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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 AARON MILLER

I, Aaron Miller, do hereby declare:

I. INTRODUCTION

I am employed by the Department of Water Resources (DWR) as a Supervising Engineer, Water Resources (Specialist). In my current role, I provide technical support and advise senior management and executive staff on a variety of projects and policies that may affect State Water Project (SWP) operations. I earned my bachelor's degree in Environmental Resource Engineering from Humboldt State University and I am a registered Civil Engineer in the State of California.

I have over 11 years of experience in the SWP Water Operations Office where my duties have included scheduling real-time water operations, formulating annual water delivery allocations to SWP contractors and evaluating SWP operations using simulation models. In addition, I have over 7 years working with various hydrodynamic, water quality, particle tracking, and river routing models prior to my experience in operations. For the most part the focus of these model applications was in the Delta. As an SWP operator, a

CalSim modeler and a Delta Simulation Model 2 (DSM2) modeler I have a unique perspective. I understand how models work, how they should be used in evaluating operations, and how models relate to real world operations. In my current role this unique experience allows me to be more effective as an operator and in advising executive staff on projects affecting SWP and the Delta.

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). For purposes of Part 2 of the hearing, including this testimony, the California WaterFix (CWF) 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). **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 FEIR/S, 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, DWR-1010.

II. OVERVIEW OF TESTIMONY

My testimony provides an overview of the SWP operations and real time decision making that will occur under CWF H3+. My testimony demonstrates how DWR might operationalize, or implement, key modeling assumptions used to assess potential impacts of CWF H3+ and how some operational decisions will likely be made in real-time. I will also discuss the differences between key modeling assumptions and how operators might implement the operating criteria by explaining how we will address simplified modeling assumptions. Finally, I will provide an example year and show how key operating criteria could have been implemented.

III. REAL-TIME OPERATIONS UNDER H3+

Real-time operations are a key component to the proposed CWF H3+ operations where 1) operators make day to day decisions to manage a variety of changing hydrologic conditions, and 2) input from multi-agency groups inform and guide the operations for protection of listed fish species. Real-time operations allow operators to more precisely respond to conditions and thus further reduce any impacts from CWF H3+ that may have been predicted in modeling results.

The term “real-time operations” describes the process of day-to-day SWP and Central Valley Project (CVP) operations and should not be confused with adaptive management. (See witnesses and testimony of Reclamation for a discussion of CVP operations.) Adaptive management is a process by which the regulatory agencies incorporate evolving science by collecting information, developing criteria, observing the results and then, if appropriate, adjusting the criteria to provide for more complete protection of listed species. (For a complete discussion of adaptive management, see the testimony of Dr. Earle, DWR-1014.) In contrast, real-time operation is the process of collecting and processing data, forecasting future conditions, estimating potential changes, balancing risk and reacting to those conditions to require compliance with the existing regulatory requirements.

A. DAY TO DAY OPERATIONAL DECISIONS

Day to day operations is a critical component of real-time operations. DWR operational planning, using modeling, accounts for the regulatory requirements throughout the year, but daily SWP management is required to meet those requirements every day. Through operational planning, to the extent possible, DWR and Reclamation look ahead by evaluating a range of hydrologic possibilities. However, it is impossible to perfectly predict the nuances, or variables, of any one year within the planning process because there are too many potential outcomes. These variables can include changes in tidal energy due to wind or pressure, changes in projected inflow due to storm events, or changes in upstream or Delta diversions.

SWP operators use many analytical tools in operational planning to help manage the Delta and the various objectives. These tools help forecast the many physical processes prevalent in the Delta. Tide, wind and pressure forecasts help inform operators of potential near term changes in the tidal energy. Precipitation and runoff forecasts indicate likely inflow in the coming days. Hydrodynamic and water quality models like DSM2 help inform operators on the effectiveness of alternative operational choices. End of May storage conditions give operators an approximation of available cold water pool.

