United States Department of the Interior

BUREAU OF RECLAMATION
Central Valley Operations Office
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

151422-SWR2006-SA00268

#1779

IN REPLY
REFER TO:

FEB 14 2018

CVO-100
PRJ-23.00

VIA ELECTRONIC MAIL AND U.S. MAIL

Ms. Maria Rea
Assistant Regional Administrator
California Central Valley Area Office
650 Capital Mall, Suite 5-100
Sacramento, Ca 95814

Subject: Transmittal of February 2018 Central Valley Project (CVP) Reservoir Operations Forecasts

Dear Ms. Rea:

As required by the 2009 National Marine Fisheries Service (NMFS) Biological Opinion Reasonable and Prudent Alternatives (RPA) Action I.2.3, please find enclosed a set of CVP operational outlooks and a set of Sacramento River temperature model results for projected operations over the coming spring and summer. It is important to note that these operational outlooks and temperature models do not suggest a certain actual future outcome, but rather the statistical likelihood of an event occurring, including, but not limited to, projected storage and releases as well as temperature performance. Thus, the outlooks do not provide exact end of month storages, flow rates, or projected water temperatures, but general projections that will likely fall within the range of uncertainty based on the different hydrologic runoff conditions between the 90% and 50% hydrology.

The operational outlooks are based on February 1, 2018, hydrologic conditions and a forecast of reservoir inflows assuming both a 90% exceedance hydrology, and a 50% exceedance hydrology. The 90% exceedance hydrology is currently a "Dry" year type under the Sacramento Valley Index. The estimated annual inflow to Shasta Lake is 3.59 million acre-feet (MAF) and the projected end of September storage is 2.2 MAF.

The Sacramento River temperature model runs were completed using the HEC-5Q modeling software, and are also based on February 1 hydrology and a Shasta Lake profile from February 6, 2018. Because this is an early season profile, there is a high degree of uncertainty in the cold water pool volume calculated by the model. Higher confidence will come with the end of April Shasta Lake profile. Based on the model runs, we are currently projecting the capability to meet a 56 degree daily average temperature (DAT) at the Balls Ferry compliance point throughout the season. However, based on past analysis, there is an elevated degree of uncertainty in the September and October timeframe. One factor is that the modeled release temperatures are

cooler than has historically been achieved when all release is through the side gates (lowest gates), especially when there exists a large temperature gradient between the pressure relief gates and the side gates. For this reason, estimated temperatures for September and October in the first table of the attachment are based on a Fall Temperature Index (chart shown in the attachment), illustrating historical performance and indicating some uncertainty in late-season accomplishment of Balls Ferry temperature management at 56 degrees DAT.

The overall projected system operations and hydrologic conditions and the full Federal share of San Luis Reservoir south of the Delta gives us confidence that, even with a conservative assumption of pumping from the delta, we are able to support the following initial Central Valley Project allocations:

February 90% Exceedance Municipal & Industrial Water Service Contracts - Agricultural Water Service Contracts				
	North of Delta M&I	North of Delta Agricultural[1]	South of Delta M&I	South of Delta Agricultural
Allocation	75%	50%	70%	20%

As outlined above, based on the temperature modeling runs illustrating 56 degree performance at Balls Ferry and a 2.2 MAF end of September storage, we believe these conditions are consistent with RPA I.2.3.A, and we request your concurrence with our proposed operations, planning efforts, and allocations. With the uncertainty in September and October temperature performance, we recognize that the possibility exists that we may enter into a condition necessitating the activities under Action I.2.3.B, particularly if the hydrology remains dry in the coming months. Given that potential, please note that the following actions and activities are underway or projected:

- Keswick releases are currently being ramped down to 3,250 cfs; those reductions began on February 12 and due to the required ramping rates, will reach that rate by February 19.
- We believe the attached monthly Keswick release projections can be used during the next one to two months as we further evaluate conditions in coordination with your agency.
    - Though our projection illustrates a 3,250 cfs release projection in March, the ability to hold those releases is dependent on forecasted accretions and creek flows. We plan to further work with NMFS prior to March 1 to develop an understanding of an initial Keswick monthly release schedule. Should changed conditions result in a need to alter releases to meet downstream diversion requirements or Delta outflow, X2, or other legal requirements, Bureau of Reclamation will also consult with NMFS on these real-time changes.

[1] The north of Delta allocations illustrated above are in conformance with Section 4005(e) of P.L. 114-322, the Water Infrastructure Improvements for the Nation Act (WIIN), as well as Reclamation's M&I shortage policy.

- We plan to continue to consult with you monthly or more often as appropriate on the overall outlooks based on updated forecasts.

As noted above, we will be updating the projections of water supply availability and temperature management operations through the coming months as new water supply forecasts become available. We look forward to our continued close coordination as we develop our final Sacramento River temperature management plan for 2018. If you have any questions, please contact Elizabeth Kiteck at 916-979-2197 or Randi Field at 916-979-2066.

