SVWU-402

CALIFORNIA WATER FIX CWF H3+

MODELING REVIEW

MBK Engineers

JULY 2018

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Executive Summary

Proponents of the California Water Fix (CWF) developed and submitted exhibits and testimony regarding their modeling work to the State Water Resources Control Board (SWRCB) for Part 2 of the CWF hearing. MBK Engineers (MBK) reviewed the underlying CalSim II model developed by the California Department of Water Resources (DWR) and United States Bureau of Reclamation (USBR) and used for the proponents' Part 2 exhibits and testimony. That modeling is Exhibit DWR-1077, and referred to as DWR/USBR CWF H3+ in this report. MBK's review included comparisons with previous modeling by DWR/USBR for the January 2016 CWF Draft Biological Assessment and used for the CWF proponents' exhibits and testimony in Part 1 of the CWF hearing. Based on this review, we reached the following conclusions.

1. Four of the five key conclusions from review of DWR/USBR CWF BA modeling in Part 1, as documented in Exhibit SVWU-107, are still applicable to DWR/USBR CWF H3+. Therefore, our key overall conclusions in Exhibit SVWU-107 are still applicable to the proponents' DWR/USBR CWF H3+ modeling, namely that: 1) the proponents' modeling does not realistically simulate Central Valley Project and State Water Project operations with CWF, and 2) system-wide effects of the CWF are not adequately represented.

2. DWR/USBR CWF H3+ modeling includes a new March Delta outflow criteria incorporated from Section 5.3.2.3.2 of the CWF Incidental Take Permit (ITP) application (Exhibit DWR-1036 page 5-28) and Table 6.1-4 from the United States Fish and Wildlife Service's (USFWS) Biological Opinion for the California WaterFix (Exhibit SWRCB-105). DWR/USBR CWF H3+ modeling fails to meet the new March Delta outflow criteria in 13 percent of the years simulated. The annual volume of additional water needed to meet the new March Delta outflow criteria, above simulated Delta outflow in DWR/USBR CWF H3+, ranges from 24,000 acre-feet to 1,115,000 acre-feet with an annual average of 38,000 acre-feet.

3. The CWF ITP issued by California Department of Fish and Wildlife (Exhibit SWRCB-107) includes new Delta outflow criteria for March, April, and May. CWF ITP Delta outflow criteria are different than those analyzed in DWR/USBR CWF H3+. DWR has taken the position that the ITP Delta outflow criteria are "targets to be met to the extent export cuts down to a minimum of 1,500 cfs can achieve them" (Exhibit SWRCB-107, Clarification Letter; March 2, 2018 transcript pp. 151:18-172:15), but reductions in exports are not the only way spring Delta outflow targets in the ITP can be met. CVP and SWP operators may choose to increase releases from upstream reservoirs in order to meet the ITP spring Delta outflow targets without reductions in exports. Effects of Delta outflow criteria contained in the CWF ITP on CVP and SWP operations with CWF have not been analyzed, and therefore the effects are unknown.

4. The SWRCB will evaluate potential terms and conditions for the CWF project, including those proposed by other protestants to the CWF (see Exhibit NRDC-58 Errata, Exhibit PCFFA-130, Exhibit CSPA-200-Corrected, and Exhibit CSPA-202 Errata). Potential terms and conditions may

include Delta outflow requirements including those analyzed in the SWRCB's 2010 Delta Flow Criteria Report. MBK previously reviewed the SWRCB's 2010 Delta Flow Criteria Report and concluded there would be significant impacts to water supply deliveries, reservoir storage conditions, and ability to comply with existing SWRCB requirements with implementation of a minimum Delta outflow requirement of 40 to 50 percent of unimpaired flow. These conclusions remain relevant for the SWRCB's consideration during evaluation of potential terms and conditions for CWF.

The four sections of this report provide additional detail and support for each of the above conclusions.

Modeling Issues Identified in Part 1 Persist in DWR/USBR CWF H3+

CWF proponents, DWR and USBR, developed and submitted exhibits and testimony for Part 2 of the CWF hearing based in part on a new CalSim II model with CWF, referred to here as DWR/USBR CWF H3+. This modeling is Exhibit DWR-1077. MBK reviewed DWR/USBR CWF H3+ model files and output, compared model files and output with modeling used by CWF proponents for exhibits and testimony during Part 1, and reached several conclusions regarding the adequacy of the DWR/USBR CWF H3+ model for use in Part 2.

For Part 1 of the hearing, MBK conducted a detailed evaluation of the proposed operational scenario contained in the January 2016 CWF Draft Biological Assessment (BA), and prepared a report on multiple issues in the proponents' modeling. This report was Sacramento Valley Water Users (SVWU) Exhibit 107 (Exhibit SVWU-107). Exhibit SVWU-107 is a detailed summary of the review of proponents' modeling for the draft BA, on which CWF proponents relied in Part 1 (Exhibit DOI-33 Errata). A section of Exhibit SVWU-107 focused on review of the proponents' No Action Alternative (NAA) and Alternative 4A that included CWF. Exhibit SVWU-107 included five key conclusions applicable to proponents' NAA, Alternative 4A, or both.

For Part 2, CWF proponents submitted only a revised "with CWF" model, DWR/USBR CWF H3+, and continue to rely upon the NAA submitted for Part 1. Per the testimony of Mr. Reyes in Exhibit DWR-1016, page 5:

> "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 (Old and Middle rivers) and export restrictions."

Our review of the DWR/USBR CWF H3+ modeling confirmed Mr. Reyes' statement. Therefore, four of the five key conclusions from review of DWR/USBR CWF BA modeling in Part 1, as documented in Exhibit SVWU-107, are still applicable to DWR/USBR CWF H3+. The following is a summary of the four key conclusions. Please refer to Exhibit SVWU-107 for a detailed technical description of each issue.

1. **DWR/USBR CWF H3+ Model does not consider the additional capacity that would be made available by the North Delta Diversion (NDD) when modeling allocations to south-of-Delta CVP and SWP contractors.**
   Although the NDD would provide increased ability to convey water released from storage in upstream reservoirs to south Delta exports, export estimates used in CalSim II to calculate south-of-Delta (SOD) CVP water service contract allocations and SWP Table A contract allocations in the DWR/USBR CWF H3+ are set to those in the DWR/USBR BA NAA. This artificially and unrealistically limits the modeled ability of the CWF to increase CVP and SWP SOD allocations through use of the NDD and incorrectly keeps modeled storage in north-of-Delta (NOD) CVP and SWP reservoirs higher under DWR/USBR CWF H3+ as compared to the No Action Alternative.

2. **DWR/USBR CWF H3+ Model includes artificial limits on the modeled use of Joint Point of Diversion (JPOD).**
   DWR/USBR CWF H3+ modeling limits JPOD to remaining Banks South Delta Diversion (SDD) permitted capacity (under the permit issued by the U.S. Army Corps of Engineers under Section 10

of the Rivers and Harbors Act), regardless of whether the water is modeled as being conveyed through the SDD or the NDD. This assumption limits the CVP's modeled ability to use JPOD to convey both excess Delta outflow (outflow in excess of existing regulatory requirements) and water stored in upstream CVP reservoirs. This assumption tends to artificially and incorrectly keep modeled storage in NOD CVP reservoirs higher under DWR/USBR CWF H3+ as compared to the No Action Alternative.