This is why SWP water management requires decision making on a near daily basis where the operators evaluate the conditions and the status of meeting the various regulatory criteria. Adjustments are implemented as needed to react to those real-time conditions and regulatory standards. The daily observed results of SWP management are then fed back into revised operational planning processes. The two primary SWP management tools the operators have are releases from the upstream reservoirs and the adjustments to diversions in the Delta. These tools were discussed in detail in Mr. Leahigh's testimony. (DWR-61, p. 6.) It is through this interaction of operational planning and real-time operations that the SWP is managed to meet the regulatory obligations.

B. INTERAGENCY COORDINATION

Interagency coordination has been an important aspect of real-time operations in the past and will continue under the CWF H3+. This coordination between agencies occurs through a number of technical workgroups and management teams. The 2017 Certified FEIR provides a full listing of these workgroups and teams. (SWRCB-102, Table 3-35, p.3-277.) I will summarize some of these groups in the following testimony.

The Water Operations Management Team (WOMT) is a management level team established to facilitate decisions involving operations and fishery protection. The team consists of representatives from the project agencies and the regulatory agencies (Reclamation, DWR, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and California Department of Fish and Wildlife). WOMT relies on the assessments from technical working teams to evaluate the current and forecasted conditions and estimate risk to specific listed fish species. With these assessments, WOMT is typically able to come to consensus on future operations, but at times decisions are elevated to the agency directors for final decision making.

There are several technical teams that gather information on operations and specific fish species and assess potential impacts and provide that assessment to the regulatory agencies and the WOMT as a whole. The Smelt Working Group (SWG) and the Delta Operations for Salmonids and Sturgeon (DOSS) are the two primary technical teams focused on Delta operations and potential effects on listed fish species.

The SWG focuses on monitoring conditions and evaluating actions related to Delta Smelt and Longfin Smelt. Some conditions discussed by the SWG include observed fish at various sampling locations, turbidity conditions in the Delta channels, and projected SWP and CVP operations. Based on these conditions and forecasted operations a risk matrix is developed for Old and Middle River (OMR) flow categories. The risk matrix indicates the entrainment risk level for a specific OMR range and is based on working group consensus. This matrix is provided to WOMT for further discussion and potential action.

The DOSS group consolidates information on operations and on listed salmonids and green sturgeon. This technical advisory team provides recommendations to WOMT on measures to reduce adverse effects of Delta operations on salmonids and green sturgeon. This team also coordinates the work of the other technical teams.

As described in the 2017 Certified FEIR, interagency coordination will continue to be an important tool for the operators and the fishery agencies in the future.

IV. OPERATIONALIZATION OF KEY MODELING ASSUMPTIONS OF CWF H3+

As described in the project description and modeling testimony (Exhibits DWR-1010 and DWR-1016), CWF H3+ describes the initial operating criteria of the CWF. The CWF has been modeled to analyze potential water supply performance and fishery protection. (Exhibits DWR-1016, DWR-1015, and DWR-1019.) The main operational modeling assumptions are listed in DWR-1016 and include criteria that will need to be operationalized. Operationalization is the implementation of operational modeling assumptions. I have chosen a recent year where we know the hydrodynamics and based upon that year I will describe three examples of operationalization based upon modeling assumptions contained in CWF H3+. Those examples are: better definition to the spring outflow component, which is used to maintain spring outflows similar to current conditions; OMR management, and; unlimited pulse flow protection, which limits diversions whenever a fish density threshold is reached. I am presenting three examples, but I have reviewed and evaluated the entire proposed operating criteria described by CWF H3+ and I have determined that it is possible to operationalize all the intended protections described by the modeling assumptions for CWF H3+.

A. RECENT YEAR CONCEPTUAL OPERATION

To demonstrate how the CWF would likely operate I assessed a recent year and applied the proposed CWF H3+ criteria to these historical conditions. In Part 1 of this hearing Mr. Leahigh presented an example of how the CWF would have operated in 2016 using the criteria described by the RDEIR/SDEIS operational scenario H3. Water year 2016 followed some of the driest conditions in recorded history. However, in December, northern California began to experience wet hydrology with several significant storm events. As the year progressed more storms generated runoff which the proposed CWF facilities could have diverted while still meeting the protective criteria to listed fish species and manage to D-1641 standards adopted by the State Water Resources Control Board. For this conceptual operation, I reviewed how the SWP and CVP were actually operated and how DWR might have operated with the CWF H3+ in place in 2016.

I reviewed the proposed operating criteria of CWF H3+ and how the SWP would likely have operated to those criteria based on the conditions observed in 2016. For a conceptual operation in 2016 I applied a pulse protection based on the presence of winter run and spring run salmon at the Knight Landing monitoring trap. I also applied the additional OMR and spring outflow criteria proposed as part of CWF H3+.

Exhibits DWR-1032, DWR-1033 and DWR-1034 illustrate how DWR would have likely operated to these CWF H3+ criteria in comparison to the actual SWP and CVP operations from October 1, 2015 to June 30, 2016.

B. OPERATIONALIZING PULSE PROTECTION CRITERIA

The Northern Delta Diversions (NDD) would divert water directly from the Sacramento River as described in Mr. Bednarski's testimony. (Exhibit DWR-57.) In scheduling the daily diversions for the three intakes, several parameters will be assessed; from local hydrodynamic conditions at each intake, to downstream reverse flow potential, to management of the Delta as a whole. Scheduling of diversions at these intakes will incorporate the aspects of real-time operations discussed above, such as forecasts based on hydrodynamic and water quality modeling, real-time monitoring of flows and water quality, and fish presence. In this example, I specifically describe how the pulse protection criteria is operationalized.

1. MODELING

The modeling for the CWF used generalized rules to simulate CWF operations. As discussed in Part 1, the modeling does not simulate fish presence nor does it simulate operator's real-time decision making. Instead the model uses surrogate relationships and generalized rules. For example, the modeling uses a specific timing and characteristic flow event on the Sacramento River at Wilkin's Slough as a representation of a pulse of fish migrating to the Delta as described in SWRCB-102, Table 3-34.

2. OPERATIONALIZATION

As described in the 2017 Certified FEIR, the bypass flow requirement is dependent on numerous factors including flow in the Sacramento River above the NDD, the flow and duration of antecedent bypass flows, and the monitoring results for fish species. (Exhibit SWRCB-84.) It is expected that the maximum allowable daily average diversion will be the difference between the previous day's Freeport flow and the required bypass flow. However, many other factors will determine the actual diversion. Some of these other factors include: managing to State Water Board D-1641 standards and maintaining appropriate sweeping velocities in front of each intake during use.

The NMFS 2017 CWF Biological Opinion (Exhibit SWRCB-106) describes an unlimited out-migrating fish pulse protection process (pulse protection) where monitoring results for winter run and spring run Chinook salmon could trigger the need to drop the NDD down to "pulse protection" operations. Pulse protection operations allow only 6% of the Sacramento River flow to be diverted up to a maximum of 900 cfs (300 cfs per intake). The NDD will be maintained at these levels until the fish monitoring shows fish presence at low levels for 5 consecutive days. Only when the bypass flows exceed 35,000 cfs can the NDD divert more than 900 cfs during pulse protection operations.

In real-time operations, actual fish monitoring will trigger pulse protection flows. NMFS BO Section 2.5.1.2.7.4.1 used the Knights Landing Catch Index (KLCI) to indicate a fish pulse and trigger a pulse protection operation. (Exhibit SWRCB-106.) Specifically, if the KLCI of winter run and spring run Chinook salmon are greater than 5 fish per day, then a pulse protection operation is implemented. The threshold value and monitoring location may change through the adaptive management process. Under these conditions the NDD would be reduced to a maximum of 300 cfs at each intake, or 900 cfs for all three combined within 24 hours of detection. The NDD will be held to this maximum until the KLCI is less than 5 fish per day for winter-run and spring-run Chinook salmon for 5 consecutive days.

3. CONCEPTUAL 2016 OPERATION

In 2016, the NDD would have had three pulse protection operations based on the KLCI. Exhibit DWR-1032 illustrates these three periods in the green shades area. The first fish pulse occurred in late December during a period when the Delta was being managed for water quality conditions. During this period no additional water would have been diverted with CWF.