Sincerely,

Jeff Rieker
Operations Manager

Enc.

Estimated CVP Operations Feb 90% Exceedance

Storages

Federal End of the Month Storage/Elevation (TAF/Feet)

		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Trinity	1776	1800	1842	1841	1676	1508	1353	1228	1114	1084	1066	1076	1108
	Elev.	2327	2330	2330	2317	2304	2291	2279	2267	2264	2262	2263	2267
Whiskeytown	205	206	206	238	238	238	238	238	230	206	206	206	206
	Elev.	1199	1199	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199
Shasta	3349	3441	3812	3803	3712	3383	2891	2470	2192	2067	2062	2188	2385
	Elev.	1026	1041	1040	1037	1024	1003	983	968	961	961	968	978
Folsom	582	571	624	617	590	425	337	305	280	253	231	221	271
	Elev.	425	431	430	427	407	393	388	383	378	374	372	382
New Melones	1981	1940	1972	1901	1847	1793	1716	1658	1619	1589	1605	1622	1637
	Elev.	1047	1050	1043	1038	1033	1025	1020	1016	1012	1014	1016	1017
San Luis	973	920	942	899	824	560	273	99	164	284	322	370	542
	Elev.	519	529	519	503	463	415	370	367	372	381	402	428
Total		8877	9397	9298	8887	7907	6808	5999	5598	5483	5492	5683	6149

State End of the Month Reservoir Storage (TAF)

Oroville	1408	1510	1747	1748	1647	1456	1236	1078	1048	969	864	819	894
	Elev.	732	758	758	747	725	698	676	671	659	642	634	647
San Luis	763	805	910	827	717	548	375	210	121	36	60	168	218
Total San Luis (TAF)	1736	1725	1852	1726	1541	1108	649	308	286	320	383	538	760

Monthly River Releases (TAF/cfs)

Trinity	TAF	17	18	36	92	47	28	53	52	23	18	18	18
	cfs	300	300	600	1,498	783	450	857	870	373	300	300	300
Clear Creek	TAF	11	12	13	13	17	9	9	9	12	12	12	12
	cfs	200	200	218	216	288	150	150	150	200	200	200	200
Sacramento	TAF	194	200	446	523	654	768	615	476	369	268	204	200
	cfs	3500	3250	7500	8500	11000	12500	10000	8000	6000	4500	3320	3250
American	TAF	139	126	159	155	224	137	84	76	62	62	62	61
	cfs	2500	2053	2672	2514	3769	2227	1368	1269	1013	1045	1010	1000
Stanislaus	TAF	59	12	91	76	22	15	15	15	49	12	12	14
	cfs	1070	200	1537	1242	363	250	250	250	797	200	200	226
Feather	TAF	97	80	101	49	54	92	92	71	61	57	58	58
	cfs	1750	1300	1700	800	900	1500	1500	1200	1000	950	950	950

Trinity Diversions (TAF)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Carr PP	20	23	53	112	135	130	71	62	16	21	12	3
Spring Crk. PP	20	30	23	105	120	120	60	60	30	15	12	10

Delta Summary (TAF)

		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Tracy		135	136	24	25	25	40	100	250	249	95	84	210
USBR Banks		0	0	0	0	0	9	9	9	0	0	0	0
Contra Costa		14.0	12.7	12.7	12.7	9.8	11.1	12.7	14.0	16.8	18.4	18.3	14.0
Total USBR		149	149	37	37	35	60	122	273	266	113	102	224
State Export		161	205	18	18	20	25	20	60	66	160	217	210
Total Export		310	354	54	56	55	85	142	333	332	273	319	434
COA Balance		6	0	5	-10	9	23	19	65	22	22	22	22
Old/Middle River Std.													
Old/Middle R. calc.		-3,840	-4,301	-152	-279	-901	-1,302	-2,047	-4,530	-3,956	-3,570	-4,038	-5,463
Computed DOI		11436	11403	10405	7597	7598	4994	3497	3009	4002	4505	4506	5677
Excess Outflow		36	0	0	0	0	0	0	0	0	0	0	1171
% Export/Inflow		33%	33%	6%	7%	6%	11%	21%	47%	47%	44%	51%	58%
% Export/Inflow std.		45%	35%	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%

Hydrology

	Trinity		Shasta		Folsom	New Melones	
Water Year Inflow (TAF)	474		3,447		1,562	776	
Year to Date + Forecasted % of mean	39%		62%		57%	73%	

CVP actual operations do not follow any forecasted operation or outlook; actual operations are based on real-time conditions.
CVP operational forecasts or outlooks represent general system-wide dynamics and do not necessarily address specific watershed/tributary details.
CVP releases or export values represent monthly averages.
CVP Operations are updated monthly as new hydrology information is made available December through May.