3. **DWR/USBR CWF H3+ Model changes NOD/SOD reservoir balancing criteria so that less stored water is modeled as being conveyed from north-of-Delta reservoirs to San Luis Reservoir during summer months.**

CalSim II balances Sacramento Valley CVP and SWP reservoir storage with storage in San Luis Reservoir by setting target storage levels in San Luis Reservoir. These target storage levels are the San Luis Rulecurve for the CVP and SWP. San Luis Rulecurve, in conjunction with CVP and SWP SOD contract allocations, govern how much stored water is modeled as being released from upstream reservoirs and exported from the Delta. CalSim II will model releases of water from upstream reservoirs to meet Rulecurve in San Luis Reservoir, as long as there is capacity to convey water and water is available in upstream reservoirs.

Figures 1 and 2 compare Rulecurves for CVP and SWP portions of San Luis Reservoir, respectively, for the NAA, DWR/USBR Alt 4A, and DWR/USBR CWF H3+ scenarios. Figures show the San Luis Rulecurve for DWR/USBR CWF H3+ is different from NAA for both CVP and SWP San Luis operations and similar to the Rulecurves in DWR/USBR Alt 4A.

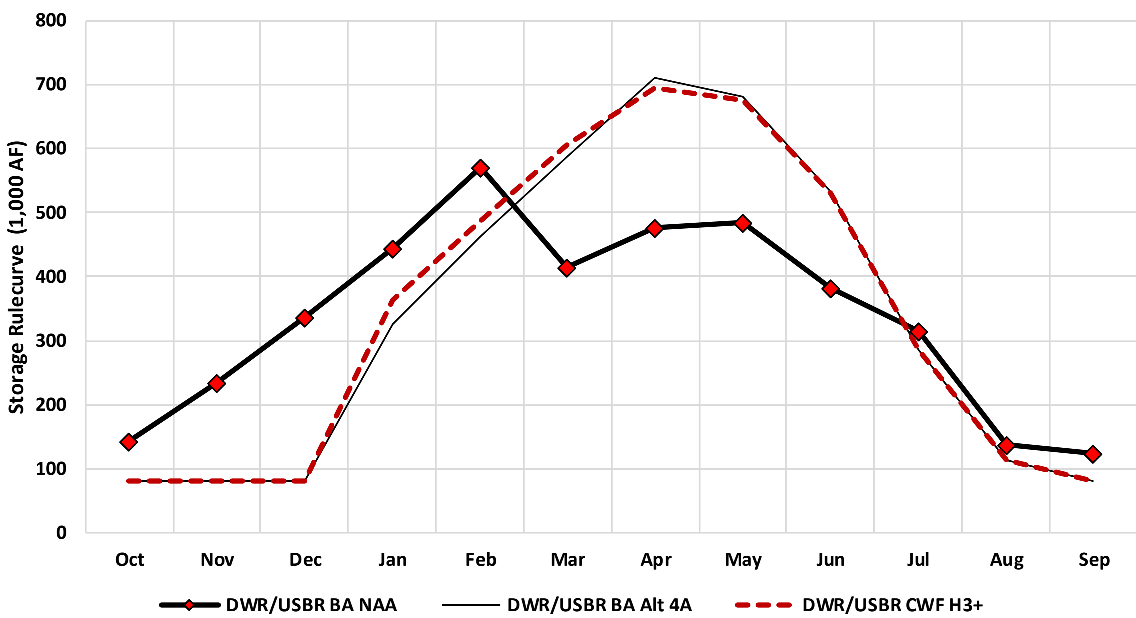

Figure 1. CVP San Luis Reservoir Rulecurve

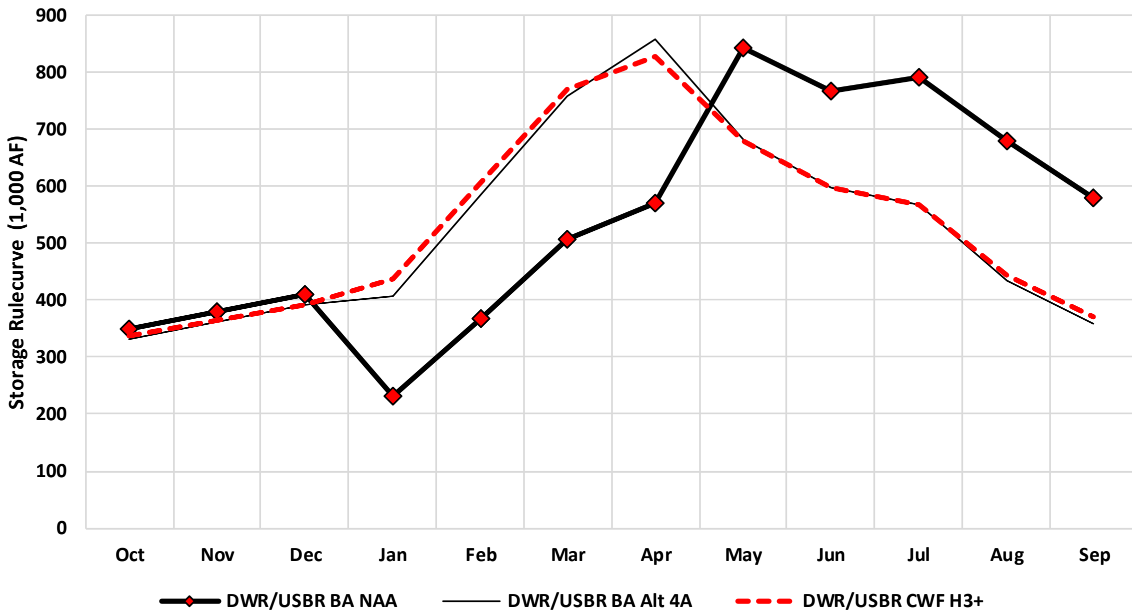

Figure 2. SWP San Luis Reservoir Rulecurve

DWR/USBR CWF H3+ increased modeled San Luis Reservoir target storage levels in winter and spring months and then decreased modeled target storage levels during summer months. When combined with artificial limits on export estimates described in conclusion 1 above, the result is a decrease in modeled release and conveyance of previously stored water from NOD CVP and SWP reservoirs. These criteria tend to artificially and incorrectly keep modeled storage in NOD CVP and SWP reservoirs higher under DWR/USBR CWF H3+ as compared to the No Action Alternative.

4. **CalSim II does not address effects on many types of water users.**
CalSim II is used for this modeling analysis, and although CalSim II simulates changes in Delta exports, Delta outflows, river flows, and CVP and SWP reservoir storage levels, it does not model any changes in water deliveries to Sacramento River Settlement Contractors, Feather River Settlement Contractors, wildlife refuges, CVP Exchange Contractors or non-Project water right holders. Because all CVP and SWP Settlement Contractor deliveries and all non-Project water user deliveries are "Hard Coded", the model is forced to meet these deliveries unless it runs out of water. For the purpose of CalSim II, it runs out of water when a reservoir reaches dead pool.

Because CalSim II does not reduce water use by non-Project water right holders or reduce deliveries to Settlement Contractors to comply with regulatory requirements, effects on these water users must be determined by evaluating the model output, see additional discussion on page 3 of Exhibit SVWU-107 and page 9 of Exhibit SVWU-108.

Exhibit SVWU-107 identified a fifth key conclusion that modeled diversions of excess Delta outflows were constrained beyond limits described in the CWF BA. This issue does not exist in DWR/USBR CWF H3+.

Overall, DWR/USBR CWF H3+ modeling does not provide sufficient information to understand how the CWF project may affect CVP/SWP operations. Therefore, our conclusion in Exhibit SVWU-107 that the proponent's modeling does not realistically simulate CVP and SWP operations with CWF, and that system-wide effects of the CWF are not adequately represented does not change with the new DWR/USBR CWF H3+ model.

March Delta Outflow Criteria in DWR/USBR CWF H3+

This section presents an evaluation of the March Delta outflow criteria included in DWR/USBR CWF H3+. A description of spring Delta outflow criteria is provided in California ITP Application for CWF, Section 5.3.2.3.2. Effects of Spring Outflow in Exhibit DWR-1036, page 5-28. Exhibit DWR-1036 describes spring Delta outflow criteria for the March through May period; however, only March criteria are a new operational requirement as modeled in CWF H3+. Delta outflow targets in April and May are based on the San Joaquin River inflow to export ratio contained in the 2009 National Marine Fisheries Service's Biological Opinion, and the extension of this export limit to Delta exports at both the NDD and existing SDD.

Proponents modeled Delta outflow criteria for March based on the Eight River Index. The same March Delta outflow and Eight River Index relationship is also Table 6.1-4 in the USFWS's Biological Opinion for the California WaterFix (Exhibit SWRCB-105). March Delta outflow criteria include Delta outflow targets based on the Eight River Index, and reductions in CVP/SWP Delta exports, to a minimum of 1,500 cubic feet per second (cfs), in order to meet the Delta outflow target. Figure 3 is the relationship between the March Delta outflow target and the Eight River Index in ITP Application Section 5.2.2.3.2 and modeled in DWR/USBR CWF H3+. DWR/USBR CWF H3+ includes a table of the March Eight River Index for each year, as adjusted by DWR to reflect an Early Long Term climate change condition.

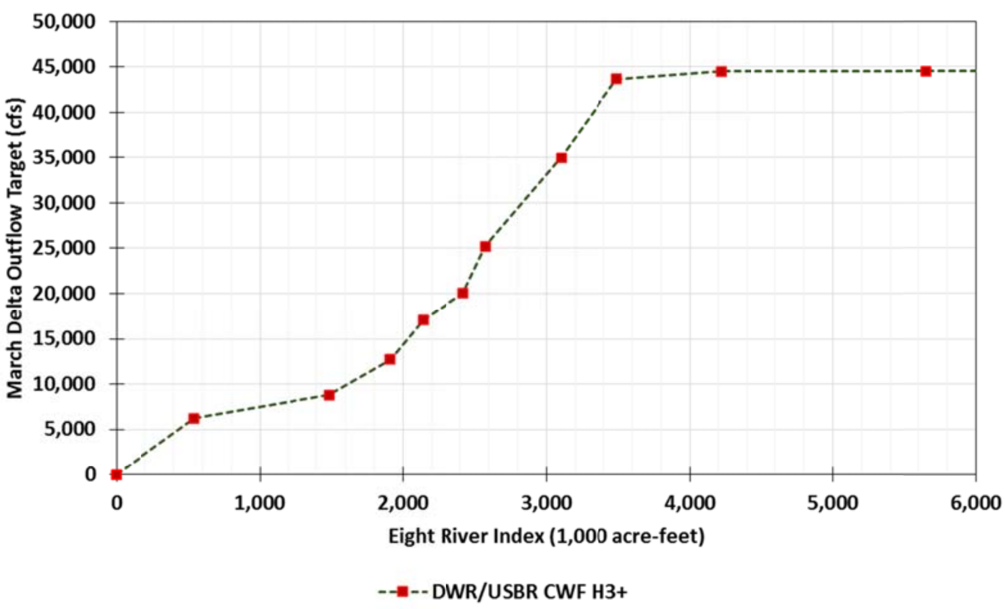

Figure 3. March Delta Outflow Targets for DWR/USBR CWF H3+

DWR/USBR CWF H3+ from Table 5.3-1. Proposed Longfin Smelt Spring Outflow Criteria: Monthly Net Delta Outflow Index in Relation to Eight River Index. (Exhibit DWR-1036)

Table 1 is a comparison of March Delta outflow targets simulated in DWR/USBR CWF H3+ along with that modeling's simulated March Delta outflow and combined CVP and SWP Delta exports at the NDD and SDD. Table 1 also includes the Delta outflow deficit (highlighted) for any year when simulated Delta outflow is less than the Delta outflow target.

Table 1. Comparison of Simulated March Delta Outflow Target, Delta Outflow, Combined Exports, and Delta Outflow Deficit in DWR/USBR CWF H3+

Water Year	Delta Outflow Target[1] (cfs)	Delta Outflow[2] (cfs)	Combined Delta Exports[3] (cfs)	Delta Outflow Deficit[4] (1,000 acre-feet)
1922	26,793	31,339	9,519	0
1923	8,855	10,672	5,965	0
1924	6,363	9,371	1,954	0
1925	18,504	18,504	2,292	0
1926	10,819	12,516	2,481	0
1927	43,976	43,976	6,634	0
1928	44,500	82,408	9,694	0
1929	8,144	9,841	3,625	0
1930	28,071	28,071	6,888	0
1931	7,805	7,334	1,500	29
1932	26,182	14,576	1,500	714
1933	13,219	13,219	2,637	0
1934	12,580	11,400	1,500	73
1935	16,831	22,935	9,514	0
1936	31,276	31,276	5,126	0
1937	43,875	47,299	10,084	0
1938	44,500	178,436	8,277	0
1939	12,009	12,009	1,756	0
1940	44,500	114,114	11,825	0
1941	44,500	95,589	8,920	0
1942	18,885	26,592	9,716	0
1943	44,500	83,052	12,916	0
1944	14,602	16,096	6,548	0
1945	18,225	22,906	8,161	0
1946	19,164	19,164	2,869	0
1947	22,161	19,567	1,500	159
1948	9,307	12,352	5,963	0
1949	40,045	40,045	9,068	0
1950	23,579	21,693	1,500	116
1951	26,645	27,943	8,772	0
1952	44,245	71,695	8,901	0
1953	15,813	18,519	8,273	0
1954	43,860	43,860	5,463	0
1955	8,188	8,188	4,114	0
1956	37,668	41,239	8,151	0
1957	43,743	42,863	1,500	54
1958	44,500	102,158	7,978	0
1959	13,968	13,968	3,744	0

Water Year	Delta Outflow Target[1] (cfs)	Delta Outflow[2] (cfs)	Combined Delta Exports[3] (cfs)	Delta Outflow Deficit[4] (1,000 acre-feet)
1960	37,691	19,560	1,500	1115
1961	13,372	13,372	6,821	0
1962	26,867	26,478	1,500	24
1963	16,581	23,586	8,186	0
1964	7,879	7,879	4,398	0
1965	13,257	16,861	8,295	0
1966	21,688	21,688	3,227	0
1967	44,374	57,068	9,521	0
1968	21,688	21,759	12,695	0
1969	43,874	73,133	5,614	0
1970	34,166	36,581	10,646	0
1971	44,074	44,074	3,024	0
1972	38,206	25,453	1,500	784
1973	43,409	57,965	8,718	0
1974	44,500	108,566	10,154	0
1975	44,500	83,454	11,385	0
1976	8,340	11,826	4,224	0
1977	5,745	7,239	1,500	0
1978	44,500	78,707	6,352	0
1979	32,295	32,295	5,107	0
1980	44,021	66,605	5,339	0
1981	19,329	19,329	5,048	0
1982	44,500	88,625	8,211	0
1983	44,500	291,622	5,099	0
1984	34,537	35,473	8,839	0
1985	9,667	11,741	5,441	0
1986	44,500	144,960	12,183	0
1987	24,829	24,829	2,334	0
1988	7,912	7,321	1,500	36
1989	44,500	44,500	7,014	0
1990	11,649	10,820	1,500	51
1991	26,867	29,967	6,311	0
1992	14,372	16,168	5,392	0
1993	44,500	47,246	7,409	0
1994	8,770	8,668	3,331[5]	6
1995	44,500	224,226	11,400	0
1996	44,500	71,217	12,640	0
1997	22,600	24,714	11,687	0
1998	44,500	87,663	14,131	0
1999	44,255	64,543	8,762	0
2000	44,500	67,940	11,864	0
2001	19,659	19,659	7,984	0
2002	18,638	18,532	3,196[5]	6
2003	23,748	23,748	2,386	0

[1] Delta Outflow Target = CalSim II output variable *DOREQFLOW_LFSDV*.
[2] Delta Outflow = CalSim II output variable *C406*.

[3] Combined Exports = CalSim II output variable *TOTAL_EXP*.
[4] Delta Outflow Deficit is calculated as the positive difference between Delta Outflow Target and Delta Outflow, converted to 1,000 acre-feet.
[5] Combined exports are not reduced to 1,500 cfs to meet Delta outflow target.

Results illustrate the March Delta outflow target is not met in 11 years (13%) in the 82-year period of simulation, despite combined Delta exports being reduced to 1,500 cfs. In two additional years, 1994 and 2002, simulated combined Delta exports were not reduced to 1,500 cfs despite not meeting the Delta outflow target.

In the 11 years when reductions in Delta exports cannot meet the Delta outflow target, the Delta outflow deficit, the additional volume of water needed to meet the Delta outflow target, ranges from 24,000 acre-feet to 1,115,000 acre-feet, with an annual average deficit of 39,000 acre-feet. Delta outflow deficits can be a significant volume of water that, if required to be provided through additional operational mechanisms beyond Delta export reductions, could have significant effects on CVP and SWP operations, including increased releases from NOD reservoirs and decreased storage in those reservoirs.

Spring Delta Outflow Criteria in Incidental Take Permit for CWF

Exhibit SWRCB-107 contains the ITP issued by the California Department of Fish and Wildlife (CDFW) for CWF. ITP condition of approval 9.9.4.3 and Sub Table B define the spring Delta outflow criteria for the protection of longfin smelt for the period March 1 through May 31. Condition of approval 9.9.4.3 states:

> "To minimize take of LFS [longfin smelt] associated with impacts of Project operations on abiotic habitat, *Permittee shall maintain Delta outflows* that are protective of LFS every year from March 1 – May 31. These outflows will: 1) maintain estuarine processes and flow positively associated with LFS abundance; 2) maintain downstream transport of LFS larvae to rearing habitat; and 3) dedicate water to maintain LFS habitat quality and quantity at levels consistent with recent conditions. *Protective outflows from March 1 – May 31 every year shall be determined by the use of a lookup table derived from a linear relationship between the 50% exceedance forecast for the current month's 8RI [Eight River Index] and recent historic Delta outflow (1980 – 2016), as shown in Sub Table B.*"

(Exhibit SWRCB-107, p. 188 (emphasis added).)

Sub Table B under Table 9.9.4-1 presents the Delta outflow criteria as a function of the Eight River Index (Exhibit SWRCB-107, pp. 185-187). The ITP includes the following statement regarding how spring Delta outflow targets are to be met (Exhibit SWRCB-107, page 189).

> "These targets are intended to be provided through the acquisition of water from willing sellers and through operations of the CVP/SWP."

CDFW provided a clarification letter on October 18, 2017 to DWR regarding ITP condition of approval 9.9.4.3 to maintain spring Delta outflow (Clarification Letter). The Clarification Letter states the Eight River Index and spring Delta outflow relationships provided as Sub Table B in the ITP are "targets to be met to the extent export cuts down to a minimum of 1,500 cfs can achieve them."

Based on CDFW's Clarification Letter, DWR has taken the position that the ITP Delta outflow criteria are "targets to be met to the extent export cuts down to a minimum of 1,500 cfs can achieve them"

(SWRCB-107, Clarification Letter; March 2, 2018 transcript pages 152-172). It is unclear how the ITP will be interpreted and enforced in the future. Reductions in Delta exports are not the only way spring Delta outflow targets in the ITP can be met. CVP and SWP operators may choose to increase releases from upstream reservoirs in order to meet the ITP spring Delta outflow targets without reductions in exports.

Spring Delta outflow criteria contained in the ITP are different from spring Delta outflow criteria included in the DWR/USBR CWF H3+ modeling. Figure 4 shows the relationship between the Eight River Index and the March Delta outflow target for DWR/USBR CWF H3+ and ITP.

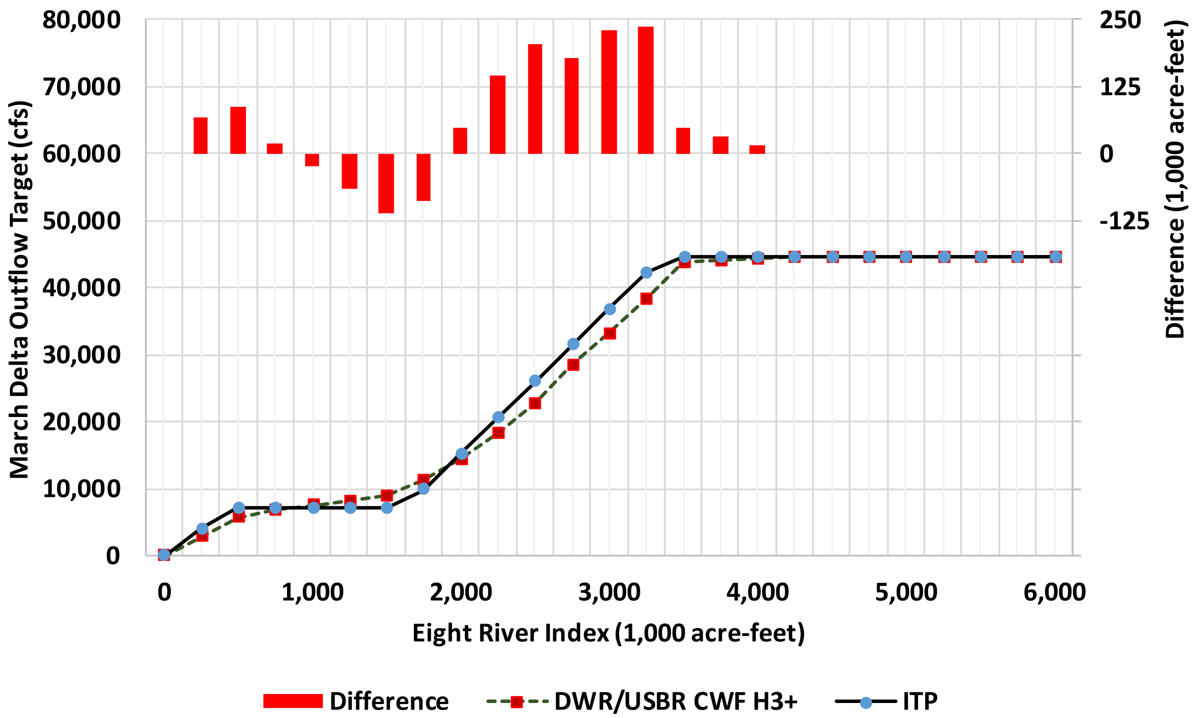

Figure 4. March Delta Outflow Targets for DWR/USBR CWF H3+ and ITP

DWR/USBR CWF H3+ from Table 5.3-1. Proposed Longfin Smelt Spring Outflow Criteria: Monthly Net Delta Outflow Index in Relation to Eight River Index. (Exhibit DWR-1036)
ITP from Sub Table B, Table 9.4.4-1 New and Existing Water Operations Flow Criteria (Exhibit SWRCB-107)

Figure 4 illustrates the difference in March Delta outflow targets between the ITP and DWR/USBR CWF H3+. March Delta outflow targets under the ITP are approximately 1,000 to 4,000 cfs, approximately 61,000 to 246,000 acre-feet, higher than DWR/USBR CWF H3+ for an Eight River Index between 2,100 and 3,100 thousand acre-feet (TAF). Based on a review of estimated March Eight River Indices for an Early Long Term climate change condition, the Eight River Index is between 2,100 and 3,100 TAF approximately 28 percent of years.

Additionally, DWR/USBR CWF H3+ does not include an explicit Delta outflow target for April and May based on the Eight River Index. DWR/USBR CWF H3+ is based on the ITP application's spring Delta outflow requirement that relies on the San Joaquin River inflow to export ratio contained in the 2009 National Marine Fisheries Service's Biological Opinion (Exhibit DWR-1036) to provide Delta outflow in

April and May. The ITP includes Delta outflow targets for April and May based on the Eight River Index as illustrated in Figure 5.

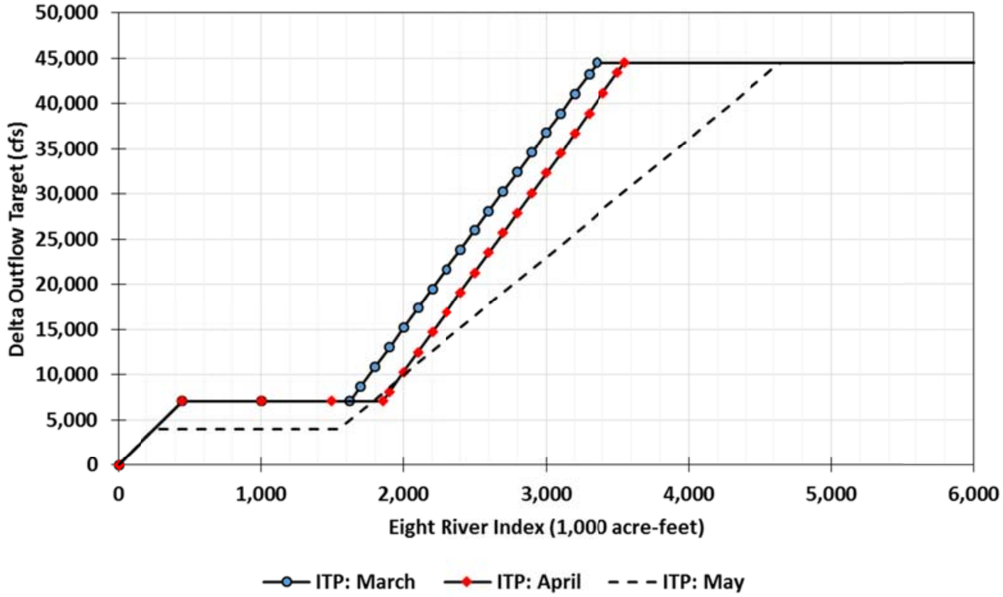

Figure 5. March through May Delta Outflow Targets in ITP

CWF proponents have not submitted testimony or exhibits that summarize an analysis of CVP/SWP operations, reservoir levels, water deliveries, river flows, or Delta outflow with CWF as governed by the ITP. It is our opinion that CWF proponents have not fully analyzed the CWF project without modeling CVP/SWP operations with both CWF and conditions in the ITP. Modeling of CWF should include the ability to meet the spring Delta outflow targets described in Exhibit SWRCB-107, page 198, including through the acquisition of water from willing sellers and through operations of the CVP/SWP, including both potential export reductions and potential increased releases from upstream reservoirs. Modeling CWF with the conditions in the ITP in this way would likely illustrate the potential impacts of CWF on reservoir storage, stream flow, and CVP/SWP operations.

Comparison of ITP Delta Outflow Targets with DWR/USBR CWF H3+ Delta Outflow

Based on information in Figure 4 and Figure 5, we expect differences in Delta outflow between DWR/USBR CWF H3+ and CVP/SWP operations with CWF, as governed by ITP Delta outflow criteria. Expected differences in spring Delta outflow are contrary to testimony by DWR witness Aaron Miller. Mr. Miller stated he compared the ITP Delta outflow criteria with the Delta outflow criteria simulated in the DWR/USBR CWF H3+ modeling and that the resulting outflow “would be substantially the same.” (February 26, 2018 transcript, pp. 73:8-76:4.)

We compared March through May Delta outflow criteria contained in the ITP with simulated Delta outflow from DWR/USBR CWF H3+ modeling. We made this comparison because CWF proponents have not submitted modeling of CVP/SWP operations with both CWF and conditions in the ITP. Additionally, there is uncertainty regarding how Delta outflow criteria contained in the ITP will be interpreted, operated to, and enforced.

The comparison of March through May ITP Delta outflow criteria with simulated Delta outflow from DWR/USBR CWF H3+ involved the following steps.

1. Calculate a March, April, and May Delta outflow target based on Sub Table B of the ITP (ITP Outflow Target) and the Eight River Index from DWR/USBR CWF H3+.
2. Compare the ITP Outflow Target with simulated monthly Delta outflow from DWR/USBR CWF H3+ for each month.
3. Identify months when DWR/USBR CWF H3+ Delta outflow is less than the ITP Outflow Target.
4. In these months, adjust combined Delta exports until: a) the ITP Outflow Target is met, or b) adjusted combined Delta exports are 1,500 cfs.
5. Calculate any remaining deficit between the ITP Outflow Target and simulated Delta outflow after consideration of reductions to combined Delta exports.

The first step in the comparison was to calculate a monthly ITP Outflow Target for March, April, and May. We calculated the ITP Outflow Target as a day-weighted average for each month that assumes the Eight River Index (8RI) forecast for each month is available on approximately the 16th day of each month. ITP Outflow Targets in the tables below for March, April, and May for each year were computed using the following equations.

March ITP Outflow Target = (15 days*Feb. 8RI Target + 16 days*Mar. 8RI Target)/31 days
April ITP Outflow Target = (15 days*Mar. 8RI Target + 15 days*Apr. 8RI Target)/30 days
May ITP Outflow Target = (15 days*Apr. 8RI Target + 16 days*May 8RI Target)/31 days

These equations were included in a document produced by DWR in response to SVWU's July 7, 2017 subpoena for documents regarding modeling performed in connection with CDFW's ITP spring outflow criteria. (SVWU July 7, 2017 Subpoena, category f; SVWU July 19, 2017 Reply to DWR's Opposition to Keep Open Part 1 of the Hearing, Exhibit C.)

Tables 2, 3, and 4 are summaries of the above steps. As an example for March 1922 in Table 2, simulated Delta outflow under DWR/USBR CWF H3+ is 31,339 cfs, below the ITP Outflow Target of 36,134 cfs, a deficit of approximately 4,795 cfs. In this month, the deficit could be met by reducing Delta exports from 9,519 cfs to approximately 4,723 cfs, a reduction of approximately 4,795 cfs, and there would be no remaining Delta outflow deficit.

As a second example, using April 1922 in Table 3, simulated Delta outflows under DWR/USBR CWF H3+ is 31,608 cfs, below the ITP Outflow Target of 36,396 by 4,788 cfs. Simulated combined Delta exports are 1,954 cfs. In this month, reducing combined Delta exports from 1,954 cfs to the minimum health and safety limit of 1,500 cfs is not adequate to meet the ITP Outflow Target, resulting in a remaining Delta outflow deficit of 4,334 cfs or approximately 258 TAF. This example shows how the ITP Outflow Targets may not be achievable with only reduction in Delta exports. Each of the three tables are formatted so that Delta outflow less than the ITP Outflow Target is in red text, and also highlighted for any year when a Delta outflow deficit remains after reducing combined Delta exports to the minimum health and safety limit of 1,500 cfs.

This analysis is approximate and useful only to understand an order-of-magnitude difference between Delta outflow simulated in DWR/USBR CWF H3+ and the ITP Outflow Targets. The DWR/USBR CWF H3+

model does not contain ITP Delta outflow criteria and thus, the DWR/USBR CWF H3+ model does not simulate CVP/SWP operations to comply with ITP Delta outflow criteria.

Results in Table 2 show ITP Outflow Targets in March are not met in 20 years (24%) in the 82-year simulation period, as compared to 11 years (13%) with DWR/USBR CWF H3+ Delta outflow criteria. Results in Table 3 show April ITP Outflow Targets are not met during 51 years (62 %). Results in Table 4 show May ITP Outflow Targets are not met during 60 years (73 %) of the 82 years simulated. Remaining Delta outflow deficits for meeting ITP Delta Outflow Targets range from 0 TAF to 1,584 TAF with average deficits in March, April, and May at 100 TAF, 376 TAF, and 497 TAF, respectively; and an average annual deficit of 973 TAF. A comparison of tables 1 and 2 shows March Delta outflow deficits are greater with ITP Outflow Targets than Delta outflow targets in the ITP application.

Table 2. Comparison of Simulated Delta Outflow in DWR/USBR CWF H3+ and Incidental Take Permit Delta Outflow Targets in March

Water Year	March				
	ITP Outflow Target (cfs)	Delta Outflow[1] (cfs)	Combined Delta Exports[2] (cfs)	Adjusted Combined Delta Exports[3] (cfs)	Remaining Delta Outflow Deficit[4] (1,000 acre-feet)
1922	36,134	31,339	9,519	4,723	0
1923	10,556	10,672	5,965	5,965	0
1924	8,547	9,371	1,954	1,954	0
1925	32,632	18,504	2,292	1,500	820
1926	25,698	12,516	2,481	1,500	750
1927	44,500	43,976	6,634	6,110	0
1928	35,982	82,408	9,694	9,694	0
1929	9,040	9,841	3,625	3,625	0
1930	27,806	28,071	6,888	6,888	0
1931	7,100	7,334	1,500	1,500	0
1932	26,990	14,576	1,500	1,500	763
1933	10,422	13,219	2,637	2,637	0
1934	15,689	11,400	1,500	1,500	264
1935	18,471	22,935	9,514	9,514	0
1936	38,767	31,276	5,126	1,500	238
1937	44,500	47,299	10,084	10,084	0
1938	44,500	178,436	8,277	8,277	0
1939	9,221	12,009	1,756	1,756	0
1940	44,500	114,114	11,825	11,825	0
1941	44,500	95,589	8,920	8,920	0
1942	32,295	26,592	9,716	4,013	0
1943	44,500	83,052	12,916	12,916	0
1944	16,635	16,096	6,548	6,009	0
1945	32,191	22,906	8,161	1,500	161
1946	19,171	19,164	2,869	2,862	0
1947	22,291	19,567	1,500	1,500	167
1948	7,100	12,352	5,963	5,963	0
1949	26,354	40,045	9,068	9,068	0

Water	March				
1950	34,566	21,693	1,500	1,500	792
1951	36,394	27,943	8,772	1,500	73
1952	44,500	71,695	8,901	8,901	0
1953	18,826	18,519	8,273	7,967	0
1954	44,500	43,860	5,463	4,823	0
1955	8,244	8,188	4,114	4,058	0
1956	42,460	41,239	8,151	6,929	0
1957	44,214	42,863	1,500	1,500	83
1958	44,500	102,158	7,978	7,978	0
1959	28,670	13,968	3,744	1,500	766
1960	42,670	19,560	1,500	1,500	1,421
1961	21,620	13,372	6,821	1,500	180
1962	36,451	26,478	1,500	1,500	613
1963	30,589	23,586	8,186	1,500	19
1964	8,265	7,879	4,398	4,012	0
1965	23,238	16,861	8,295	1,918	0
1966	22,869	21,688	3,227	2,046	0
1967	43,278	57,068	9,521	9,521	0
1968	34,415	21,759	12,695	1,500	90
1969	44,500	73,133	5,614	5,614	0
1970	41,045	36,581	10,646	6,183	0
1971	35,280	44,074	3,024	3,024	0
1972	31,987	25,453	1,500	1,500	402
1973	44,500	57,965	8,718	8,718	0
1974	38,231	108,566	10,154	10,154	0
1975	44,500	83,454	11,385	11,385	0
1976	7,100	11,826	4,224	4,224	0
1977	7,044	7,239	1,500	1,500	0
1978	44,500	78,707	6,352	6,352	0
1979	35,384	32,295	5,107	2,018	0
1980	44,500	66,605	5,339	5,339	0
1981	22,557	19,329	5,048	1,820	0
1982	44,500	88,625	8,211	8,211	0
1983	44,500	291,622	5,099	5,099	0
1984	37,037	35,473	8,839	7,274	0
1985	10,302	11,741	5,441	5,441	0
1986	44,500	144,960	12,183	12,183	0
1987	23,131	24,829	2,334	2,334	0
1988	8,421	7,321	1,500	1,500	68
1989	27,475	44,500	7,014	7,014	0
1990	8,717	10,820	1,500	1,500	0
1991	18,474	29,967	6,311	6,311	0
1992	26,516	16,168	5,392	1,500	397
1993	44,500	47,246	7,409	7,409	0
1994	10,309	8,668	3,331	1,690	0
1995	44,500	224,226	11,400	11,400	0
1996	44,500	71,217	12,640	12,640	0

Water	March				
1997	33,395	24,714	11,687	3,006	0
1998	44,500	87,663	14,131	14,131	0
1999	44,500	64,543	8,762	8,762	0
2000	44,500	67,940	11,864	11,864	0
2001	22,336	19,659	7,984	5,307	0
2002	22,211	18,532	3,196	1,500	122
2003	24,378	23,748	2,386	1,756	0

Notes:

[1] Delta Outflow = CalSim II output variable *C406*.

[2] Combined Exports = CalSim II output variable *TOTAL_EXP*.

[3] Resulting Combined Delta Exports after reductions to meet ITP Outflow Target or 1,500 cfs.

[4] Delta Outflow Deficit is calculated as the positive difference between ITP Outflow Target and Delta Outflow after adjustment to Combined Delta Exports, converted to 1,000 acre-feet.

Table 3. Comparison of Simulated Delta Outflow in DWR/USBR CWF H3+ and Incidental Take Permit Delta Outflow Targets in April

Water Year	April				
	ITP Outflow Target (cfs)	Delta Outflow[1] (cfs)	Combined Delta Exports[2] (cfs)	Adjusted Combined Delta Exports[3] (cfs)	Remaining Delta Outflow Deficit[4] (1,000 acre-feet)
1922	36,396	31,608	1,954	1,500	258
1923	22,621	28,815	1,778	1,778	0
1924	7,100	6,521	1,786	1,500	17
1925	33,003	28,460	1,857	1,500	249
1926	24,810	22,341	3,449	1,500	31
1927	44,500	48,842	1,354	1,354	0
1928	44,238	24,186	2,025	1,500	1,162
1929	7,100	7,849	2,069	2,069	0
1930	25,235	11,179	1,911	1,500	812
1931	7,100	7,817	1,496	1,496	0
1932	26,962	12,575	1,259	1,259	856
1933	10,347	9,673	1,964	1,500	12
1934	9,244	9,673	1,322	1,322	0
1935	30,786	46,436	8,455	8,455	0
1936	38,946	26,265	1,576	1,500	750
1937	44,500	27,562	2,393	1,500	955
1938	44,500	76,223	9,630	9,630	0
1939	11,617	9,673	1,756	1,500	100
1940	44,500	65,011	9,236	9,236	0
1941	44,500	70,215	8,564	8,564	0
1942	32,677	54,375	2,223	2,223	0
1943	44,500	31,642	2,552	1,500	703
1944	10,548	11,177	1,557	1,557	0
1945	24,396	16,961	1,100	1,100	442
1946	29,916	17,673	1,466	1,466	728
1947	18,751	9,519	2,292	1,500	502
1948	25,800	27,675	1,538	1,538	0

Water	April				
1949	39,141	12,517	1,464	1,464	1,584
1950	34,843	20,315	1,671	1,500	854
1951	24,976	15,538	1,809	1,500	543
1952	44,500	72,849	7,782	7,782	0
1953	26,008	18,397	1,576	1,500	448
1954	44,500	39,925	1,444	1,444	272
1955	7,723	10,718	2,459	2,459	0
1956	40,140	21,904	1,563	1,500	1,081
1957	31,059	12,878	1,534	1,500	1,080
1958	44,500	102,169	9,584	9,584	0
1959	13,407	9,579	1,595	1,500	222
1960	30,277	12,342	2,145	1,500	1,029
1961	11,179	9,175	1,567	1,500	115
1962	36,703	15,056	1,420	1,420	1,288
1963	31,024	90,148	9,776	9,776	0
1964	7,100	9,761	2,085	2,085	0
1965	28,666	45,601	1,968	1,968	0
1966	26,681	11,894	1,544	1,500	877
1967	44,500	56,167	9,574	9,574	0
1968	17,886	10,148	1,745	1,500	446
1969	44,500	58,273	6,694	6,694	0
1970	22,453	12,442	1,365	1,365	596
1971	41,213	24,532	1,644	1,500	984
1972	28,404	11,406	3,101	1,500	916
1973	37,565	19,264	1,523	1,500	1,088
1974	44,500	60,358	9,323	9,323	0
1975	38,674	26,825	1,558	1,500	702
1976	7,100	8,557	2,112	2,112	0
1977	7,100	7,100	1,100	1,100	0
1978	44,500	46,483	3,395	3,395	0
1979	29,558	18,184	1,532	1,500	675
1980	38,706	22,045	1,939	1,500	965
1981	18,110	13,113	1,826	1,500	278
1982	44,500	147,516	9,617	9,617	0
1983	44,500	86,983	6,066	6,066	0
1984	27,476	16,684	1,521	1,500	641
1985	16,529	13,079	2,132	1,500	168
1986	39,212	27,225	3,339	1,500	604
1987	17,245	8,893	2,695	1,500	426
1988	7,100	9,810	1,654	1,654	0
1989	43,122	19,020	1,747	1,500	1,419
1990	8,667	9,427	1,443	1,443	0
1991	19,113	11,206	1,584	1,500	465
1992	12,939	8,886	1,475	1,475	241
1993	44,500	40,603	1,228	1,228	232
1994	7,100	10,063	1,532	1,532	0
1995	44,500	65,906	7,326	7,326	0

Water	April				
1996	44,500	43,841	1,728	1,500	26
1997	22,302	17,114	1,336	1,336	309
1998	44,500	58,791	9,295	9,295	0
1999	40,859	30,194	1,506	1,500	634
2000	40,463	20,220	1,465	1,465	1,205
2001	15,387	10,539	2,318	1,500	240
2002	22,167	15,685	1,774	1,500	369
2003	31,843	28,160	1,277	1,277	219

Notes:
[1] Delta Outflow = CalSim II output variable *C406*.
[2] Combined Exports = CalSim II output variable *TOTAL_EXP*.
[3] Resulting Combined Delta Exports after reductions to meet ITP Outflow Target or 1,500 cfs.
[4] Delta Outflow Deficit is calculated as the positive difference between ITP Outflow Target and Delta Outflow after adjustment to Combined Delta Exports, converted to 1,000 acre-feet.

Table 4. Comparison of Simulated Delta Outflow in DWR/USBR CWF H3+ and Incidental Take Permit Delta Outflow Targets in May

Water Year	May				
	ITP Outflow Target (cfs)	Delta Outflow[1] (cfs)	Combined Delta Exports[2] (cfs)	Adjusted Combined Delta Exports[3] (cfs)	Remaining Delta Outflow Deficit[4] (1,000 acre-feet)
1922	44,500	51,084	9,000	9,000	0
1923	32,697	16,313	1,457	1,457	1,007
1924	5,500	4,000	1,515	1,500	91
1925	35,382	16,454	1,009	1,009	1,164
1926	24,293	12,282	2,649	1,500	668
1927	40,103	23,436	1,326	1,326	1,025
1928	30,569	10,554	1,547	1,500	1,228
1929	10,039	7,100	1,774	1,500	164
1930	15,167	7,819	1,918	1,500	426
1931	5,500	4,000	1,479	1,479	92
1932	31,853	13,075	1,274	1,274	1,155
1933	8,796	7,239	1,992	1,500	66
1934	5,500	7,100	900	900	0
1935	43,458	16,853	4,324	1,500	1,462
1936	35,673	15,584	1,470	1,470	1,235
1937	44,043	20,661	2,725	1,500	1,362
1938	44,500	69,360	11,598	11,598	0
1939	7,883	10,397	1,500	1,500	0
1940	34,812	16,446	1,538	1,500	1,127
1941	44,500	45,778	3,341	3,341	0
1942	44,374	37,211	2,465	1,500	381
1943	34,505	17,249	1,646	1,500	1,052
1944	15,691	9,152	1,353	1,353	402
1945	28,750	14,655	1,008	1,008	867
1946	32,138	13,552	1,432	1,432	1,143
1947	9,897	8,181	2,169	1,500	64

Water	May				
1948	44,443	27,408	1,531	1,500	1,046
1949	29,961	11,141	1,474	1,474	1,157
1950	35,632	13,178	1,580	1,500	1,376
1951	19,755	14,728	1,484	1,484	309
1952	44,500	65,669	10,018	10,018	0
1953	29,811	23,165	1,573	1,500	404
1954	32,303	12,694	1,407	1,407	1,206
1955	15,224	10,070	2,237	1,500	272
1956	42,193	38,970	1,754	1,500	183
1957	24,057	19,653	1,474	1,474	271
1958	44,500	46,290	3,206	3,206	0
1959	8,944	9,968	1,511	1,511	0
1960	15,779	8,302	2,066	1,500	425
1961	8,861	8,500	1,500	1,500	22
1962	33,370	11,138	1,402	1,402	1,367
1963	44,500	27,636	1,306	1,306	1,037
1964	9,868	9,707	1,631	1,500	2
1965	36,875	16,891	1,328	1,328	1,229
1966	20,144	10,923	1,449	1,449	567
1967	44,500	46,934	11,603	11,603	0
1968	9,495	9,679	1,536	1,536	0
1969	44,500	59,208	9,473	9,473	0
1970	11,818	12,141	1,265	1,265	0
1971	36,883	26,701	1,438	1,438	626
1972	15,633	7,791	2,768	1,500	404
1973	35,818	16,908	1,581	1,500	1,158
1974	40,829	19,783	1,427	1,427	1,294
1975	38,862	29,741	1,294	1,294	561
1976	5,500	9,831	1,562	1,562	0
1977	5,500	4,000	1,422	1,422	92
1978	42,110	25,907	3,872	1,500	850
1979	30,599	16,933	1,100	1,100	840
1980	29,748	17,944	1,921	1,500	700
1981	10,353	8,334	1,578	1,500	119
1982	44,500	45,033	4,902	4,902	0
1983	44,500	72,024	7,956	7,956	0
1984	23,256	12,911	1,100	1,100	636
1985	17,393	9,013	1,619	1,500	508
1986	29,274	18,113	2,690	1,500	613
1987	5,500	9,221	2,324	2,324	0
1988	5,500	7,100	1,575	1,575	0
1989	25,002	12,084	1,559	1,500	791
1990	5,563	5,997	1,689	1,689	0
1991	11,265	6,193	1,545	1,500	309
1992	7,438	7,377	1,100	1,100	4
1993	44,500	27,007	1,323	1,323	1,076
1994	5,756	7,348	1,914	1,914	0

Water	May				
1995	44,500	78,030	10,222	10,222	0
1996	44,500	41,363	1,777	1,500	176
1997	19,401	12,762	1,373	1,373	408
1998	44,500	50,906	10,903	10,903	0
1999	35,342	17,390	1,357	1,357	1,104
2000	30,988	14,998	1,413	1,413	983
2001	10,151	7,530	2,248	1,500	115
2002	18,382	11,699	2,216	1,500	367
2003	41,065	42,419	1,298	1,298	0

Notes:

[1] Delta Outflow = CalSim II output variable *C406*.

[2] Combined Exports = CalSim II output variable *TOTAL_EXP*.

[3] Resulting Combined Delta Exports after reductions to meet ITP Outflow Target or 1,500 cfs.

[4] Delta Outflow Deficit is calculated as the positive difference between ITP Outflow Target and Delta Outflow after adjustment to Combined Delta Exports, converted to 1,000 acre-feet.

Effects of SWRCB 2010 Delta Flow Criteria Report

Witnesses for several CWF protestants submitted proposed terms and conditions for inclusion in water rights for the operation of the CVP and SWP with CWF. Witnesses and groups include: Mr. Rosenfield for Natural Resources Defense Council (NRDC) in Exhibit NRDC-58 Errata, Mr. Oppenheim for Pacific Coast Federation of Fishermen's Associations (PCFFA) and the Institute for Fisheries Resources (IFR) in Exhibit PCFFA-130, and Mr. Jennings and Mr. Shutes of California Sportfishing Protection Alliance (CSPA) in Exhibits CSPA-200-Corrected and CSPA-202 Errata, respectively. Several witnesses referred to Delta outflow requirements, updates to the Bay-Delta Water Quality Control Plan, the SWRCB's 2010 Delta Flow Criteria Report, and information submitted during public workshops on the SWRCB's 2010 Delta Flow Criteria Report.

MBK previously analyzed the effects of implementing the SWRCB's 2010 Delta Flow Criteria Report, and submitted resulting testimony to the SWRCB on August 17, 2012 on behalf of SVWU and the Northern California Water Association (NCWA). That testimony is attached here as Exhibit SVWU-404. Exhibit SVWU-404 includes: the testimony and resume of Mr. Walter Bourez; a December 15, 2011 memorandum from Mr. Bourez to NCWA relating Delta smelt index to X2 position, Delta flows, and water use; an April 25, 2012 MBK Report, Evaluation of Potential State Water Resources Control Board Unimpaired Flow Objectives (2012 MBK Report); and exhibits used at the public workshop. Exhibit SVWU-405 contains the model files described in the 2012 MBK Report.

Analysis described in the 2012 MBK Report evaluated the effects of implementing minimum monthly Delta outflow requirements of 50 percent and 40 percent of the monthly, unimpaired flow from January through June. Analysis summarized in the 2012 MBK Report was at a reconnaissance-level, but was adequate to estimate potential effects and challenges associated with implementing minimum monthly Delta outflow requirements based on 40 and 50 percent of unimpaired flow. Conclusions described and illustrated in the 2012 MBK Report include:

- Effects to CVP and SWP operations would be severe and would result in the inability to maintain viable operations

- Increases in average annual Delta outflows, above conditions with the current biological opinions, would be approximately:
  - 1,100,000 acre-feet for a 50 percent of unimpaired flow requirement; and
  - 480,000 acre-feet for a 40 percent of unimpaired flow requirement
- Reductions in average, combined CVP and SWP carryover storage in Trinity, Shasta, Oroville, and Folsom would be approximately:
  - 2,200,000 acre-feet for a 50 percent of unimpaired flow requirement; and
  - 1,000,000 acre-feet for a 40 percent of unimpaired flow requirement
- Seasonal changes in river flows and Delta outflow would include:
  - Increases in March through June
  - Decreases in July through December
- Regular and multiple violations of existing SWRCB standards and biological opinion requirements would occur
- Severe water supply impacts would include:
  - Reductions in available water supplies for Sacramento River Settlement, San Joaquin River Exchange, and Feather River Settlement Contractors who hold water rights senior to the CVP and SWP
  - Significant reductions in north-of-Delta CVP water service contract allocations and deliveries
  - Inability to meet public health and safety water deliveries within the CVP
  - Reductions in water deliveries to wildlife refuges

The 2012 MBK Report also estimated an increase in groundwater pumping within the Sacramento Valley in response to reductions in the availability of surface water. These estimated increases in groundwater pumping may or may not be feasible under the requirements of the Sustainable Groundwater Management Act.

These conclusions remain relevant for the SWRCB's consideration during evaluation of potential terms and conditions for CWF.