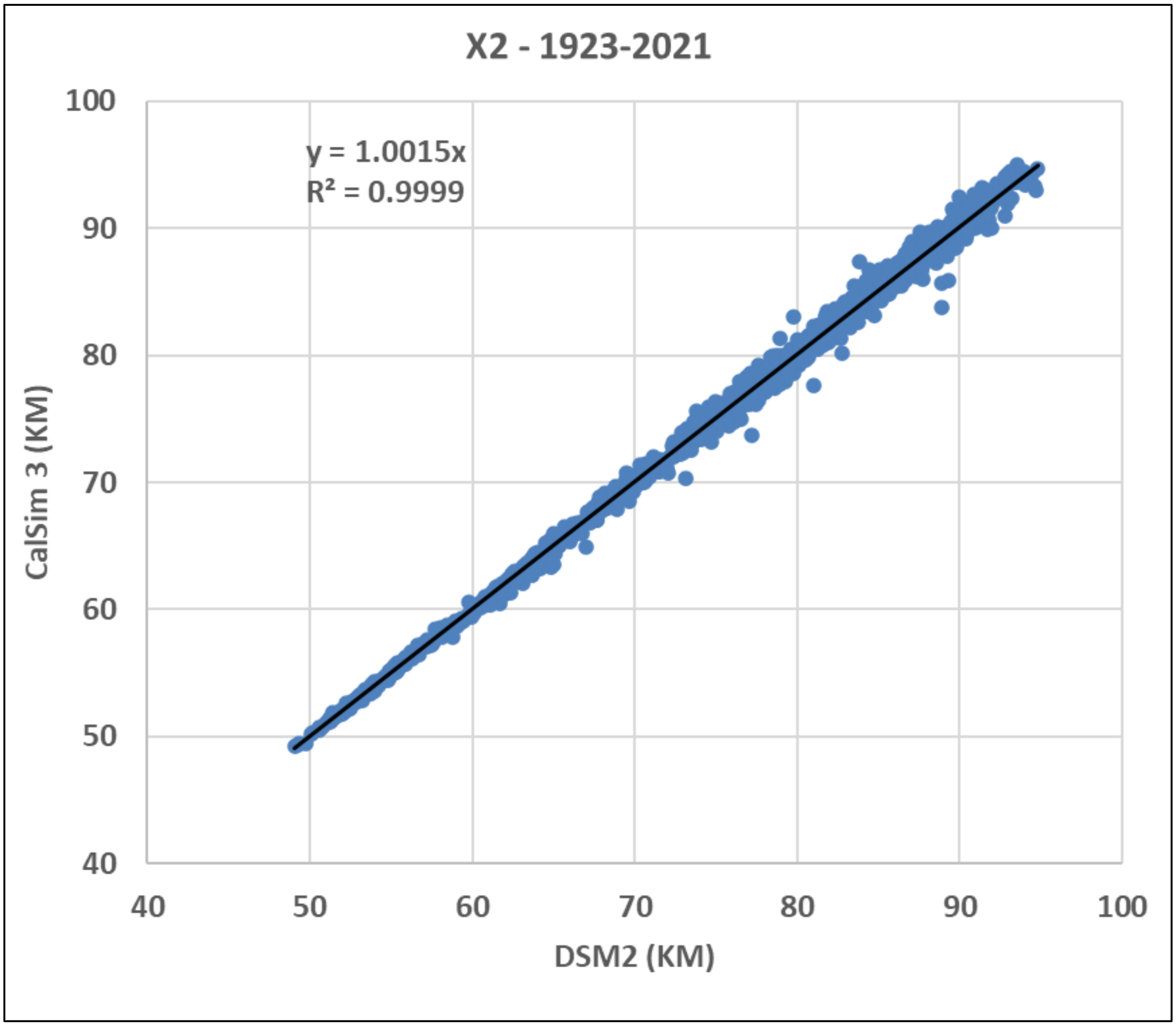

Figure 4A-6-4. X2 comparison for CalSim3 (ANN) vs DSM2

4A-6.3 Old and Middle River Flows

This section describes the method with which CalSim 3 represents OMR flows under the Baseline Conditions and Proposed Project.

4A-6.3.1 Baseline Conditions

Calculations of the net tidal flow in the OMR have been used in recent years as a surrogate for determining the relative influence of water project export rates on Delta aquatic species listed for Endangered Species Act protection under both federal and state law.

USFWS and NMFS issued BOs for delta smelt and Central Valley salmonids in 2019 (2019 BOs), and CDFW issued the incidental take permit (ITP) for the SWP in 2020. The 2019 BOs and the 2020 ITP included OMR restrictions to minimize potential loss of sensitive fish species due to water project exports.

4A-6.3.1.1 Previous Approach Used for CalSim Studies (2009 CalSim II Assumptions)

During the issuance of the 2019 BOs and 2020 ITP, there was a multi-agency effort to develop representations of these new OMR criteria in CalSim II for the purpose of estimating the operations of the SWP and CVP for water supply and California Environmental Quality Act/National Environmental Protection Act processes. Many of the assumptions were based on best guesses and limited data at the time. The methods used in estimating the OMR requirements are detailed in Attachments 1-4 and 1-5 of Appendix H of the 2020 ITP Final EIR.

4A-6.3.1.2 Proposed New Approach for CalSim Studies

As part of the development for the Proposed Project, previous assumptions under the Baseline Conditions (i.e., from the 2019 BOs and 2020 ITP) were reevaluated for consistency with the current understanding of OMR management. This review was especially necessary considering the availability of recent data; data from 2010 to 2022 was used to determine new assumptions for the Proposed Project and update previous assumptions for the Baseline Conditions.

This historical data was used to determine what percentage of each month (January through June) an OMR action would have been triggered, herein referred to as the "historical percentage of month" method. A hypothetical table for 2010 to 2022 OMR percentages is shown below in Table 4A-6-1.

Table 4A-6-1. 2010 to 2022 Hypothetical OMR Percentage

Year	Jan	Feb	Mar	Apr	May	Jun
2010	0%	4%	93%	18%	13%	0%
2011	0%	39%	93%	93%	93%	0%
2012	0%	0%	47%	93%	93%	0%
2013	0%	0%	64%	63%	93%	0%
2014	0%	0%	0%	0%	0%	0%
2015	0%	14%	93%	68%	33%	0%
2016	0%	39%	93%	68%	93%	0%
2017	0%	0%	43%	93%	93%	0%
2018	0%	0%	93%	93%	93%	0%
2019	0%	72%	93%	0%	58%	0%
2020	0%	0%	0%	0%	0%	0%
2021	0%	0%	0%	0%	0%	0%
2022	0%	0%	0%	0%	0%	0%

The values presented in Table 4A-6-1 were then averaged by water year type. The historical 50% exceedance forecast was used for the water year type for each month. Table 4A-6-2 shows the historical 50% exceedance forecasted water year types by year and month from 2010 to 2022. A breakdown of the data in Table 4A-6-2 by water year type is shown in Table 4A-6-3.