2/13/2018

Estimated CVP Operations Feb 50% Exceedance

Storages

Federal End of the Month Storage/Elevation (TAF/Feet)

		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Trinity	1776	1805	1901	1994	1912	1849	1742	1605	1477	1439	1426	1456	1521
	Elev.	2327	2334	2341	2335	2330	2322	2312	2301	2298	2297	2300	2305
Whiskeytown	205	206	206	238	238	238	238	238	230	206	206	206	206
	Elev.	1199	1199	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199
Shasta	3349	3445	3985	4222	4160	3849	3325	2953	2694	2630	2619	2764	3170
	Elev.	1026	1047	1056	1053	1042	1022	1006	994	991	990	997	1015
Folsom	582	579	669	754	855	727	522	408	353	306	277	266	310
	Elev.	426	436	445	455	442	419	404	396	388	383	381	389
New Melones	1981	1952	1922	1864	1819	1768	1703	1643	1602	1562	1583	1610	1644
	Elev.	1048	1045	1040	1035	1031	1024	1018	1014	1010	1012	1015	1018
San Luis	966	966	966	881	740	427	181	39	68	178	363	568	704
	Elev.	525	540	524	499	455	407	359	371	393	430	461	477
Total		8954	9648	9953	9725	8858	7711	6886	6424	6320	6474	6870	7554

State End of the Month Reservoir Storage (TAF)

Oroville	1408	1677	2053	2125	2008	1784	1535	1386	1300	1206	1139	1201	1378
	Elev.	750	788	794	783	761	734	717	706	694	685	693	716
San Luis	763	838	1019	910	761	598	395	197	246	290	421	513	552
Total San Luis (TAF)	1729	1804	1985	1791	1501	1025	576	235	315	468	783	1082	1255

Monthly River Releases (TAF/cfs)

Trinity	TAF	17	18	32	180	47	28	53	52	23	18	18	18
	cfs	300	300	540	2,924	783	450	857	870	373	300	300	300
Clear Creek	TAF	11	12	13	13	17	9	9	9	12	12	12	15
	cfs	200	200	218	216	288	150	150	150	200	200	200	240
Sacramento	TAF	205	200	297	492	625	799	615	506	338	327	246	200
	cfs	3700	3250	5000	8000	10500	13000	10000	8500	5500	5500	4000	3250
American	TAF	194	154	149	108	228	272	178	119	123	119	123	108
	cfs	3500	2500	2500	1750	3839	4432	2891	2000	2000	2000	2000	1750
Stanislaus	TAF	59	93	83	96	56	18	18	18	49	12	12	14
	cfs	1070	1521	1400	1555	940	300	300	300	797	200	200	232
Feather	TAF	97	80	119	92	119	187	156	143	123	104	61	108
	cfs	1750	1300	2000	1500	2000	3050	2540	2400	2000	1750	1000	1750

Trinity Diversions (TAF)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Carr PP	22	35	36	24	71	84	85	76	26	25	9	0
Spring Crk. PP	35	60	15	25	60	75	75	75	40	20	12	20

Delta Summary (TAF)

		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Tracy		143	112	48	49	128	250	270	261	270	260	260	200
USBR Banks		0	0	0	0	0	26	26	26	0	0	0	0
Contra Costa		14.0	12.7	12.7	12.7	9.8	11.1	12.7	14.0	16.8	18.4	18.3	14.0
Total USBR		157	125	60	62	138	287	309	301	287	278	278	214
State Export		200	300	42	43	102	76	65	269	262	325	260	200
Total Export		357	425	102	105	240	363	374	570	549	603	538	414
COA Balance		0	0	0	0	0	0	0	138	138	138	138	138
Old/Middle River Std.													
Old/Middle R. calc.		-3,244	-3,490	71	281	-2,711	-4,527	-4,726	-7,386	-6,535	-7,652	-6,577	-4,903
Computed DOI		18677	22563	12372	10867	7598	6507	4002	3009	4246	4572	8329	14966
Excess Outflow		7276	11159	1109	3091	0	0	0	0	244	67	3823	10460
% Export/Inflow		25%	23%	10%	11%	27%	35%	43%	62%	59%	64%	50%	31%
% Export/Inflow std.		45%	35%	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%

Hydrology

	Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)	754		3,937		1,944		887	
Year to Date + Forecasted % of mean	62%		71%		71%		84%	

CVP actual operations do not follow any forecasted operation or outlook; actual operations are based on real-time conditions.
CVP operational forecasts or outlooks represent general system-wide dynamics and do not necessarily address specific watershed/tributary details.
CVP releases or export values represent monthly averages.
CVP Operations are updated monthly as new hydrology information is made available December through May.