The second pulse of fish began about a week later and corresponded with significant flows on the Sacramento River. Because the KLCI was above 5 fish per day, the northern diversions would have remained limited to 900 cfs for the 11 days following the second pulse being triggered. Only after the bypass flows exceeded 35,000 cfs would the northern diversions be able to exceed 900 cfs.

The third fish pulse occurred in late March on the tail of a significant runoff event. The northern diversions could have been operating at full 9,000 cfs capacity at this time. Due to Sacramento River bypass flows well in excess of 35,000 cfs, the northern diversions would have been able to continue the 9,000 cfs diversions for most of March. The pulse protection would have continued into April, but at this time the spring outflow criteria would have also controlled total diversions where the combined SWP and CVP diversions would have been around 1,500 cfs.

C. OPERATIONALIZING CWF OLD AND MIDDLE RIVER FLOW

The OMR flow criteria were introduced in the 2008 and 2009 USFWS and NMFS Biological Opinions (2008-09 BOs). (Exhibits SWRCB-87 and SWRCB-84.) The OMR criteria described in the 2008-09 BOs can be a range between -1,250 and -5,000 cfs, where negative flow indicates upstream flow toward the SWP and CVP southern diversions. Adjusting SWP and CVP southern diversions are the primary tool available to manage OMR flow objectives. In addition to the OMR criteria required by the 2008-09 BOs, CWF H3+ proposes additional OMR criteria. (Exhibit SWRCB-104, Table 3.3-1.)

1. MODELING

The modeling for the CWF applied two layers of OMR criteria that represents the 2008-09 BOs criteria and the new criteria. The model then used the OMR limit that was the most restrictive. However, since the models don't have the capability to simulate fish presence, other surrogate information was used to determine the most likely OMR limits.

2. OPERATIONALIZATION

SWP operators have experience operating to OMR and operationalizing the additional criteria is achieved by applying the criteria at the appropriate time and level. In December, if the KLCI triggers a pulse protection action, an OMR limit of -5,000 cfs will be implemented in concert with the reduced northern diversion. In January through March and June, the requirement will be determined by the real-time operations decision making process similar to today. In April and May, the OMR will be determined based on the San Joaquin River flow measured at Vernalis. The operations under CWF recognize these criteria until NMFS or USFWS determine that a more restrictive OMR is needed for the protection of listed species. The CWF operations would limit the south of Delta diversion to whichever criteria is most restrictive.

3. CONCEPTUAL 2016 OPERATION

As discussed above the CWF proposes additional OMR criteria in addition to real-time determinations made by USFWS and NMFS. Exhibit DWR-1033 shows with the tan shaded areas, the periods throughout 2016 where these additional criteria would have increased the criteria by 500 cfs or more. In other words, the proposed CWF H3+ criteria would have been more protective than the actual OMR criteria in 2016.

D. OPERATIONALIZING ADDITIONAL SPRING OUTFLOW TARGET

The spring outflow target purpose is to maintain the Delta outflow occurring under today's conditions. This was initially described as maintaining a Delta outflow with the same frequency of exceedance as existing conditions. To maintain the same frequency of exceedance for average outflow March through May that occurs under current conditions and absent the CWF, a simple and implementable method was developed. This method applies an export constraint to each month between March and May until an outflow threshold is achieved.

1. MODELING

As described in the modeling testimony (DWR-1016), maintaining the existing outflow is accomplished with applying an Eight River Index (8RI) (SWRCB-27, Table 3, footnote 9) based outflow target in March and the NMFS 2009 BO Action IV.2.1 (Exhibit SWRCB-84) (SJR IE) in April and May. Based on the modeling analysis completed for the ITP application, the frequency of outflow exceedance was consistent with current conditions, achieving the proposed spring outflow requirement. This is further discussed in

DWR-1016.

2. OPERATIONALIZATION

Implementing this target would be very similar as to how it was modeled. However, rather than using the actual 8RI for March, the value for which will not be known until the following month (April), a forecasted 8RI must be used instead. At this point in time we have a few ways to estimate the 8RI. One estimate is developed by the DWR Division of Flood Management (DFM), the same group that puts together the Bulletin 120 *Water Conditions in California*. DFM provides an estimate for the 8RI every month through the winter and spring. The National Weather Services' California Nevada River Forecast Center (CNRFC) also provides an estimate for the 8RI and updates it daily which provides a refined estimate throughout the month. Both DFM and CNRFC are actively improving their forecasting ability and it is anticipated that the accuracy of these estimates will increase over time.

The CWF H3+ target outflow for March is determined using the outflow table in the 2081(b) Incidental Take Permit Application (DWR-1036, Page 5-28, Table 5.3-1), and the forecasted 8RI for March. Once the outflow target is determined, exports will be maintained to meet the daily outflow target. The exports will not be lowered below 1,500 cfs to meet the daily outflow target. Once the outflow is in excess of the outflow target and all other requirements are being met, only then will the SWP be able to increase exports, and only up to the amount that would continue to provide enough outflow to meet the target.

The CWF H3+ target outflow for April and May is determined by using the criteria used today for the SJR IE. This action limits the south Delta exports based on the hydrologic conditions in the San Joaquin water shed, defined by the San Joaquin Valley Water Year Hydrologic Classification (San Joaquin WYT) and described by D-1641 (Exhibit SWRCB-21, p.189, Figure 2,) where exports are limited by the flow in the San Joaquin River measured at Vernalis. The inflow to export ratio of the SJR IE varies between 1 to 1 in critical years and 4 to 1 in wet years. To operate to this criteria, the SWP and CVP use the observed flow measured at Vernalis on the San Joaquin River and then schedule exports based on the ratio for the San Joaquin WYT and limit exports such that the 14-day running average is at or below the required ratio.

To maintain the outflow in April and May, the proposed project would continue to operate to the SJR IE so total exports for both the northern and southern diversions fall within the restriction. The export restriction would be lifted in the event that Delta outflow exceeds 44,500 cfs. The resulting outflow would be the same that would have occurred absent the CWF.

3. CONCEPTUAL 2016 OPERATION

The spring outflow target in March is guided by the 8RI forecast for March, and as described above there are a couple of ways to estimate the 8RI. For this example, I am using the estimate that was developed by DFM. The forecasted 8RI for March was 2,314 TAF and based on the March Spring Outflow table, the outflow target would have been 18,897 cfs. Exhibit DWR-1034 shows in the blue shaded area the outflow target. In the beginning of the month, the total northern and southern diversions would have dropped to 1,500 cfs in an attempt to meet the target outflow. This action would have boosted the outflow in the beginning of the month by an additional 4,000 cfs. Soon afterward, the flows increased significantly and far exceeded the outflow target. At that time, the northern diversions would have been able to divert at full capacity of 9,000 cfs.

In April and May, the outflow target would be determined by what the south Delta diversions are able to export under the current 2009 NMFS BO without the CWF in place. During this period the SJR IE would be determined just like it is today. The San Joaquin WYT was categorized as a “Dry” year type, which limits the south of Delta diversions to one half the San Joaquin River flow. The San Joaquin River flow during this period was such that total diversion would have been consistently around 1,500. To maintain the Delta outflow that would occur under conditions without CWF, the northern and southern diversions would have been limited to a combined total of 1,500 cfs.

Even after meeting the March Delta outflow target, SWP and CVP would have been able to divert an additional 336 TAF in March, because of sustained high flow levels. In April and May no additional diversions would have been made and would have resulted in very similar outflow that actually occurred.

V. CONCLUSION

The SWP and CVP operations incorporate coordination with the regulatory agencies to share data and make determinations to protect listed species. The CWF will give the water operators and the regulatory agencies another tool in the toolbox to help manage the ever-complex Delta and to protect those species that depend on it, while also being able to divert runoff from winter and spring storms. These criteria proposed as part of the CWF H3+ are implementable in real-time operations.

Executed on this 28th day of November, 2017 in Sacramento, California.

Aaron Miller