Table 4A-6-2. 2010 to 2022 Historical Water Year Type

Year	Jan	Feb	Mar	Apr	May	Jun
2010	D	BN	D	D	BN	BN
2011	AN	AN	BN	W	W	W
2012	BN	D	D	D	BN	BN
2013	W	BN	D	D	D	D
2014	C	C	C	C	C	C
2015	BN	C	C	C	C	C
2016	D	D	D	BN	BN	BN
2017	AN	W	W	W	W	W
2018	AN	BN	D	BN	BN	BN
2019	BN	BN	W	W	W	W
2020	BN	BN	D	D	D	D
2021	C	C	C	C	C	C
2022	BN	D	C	C	C	C

Table 4A-6-3. 2010 to 2022 Historical Water Year Type Summary

WY Type	Jan	Feb	Mar	Apr	May	Jun
C	2	3	4	4	4	4
D	2	3	6	4	2	2
BN	5	5	1	2	4	4
AN	3	1	0	0	0	0
W	1	1	2	3	3	3

Tables 4A-6-1 and 4A-6-2 were used to determine the average OMR percentage by water year type and month for input into CalSim 3. For example, there are three February Dry (D) years in the 2010 to 2022 data: 2012, 2016, and 2022. The respective OMR percentages for these months in Table 4A-6-1 are: 0%, 39%, and 0%. These percentages are averaged to get the Dry year OMR percentage for use in CalSim 3 (i.e., 13%). Because there are zero Above Normal (AN) water year types for March through June (as shown in Table 4A-6-3), the average of the Below Normal (BN) and Wet (W) water year types was used for these months. The OMR percentages by water year type and month are shown in Table 4A-6-4 for this hypothetical example.

Table 4A-6-4. 2010 to 2022 Historical Water Year Type Summary

WY Type	Jan	Feb	Mar	Apr	May	Jun
C	0%	5%	23%	17%	8%	0%
D	0%	13%	65%	44%	47%	0%
BN	0%	15%	93%	81%	73%	0%
AN	0%	39%	81%	71%	77%	0%
W	0%	0%	68%	62%	81%	0%

4A-6.3.1.3 Integrated Early Winter Pulse Protection (First Flush) Trigger and Criteria

In modeling the Baseline Conditions, the 2019 BOs Integrated Early Winter Pulse Protection or "First Flush" was assumed to be implemented under the following conditions:

- December, when the unimpaired Sacramento River Runoff (SRR) is greater than 20,000 cfs, or
- January, if no First Flush occurred in December and when the SRR is greater than 20,000 cfs.

The First Flush action is assumed to restrict OMR to -2,000 cfs for 14 days. Since CalSim utilizes a monthly timestep, this 14-day action is implemented using a weighted average with a background level. For December, the background level is -8,000 cfs, and for January, the background level is -5,000 cfs.

These assumptions were developed using Sacramento River at Freeport flow and turbidity data from 2008 to 2019. In addition, turbidity data from Sacramento River at Hood was used to populate and validate turbidity data at Freeport. Since the first flush is limited to the December to January period, the analyzed data was also limited to this timeframe. Turbidity is a parameter that is not simulated in CalSim; as such, a flow surrogate was used and consistent with past practice. SRR represents the unimpaired flow from the major tributaries to the Sacramento River. As shown in Figure 4A-6-5, the approximate transition where Freeport flow and turbidity levels would trigger a first flush is around an SRR of about 20,000 cfs.

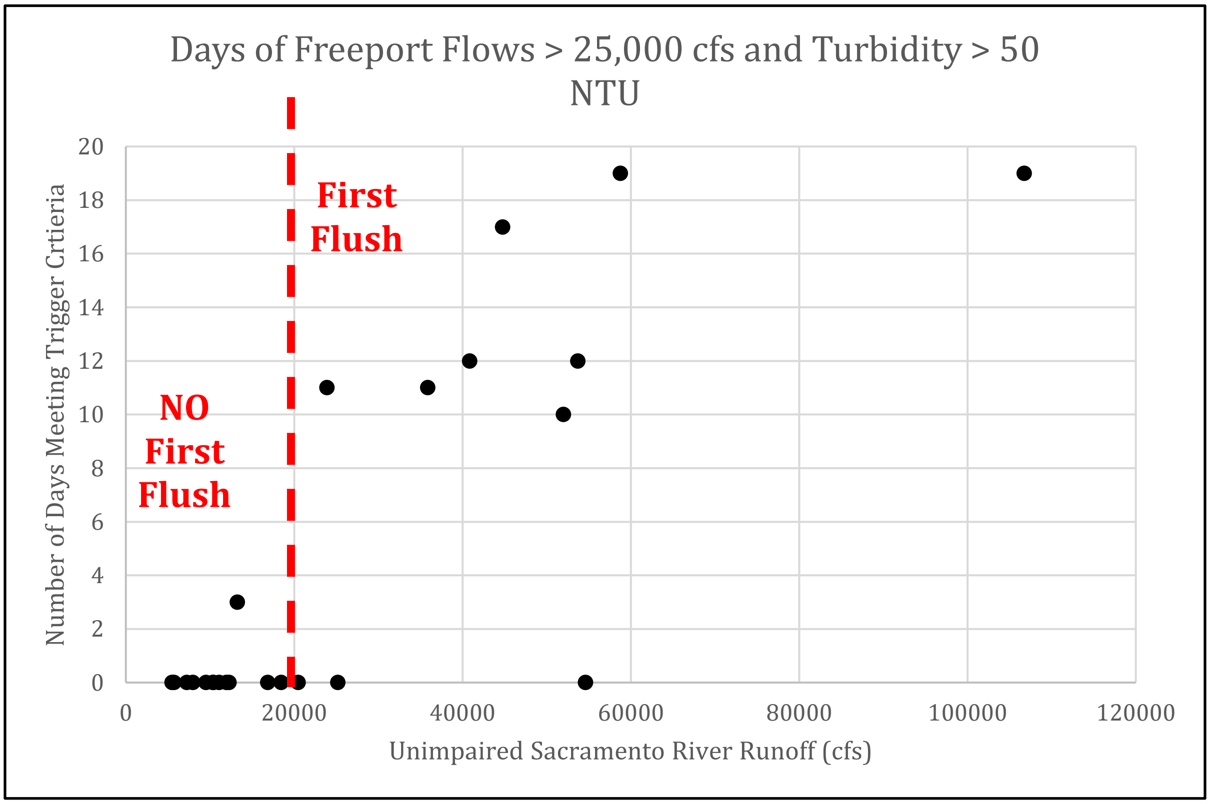

Figure 4A-6-5. Relationship between Sacramento River Runoff and the flow and turbidity at Freeport exceeding 25,000 cfs and 50 NTU.

4A-6.3.1.4 Turbidity bridge avoidance trigger and criteria

In modeling the Baseline Conditions, the turbidity bridge avoidance was assumed to apply an additional OMR requirement of -2,000 cfs for five days when the following conditions occur:

- Timeframe under which a turbidity avoidance action may occur:
  - January, if First Flush occurs in December or
  - February, if First Flush occurs in January or not at all
- SRR > 20,000 cfs

Like other turbidity-related actions, this requires the use of a surrogate to determine when an action is triggered. The turbidity station at Old River at Bacon Island (OBI) is in the interior Delta, south of the San Joaquin River. The complex hydrodynamics and water quality interactions at this location make accurately predicting turbidity difficult. However, the SRR is and has been used for other turbidity-based actions. Using historical OBI data from 2008 to 2019, daily average values above 12 NTU were summed for January and February. The resulting number of days per month exceeding 12 NTU were compared to the SRR for the same month (Figure 4A-6-6). The red line indicates the rough transition point using the SRR.