2/13/2018

February 13, 2018

Upper Sacramento River – February 2018 Preliminary Temperature Analysis

Summary of Temperature Results by Month (Monthly Average Temperature °F)

Initial Compliance Location (°F DAT)	APR	MAY	JUN	JUL	AUG	SEP*	OCT*
February 90%-Exceedance Outlook – 10% Historical Meteorology							
Keswick Dam KWK	52.5	52.8	53.4	53.9	53.9	NA	NA
Sac. R. abv Clear Creek CCR	52.4	52.9	53.5	54.1	54.0	NA	NA
Balls Ferry BSF	54.1	55.2	55.3	55.4	55.3	57.3	57.3
February 90%-Exceedance Outlook – 50% Historical Meteorology							
Keswick Dam KWK	52.2	52.3	52.7	53.5	53.5	NA	NA
Sac. R. abv Clear Creek CCR	52.2	52.7	53.2	54.0	53.9	NA	NA
Balls Ferry BSF	53.9	55.6	55.5	55.9	55.7	56.6	56.6
February 50%-Exceedance Outlook – 10% Historical Meteorology							
Keswick Dam KWK	52.9	53.0	53.1	53.9	54.3	NA	NA
Sac. R. abv Clear Creek CCR	52.7	53.1	53.3	54.0	54.4	NA	NA
Balls Ferry BSF	54.8	55.5	55.1	55.3	55.7	56.3	56.3
February 50%-Exceedance Outlook – 50% Historical Meteorology							
Keswick Dam KWK	52.5	51.6	52.3	53.2	53.7	NA	NA
Sac. R. abv Clear Creek CCR	52.5	52.1	52.8	53.7	54.1	NA	NA
Balls Ferry BSF	54.5	55.3	55.3	55.5	55.9	55.8	55.8

* The HEC5Q model output is displayed above for the months April through August. Based on past analysis, the temperature model does not perform well in late September and October. One factor is that the modeled release temperatures are cooler than has historically been achieved when all release is through the side gates (lowest gates), especially when there's a large temperature gradient between the pressure relief gates (PRG) and the side gates. For the months of September and October estimated temperatures

are provided based on the Fall Temperature Index (graphic below). This relationship is an end of September Lake Shasta Volume less than 56°F and likely downstream temperature performance at Balls Ferry for the early fall months.

Temperature Model Inputs, Assumptions, Limitations and Uncertainty:

