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BEFORE THE

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

HEARING IN THE MATTER OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND UNITED STATES BUREAU OF RECLAMATION REQUEST FOR A CHANGE IN POINT OF DIVERSION FOR CALIFORNIA WATER FIX

TESTIMONY OF ERIK REYES

I, Erik Reyes, do hereby declare:

I. INTRODUCTION

I am an expert in modeling the California Central Valley system as it relates to the State Water Project (SWP) and Central Valley Project (CVP). I am employed by the Department of Water Resources (DWR) as Chief of the Central Valley Modeling Section in DWR's Bay-Delta Office. I received a Bachelor of Science degree in civil engineering from the University of California at Los Angeles. I am a registered Civil Engineer in the State of California. I have over eighteen years of experience in Central Valley water modeling and have spent the last 4 years in my current role as Chief. I am responsible for leading the development, maintenance and application of mathematical models for the California Central Valley system related to the State Water Project and Central Valley Project. A true and correct copy of my statement of qualifications has been submitted as Exhibit DWR-27.

In October 2015 DWR and the U.S. Bureau of Reclamation (Reclamation) (jointly

Petitioners) petitioned the State Water Board for the addition of three new points of diversion on Petitioners' water rights permits. In testimony submitted in Part 1 of this hearing, the project was described as Alternative 4A with initial operational criteria that would fall within a range of operations described as H3 to H4. These operational criteria were described in the Recirculated Draft Environmental Impact Report/Supplemental Draft Environmental Impact Statement (RDEIR/SDEIS). (Exhibit SWRCB-3.) For purposes of Part 2 of the hearing, including this testimony, the California WaterFix project is described by Alternative 4A under an operational scenario described as H3+ that is set forth in the Final Environmental Impact Report/Environmental Impact Statement and supplemental information adopted by DWR through the issuance of a Notice of Determination in July 2017 (2017 Certified FEIR). (Collectively Exhibits SWRCB-102, SWRCB-108, SWRCB-109, SWRCB-110, SWRCB-111 and SWRCB-112.) **The adopted project is referred to as CWF H3+.** Additional information is also referenced in this testimony from documents released prior to July 2017, including the Alternative 4A described in the Final Environmental Impact Report/Environmental Impact Statement, Biological Assessment and the Biological Opinions, referred to herein as the 2016 FEIR/FEIS, BA and the BO respectively. Similarly, after July 2017 the California Department of Fish and Wildlife issued a 2081(b) Incidental Take Permit, which is referred to as the ITP. The interrelationship and use of these terms is further described in the testimony of Ms. Buchholz, Exhibit DWR-1010.

II. OVERVIEW OF TESTIMONY

This testimony provides overviews of the CWF operations criteria, associated modeling, and key modeling results. The results included in this testimony are based on the CalSim II modeling. Ms. Tara Smith's submitted testimony provides additional results based on the DSM2 modeling. (See Exhibit DWR-1015.)

Part 1 of the hearing provided a modeling overview to explain the analytical approach used to evaluate CA WaterFix scenarios including descriptions of CalSim II and

DSM2. (See Exhibits DWR-71 and DWR-66.) This testimony additionally describes the analytical framework used for the biological analysis included in the Part 2 testimony. Part 1 of the hearing also included extensive testimony on the appropriate comparative use of modeling results prepared for various CA WaterFix analyses. Those cautions remain relevant for Part 2.

Based on the analysis presented in this testimony I provide the following opinions:

1. CWF H3+ scenario meets the Water Rights Decision 1641 (D-1641) fish and wildlife requirements including X2, Net Delta Outflow Index (NDOI), Rio Vista, and export/inflow ratio, similar to the No Action Alternative (NAA).
2. CWF H3+ scenario meets the 2008 U.S. Fish and Wildlife Service (USFWS) and 2009 National Marine Fisheries Service (NMFS) Biological Opinions (2008/09 BOs) requirements including Old and Middle River flows (OMR) and Fall X2, similar to the NAA.
3. CWF H3+ results in similar end-of-May and end-of-September storage levels compared to the NAA in major SWP and CVP upstream reservoirs. As stated by Mr. Miller in Exhibit DWR-1011, End of May storage is an indicator of available cold water pool for temperature management over the summer and fall months. Consistent with the results presented in Part 1, slightly lower end-of-September storage levels are simulated in Folsom Reservoir, when the storage levels are greater than 500,000 acre-feet.
4. CWF H3+ scenario results in similar water deliveries to CVP and SWP contractors, including Settlement Contractors, Exchange Contractors, Refuge Level 2, and Feather River Service Area Contractors, compared to the NAA.
5. Simulated long-term average deliveries to CVP and SWP north of Delta and south of Delta water service contractors were similar or higher than NAA under CWF H3+ scenario. In some water year types, CWF H3+ resulted in less than 3% reduction of