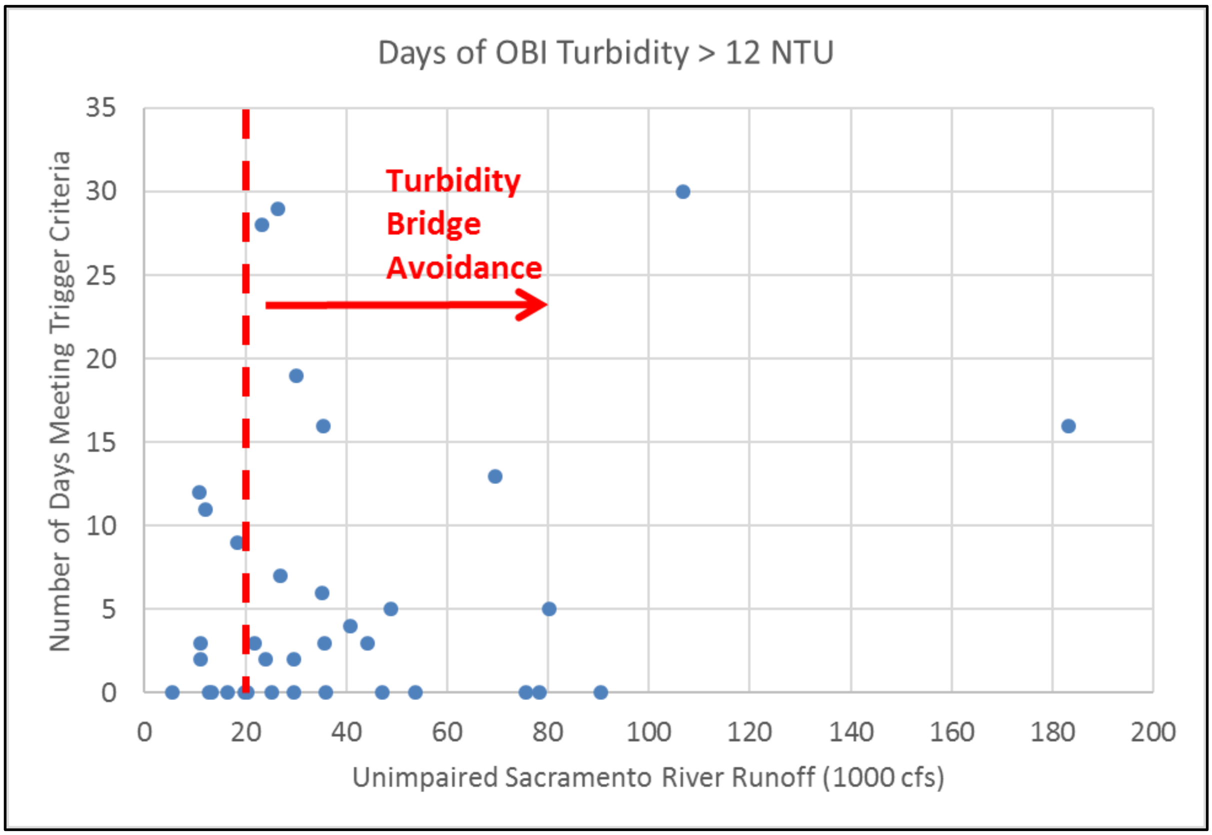

Figure 4A-6-6. Monthly Comparison of Number of Days in Month Exceeding 12 NTU at OBI and SRR

This relationship could be stronger, but it should be recognized that the location of OBI is subject to many variables, such as wind-driven turbidity and lower turbidity due to proactive project operations that are embedded in the data. In general, the historic data resulted in a 72% frequency of a triggering event. Using an SRR surrogate of 20,000 cfs results in a 61% triggering frequency.

4A-6.3.1.5 OMR Flex Trigger and Criteria

In modeling the Baseline Conditions, OMR Flex was assumed to be -6,250 cfs for up to six days under the following conditions:

- Delta in Excess
- X2< 81 km
- Sacramento River Runoff < 20,000 cfs
- Qwest > +1,000 cfs
- January and February

Historically, the Projects have not operated to the OMR Storm Flex and the criteria above only occurs a handful of times in the Baseline Conditions CalSim 3 model.

4A-6.3.1.6 Salvage Loss Thresholds Trigger and Criteria

The Baseline Conditions include real-time OMR management actions based on percent of winter-run Chinook Salmon and Central Valley steelhead salvaged relative to proposed Single Year Loss Thresholds (described in Attachments 1-4 and 1-5 of Appendix H of the 2020 ITP Final EIR).

The salvage loss threshold OMR assumption was modified from previous analyses to ensure consistent methodology with the Proposed Project, using the historical percentage of month method.

Historic salvage data, based on the length at date Delta Model (LAD), at the fish facilities at Banks and Jones pumping plants for WY 2010 to 2022 ~~and fish catch data at Chipps Island trawl during WY 2017 to 2021~~ were analyzed. Historic salvage data provides the potential timing of triggering the 50% levels of the proposed single year loss thresholds. For modeling purposes, it is assumed that if the 50% level is triggered, the 75% level would not be triggered. Loss thresholds were identified for the December to June period for winter-run Chinook Salmon. For Central Valley steelhead, separate loss thresholds were identified for December to March and April to May. Table 4A-6-5 summarizes the 2010 to 2022 historic salvage data for winter-run and steelhead.

Table 4A-6-5. 2010-2022 Historical Winter-Run and Steelhead Salvage Loss

Water Year	Steelhead Dec–Mar	Steelhead Apr–May	WR Natural	WR Hatchery
2010	~~10~~ 11 -Feb	-	-	~~-~~ 7-Mar
2011	~~15-Feb~~ 7-Mar	~~7~~ 13 -May	~~29-Mar~~ 22-Feb	-
2012	~~22~~ 31 -Mar	-	~~31~~ 9 -Mar	-
2013	~~9~~ 25 -Mar	~~9-Apr~~ 1-May	-	-
2014	-	-	-	-
2015	~~22-Feb~~ -	-	-	-
2016	~~15-Feb~~ -	-	-	-
2017	-	-	-	-
2018	~~5~~ 26 -Mar	~~6~~ 8 -Apr	-	-
2019	~~6-Feb~~ 11-Mar	~~11-May~~	-	-
2020	-	-	-	-
2021	-	-	-	-
2022	-	-	-	-

The salvage data above was summarized to the percent of the month the threshold would trigger. For example, the 2011 steelhead (December to March) loss threshold triggered on ~~February 15~~ March 7; therefore, OMR would be -3,500 cfs from ~~February 16~~ March 8 through March 31. Similarly, the steelhead (April to June) loss threshold was triggered on May ~~7~~ 13; therefore, OMR would be -3,500 cfs from May ~~8~~ 14 through May 31. Finally, the winter-run loss threshold was triggered ~~March 29~~ February 22; it was assumed that OMR would be -3,500 cfs from ~~May 8~~ February 23 through May 31. The weekly triggers for the entire 2010 to 2022 period are summarized in Tables 4A-6-6 and 4A-6-7 below. Decimal values represent the fraction of a given week that a trigger would be in effect. For example, a value of 0.43 indicates that a trigger would be in effect three days out of a given week (3/7=0.43). Values of 1 and 0 represent a full week and no action being triggered, respectively.

Table 4A-6-6. 2010–2022 Historical Winter-Run Loss OMR Triggers

Water Year	1/1–1/7	1/8–1/14	1/15–1/21	1/22–1/28	1/29–2/4	2/5–2/11	2/12–2/18	2/19–2/25	2/26–3/4	3/5–3/11	3/12–3/18	3/19–3/25	3/26–4/1	4/2–4/8	4/9–4/15	4/16–4/22	4/23–4/29	4/30–5/6	5/7–5/13	5/14–5/20	5/21–5/27	5/28–6/3
2010	0	0	0	0	0	0	0	0	0	~~0~~ 0.71	~~0~~ 1	~~0~~ 0.43	~~0.5~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0
2011	0	0	0	0	0	0	0	0.57	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1	1	1	1	1	1	1	1	1	1
2012	0	0	0	0	0	0	0	0	0	~~0~~ 0.43	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1
2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4A-6-7. 2010–2022 Historical Steelhead Loss OMR Triggers

Water Year	1/1–1/7	1/8–1/14	1/15–1/21	1/22–1/28	1/29–2/4	2/5–2/11	2/12–2/18	2/19–2/25	2/26–3/4	3/5–3/11	3/12–3/18	3/19–3/25	3/26–4/1	4/2–4/8	4/9–4/15	4/16–4/22	4/23–4/29	4/30–5/6	5/7–5/13	5/14–5/20	5/21–5/27	5/28–6/3
2010	0	0	0	0	0	~~0.29~~ 0.14	1	1	1	1	1	1	~~1~~ 0.86	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	~~0.43~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0.71	1	1	~~1~~ 0.86	0	0	0	0	0	~~1~~ 0.14	1	1	1
2012	0	0	0	0	0	0	0	0	0	0	0	~~0.43~~ 0	~~1~~ 0.14	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	~~0.29~~ 0	~~1~~ 0	~~1~~ 0.14	~~1~~ 0.86	0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0.86	1	1	1	1
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	~~0.43~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	~~0.43~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0.86	~~0.43~~ 0.14	1	1	1	1	1	1	1	1
2019	0	0	0	0	0	~~0.86~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0	~~1~~ 0.14	1	1	~~1~~ 0.86	0	0	0	0	0	0	~~1~~ 0	~~1~~ 0	~~1~~ 0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

4A-6.3.1.7 Larval and Juvenile Delta Smelt

The Baseline Conditions previously assumed larval and juvenile Delta Smelt were covered by the same assumption made for winter-run and steelhead. However, to ensure consistency with the assumptions made for the Proposed Project, the Baseline Conditions assumption was updated. The historical Secchi depth data for larval and juvenile Delta Smelt data was analyzed and summarized for weeks when the Secchi depth is less than 100 centimeters (cm). Table 4A-6-8 summarizes occurrences for Secchi depths less than 100 cm for larval and juvenile Delta Smelt, which would have triggered a potential OMR action to protect larval and juvenile Delta Smelt (~~1=trigger~~ >0=fraction of week that a trigger would be in effect , 0=no trigger) during the 2010 to 2022 period.

Table 4A-6-8. 2010–2022 Historical Larval and Juvenile Delta Smelt Triggers

Water Year	2/26–3/4	3/5–3/11	3/12–3/18	3/19–3/25	3/26–4/1	4/2–4/8	4/9–4/15	4/16–4/22	4/23–4/29	4/30–5/6	5/7–5/13	5/14–5/20	5/21–5/27	5/28–6/03	6/4–6/10	6/11–6/17	6/18–6/24	6/25–7/1
2010	1	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
2011	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0	0	0
2013	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	1	1	0	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0
2016	0	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1	1
2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2018	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
2019	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

4A-6.3.1.8 Larval and Juvenile Longfin Smelt

The Baseline Conditions assumes larval Longfin Smelt are covered by the assumption made for winter-run and steelhead.

4A-6.3.1.9 Combining Winter-Run, Steelhead, and Delta Smelt for Input into CalSim 3

Tables 4A-6-6 through 4A-6-8 were combined into one table, Table 4A-6-9, to determine the combined weekly triggers for winter-run, steelhead, and larval Delta Smelt (>0=fraction of week that a trigger would be in effect, 0=no trigger). This information was then summarized by percent of month and water year type. Table 4A-6-10 and Table 4A-6-11 summarize the combined 2010 to 2022 OMR percentage and water year type lookup table that was used for CalSim 3, respectively.

Table 4A-6-9. 2010–2022 Historical Winter-Run, Steelhead, and Juvenile Delta Smelt Loss

Water Year	1/1–1/7	1/8–1/14	1/15–1/21	1/22–1/28	1/29–2/4	2/5–2/11	2/12–2/18	2/19–2/25	2/26–3/4	3/5–3/11	3/12–3/18	3/19–3/25	3/26–4/1	4/2–4/8	4/9–4/15	4/16–4/22	4/23–4/29	4/30–5/6	5/7–5/13	5/14–5/20	5/21–5/27	5/28–6/3
2010	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.3~~ 0.14	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 0.86	~~1.0~~ 0	~~1.0~~ 0	~~1.0~~ 0	~~1.0~~ 1	~~1.0~~ 0	~~1.0~~ 0	~~1.0~~ 0	~~1.0~~ 1	~~1.0~~ 0
2011	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.4~~ 0	~~1.0~~ 0.57	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 0
2012	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0.43	~~0.0~~ 1	~~0.4~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~0.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 0
2013	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.3~~ 0	~~1.0~~ 0	~~1.0~~ 0.14	~~1.0~~ 0.86	~~0.0~~ 0	~~1.0~~ 0	~~1.0~~ 0	~~1.0~~ 0	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 0
2014	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0
2015	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.4~~ 0	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 0	~~1.0~~ 1	~~1.0~~ 1	~~0.0~~ 0	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0
2016	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.4~~ 0	~~1.0~~ 0	~~1.0~~ 0	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~0.0~~ 0	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 0
2017	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 0
2018	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~1.0~~ 0	~~1.0~~ 0	~~1.0~~ 0	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 0
2019	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.9~~ 0	~~1.0~~ 0	~~1.0~~ 0	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 1	~~1.0~~ 0.86	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~1.0~~ 0	~~1.0~~ 0	~~1.0~~ 0
2020	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0
2021	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0
2022	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0	~~0.0~~ 0

Table 4A-6-10. 2010–2022 Historical Winter-Run, Steelhead, and Juvenile Delta Smelt Loss OMR Percentage

Water Year	Jan	Feb	Mar	Apr	May	Jun
2010	0%	~~57~~ 54%	~~100~~ 97%	~~100~~ 25%	~~100~~ 25%	0%
2011	0%	~~36~~ 14%	100%	100%	100%	0%
2012	0%	0%	~~29~~ 69%	~~75~~ 100%	100%	0%
2013	0%	0%	~~66~~ 20%	~~75~~ 0%	100%	0%
2014	0%	0%	0%	0%	0%	0%
2015	0%	~~11~~ 0%	~~100~~ 80%	75%	50%	0%
2016	0%	~~36~~ 0%	~~100~~ 80%	75%	100%	0%
2017	0%	0%	100%	100%	100%	0%
2018	0%	0%	~~80~~ 20%	100%	100%	0%
2019	0%	~~71~~ 0%	~~100~~ 97%	0%	~~50~~ 0%	0%
2020	0%	0%	0%	0%	0%	0%
2021	0%	0%	0%	0%	0%	0%
2022	0%	0%	0%	0%	0%	0%

Table 4A-6-11. OMR Percentage by Water Year Type for Input into CalSim 3

Water Year Type	Jan Avg	Feb Avg	Mar Avg	Apr Avg	May Avg	Jun Avg
C	0%	~~4~~ 0%	~~25~~ 20%	19%	13%	0%
D	0%	~~12~~ 0%	~~62~~ 48%	~~63~~ 31%	50%	0%
BN	0%	~~26~~ 11%	100%	88%	~~100~~ 81%	0%
AN	0%	~~36~~ 14%	~~100~~ 99%	77%	~~92~~ 74%	0%
W	0%	0%	~~100~~ 99%	67%	~~83~~ 67%	0%

Table 4A-6-11 was used as a lookup table in CalSim 3, and the percentage shown for each month is assumed to be at a -3,500 OMR index. For example, March in Dry years is assumed to be at -3,500 OMR index for ~~62~~ 48% of the month.

4A-6.3.2 Proposed Project

The following OMR criteria were implemented in the Proposed Project CalSim 3 model.

4A-6.3.2.1 Winter-Run Early Season Migration

In modeling the Proposed Project, the winter-run early season migration was not modeled; historical data indicated that the action did not trigger and there was not enough data to develop an assumption for CalSim 3 (Table 4A-6-12).

Table 4A-6-12. 2010–2022 Winter-Run Early Season Migration Loss and Trigger

WR_WY	November Loss	RB Juvenile Total	Limit	Trigger	Year	WYT	December Loss	RB Juvenile Total	Limit	Trigger
2010	0.00	4237821	~~559~~ 368.72	0	2010	BN	~~3.78~~ 3.01	4302153	~~1140~~ 714.60	0
2011	0.00	11002840	~~146~~ 95.95	0	2011	W	~~25.21~~ 30.94	1234434	~~327~~ 205.04	0
2012	0.00	605098	~~80~~ 52.65	0	2012	BN	0.00	715359	~~190~~ 118.82	0
2013	0.00	628082	~~83~~ 54.65	0	2013	D	4.93	866852	~~230~~ 143.99	0
2014	0.00	636764	~~84~~ 25.35	0	2014	C	0.00	1249821	~~331~~ 95.00	0
2015	0.00	279954	~~37~~ 19.08	0	2015	C	0.00	354876	~~94~~ 46.17	0
2016	0.00	217489	~~29~~ 14.82	0	2016	BN	0.00	252675	~~67~~ 32.87	0
2017	0.00	363832	~~48~~ 27.10	0	2017	W	0.00	484841	~~128~~ 68.93	0
2018	0.00	283674	~~37~~ 23.61	0	2018	BN	0.00	407410	~~108~~ 64.73	0
2019	0.00	707433	~~93~~ 57.71	0	2019	W	0.00	884916	~~235~~ 137.82	0
2020	0.00	3217093	~~425~~ 158.83	0	2020	D	0.00	3684857	~~976~~ 347.31	0
2021	0.00	1467024	~~194~~ 59.65	0	2021	C	0.00	1759210	~~466~~ 136.56	0
2022	0.00	434371	~~57~~ 18.71	0	2022	C	0.00	544541	~~144~~ 44.78	0

4A-6.3.2.2 OMR Management Season and First Flush Trigger and Criteria

In modeling the Proposed Project, OMR management begins in December and ends in June with the OMR index no more negative than -5,000 cfs unless Storm Flex is initiated.

The First Flush was assumed to be same as the Baseline Conditions; however, this action was extended to include the month of February.

The First Flush action is assumed to restrict OMR to -2,000 cfs for 14 days when SRR > 20,000 cfs.

End of OMR Management Season was evaluated by examining the following:

- Historical 3-day average water temperature at Clifton Court Forebay (California Data Exchange station CLC) being 25 degrees Celsius (°C) or higher for Delta Smelt, and
- Historical daily water temperature at Mossdale (MSD) and Prisoner's Point (PPT) exceeding 22.2 °C for seven, non-consecutive days for salmonids.

Table 4A-6-13 shows that most of these temperature thresholds are met towards the end of June; therefore, the OMR management season extends through June in the CalSim 3 model.

Table 4A-6-13. 2010–2022 Water Temperature Data for Delta Smelt (CLC) and Salmonids (MSD and PPT)

Year	Clifton Court Forebay (CLC)	Mossdale (MSD)	Prisoner’s Point (PPT)
2010	30-Jun	-	-
2011	30-Jun	30-Jun	-
2012	30-Jun	30-Jun	-
2013	30-Jun	30-Jun	-
2014	9-Jun	30-Jun	-
2015	11-Jun	30-Jun	-
2016	5-Jun	30-Jun	-
2017	23-Jun	30-Jun	-
2018	25-Jun	30-Jun	-
2019	30-Jun	30-Jun	-
2020	26-Jun	30-Jun	2-Jun
2021	21-Jun	30-Jun	7-Jun
2022	27-Jun	30-Jun	22-Jun

4A-6.3.2.3 Turbidity Bridge Avoidance Trigger and Criteria

In modeling the Proposed Project, the turbidity bridge avoidance was assumed to apply an additional OMR requirement of -3,500 cfs for ~~10~~ 12 days when the following conditions occur:

- Timeframe under which a turbidity avoidance action may occur:
  - January, if First Flush occurs in December, or
  - February, if First Flush occurs in January or not at all,
- SRR > 20,000 cfs
- Highflow Offramp when Vernalis flows above 10,000 cfs

Like other turbidity-related actions, this requires the use of a surrogate to determine when an action is triggered. Like the Baseline Conditions, the Proposed Project looks at the turbidity station at OBI. However, the Proposed Project also considers Holland Cut (HOL) and Old River at Highway 4 (OH4). Using historical OBI, HOL, and OH4 data from 2009 to 2023, daily average values above 12 NTU for all three stations were summed for the months of January and February. The resulting number of days per month exceeding 12 NTU at OBI, HOL, and OH4 were compared to the SRR for the same month (Figure 4A-6-7). The red line indicates the rough transition point using the SRR. The average days for the points that met the trigger is ~~10~~ 12 days.

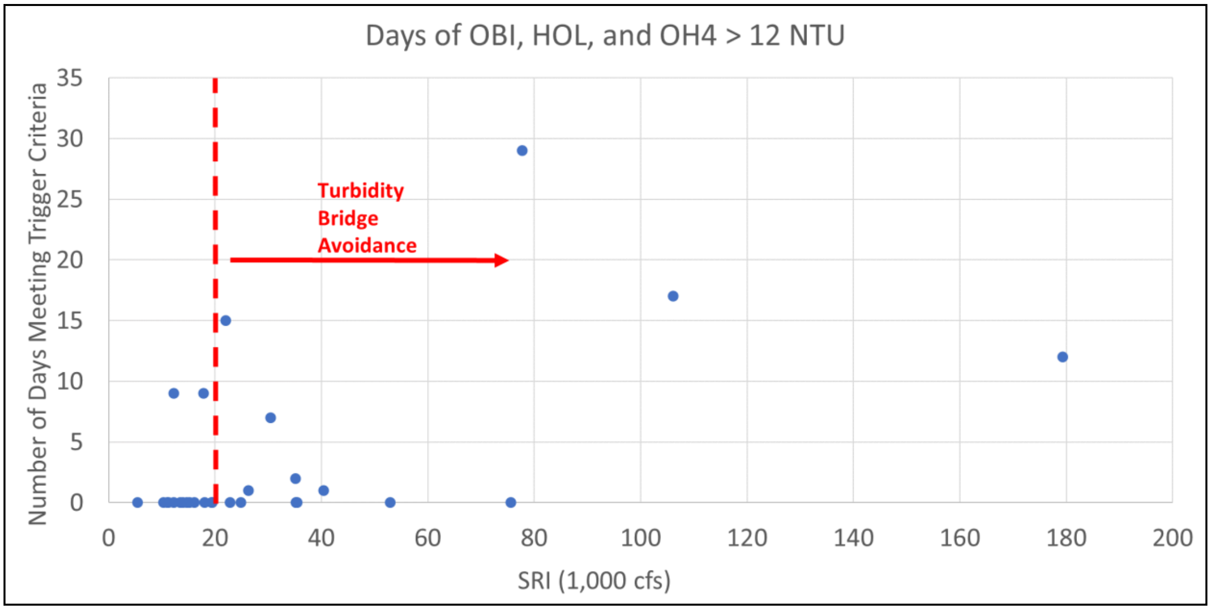

Figure 4A-6-7. Monthly Comparison of Number of Days in Month Exceeding 12 NTU at OBI, HOL, and OH4 and SRR

This relationship could be stronger, but it should be recognized that the locations of OBI, HOL, and OH4 are subject to many variables, such as wind-driven turbidity and lower turbidity due to proactive project operations that are embedded in the data.

4A-6.3.2.4 Adult Longfin Smelt

In modeling the Proposed Project, the adult Longfin Smelt OMR assumption is based on the observed salvage of Longfin Smelt greater or equal to 60 mm at ~~both~~ the CVP and SWP fish salvage facilities. The OMR action was triggered in weeks where this observed salvage exceeded the salvage threshold (e.g., based upon calculations using the San Francisco Bay Study Longfin Smelt Age 1+ Index from the previous August to December).

Table 4A-6-14 summarizes the sampling data for adult Longfin Smelt which would have triggered a potential OMR action (~~1=trigger~~ >0=fraction of week that a trigger would be in effect , 0=no trigger) during the 2010 to 2022 period.

Table 4A-6-14. 2010–2022 Historical Adult Longfin Smelt Trigger

Water Year	1/1–1/7	1/8–1/14	1/15–1/21	1/22–1/28	1/29–2/4	2/5–2/11	2/12–2/18	2/19–2/25	2/26–3/4	3/5–3/11	3/12–3/18	3/19–3/25	3/26–4/1
2010	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	1	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0

4A-6.3.2.5 Larval and Juvenile Delta Smelt

In modeling the Proposed Project, the larval and juvenile Delta Smelt OMR assumption was the same as the larval and juvenile Delta Smelt criteria in the Baseline Conditions. This action also includes a highflow offramp when Rio Vista flows exceed 55,000 cfs or Vernalis flows exceed 8,000 cfs. Table 4A-6-15 summarizes when surveys would have triggered a potential OMR action to protect larval and juvenile Delta Smelt (~~1=trigger~~ >0=fraction of week that a trigger would be in effect , 0=no trigger) during the 2010 to 2022 period.

Table 4A-6-15. 2010–2022 Historical Larval and Juvenile Delta Smelt Trigger

Water Year	2/26–3/4	3/5–3/11	3/12–3/18	3/19–3/25	3/26–4/1	4/2–4/8	4/9–4/15	4/16–4/22	4/23–4/29	4/30–5/6	5/7–5/13	5/14–5/20	5/21–5/27	5/28–6/3	6/4–6/10	6/11–6/17	6/18–6/24	6/25–7/1
2010	1	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
2011	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0	0	0
2013	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	1	1	0	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0
2016	0	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1	1
2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2018	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
2019	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

4A-6.3.2.6 Larval and Juvenile Longfin Smelt

In modeling the Proposed Project, the juvenile Longfin Smelt OMR assumption was based on the historical Smelt Larva Survey (SLS), or 20-mm survey at stations 809 and 812, exceeding the catch threshold set by the San Francisco Bay Study Longfin Smelt Age 1+ Index. Table 4A-6-16 summarizes when the surveys would have triggered a potential OMR action to protect larval and juvenile Longfin Smelt (~~1=trigger~~ >0=fraction of week that a trigger would be in effect , 0=no trigger) during the 2010 to 2022 period.

This action also includes a highflow offramp when Rio Vista flows are above 55,000 cfs or Vernalis flows are above 8,000 cfs.

Table 4A-6-16. 2010–2022 Historical Larval and Juvenile Longfin Smelt Trigger

Water Year	1/1–1/7	1/8–1/14	1/15–1/21	1/22–1/28	1/29–2/4	2/5–2/11	2/12–2/18	2/19–2/25	2/26–3/4	3/5–3/11	3/12–3/18	3/19–3/25	3/26–4/1	4/2–4/8	4/9–4/15	4/16–4/22	4/23–4/29	4/30–5/6	5/7–5/13	5/14–5/20	5/21–5/27	5/28–6/3
2010	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	1	0	1	1	1	0	0	0	1	0	1	0	0	0	1	0	0	0
2014	1	0	0	1	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
2016	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	1	0	1	0	1	0	1	1	1	1	1	0	1	0	0	0	0	0	0

4A-6.3.2.7 Winter-Run Chinook Salmon Annual Loss Threshold

In modeling the Proposed Project, the winter-run Chinook Salmon Annual Loss Threshold OMR assumption was the same as the Baseline Conditions. Table 4A-6-17 summarizes when the loss threshold would have triggered a potential OMR action to protect winter-run Chinook Salmon (~~1=trigger~~ ≥0=fraction of week that a trigger would be in effect , 0=no trigger) during the 2010 to 2022 period.

Table 4A-6-17. 2010–2022 Historical Winter-Run Chinook Salmon Annual Loss Threshold Trigger

Water Year	2/26–3/4	3/5–3/11	3/12–3/18	3/19–3/25	3/26–4/1	4/2–4/8	4/9–4/15	4/16–4/22	4/23–4/29	4/30–5/6	5/7–5/13	5/14–5/20	5/21–5/27	5/28–6/3	6/4–6/10	6/11–6/17	6/18–6/24	6/25–7/1
2010	0	~~0~~ 0.71	~~0~~ 0.43	~~0~~ 1	~~0~~ 0.71	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	~~0~~ 0.71	~~0~~ 1	~~0~~ 1	1	~~1~~ 0.14	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	~~0~~ 0.14	~~0~~ 1	~~0~~ 0.14	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	~~0~~ 1	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

4A-6.3.2.8 Winter-Run Chinook Salmon Weekly Loss Threshold

In modeling the Proposed Project, the winter-run Chinook Salmon Weekly Loss Threshold OMR assumption was based on historical loss data of genetically confirmed natural origin juvenile winter-run Chinook Salmon and, for WY 2022, loss of two LAD juvenile winter-run samples that failed during the analysis process. Table 4A-6-18 summarizes when the loss threshold would have triggered a potential OMR action to protect winter-run Chinook Salmon (1=trigger >0=fraction of week that a trigger would be in effect , 0=no trigger) during the 2010 to 2022 period.

Table 4A-6-18. 2010–2022 Historical Winter-Run Chinook Salmon Weekly Loss Threshold Trigger

Water Year	1/1–1/7	1/8–1/14	1/15–1/21	1/22–1/28	1/29–2/4	2/5–2/11	2/12–2/18	2/19–2/25	2/26–3/4	3/5–3/11	3/12–3/18	3/19–3/25	3/26–4/1	4/2–4/8	4/9–4/15	4/16–4/22	4/23–4/29	4/30–5/6
2010	0	0	0	~~1~~ 0.14	~~0~~ 0.86	0	0	0	0	~~1~~ 0.86	~~0~~ 0.86	0	~~0~~ 1	1	~~0~~ 1	~~0~~ 0.14	0	0
2011	~~1~~ 0.86	~~0~~ 1	0	1	~~0~~ 0.86	0	0	~~1~~ 0.71	1	1	1	1	1	~~0~~ 1	~~0~~ 0.29	0	0	0
2012	0	0	0	0	0	0	0	~~1~~ 0.29	1	1	1	1	1	1	~~0~~ 1	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	~~1~~ 0	1	~~0~~ 1	~~0~~ 0.14	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	~~1~~ 0.14	~~0~~ 0.86	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	~~1~~ 0.14	1	1	~~0~~ 1	~~0~~ 0.57	0	~~1~~ 0
2019	0	0	0	0	0	0	0	0	0	0	0	0	1	1	~~0~~ 1	~~1~~ 0.29	~~0~~ 1	~~0~~ 0.71
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	~~0~~ 1	~~0~~ 0.57	~~1~~ 0.29	1	~~0~~ 1
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	~~1~~ 0.43	~~0~~ 1

4A-6.3.2.9 Steelhead Annual Loss Threshold

In modeling the Proposed Project, the steelhead Annual Loss Threshold OMR assumption was not modeled as it was assumed the annual loss threshold was covered by the steelhead weekly loss threshold.

4A-6.3.2.10 Steelhead Weekly Loss Threshold

In modeling the Proposed Project, the steelhead Weekly Loss Threshold OMR assumption was based on historical loss data from the CVP and SWP fish protection facilities for WY 2010 to 2022. The threshold was set as a rolling cumulative seven-day loss of 120 or more fish. Table 4A-6-19 summarizes when the loss threshold would have triggered a potential OMR action to protect steelhead (~~1=trigger~~ >0=fraction of week that a trigger would be in effect , 0=no trigger) during the 2010 to 2022 period.

Table 4A-6-19. 2010–2022 Historical Steelhead Weekly Loss Threshold Trigger

Water Year	1/29–2/4	2/5–2/11	2/12–2/18	2/19–2/25	2/26–3/4	3/5–3/11	3/12–3/18	3/19–3/25	3/26–4/1	4/2–4/8	4/9–4/15	4/16–4/22	4/23–4/29	4/30–5/6	5/7–5/13	5/14–5/20	5/21–5/27	5/28–6/3	6/4–6/10	6/11–6/17	6/18–6/24	6/25–7/1
2010	~~1~~ 0.29	1	1	~~0~~ 1	~~0~~ 0.71	~~1~~ 0.57	~~0~~ 1	~~1~~ 0.86	1	~~0~~ 0.86	0	0	0	0	0	0	0	~~1~~ 0.29	~~0~~ 1	~~0~~ 0.14	~~0~~ 0.86	~~0~~ 1
2011	0	0	~~0~~ 0.29	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 0.14	~~0~~ 0.14	~~0~~ 1	~~0~~ 1	~~0~~ 0.71	~~0~~ 0.43	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 0.71	0	~~0~~ 1	~~0~~ 1	~~0~~ 1	~~0~~ 0.86
2012	0	0	0	0	0	0	0	~~1~~ 0.29	1	1	~~0~~ 0.71	~~1~~ 0.86	~~0~~ 0.71	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	~~1~~ 0.71	1	1	1	1	~~1~~ 0.86	1	1	~~0~~ 0.14	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	~~1~~ 0.14	1	1	1	1	1	~~0~~ 0.29	0	0	~~1~~ 0.71	1	1	0	0	0	0
2019	0	~~1~~ 0.14	1	1	1	~~1~~ 0.86	~~0~~ 0.57	0	~~1~~ 0.43	1	~~0~~ 0.57	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	~~1~~ 0.86	1	~~0~~ 0.29	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

4A-6.3.2.11 Spring-Run Chinook Salmon and Surrogate Thresholds

~~In modeling the Proposed Project, spring-run Chinook Salmon was not modeled as it was assumed it is covered by other actions.~~ In modeling the Proposed Project, the spring-run Chinook Salmon threshold OMR assumption was based on historical loss from the CVP and SWP fish protection facilities for WY 2010 to 2022. The threshold was set at a loss of 0.25% of the estimated release number for each of the yearling spring-run Chinook Salmon surrogate groups (Coleman National Fish Hatchery late-fall Chinook Salmon). Table 4A-6-20 summarizes when the loss threshold would have triggered a potential OMR action to protect yearling spring-run Chinook Salmon (>0=fraction of week that a trigger would be in effect, 0=no trigger) during the 2010–2022 period. No yearling spring-run Chinook Salmon triggers occurred after the week of 2/5–2/11 in WY 2010–2022.

Insufficient data existed to develop an assumption for young-of-year spring-run Chinook Salmon surrogates.

Table 4A-6-20. 2010–2022 Historical Spring Run Loss Threshold Trigger

Water Year	1/1–1/7	1/8–1/14	1/15–1/21	1/22–1/28	1/29–2/4	2/5–2/11	2/12–2/18	2/19–2/25	2/26–3/4	3/5–3/11
2010	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0.86	0.57	0	0	0	0
2017	0	0.71	0.29	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0
2019	0	0	0.14	0.86	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0

4A-6.3.2.12 Combining Delta Smelt, Longfin, Winter-Run, Spring-Run, and Steelhead for Input into CalSim 3

Tables 4A-6-14 through 4A-6- ~~19~~ 20 were combined into one weekly table that can be used in CalSim 3 for the No Highflow Offramp conditions. Tables 4A-6-15 through 4A-6- ~~19~~ 20 were combined into one weekly table that can be used in CalSim 3 for the With Highflow Offramp conditions. For weeks where multiple species would have triggered an OMR action, only one was counted to prevent any double counting. Table 4A-6- ~~20~~ 21 and Table 4A-6- ~~21~~ 22 summarize the combined 2010 to 2022 OMR percentage for the No Highflow Offramp and With Highflow Offramp conditions, respectively. Table 4A-6- ~~22~~ 23 and 4A-6- ~~23~~ 24 summarize the OMR percentages by water year for the No Highflow Offramp and With Highflow Offramp conditions, respectively, based on Tables 4A-6- ~~20~~ 21 and 4A-6- ~~21~~ 22 .

Table 4A-6- ~~20~~ 21. 2010 to 2022 Historical Delta Smelt, Longfin, Winter-Run, Spring-Run, and Steelhead OMR Percentage, No Highflow Offramp

Water Year	Jan	Feb	Mar	Apr	May	Jun
2010	~~100~~ 79%	~~75~~ 100%	100%	~~50~~ 79%	25%	~~20~~ 66%
2011	~~50~~ 71%	75%	100%	~~25~~ 79%	~~0~~ 93%	~~0~~ 77%
2012	50%	~~75~~ 57%	~~80~~ 100%	~~75~~ 100%	100%	40%
2013	0%	75%	60%	~~100~~ 96%	100%	80%
2014	50%	75%	20%	0%	0%	0%
2015	0%	0%	80%	75%	50%	0%
2016	~~25~~ 4%	~~25~~ 39%	80%	75%	100%	60%
2017	~~0~~ 25%	0%	100%	100%	100%	100%
2018	0%	0%	~~60~~ 43%	~~75~~ 82%	~~75~~ 43%	20%
2019	~~0~~ 25%	~~75~~ 54%	80%	~~50~~ 82%	~~0~~ 18%	0%
2020	0%	0%	~~60~~ 57%	~~75~~ 79%	~~0~~ 25%	0%
2021	0%	0%	0%	0%	0%	0%
2022	25%	50%	80%	~~75~~ 61%	~~0~~ 36%	40%

Table 4A-6- ~~21~~ 22. 2010 to 2022 Historical Delta Smelt, Longfin, Winter-Run, Spring-Run, and Steelhead OMR Percentage, With Highflow Offramp

Water Year	Jan	Feb	Mar	Apr	May	Jun
2010	~~25~~ 4 %	~~75~~ 100 %	~~60~~ 94 %	~~25~~ 54 %	0%	~~20~~ 66 %
2011	~~50~~ 71 %	~~25~~ 54 %	100%	~~0~~ 79 %	~~0~~ 93 %	~~0~~ 77 %
2012	0%	~~25~~ 7 %	~~80~~ 100 %	~~50~~ 89 %	0%	0%
2013	0%	0%	40%	~~100~~ 96 %	~~50~~ 54 %	0%
2014	0%	0%	0%	0%	0%	0%
2015	0%	0%	0%	0%	0%	0%
2016	~~25~~ 4 %	~~0~~ 39 %	0%	0%	0%	0%
2017	~~0~~ 25 %	0%	0%	0%	0%	0%
2018	0%	0%	~~60~~ 43 %	~~75~~ 82 %	~~75~~ 43 %	20%
2019	~~0~~ 25 %	~~75~~ 54 %	~~60~~ 69 %	~~50~~ 82 %	~~0~~ 18 %	0%
2020	0%	0%	~~20~~ 17 %	~~75~~ 79 %	~~0~~ 25 %	0%
2021	0%	0%	0%	0%	0%	0%
2022	0%	0%	0%	~~25~~ 11 %	~~0~~ 36 %	0%

Table 4A-6- ~~22~~ 23. OMR Percentage by Water Year Type for Input into CalSim 3, No Highflow Offramp

Water Year Type	Jan Avg	Feb Avg	Mar Avg	Apr Avg	May Avg	Jun Avg
C	25%	25%	45%	~~38~~ 34 %	~~13~~ 21 %	10%
D	~~63~~ 41 %	~~50~~ 49 %	73%	~~75~~ 88 %	~~50~~ 63 %	40%
BN	~~15~~ 20 %	~~45~~ 46 %	100%	~~75~~ 79 %	~~75~~ 67 %	~~35~~ 46 %
AN	~~17~~ 32 %	75%	95%	~~67~~ 83 %	~~54~~ 69 %	~~34~~ 53 %
W	0%	0%	90%	~~58~~ 87 %	~~33~~ 70 %	~~33~~ 59 %

Table 4A-6- ~~23~~ 24. OMR Percentage by Water Year Type for Input into CalSim 3, With Highflow Offramp

Water Year Type	Jan Avg	Feb Avg	Mar Avg	Apr Avg	May Avg	Jun Avg
C	0%	0%	0%	~~6~~ 3 %	~~0~~ 9 %	0%
D	~~25~~ 4 %	~~8~~ 15 %	~~43~~ 49 %	~~63~~ 79 %	~~25~~ 39 %	0%
BN	~~0~~ 5 %	~~30~~ 31 %	100%	~~38~~ 41 %	~~19~~ 11 %	~~10~~ 21 %
AN	~~17~~ 32 %	~~25~~ 54 %	~~65~~ 67 %	~~27~~ 47 %	~~9~~ 24 %	~~5~~ 24 %
W	0%	0%	~~30~~ 34 %	~~17~~ 54 %	~~0~~ 37 %	~~0~~ 26 %

Table 4A-6- ~~22~~ 23 and Table 4A-6- ~~23~~ 24 were used as lookup tables in CalSim 3; it was assumed the percent shown for each month is at a -3,500 OMR Index. For example, from Table 4A-6- ~~22~~ 23 , March in Dry years was assumed to be at a -3,500 OMR Index for half the month (~~50~~ 73 %).

4A-6.3.2.13 OMR Flex Trigger and Criteria

In modeling the Proposed Project, OMR Flex was assumed to be the same as the Baseline Conditions, except for the Qwest criteria. This was updated from 1,000 cfs to 1,500 cfs.

4A-6.4 References

California Department of Water Resources. 2021. *DSM2 V8.2.0 Calibration.* February 2021.

California Department of Water Resources. 2022. *CalSim 3 Report, A Water Resources System Planning Model for State Water Project & Central Valley Project.* August 2022.

Jayasundara, N. C., S. A. Seneviratne, E. Reyes, and F. I. Chung. 2020. Artificial neural network for Sacramento–San Joaquin Delta flow–salinity relationship for CalSim 3.0. *Journal of Water Resources Planning and Management* 146(4):p.04020015.

Sandhu, N., D. Wilson, R. Finch, and F. Chung. 1999. *Modeling Flow-Salinity Relationships in the Sacramento-San Joaquin Delta Using Artificial Neural Networks.* Technical Information Record OSP-99-1, Sacramento: California Department of Water Resources.

State Water Contractors. 2017. *A Template and Guide for Adaptively Managing Operations of the Suisun Marsh Salinity Control Gates to Benefit Delta Smelt.* November 2017.

U.S. Bureau of Reclamation. 2015. *Coordinated Long Term Operation of the CVP and SWP EIS, Appendix 5A CalSim II and DSM2 Modeling.*

Wilbur, R., and A. Munévar. 2001. *Chapter 7: Integration of CALSIM and Artificial Neural Networks Models for Sacramento-San Joaquin Delta Flow-Salinity Relationships.*