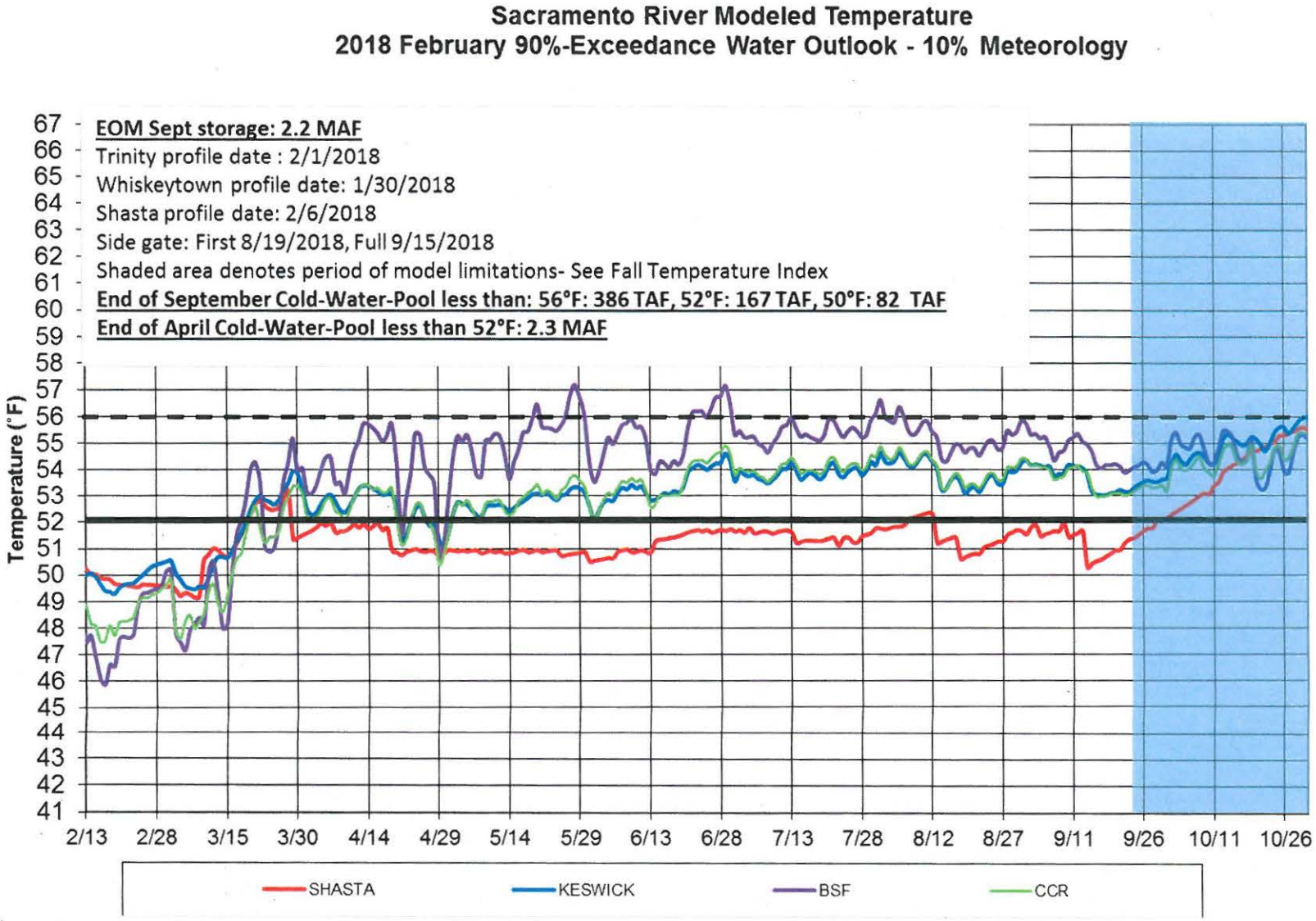
1. The latest available profiles for Shasta, Trinity, and Whiskeytown were taken on February 6, February 1, and January 30, respectively. Model results are sensitive to initial reservoir temperature conditions and the model performs best under highly stratified conditions. The February 2018 temperature profile does not yet exhibit conditions for ideal model computations (still nearly isothermal conditions). The model performs well after the reservoir stratifies, typically in late spring. The concern this year is assuming lower than actual inflow temperatures due to low snow/higher than normal air temperature conditions and not capturing the stratification with sufficient detail to project.
2. Guidance on forecasted flows from the creeks (e.g., Cow, Cottonwood, Battle, etc.) between Keswick Dam and Bend Bridge are not available beyond 5 days. Creek flows developed from the historical record that most closely reflects current conditions were used for all model runs. The resulting greater than normal creek flows cause additional warming in the upper Sacramento River during spring.
3. Operation is based on the February 2017 Operation Outlooks (monthly flows, reservoir release, and end-of-month reservoir storage) for the 90%- and 50%-exceedances. Trinity Lake inflows are updated with the CNRFC 90% runoff exceedance for both the 90% and 50% runoff exceedance studies.
4. Although mean daily flows and releases are temperature model inputs, they are based on the mean monthly values from the operation outlooks. Mean daily flow patterns are user defined and are generalized representations. It is important to note that these outlooks do not suggest a certain actual future outcome, but rather the statistical likelihood of an event occurring, including, but not limited to, projected storage and releases. Thus, the outlooks do not provide exact end of month storages or flow rates but general projections that will likely fall within the range of uncertainty based on the different hydrologic runoff conditions between the 90% and 50% runoff exceedance hydrology.
5. Cottonwood Creek flows, Keswick to Bend Bridge local flows, and ACID diversions are mean daily synthesized flows based on the available historical record for a 1922-2002 study period. Inflows were adjusted to a 75% historical exceedance for both the 90% and 50% runoff exceedance studies.
6. Meteorological inputs represent historical (1920 – 2005) monthly mean equilibrium temperature exceedance at 10% and 50% patterned after like months on a 6-hour timestep.
7. Meteorology, as well as the flow volume and pattern, significantly influences reservoir inflow temperatures and downstream tributary temperatures; and consequently, the development of the cold-water pool during winter and early spring.
8. Modified model coefficients more closely represent actual Keswick Dam temperatures. As a result, temperature predictions downstream of Keswick Dam are likely to be warmer than actual. Model re-calibrations efforts are underway.

Model Run Date February 13, 2018

Temperature Analysis Results:

Modeling runs explore Sacramento River compliance performance above Clear Creek confluence and Balls Ferry locations by varying hydrology and meteorology. The temperature results for the Sacramento River between Keswick Dam and Balls Ferry are shown in Figures 1 through 3. The relationship between end-of-September lake volume below 56°F and a Balls Ferry compliance through fall is based on the Figure 5.

Model Run	End of September Cold Water Pool <56°F (TAF)	First Side Gate	Full Side Gates
90% Hydro, 10% Met	386	8/19	9/15
90% Hydro, 50% Met	529	8/29	10/4
50% Hydro, 10% Met	602	9/5	9/24
50% Hydro, 50% Met	707	9/17	10/14