the annual deliveries to the north of Delta CVP service contractors compared to the NAA.

6. The sensitivity analysis shown in "Developments after Publication of the Proposed Final Environmental Impact Report" (Exhibit SWRCB-108) compared the incremental changes under the BA H3+ and the CWF H3+ relative to the NAA. The sensitivity analysis results showed that overall operations including upstream storage, river flows, and water supply deliveries remained similar. The OMR remained more positive or less negative compared to the NAA. The Delta outflow results are nearly identical in all months except October and March. In March, CWF H3+ outflow is higher than the BA H3+ due to the spring outflow requirement, and in October the CWF H3+ outflow remains largely similar to the NAA instead of increasing as in the BA H3+.

III. DISCUSSION OF TESTIMONY

This section provides a roadmap for the CWF H3+ operations criteria and explains the progression of operations scenarios from the RDEIR/SDEIS to the 2017 Certified FEIR. Figure 1 summarizes the progression.

In Part 1, DWR presented Alternative 4A with a range of operations criteria from H3 to H4 as described in the RDEIR/SDEIS. (DWR-515, Table 1.) The BA included only one set of operations criteria (BA H3+), rather than a range. The December 2016 Final EIR/S (2016 FEIR/S) evaluated BA H3+. The BA H3+ operating criteria was then refined slightly and adopted as CWF H3+, the project now presented in Part 2, with the 2017 Certified FEIR and associated Notice of Decision (NOD). The sections below explain what operational criteria remained the same and what operational criteria are changed between these documents. Importantly, Section I.A.2 explains how the modeling results for CWF H3+ are largely not impacted by the refinements from BA H3+ to CWF H3+ relative to the operating range H3 to H4 presented in Part 1, and when compared to the NAA.

A. What has not changed

All the operational criteria presented in Part 1 (DWR-515 Table 1) remain the same except for (1) the spring outflow and (2) the fall south Delta OMR and export restrictions. Table 1 below shows the operational criteria for NAA, H3, H4, BA H3+, and CWF H3+ scenarios. The table can be used to quickly identify the operating criteria for each scenario.

B. What has changed

In the BA H3+, all the common criteria in the H3 and H4 continued, except the spring outflow criteria was modified. Compared to the BA H3+, the CWF H3+ was refined based on feedback from the fishery agencies during the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA) consultation processes. These refinements are described below and in detail in the "Developments after Publication of the Proposed Final Environmental Impact Report" document released with the 2017 Certified FEIR. (See Exhibit SWRCB-108.)

Changes to spring outflow requirement:

BA H3+ implemented the spring outflow criteria, which requires maintaining the March through May average Delta outflow that would have resulted due to export restrictions under the 2008/2009 BOs, without CWF. This requirement was achieved by constraining the total Delta exports in April and May per the 2009 NMFS BO San Joaquin River Inflow-Export Ratio (SJR i-e ratio) constraint.

For the CWF H3+, an outflow requirement was added for March in addition to the April-May requirement. This outflow requirement is dependent upon the forecasted hydrologic conditions in March per the eight river index (8RI). The total Delta exports are curtailed to no less than 1500 cfs, if needed, to achieve the March outflow requirement. The CWF H3+ scenario also assumed that the SJR i-e ratio constraint would not be applicable in April and May when the Delta outflow is greater than 44,500 cfs.

Changes to fall south Delta export constraints:

As in H3 and H4, the BA H3+ included new OMR flow requirements and south Delta export restrictions during October and November compared to the NAA. In the CWF H3+ Scenario, these OMR flow requirements and the south Delta export restrictions were removed.

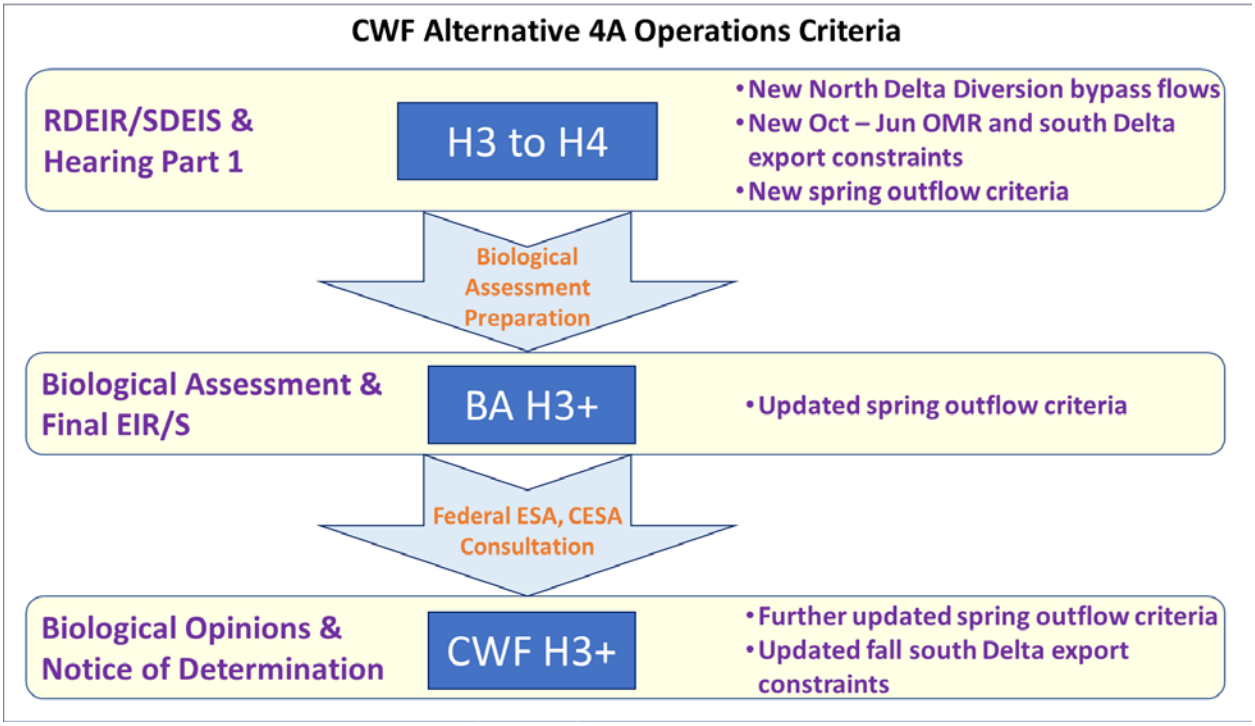

Figure 1 (Exhibit DWR-1030): Roadmap for the CWF operations criteria

C. Analysis of BA H3+ to CWF H3+ Changes

To assess operational effects of the changes between BA H3+ and CWF H3+, a sensitivity analysis was performed as described in the 2017 Certified FEIR. (SWRCB-108, pp.129-155.) The sensitivity analysis illustrates the incremental changes in resulting operations for the CWF H3+ and the BA H3+ compared to the NAA. Figures 1 through 26 in Exhibit SWRCB-108 show CalSim II results for key operational parameters.

The sensitivity analysis results show that the end of May and end of September storage conditions in Trinity Lake, Shasta Lake, Lake Oroville and Folsom Lake for the BA H3+ and

CWF H3+ result in similar storage levels compared to the NAA. Incremental changes in monthly average flows for Trinity, Sacramento, Feather, and American rivers under the CWF H3+ are similar to the BA H3+, when compared to the NAA.

Delta outflow results differ between CWF H3+ and BA H3+ in October and March. CWF H3+ delta outflows are slightly lower than the BA H3+ results in October, remaining closer to the NAA results. CWF H3+ delta outflows are higher than BA H3+ results in March. Delta outflow remains nearly identical in other months in all water year types. These results are expected, given the changes in criteria which curtailed exports in March and relaxed export limits in October, relative to the BA H3+.

Annual Delta export changes under the BA H3+ and CWF H3+ compared to the NAA remain similar in all water year types. The proportion of Delta exports at the north Delta diversion intakes and the south Delta intakes under the CWF H3+ are similar to BA H3+.

The OMR flows in October under the CWF H3+ are slightly more negative compared to the BA H3+, while slightly more positive during March. These are expected changes because of the refinements in the OMR and spring outflow criteria. Even with these changes the OMR flows under the CWF H3+ are predominantly less negative (more positive) than the NAA, consistent with BA H3+.

Annual CVP and SWP deliveries are similar to or higher than the NAA, under both BA H3+ and CWF H3+. The implications to water supply, surface water, water quality and fisheries resources were described in Exhibit SWRCB-108 pages 132-133, and found to remain similar to the FEIRS Alternative 4A.

1. CWF Operations Modeling Approach

The 2015 version of the CalSim II model was used to simulate NAA and CWF operations for this hearing and the BA, while the 2010 version was used for evaluating the FEIR/S Alternatives[1]. (Exhibit DWR-71, p.9:18 – 10:1.) A description of the CalSim II

[1] Appendix 5G of the FEIRS [DWR-FEIRS] included a sensitivity analysis comparing the FEIRS Alternative 4A, which was based on CalSim II 2010, and the BA H3+, which was based on CalSim

model was included in Part 1. (Exhibit DWR-71.) A list of key CalSim II assumptions for the NAA, H3, H4, BA H3+ and CWF H3+ scenarios are included below in Table 1. What follows is a comparison of key CalSim II results for these scenarios.

2. CWF Operations Modeling Results

This section includes a comparison of key CalSim II results for the NAA, H3, H4, BA H3+ and CWF H3+ scenarios. Based on my analysis and the results shown below, it is my opinion that CWF H3+ scenario meets the D-1641 fish and wildlife and the 2008/2009 BOs requirements, including X2, NDOI, Rio Vista, export/inflow ratio, OMR, and Fall X2, similar to the NAA. It is my opinion that CWF H3+ results in similar end-of-May and end-of-September storage levels compared to the NAA in major SWP and CVP upstream reservoirs.

It is my opinion that CWF H3+ scenario also results in similar water deliveries to CVP and SWP contractors, including Settlement Contractors, Exchange Contractors, Refuge Level 2, and Feather River Service Area Contractors, compared to the NAA. Simulated long-term average deliveries to CVP and SWP north of Delta and south of Delta water service contractors were similar to NAA under CWF H3+ scenario. In some water year types, CWF H3+ resulted in less than 3% reduction of the annual deliveries to the north of Delta CVP service contractors compared to the NAA.

Detailed results presented below compare the CWF H3+ scenario to the NAA for the D-1641 requirements related to the fish and wildlife beneficial uses, and for the requirements under the 2008/2009 BOs. (Exhibits SWRCB-21, Table 3; SWRCB-87 and SWRCB-84.) Additional results showing the storage and delivery parameters presented in Part 1 testimony are included in here for completeness. These plots show the results for NAA, CWF H3+, BA H3+, H3, and H4 scenarios.

The Delta hydrodynamics and water quality results are presented in Tara Smith's

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II 2015. This comparison showed that the incremental changes in the system-wide operations with CWF were similar when compared to the NAA.

testimony. (See Exhibit DWR-1015.)

a. D-1641 Requirements

i. Delta Outflow

CWF H3+ fully complies with the Delta Outflow requirements in D-1641. Exhibit DWR-1069 **Figure 3** – **Figure 8** show the compliance frequency of meeting the Delta outflow required to maintain X2 at the required position as stated by D-1641 for each of the months of February to June, hereafter referred to as Spring X2. Positive values indicate that Delta outflow for a given study is above the requirement (and therefore is in compliance) and negative values indicate that Delta outflow is below the requirement (and therefore is not compliant). The magnitude of the values indicates how much the flow is above or below the standard. In each of the months of February to June, Delta outflow in CWF H3+ is either above or equal to the outflow required to maintain Spring X2. Therefore, CWF H3+ is fully compliant with D-1641 Spring X2 requirements.

Exhibit DWR-1069 **Figure 9**– **Figure 16** show the compliance frequency of meeting the required Net Delta Outflow Index (NDOI) as stated by D-1641 for each of the months of July to January. Positive values indicate that Delta outflow for a given study is above the requirement and negative values indicate that Delta outflow is below the requirement. For all the required months, Delta outflow in CWF H3+ is either above or equal to the NDOI outflow required by D-1641. Therefore, CWF H3+ is fully compliant with D-1641 NDOI requirements.

ii. Rio Vista

CWF H3+ fully complies with the Sacramento River at Rio Vista flow requirements in D-1641. D-1641 includes minimum instream flow requirements in the months of September to December for the Sacramento River at Rio Vista. Exhibit DWR-1069 **Figure 21** - **Figure 25** show the compliance frequency of meeting the required minimum instream flows at Rio Vista as stated by D-1641 for each of the months of

September to December. In these figures, positive values indicate that Sacramento River flow at Rio Vista is above the minimum flow requirement and negative values indicate that the flow is below the minimum flow requirement. The results show that for all the required months, Sacramento River flow at Rio Vista is above or equal to the requirement. Therefore, CWF H3+ is fully compliant with D-1641 Rio Vista minimum instream flow requirements.

iii. Export/Inflow Ratio

CWF H3+ fully complies with the Export/Inflow ratio requirements in D-1641. Exhibit DWR-1069 **Figure 28** show exceedance plots of the Export/Inflow (EI) ratio for the NAA and CWF H3+. The values represent the modeled EI ratio for a given study. The red dashed reference lines illustrate the EI standard associated with those months. D-1641 states that EI ratio must not exceed 35% from March to June and 65% in July to January. The EI ratio for February varies from 35% – 45%, depending on the January 8 River Index (8RI). In these figures, values below the red reference lines indicate compliance.

Exhibit DWR-1069 **Figure 26** shows that CWF H3+ EI ratio never exceeds 35% from March to June.

Exhibit DWR-1069 **Figure 27** shows that CWF H3+ EI ratio never exceeds 65% from July to January.

Exhibit DWR-1069 **Figure 28** shows that CWF H3+ EI ratio in February never exceeds 35%. Therefore, CWF H3+ is fully compliant with D-1641 EI ratio requirements for all months.

b. Biological Opinion Requirements

i. Fall X2

CWF H3+ fully complies with 2008 USFWS BiOp Fall X2 requirements.

The 2008 USFWS BiOp requires the projects to meet an X2 requirement in the fall months following wet and above normal years. Exhibit DWR-1069 **Figure 17** – **Figure 20** show the compliance frequency of meeting the Delta outflow required to maintain X2 position requirements as stated by the 2008 USFWS BiOp for each of the months of September to November. Positive values indicate that Delta outflow for a given study is above the requirement and negative values indicate that Delta outflow is below the requirement. In all the required months for wet and above normal years, Delta outflow in CWF H3+ is either above or equal to the outflow required to maintain Fall X2 position. Therefore, CWF H3+ is fully compliant with USFWS Fall X2 requirements.

ii. OMR Flow

CWF H3+ fully complies with OMR operating criteria in the 2008 USFWS BiOp and the 2009 NMFS BiOp.

Exhibit DWR-1069 **Figure 29** – **Figure 36** show the compliance frequency of meeting the required OMR flow requirement as stated by the 2008 USFWS BiOp, the 2009 NMFS BiOp, and the new OMR requirements for CWF scenarios. Positive values indicate that OMR flow for a given study is more positive than the criteria (and therefore is in compliance) and negative values indicate that OMR flow is more negative than the criteria (and therefore is non-compliant).

In the months of December to June, OMR flow for CWF H3+ is either more positive or equal to the OMR reverse flow criteria. Therefore, CWF H3+ is fully compliant with OMR operating criteria in the 2008 USFWS BiOp and the 2009 NMFS BiOp. Additionally, the results show that CWF H3+ complies with the new OMR criteria for CWF.

c. Water Supply Results

i. Deliveries

Exhibit DWR-1069 **Figure 45**- **Figure 54** show the same delivery and export metrics

that were shown in Part 1 testimony (Exhibit DWR-514). All the results for the delivery metrics in Exhibit DWR-1069 **Figure 45**– **Figure 49** and **Figure 51** – **Figure 53** clearly show that CWF H3+ and BA H3+ results are similar to H3 and H4 and are nearly identical to the NAA results. Exhibit DWR-1069 **Figure 50** show the simulated average annual deliveries to the CVP North of Delta Ag and M&I service contractors. CWF H3+ results in lower deliveries than H3 and H4, but similar to the NAA. However, the results are reasonably close with Below Normal year deliveries showing the largest reduction of less than 3%, compared to the NAA.

Exhibit DWR-1069 **Figure 54** shows an exceedance chart of average annual Delta Exports. The CWF H3+ and BA H3+ results are similar to the NAA for majority of the time with higher exports in the wettest conditions.

ii. Upstream Storage (End of May)

Exhibit DWR-1069 **Figure 37 – Figure 40** show exceedance charts for End-of-May storage in the major CVP-SWP reservoirs of the Sacramento Valley. End of May storage is an indicator of available cold water pool for temperature management over the summer and fall months. The CWF H3+ and BA H3+ results for End-of-May storage exceedance for all the reservoirs are nearly always similar to the NAA and in some instances, End of May storage is slightly greater than the NAA.

iii. Upstream Storage (End of September)

Exhibit DWR-1069 **Figure 41** – **Figure 44** show exceedance charts for End-of-September storage in the major CVP-SWP reservoirs of the Sacramento Valley. The CWF H3+ and BA H3+ results for End-of-September storage exceedance for all the reservoirs are similar to or greater than the NAA, except for Folsom when the storage levels are greater than 500 TAF.

3. CWF Modeling Approach

Certain biological models used to support DWR's testimony in Part 2 require CalSim II and DSM2 outputs for physical variable inputs such as river flows and water temperature.

Figure 2 (Exhibit DWR-1068) shows how the CalSim II and DSM2 models feed results into the biological models. The integrated analysis framework including hydrologic, operations, hydrodynamics, water quality, and fisheries analyses is required to provide information for the comparative biological assessment. Figure 2 shows an overall schematic of the analytical framework used for the evaluation of the CWF scenarios in comparison to the NAA.

CWF includes constructing and operating three new north Delta diversion intakes and associated conveyance, and changes in operating the existing south Delta export facilities. Both these operational changes and other external drivers such as climate and sea level changes influence the future conditions of reservoir storage, river flow, Delta flows, exports, water temperature and water quality. Evaluating these conditions is the primary focus of the physically based modeling approach.

The analytical framework in Figure 2 shows the modeling tools used and the relationship between these tools. Each model included in Figure 2 provides information to the next “downstream” model whose results support the effects analyses. As described in DWR-71, changes to the historical hydrology related to future climate and sea level are applied in the CalSim II model and combined with changes in facilities and regulations to evaluate resulting operations for the NAA and the CWF scenarios.

The Delta boundary flows and exports from CalSim II are then used to drive the DSM2 Delta hydrodynamic and water quality models for estimating tidally-based flows, stage, velocity, and salt transport within the estuary. DSM2 Particle Tracking Model uses the velocity fields generated by the hydrodynamics model (DSM2 HYDRO) to emulate movement of particles throughout the Delta system. Temperature models for the upstream river systems use the CalSim II reservoir storage, reservoir releases, river flows, and meteorological conditions to estimate reservoir and upstream river temperatures under each scenario. The results from this suite of physical models are used to run numerous fisheries models and other analyses to study the effects of the NAA and the CWF

scenarios.

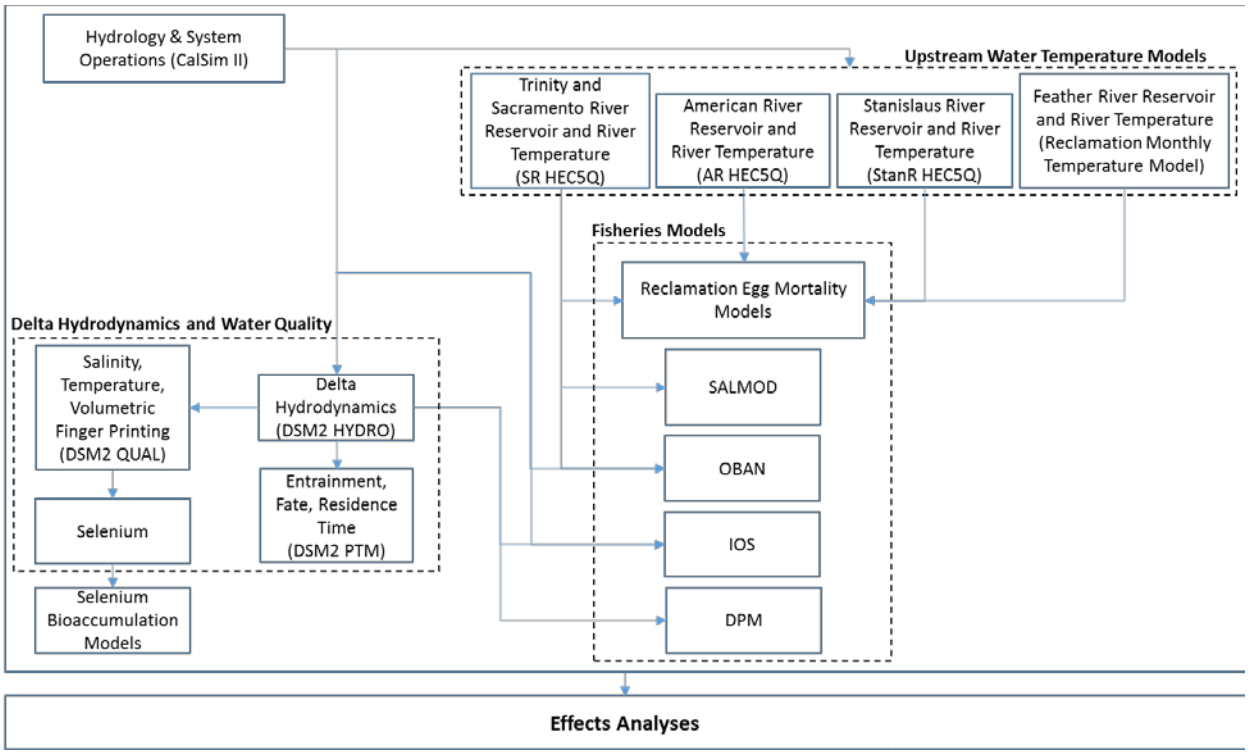

Figure 2: Analytical Framework used to Evaluate Effects of the CWF in the Biological Assessment

IV. CONCLUSION

Based on the analysis presented in this testimony I provide the following opinions:

1. CWF H3+ scenario meets the D-1641 fish and wildlife requirements including X2, Net NDOI, Rio Vista, and export/inflow ratio, similar to the NAA.
2. CWF H3+ scenario meets the 2008/09 BOs requirements including OMR and Fall X2, similar to the NAA.
3. CWF H3+ results in similar end-of-May and end-of-September storage levels compared to the NAA in major SWP and CVP upstream reservoirs. As stated by Mr. Miller in Exhibit DWR-1011, End of May storage is an indicator of available cold water pool for temperature management over the summer and fall months.

Consistent with the results presented in Part 1, slightly lower end-of-September storage levels are simulated in Folsom Reservoir, when the storage levels are greater than 500,000 acre-feet.

4. CWF H3+ scenario results in similar water deliveries to CVP and SWP contractors, including Settlement Contractors, Exchange Contractors, Refuge Level 2, and Feather River Service Area Contractors, compared to the NAA.
5. Simulated long-term average deliveries to CVP and SWP north of Delta and south of Delta water service contractors were similar or higher than NAA under CWF H3+ scenario. In some water year types, CWF H3+ resulted in less than 3% reduction of the annual deliveries to the north of Delta CVP service contractors compared to the NAA.
6. The sensitivity analysis shown in "Developments after Publication of the Proposed Final Environmental Impact Report" (Exhibit SWRCB-108) compared the incremental changes under the BA H3+ and the CWF H3+ relative to the NAA. The sensitivity analysis results showed that overall operations including upstream storage, river flows, and water supply deliveries remained similar. The OMR remained more positive or less negative compared to the NAA. The Delta outflow results are nearly identical in all months except October and March. In March, CWF H3+ outflow is higher than BA H3+ outflow due to the spring outflow requirement, and in October the CWF H3+ outflow remains largely similar to the NAA instead of increasing as in the BA H3+.

Executed on this 29 day of November, 2017 in Sacramento, California.

Erik Reyes

(Erik Reyes)