Sacramento River Modeled Temperature
2018 February 90%-Exceedance Water Outlook - 10% Meteorology
EOM Sept storage: 2.2 MAF
Trinity profile date : 2/1/2018
Whiskeytown profile date: 1/30/2018
Shasta profile date: 2/6/2018
Side gate: First 8/19/2018, Full 9/15/2018
Shaded area denotes period of model limitations- See Fall Temperature Index
End of September Cold-Water-Pool less than: 56°F: 386 TAF, 52°F: 167 TAF, 50°F: 82 TAF
End of April Cold-Water-Pool less than 52°F: 2.3 MAF
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
2/13
2/28
3/15
3/30
4/14
4/29
5/14
5/29
6/13
6/28
7/13
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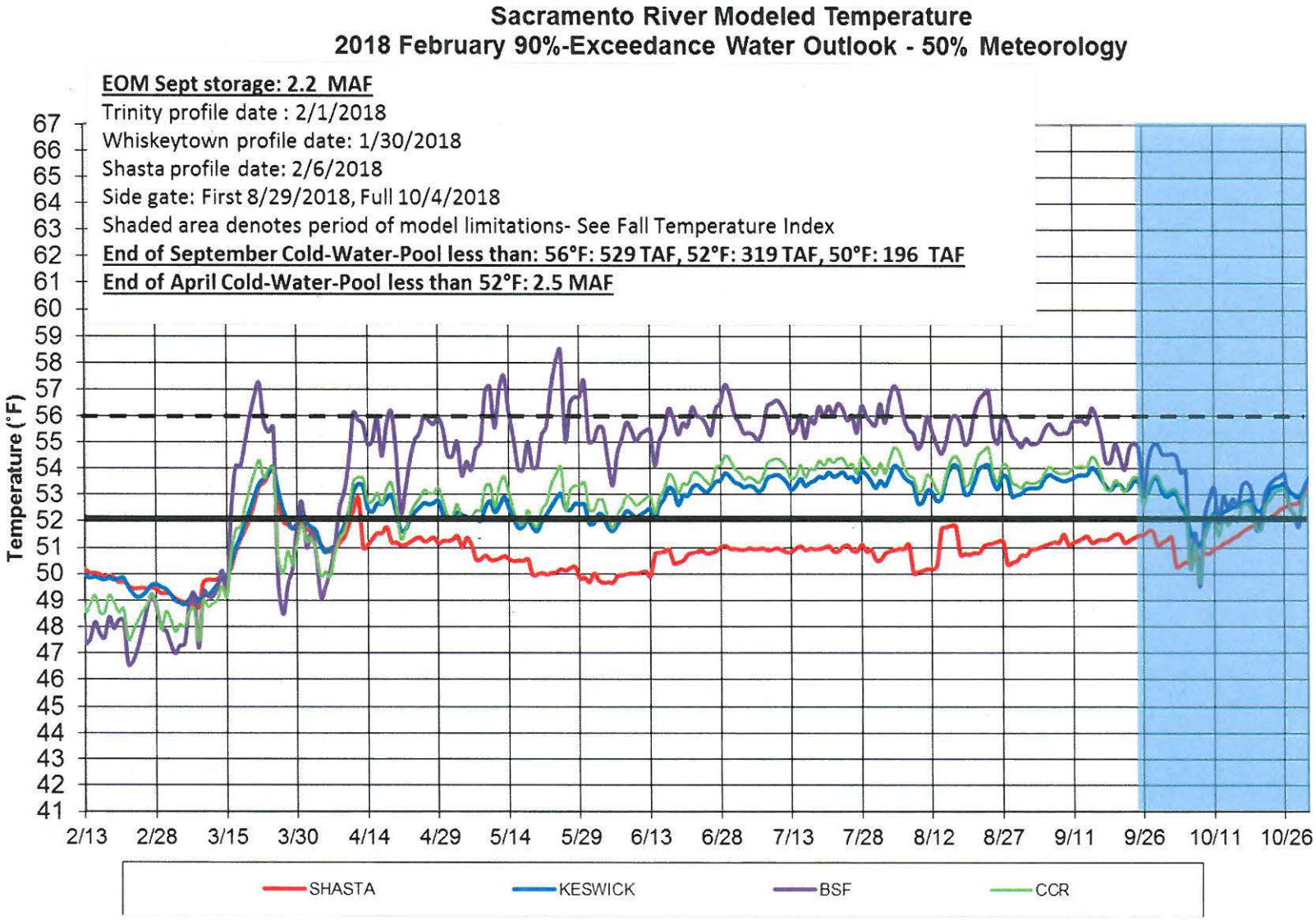
8/27
9/11
9/26
10/11
10/26
SHASTA
KESWICK
BSF
CCR

Figure 1


Sacramento River Modeled Temperature
2018 February 90%-Exceedance Water Outlook - 50% Meteorology
EOM Sept storage: 2.2 MAF
Trinity profile date : 2/1/2018
Whiskeytown profile date: 1/30/2018
Shasta profile date: 2/6/2018
Side gate: First 8/29/2018, Full 10/4/2018
Shaded area denotes period of model limitations- See Fall Temperature Index
End of September Cold-Water-Pool less than: 56°F: 529 TAF, 52°F: 319 TAF, 50°F: 196 TAF
End of April Cold-Water-Pool less than 52°F: 2.5 MAF
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
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53
52
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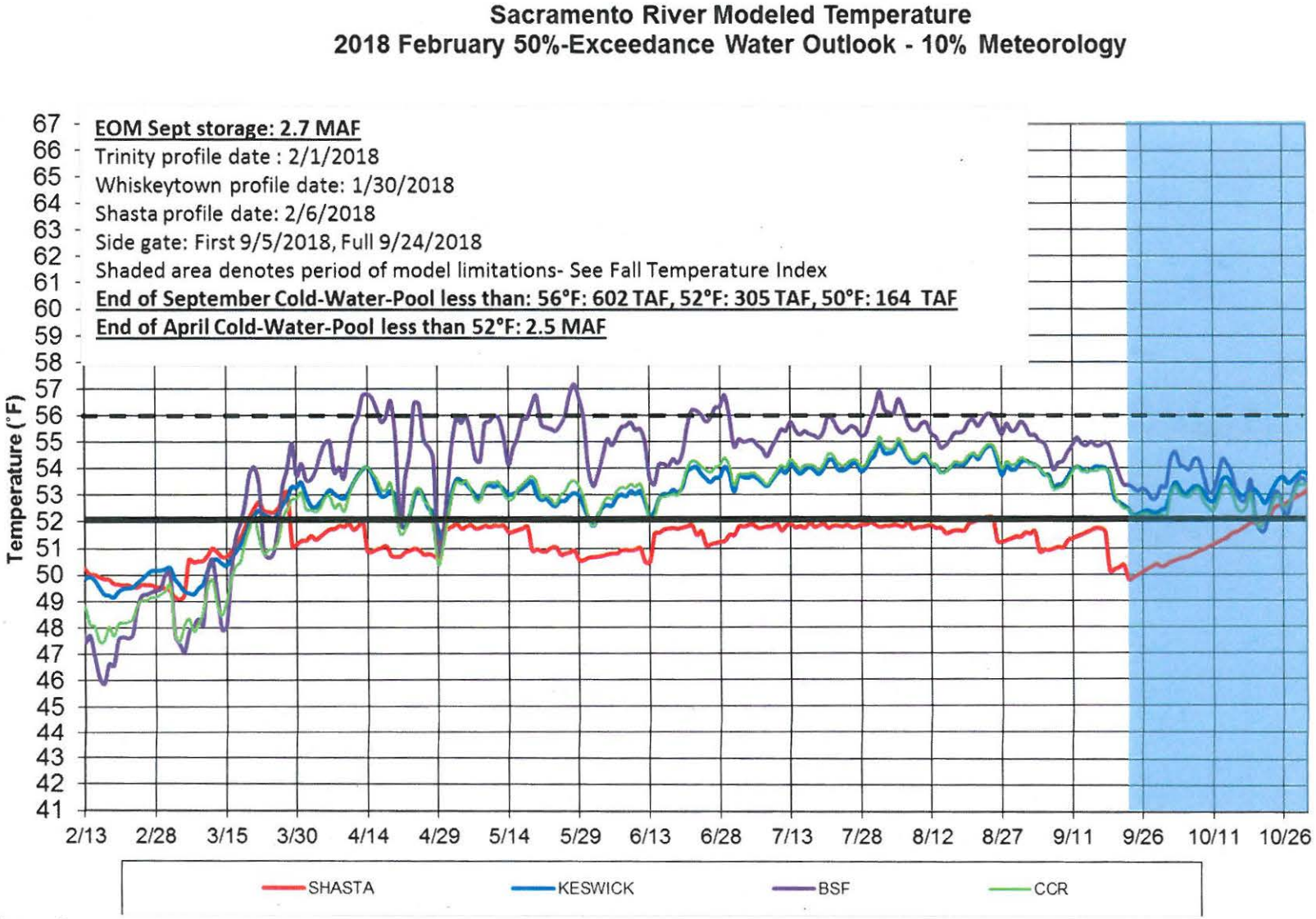
10/11
10/26
SHASTA
KESWICK
BSF
CCR

Figure 2


Sacramento River Modeled Temperature
2018 February 50%-Exceedance Water Outlook - 10% Meteorology
EOM Sept storage: 2.7 MAF
Trinity profile date : 2/1/2018
Whiskeytown profile date: 1/30/2018
Shasta profile date: 2/6/2018
Side gate: First 9/5/2018, Full 9/24/2018
Shaded area denotes period of model limitations- See Fall Temperature Index
End of September Cold-Water-Pool less than: 56°F: 602 TAF, 52°F: 305 TAF, 50°F: 164 TAF
End of April Cold-Water-Pool less than 52°F: 2.5 MAF
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
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43
42
41
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6/28
7/13
7/28
8/12
8/27
9/11
9/26
10/11
10/26
SHASTA
KESWICK
BSF
CCR

Figure 3

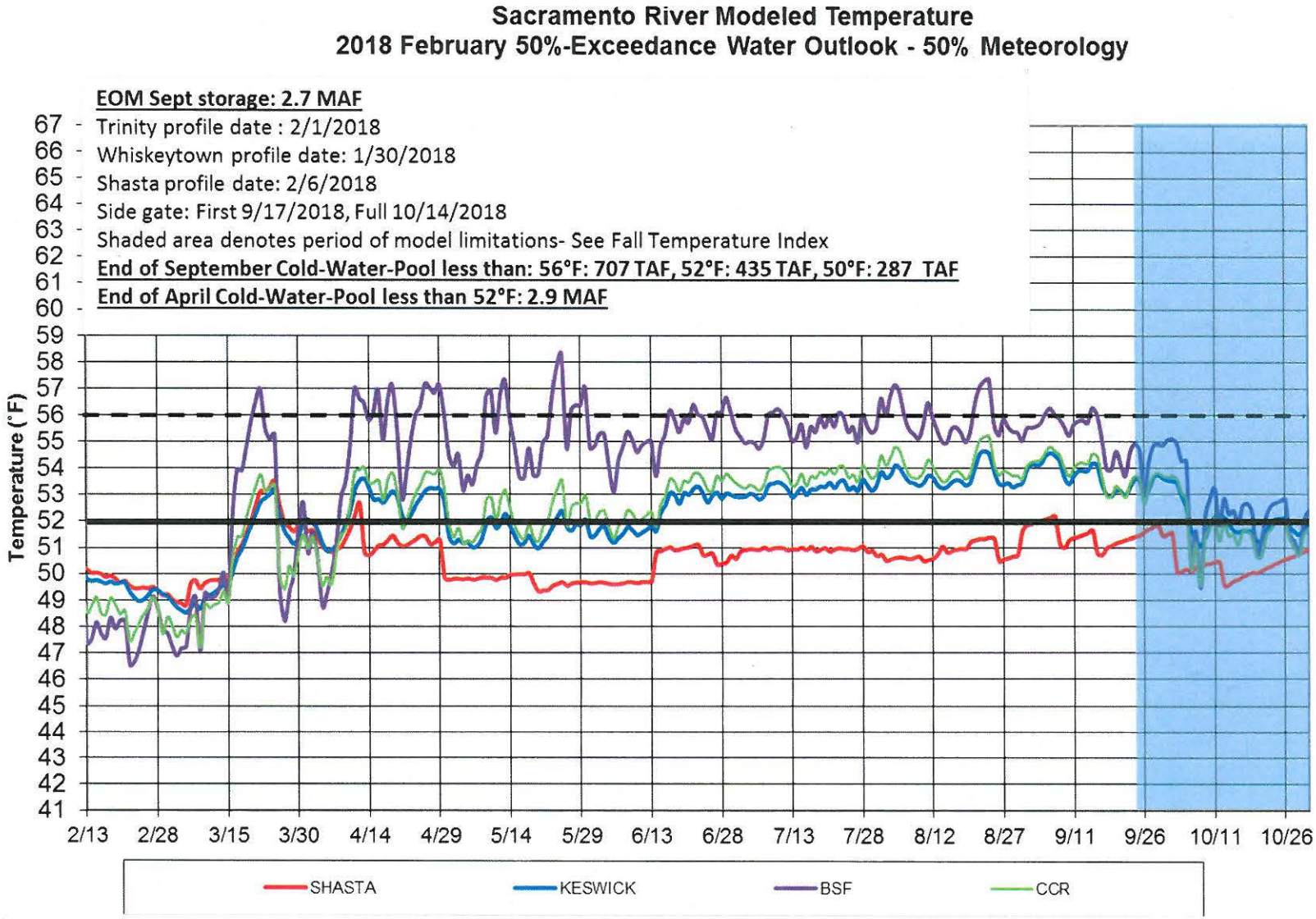
Sacramento River Modeled Temperature
2018 February 50%-Exceedance Water Outlook - 50% Meteorology
EOM Sept storage: 2.7 MAF
Trinity profile date : 2/1/2018
Whiskeytown profile date: 1/30/2018
Shasta profile date: 2/6/2018
Side gate: First 9/17/2018, Full 10/14/2018
Shaded area denotes period of model limitations- See Fall Temperature Index
End of September Cold-Water-Pool less than: 56°F: 707 TAF, 52°F: 435 TAF, 50°F: 287 TAF
End of April Cold-Water-Pool less than 52°F: 2.9 MAF
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
2/13
2/28
3/15
3/30
4/14
4/29
5/14
5/29
6/13
6/28
7/13
7/28
8/12
8/27
9/11
9/26
10/11
10/26
SHASTA
KESWICK
BSF
CCR

Figure 4

Figure 5 Model Performance and Fall Temperature Index:

1. Based on past analyses, the temperature model does not perform well in late September and October. One factor is that the modeled release temperatures are cooler than has historically been achieved when all release is through the side gates (lowest gates), especially when there's a large temperature gradient between the pressure relief gates (PRG) and the side gates.
2. Based on historical records, the end-of-September Lake Shasta volume below 56°F is a good indicator of fall water temperature in the river reach to Balls Ferry.
3. For river temperatures not to exceed 56 °F downstream to Balls Ferry, the end-of-September lake volume less than 56°F should be greater than about 600 TAF, see chart below: