April 23, 2020

Draft Temperature Management Plan
Water Year 2020

Communication and Coordination

December through January – Conservation of Cold Water Pool and Inactive Temperature Management Period

The U.S. Bureau of Reclamation (Reclamation) provided monthly updates via e-mail to the Sacramento Temperature Task Group (SRTTG), outlining current river and reservoir conditions, operations, hydrology, meteorology, and long-range precipitation forecast information. No significant issues concerning temperature management arose during this period and the SRTTG was not convened.

February through April – Temperature Management Preparation

Reclamation started convening SRTTG meetings in February on a monthly basis to ensure communication and coordination among the parties in preparation for the temperature management season.

In mid-February, Reclamation prepared initial projections of anticipated temperature management capability and considerations based on the February hydrologic and runoff forecasts from the Department of Water Resources and National Weather Service River Forecast Center. These initial projections used Reclamation's historical performance relationships based on total and cold water pool storage and physically-based temperature simulations. These projections were shared with the SRTTG in the third full week of February and represented the initiation of the process for developing the Temperature Management Plan for the year, recognizing that the forecasts remain highly uncertain this early in the year. In preparing for the February SRTTG meeting, Reclamation identified that a potential Tier 3 year was possible based on anticipated temperature management capability. Reclamation initiated interagency coordination through the Drought and Dry Year activities and stakeholder coordination through the Meet and Confer activities described in the Reclamation LTO Action.

In mid-March, Reclamation prepared updated projections of anticipated temperature management capability and considerations as updated hydrologic forecasts became available. These projections used Reclamation's historical performance relationships based on total and cold water pool storage and physically-based temperature simulations. These updated projections were shared with the SRTTG in advance of the scheduled SRTTG meeting. The projections have assisted with on-going development of the draft Temperature Management Plan. In March, the projected total Shasta storage on May 1 was more than 2.5 MAF, so Reclamation did not initiate discussions regarding Tier 4 operations and intervention measures.

In mid-April, Reclamation prepared updated projections of anticipated temperature management capability including considerations from updated hydrologic forecasts. These updated projections have been shared with the SRTTG in advance of scheduled SRTTG meetings and serve as the first forecast of the temperature tier.

Reclamation drafted a Temperature Management Plan to submit to the SRTTG. Reclamation will also draft a Temperature Management Plan and submit it to the State Water Resources Control Board (SWRCB). The draft Temperature Management Plan balances the most protective

possible temperature tier with what is achievable and sustainable with the cold water pool volume for the duration of the temperature control period through October 30, 2020. During Water Year 2020, Reclamation has been able to improve Shasta Reservoir conditions, when feasible, by reducing releases in March and April, utilizing a conservative 90% forecast, and reducing water delivery contracts. These activities have improved Shasta Reservoir storage compared to earlier season forecasts and should result in an improvement in temperature management throughout summer and early fall of 2020. Conditions do not indicate projected total Shasta storage on May 1 will be less than 2.5 MAF, and Reclamation has not initiated discussions regarding Tier 4 operations and intervention measures.

May – Communication of Draft Plan and Transition to Temperature Management

In early May, Reclamation will determine, based on actual conditions, the Shasta cold water pool volume on May 1. This in concert with modeling information will determine the final temperature tier. Spawner and redd survey data collection by California Department of Fish and Wildlife (CDFW) and United States Fish and Wildlife Service (USFWS) will be communicated by these groups on a weekly basis to the SRRTG at the start of these surveys after May 1. Information regarding spawning Winter-run Chinook salmon, redd construction or observation by CDFW and USFWS will constitute a critical communication to CVO operations to coordinate the real-time starting date of temperature management: either May 15 or when the SRTTG determines, based on real-time information, that Winter-Run Chinook Salmon have spawned, whichever is later.

Also in early May, Reclamation anticipates presenting a draft Temperature Management Plan to Central Valley Project and State Water Project water and power contractors, Tribes, non-governmental organizations, and other interested parties and stakeholders during the regularly scheduled Fish and Water Operations Coordination Call during the first full week of May. Based on feedback from that meeting and any other on-going dialog among the SRTTG, Reclamation anticipates submitting a final Temperature Management Plan to SWRCB and National Marine Fisheries Service (NMFS) on or about May 20.

June through October – Active Temperature Management

Reclamation plans to convene SRTTG meetings each month through October, or more often as warranted by any changing conditions, to ensure tracking and monitoring of the Temperature Management Plan. Temporary exceedances of the daily average temperature criteria of more than 3 consecutive days will be reported to the SRTTG. Should changes to the plan be necessary, those changes will be developed through communication and coordination with the SRTTG, and other interested parties as warranted.

In October, data collection by CDFW and communication to CVO operations will be coordinated to determine the ending date of temperature management: October 31, or when the SRTTG determines, based on real-time information, that Winter-run Chinook Salmon have emerged, whichever is earlier.

November – Fall Transition Temperature Management

Reclamation plans to operate the Temperature Control Device (TCD) in a manner to minimize in-river thermal impacts with remaining cold water pool resources after the end of the temperature management season, if available, until seasonal changes and ambient conditions dominate river cooling downstream.

Monitoring and Reporting

For Water Year 2020, Reclamation will complete the following monitoring and reporting practices:

- Monthly letters to the Board containing relevant data and information as identified in Order 90-5.
- Near-real-time reporting through Reclamation's web interface of relevant information, located at the following website: http://www.usbr/gov/mp/cvo/vungvari/sactemprpt.pdf.
- Transmittal of pertinent data and information to the SRTTG prior to meetings or more often as conditions warrant, including applicable modeling and tracking information during the course of the temperature management season. It is anticipated that the specifics of the modeling and tracking information that will be utilized in 2020 will be outlined in the development of the final Temperature Management Plan for WY 2020.
- Monitoring and communication to determine on-set of Winter-Run Chinook Salmon spawning.
- Monitoring and communication to determine when 95% of Winter-Run Chinook Salmon eggs have hatched and alevin have emerged.

Reclamation intends to provide temperature profile measurements for Shasta, Whiskeytown, and Trinity Reservoirs in Water Year 2020 as show in the following table:

Reservoir	Every Month	Every 2 Weeks	Every Week	Comment
Shasta	01/01–03/01 12/1–12/31	03/01–05/01 11/15–12/01	05/01–11/15	25 ft intervals for "Every Month," otherwise 5 ft intervals
Whiskeytown	01/01–12/31			25 ft intervals
Trinity	01/01–12/31			25 ft intervals

The time and depth intervals identified above are linked to the historical stratification and de-stratification of the lakes. When the lake is de-stratified and temperature management is inactive, a finer resolution of the thermal profile at Shasta Reservoir is not needed.

Reclamation believes that monthly temperature profiles for Whiskeytown and Trinity are sufficient to capture the thermal dynamics; both have limited abilities to actively manage selective withdrawal and the cold-water-pool volume does not rapidly change for most of the year. Reclamation will post the corresponding isothermobaths on our website identified above as soon as the information becomes available.

Reclamation intends to rely on CDFW's carcass and redd surveys to determine onset of Winter-run Chinook salmon spawning and calculate when 95% of eggs and alevin have hatched and emerged. As in past years, Reclamation intends to use the CDFW redd dewatering survey to provide information on potential redd dewatering and stranding for informing real-time operations of Shasta and Keswick Dams during the fall transition period. Reclamation will continue to coordinate with CDFW on river operations and any flood control releases to ensure this program can be safely and effectively implemented.

It is Reclamation's understanding that the manner in which the information is provided on Reclamation's website and in its letters currently meets the needs of the Board and fisheries

agencies for the locations currently being monitored. Should the SWRCB or fisheries agencies require the data from any of the monitoring stations outlined above in other formats, or obtain data from other monitoring sites that Reclamation maintains or has access to, Reclamation can work with the SWRCB or fisheries agencies to provide that data.

Temperature Tier Selection Protocol

Reclamation developed a set of 358 scenarios to evaluate potential temperature tiers as part of a Temperature Tier Scenario Protocol (TTSP). This protocol is similar to the Automated Temperature Selection Process (ATSP) used by the American River Group to assess the available cold water pool resource and incrementally trades off the benefits of cool water temperatures temporally across the Winter-run Chinook salmon redd and alevin incubation window. However, it differs in that a selection process is not automated and technical assistance from the SRTTG is being utilized with a set of criteria to evaluate feasible scenarios. Reclamation introduced this approach with the Sacramento River Temperature Task Group during its March 26 meeting. Reclamation received technical assistance from biologists and scientists from CDFW, NMFS, and SWRCB at meetings on April 1 and April 15 to discuss development of scenarios representing Tier 2 and Tier 3 operations, potential criteria for selecting the feasible temperature management run, and biologically relevant timing of Tier 2 and Tier 3 operations.

Preliminary temperature analyses, presented to the SRTTG in February and March, included model runs bounding the tiering system with two model runs with CCR target temperature at 53.5°F and 56°F. These preliminary simulation results showed that the temperature target at 53.5°F run could not maintain the temperature for the entire temperature management season. These runs are characterized by end of September cold water pool volumes less than 460 TAF, early side gate use, and rising temperatures above target thresholds at the end of the simulation. Simulations targeting 56°F yielded an achievable Fall temperature (i.e. end of September cold water pool volume is greater than 460 TAF) and later side gate use. All simulations showed cooler temperatures at the beginning of the temperature management period due to Shasta Reservoir elevation/TCD constraints.

Since a Tier 1 temperature management approach has not been modeled to be feasible, the TTSP is used to evaluate the possibility of Tier 2 and 3 temperature management strategies. All 358 scenarios are considered in an iterative fashion; their stage-dependent and stage-independent temperature dependent mortalities (TDMs), End of September Cold Water Pool less than 56F, and side gate operations are presented. The Tier 2 or Tier 3 scenario that minimizes temperature-dependent mortality and presents feasible TCD operations will be selected for the Temperature Management Plan. The temperature management experience during the recent 2013-2016 drought suggests that a Temperature Management Plan using a conservative approach to manage unknown factors during the control period is important to reducing the likelihood of changing tiers during the temperature management period. Once the initial tier is selected by May 15th, Reclamation will not cause a shift into a warmer tier during real-time implementation of the Shasta Temperature Management Plan except in the event of responding to emergency and/or unforeseen conditions. Thus, Reclamation has selected a draft scenario that balances the most protective temperature tier with what is achievable and sustainable for the duration of the temperature control period through October 30, 2020.

April 23, 2020

The temperature tier scenario protocol used the most up-to-date information regarding the April Water Year 2020 CVP Operation Outlooks including the 90% runoff exceedance outlook, a conservative meteorology incorporating 25% Local Three Month Temperature Outlook (L3MTO) forecast based on information from NOAA Climate Prediction Center, and the most recent Shasta, Trinity, and Whiskeytown temperature profiles.

Rank	Scenario	Stage-Independent TDM	Stage-Dependent TDM	EOS CWP	1st Side Gate Sustained Operation	Full Side Gates	Tier
1	148	28%	19%	494776	Aug 10	Oct 30	3
2	145	28%	19%	480254	Aug 10	Oct 28	3
3	144	27%	19%	468383	Aug 10	Oct 24	3
4	23	27%	19%	461897	Aug 9	Sept 30	3

An assessment of scenarios suggest multiple temperature management scenarios meet Tier 3 biological objectives and facility configuration criteria to avoid loss of temperature control (exceed 56°F) throughout the duration of the temperature control period. These scenarios achieve very similar levels of temperature dependent mortality (27-28%), which are close to the modeled median temperature dependent mortality for tier 3 Upper Sacramento Performance Metrics.

Two additional factors were considered to evaluate a feasible scenario that reduces the risk of losing control of temperature management in the fall period. First, the end-of-September cold water pool estimate. Reclamation considers a minimum of 460 TAF as a conservative buffer to achieve a temperature performance of 56°F at CCR from September 15 through October 31. The four scenarios reflect a range of end-of-September cold water volumes sufficient to manage unknown factors during September and October. The other factor is the timing of opening of the first TCD side gate. Reclamation observed an extremely high occurrence (63% of TTSP scenarios) of the first TCD side gate being used on July 30, which raised concern since this would be quite early compared to the historical pattern of first side gate use. Based on Reclamation's experience, the later the first side gate is deployed, the greater the ability to maintain temperature management control into the fall. While the TTSP suggest other scenarios may have slightly lower TDM, these runs are consistently tier 3 scenarios and do not provide a conservative level of cold water volume at the end of September for Reclamation's risk of losing control in the fall period. Preliminary assessment of TTSP results show that temperature dependent mortality is higher at lower and higher cold water pool volumes (See Figure 1), suggesting top-ranking scenarios should balance facility operability and biological outcomes well.

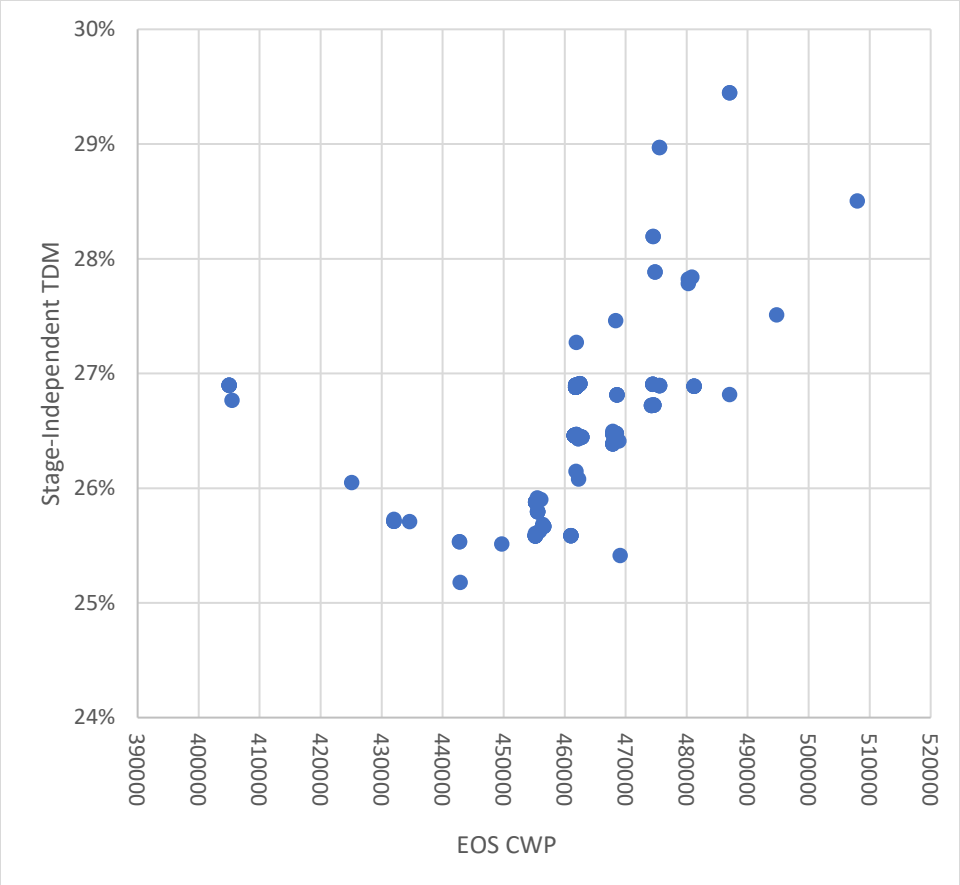


Figure 1. Subset of stage independent temperature dependent mortality simulated results for various scenarios compared to estimated end of September cold water pool less than 56°F.

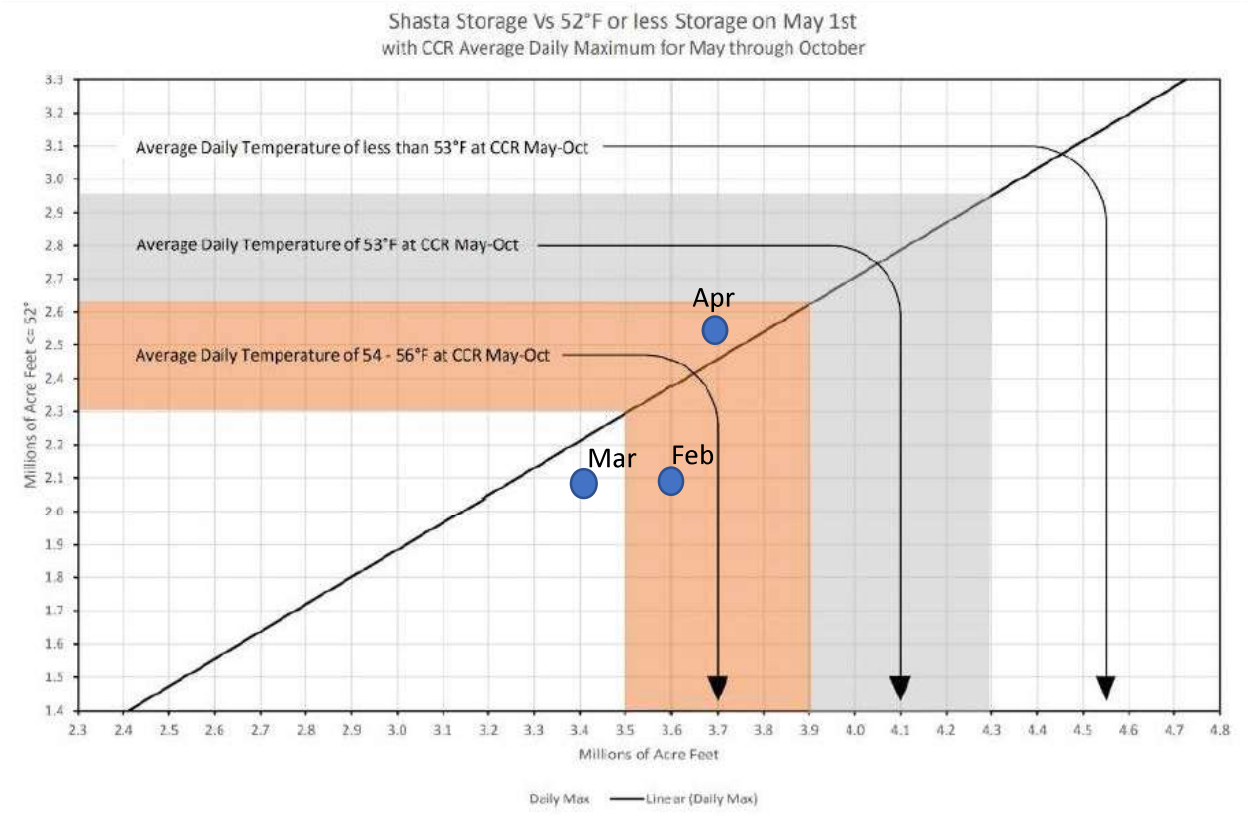
DRAFT Temperature Management Plan

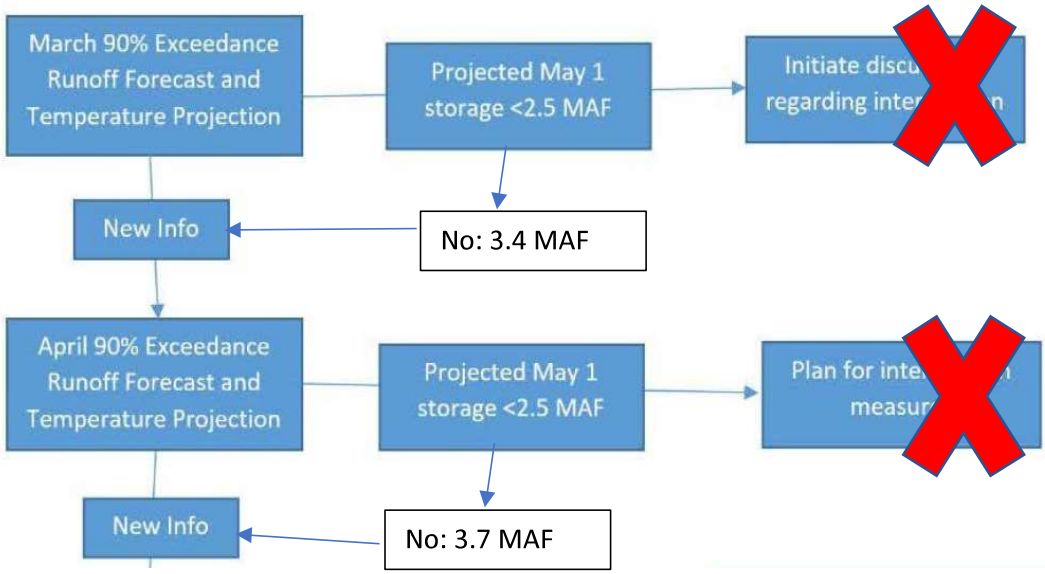
The Draft Sacramento River Temperature Management Plan consists of a compliance points at the Sacramento River above Clear Creek (CCR) and Balls Ferry (BSF) gages, using a daily average temperature (DAT) metric from May 15 through October 31. The planned temperature management operation anticipates targeting the compliance point close to the location of actual spawning once underway.

Scenario 148 (deg. F)		
Week Beginning	**CCR**	**BSF**
20200430		56.0
20200507		56.0
20200514	54.5	56.0
20200521	54.5	56.0
20200531	53.5	56.0
20200607	53.5	56.0
20200614	53.5	56.0

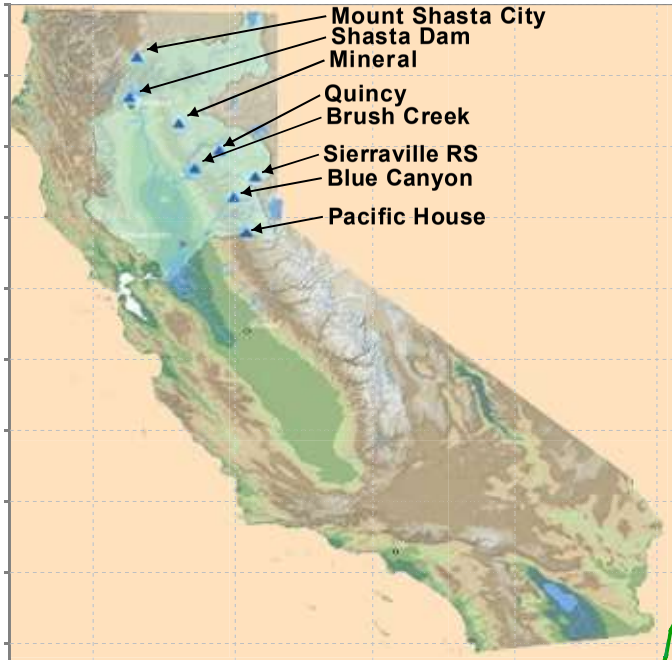
20200621	53.5	56.0
20200630	54.0	56.0
20200707	54.0	56.0
20200714	54.0	56.0
20200721	54.0	56.0
20200731	54.0	56.0
20200807	54.0	56.0
20200814	54.0	56.0
20200821	54.0	56.0
20200831	54.0	56.0
20200907	54.0	56.0
20200915	54.0	56.0
20200921	56.0	
20200930	56.0	
20201007	56.0	
20201014	56.0	
20201021	56.0	
20201031	56.0	

Reclamation will monitor the cold water pool projections and compare to actual performance during implementation to ensure sufficient cold water pool throughout the Plan's duration. The primary risk management criterion is defined as a cold water pool volume less than 49°F which is more than 10 percent less than the projected volume. In addition, ongoing modelling results will be completed for each monthly SRTTG meeting and more often as necessary. These results will be considered should they indicate increased or decreased risk to Fall temperature performance, which is a concern to Reclamation based on the uncertainty in meteorology, hydrology, and real-time operation conditions unknown to Reclamation at the time of Temperature Management Plan selection. In the event that actual cold water pool conditions vary from what is projected and the Fall temperature performance appears at risk, Reclamation will reconvene the SRTTG in preparation for an adjustment of the Temperature Management Plan. If the adjustment impacts the temperature tier and/or other indicators warrant as discussed by the SRTTG, then a more conservative summer release strategy will be evaluated to remain within the Tier's anticipated performance level. As in past years, Reclamation will work with NMFS and the other members of the SRTTG during Fall operations to address the potential for redd dewatering.


Shasta Storage Vs 52°F or less Storage on May 1st
with CCR Average Daily Maximum for May through October
Average Daily Temperature of less than 53°F at CCR May-Oct
Average Daily Temperature of 53°F at CCR May-Oct
Average Daily Temperature of 54 - 56°F at CCR May-Oct
Apr
Mar
Feb
Millions of Acre Feet <= 52°
Millions of Acre Feet
Daily Max
Linear (Daily Max)


March 90% Exceedance Runoff Forecast and Temperature Projection
Projected May 1 storage <2.5 MAF
New Info
No: 3.4 MAF
April 90% Exceedance Runoff Forecast and Temperature Projection
Projected May 1 storage <2.5 MAF
New Info
No: 3.7 MAF

Northern Sierra Precipitation: 8-Station Index, April 21, 2020



Percent of Average for this Date: 59%

2016-2017 Daily Precip (wettest) 94.7

1982-1983 (2nd wettest) 88.5

1997-1998 82.4

2018-2019 Daily Precip 70.7

Average (1966-2015) 51.8

2017-2018 Daily Precip 41.0

2014-2015 Daily Precip 37.2

Current: 27.0

1976-1977(2nd driest & driest thru Aug) 19.0

Cumulative Daily/Monthly Precipitation (inches)

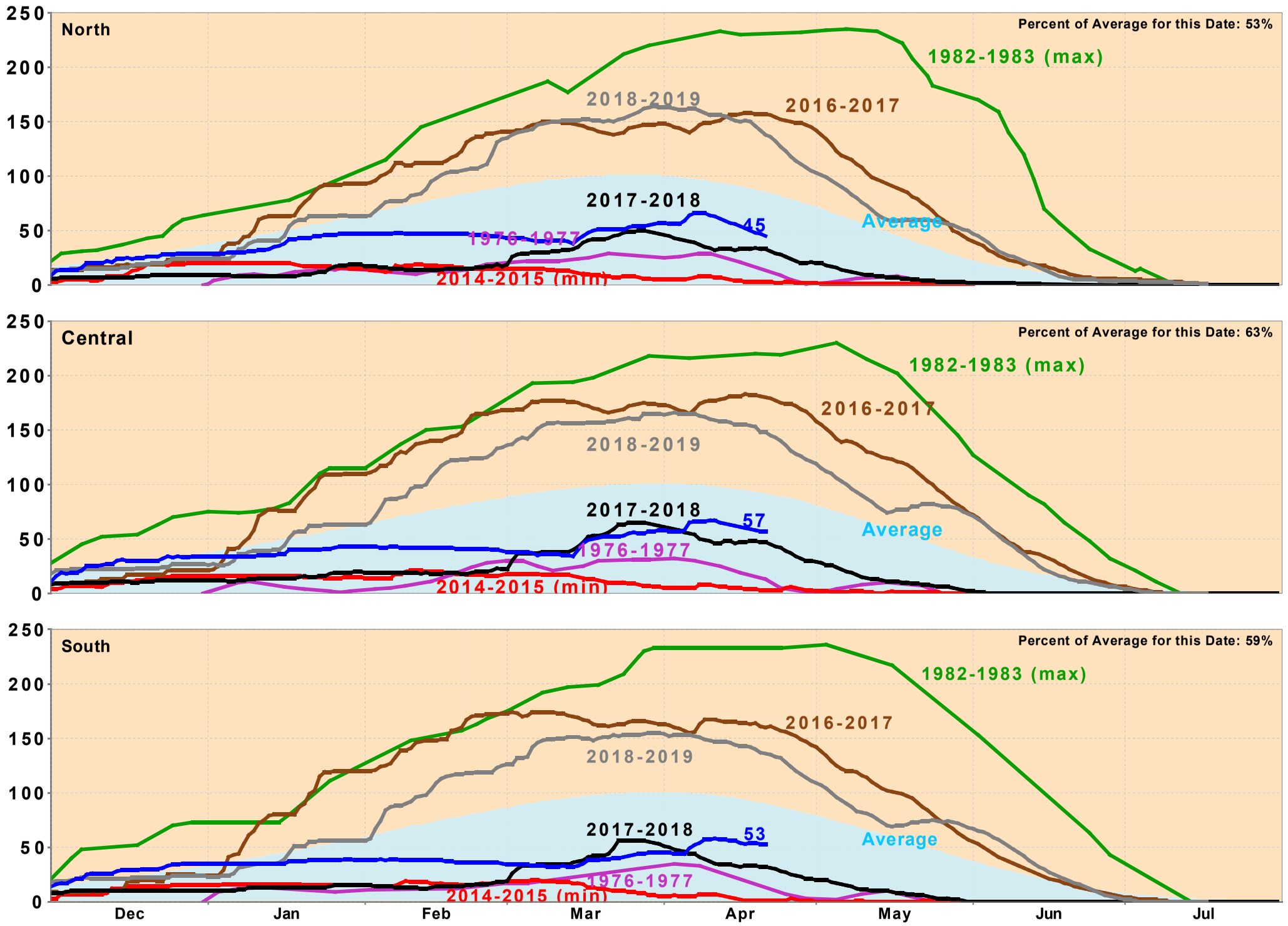
Total Water Year Precipitation

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

Oct 1 Nov 1 Dec 1 Jan 1 Feb 1 Mar 1 Apr 1 May 1 Jun 1 Jul 1 Aug 1 Sep 1 Oct 1

Water Year (October 1 - September 30)

California Snow Water Content, April 21, 2020, Percent of April 1 Average



Statewide Percent of April 1: 52%

Statewide Percent of Average for Date: 58%

UNITED STATES DEPARTMENT OF THE INTERIOR
U.S. BUREAU OF RECLAMATION-CENTRAL VALLEY PROJECT-CALIFORNIA

DAILY CVP WATER SUPPLY REPORT

APRIL 21, 2020

RUN DATE: April 22, 2020

RESERVOIR RELEASES IN CUBIC FEET/SECOND

RESERVOIR	DAM	WY 2019	WY 2020	15 YR MEDIAN
TRINITY	LEWISTON	2,806	585	322
SACRAMENTO	KESWICK	11,159	7,466	5,921
FEATHER	OROVILLE (SWP)	9,000	0	1,700
AMERICAN	NIMBUS	6,939	1,468	2,028
STANISLAUS	GOODWIN	4,006	426	1,503
SAN JOAQUIN	FRIANT	509	0	502

STORAGE IN MAJOR RESERVOIRS IN THOUSANDS OF ACRE-FEET

RESERVOIR	CAPACITY	15 YR AVG	WY 2019	WY 2020	% OF 15 YR AVG
TRINITY	2,448	1,843	2,163	1,943	105
SHASTA	4,552	3,740	4,082	3,750	100
FOLSOM	977	708	829	642	91
NEW MELONES	2,420	1,570	1,933	1,908	121
FED. SAN LUIS	966	721	930	584	81
TOTAL NORTH CVP	11,363	8,581	9,937	8,827	103
MILLERTON	520	290	278	0	0
OROVILLE (SWP)	3,538	2,446	3,119	0	0

ACCUMULATED INFLOW FOR WATER YEAR TO DATE IN THOUSANDS OF ACRE-FEET

RESERVOIR	CURRENT WY2020	WY 1977	WY 1983	15 YR AVG	% OF 15 YR AVG
TRINITY	290	103	1,390	719	40
SHASTA	2,164	1,537	7,780	3,685	59
FOLSOM	868	218	3,949	1,715	51
NEW MELONES	363	----	1,247	565	64
MILLERTON	372	116	1,836	595	62

ACCUMULATED PRECIPITATION FOR WATER YEAR TO DATE IN INCHES

RESERVOIR	CURRENT WY 2020	WY1977	WY1983	AVG (N YRS)	% OF AVG	LAST 24 HRS
TRINITY AT FISH HATCHERY	15.95	9.27	50.99	28.64 (58)	56	0.00
SACRAMENTO AT SHASTA DAM	28.59	11.04	104.29	56.21 (63)	51	0.00
AMERICAN AT BLUE CANYON	34.44	15.64	96.22	60.24 (45)	57	0.00
STANISLAUS AT NEW MELONES	21.20	----	42.10	25.26 (42)	84	0.00
SAN JOAQUIN AT HUNTINGTON LK	26.34	11.50	75.30	37.66 (45)	70	0.00

Upper Sacramento River Summary Conditions – April (On-going):

Storage/Release Management Conditions:

- Reservoir Inflow Uncertainty: Shorter term forecasts (8-14 day) suggest a below normal chance of precipitation
- Longer term forecasts (three-month outlook) suggest below normal chance of precipitation
- Dry pattern break in April: actual inflows are tracing better than the 75% inflow exceedance probability estimates for the month
- Current release from Keswick Dam: Current release (Wednesday April 22) of 8,300 cfs, Thursday April 23, increasing to 9,100 cfs, and Friday April 24, increasing to 9,500 cfs for downstream diversion demands
- "Early April Moderate Storm Event Coordinated Operation": During poorer hydrologic years Reclamation is looking to take advantage of opportunities as they present themselves to garner incremental benefits. Reclamation coordinated a Keswick release reduction during a moderate storm event: flows were reduced from 5,000 cfs to 4,500 cfs for 8 days (4/6 – 4/14), precipitation was 1.92 in, Shasta lake elevation increased from 1035 ft to 1038 ft, and Shasta storage volume increased over 71 TAF for the same time period. (Also see temperature management below). Thank you to those who participated.
- Long-term conservative (inflow hydrology) projections suggest lower Shasta storage volumes. Estimated peak storage will likely occur in April rather than May due to poor inflow.

Temperature Management:

- Temperature management: Inactive draw on cold water pool
- Selective withdrawal: Rebuilding cold-water-pool reserves. All Upper TCD gates open as of 4/7. This affords greater flexibility (reservation of cold water pool) for temperature management later in the season.
- Meteorological Uncertainty: Shorter term forecasts (8-14 day) suggest above normal temperatures
- Longer term forecasts (three-month outlook) suggest above normal temperatures

Resources:

- Reclamation Bay Delta website: https://www.usbr.gov/mp/bdo/lto/index.html
- LTO Proposed Action: https://www.usbr.gov/mp/bdo/docs/ba-chapter-4-proposed-action.pdf
- 2019 Biological Opinions: https://www.usbr.gov/mp/bdo/lto/biop.html
- Excellent link for short term precipitation forecasts, overlay with burn areas, debris flow potential, etc: https://www.cnrfc.noaa.gov/
- Comprehensive Upper Sacramento fishery information: https://www.calfish.org/ProgramsData/ConservationandManagement/CentralValleyMonitoring/CDFWUpperSacRiverBasinSalmonidMonitoring.aspx

- SacPAS: Central Valley Prediction & Assessment of Salmon: http://www.cbr.washington.edu/sacramento/
- Bulletin 120 Forecast Updates: http://cdec.water.ca.gov/b120up.html

CVP Northern System Operation Outlooks: Draft April 2020

90% Runoff Exceedance Outlook

End of Month Storage/Elevation	Apr	May	Jun	Jul	Aug	Sep
Shasta Volume (TAF)	3674	3483	3025	2489	2110	1944
Shasta Elevation (Feet)	1035	1028	1009	984	964	954

Monthly Average River Release	Apr	May	Jun	Jul	Aug	Sep
Sacramento (CFS)	7000	8500	12000	12500	9750	6500
Clear Creek (CFS)	200	265	200	150	150	150

Trinity Diversions	Apr	May	Jun	Jul	Aug	Sep
Carr Power Plant (TAF)	114	100	100	100	101	100
Spring Creek PP (TAF)	90	90	90	90	90	90

50% Runoff Exceedance Outlook

End of Month Storage/Elevation	Apr	May	Jun	Jul	Aug	Sep
Shasta Volume (TAF)	3674	3578	3169	2688	2364	2231
Shasta Elevation (Feet)	1035	1032	1015	993	977	970

Monthly Average River Release	Apr	May	Jun	Jul	Aug	Sep
Sacramento (CFS)	7000	8500	12000	12100	9350	6500
Clear Creek (CFS)	200	380	150	150	150	150

Trinity Diversions	Apr	May	Jun	Jul	Aug	Sep
Carr Power Plant (TAF)	105	99	93	99	100	99
Spring Creek PP (TAF)	90	90	90	90	90	90

Notes: Inflow is based on the DWR B120 90% or 50% inflow exceedance Outlook; Historical inflows are used in the month of October and future months.

CVP actual operations do not follow any forecasted operation or outlook; actual operations are based on real-time conditions.

CVP operational forecasts or outlooks consider general system-wide dynamics and do not necessarily address specific watershed/tributary details.

CVP releases represent monthly averages.

CVP operations are updated monthly as new hydrology information is made available December through May.

Estimated CVP Operations 90% Exceedance

Storages

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

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Trinity	**1975**	**1931**	**1835**	**1710**	**1584**	**1429**	**1275**	**1234**	**1198**	**1180**	**1178**	**1206**	**1216**
	Elev.	2336	2329	2320	2310	2297	2283	2279	2276	2274	2274	2277	2278
Whiskeytown	**211**	**238**	**238**	**238**	**238**	**238**	**238**	**206**	**206**	**206**	**206**	**206**	**206**
	Elev.	1209	1209	1209	1209	1209	1209	1199	1199	1199	1199	1199	1199
Shasta	**3600**	**3674**	**3483**	**3025**	**2489**	**2110**	**1944**	**1846**	**1870**	**1926**	**2038**	**2231**	**2592**
	Elev.	1035	1028	1009	984	964	954	948	950	953	959	970	989
Folsom	**476**	**635**	**642**	**598**	**467**	**349**	**311**	**307**	**308**	**320**	**335**	**367**	**458**
	Elev.	432	433	428	412	395	389	388	389	390	393	398	411
New Melones	**1892**	**1844**	**1791**	**1707**	**1621**	**1551**	**1509**	**1472**	**1474**	**1477**	**1481**	**1481**	**1479**
	Elev.	1038	1033	1024	1016	1009	1004	1000	1000	1001	1001	1001	1001
San Luis	**344**	**349**	**235**	**90**	**45**	**69**	**150**	**220**	**224**	**310**	**516**	**494**	**445**
	Elev.	479	464	439	422	419	428	439	453	479	505	493	481
Total		8672	8224	7368	6444	5746	5427	5284	5280	5419	5754	5984	6396

Monthly River Releases (TAF/cfs)

Trinity	TAF	36	92	47	28	53	52	23	18	18	18	17	18
	cfs	**600**	**1,498**	**783**	**450**	**857**	**870**	**373**	**300**	**300**	**300**	**300**	**300**
Clear Creek	TAF	12	16	12	9	9	9	12	12	12	12	11	17
	cfs	**200**	**265**	**200**	**150**	**150**	**150**	**200**	**200**	**200**	**200**	**200**	**275**
Sacramento	TAF	416	523	714	768	599	387	338	223	215	215	194	215
	cfs	**7000**	**8500**	**12000**	**12500**	**9750**	**6500**	**5500**	**3750**	**3500**	**3500**	**3500**	**3500**
American	TAF	89	111	107	184	177	91	44	42	44	49	73	83
	cfs	**1500**	**1800**	**1800**	**3000**	**2882**	**1528**	**723**	**710**	**715**	**800**	**1310**	**1357**
Stanislaus	TAF	37	15	9	9	9	9	35	12	12	13	12	12
	cfs	**620**	**245**	**150**	**150**	**150**	**150**	**577**	**200**	**200**	**213**	**214**	**200**

Trinity Diversions (TAF)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Carr PP	114	100	100	100	101	100	24	30	21	15	10	57
Spring Crk. PP	**90**	**90**	**90**	**90**	**90**	**90**	**45**	**20**	**12**	**10**	**10**	**60**

Delta Summary (TAF)

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Tracy		115	66	110	231	265	255	196	58	120	240	45	50
USBR Banks		0	0	0	4	4	4	0	0	0	0	0	0
Contra Costa		3.8	4.2	5.1	5.6	5.5	4.2	4.2	3.8	3.8	3.8	3.0	3.4
Total USBR		119	70	115	241	275	263	200	62	124	244	48	53
COA Balance		11	11	8	0	0	18	0	0	0	0	-25	-80
Vernalis	TAF	115	95	40	42	37	43	104	83	83	92	82	82
Vernalis	cfs	1927	1552	671	687	605	722	1700	1393	1355	1498	1475	1339
Old/Middle River Std.													
Old/Middle R. calc.		-1,826	-1,322	-2,231	-3,808	-4,696	-4,630	-3,586	-2,795	-3,999	-4,974	-952	-1,282
Computed DOI		10304	7808	7447	4994	3497	3009	4002	4505	4506	6458	11400	11403
Excess Outflow		2505	0	0	0	0	0	0	0	0	1952	0	0
% Export/Inflow		19%	16%	19%	33%	43%	50%	47%	41%	54%	54%	11%	13%
% Export/Inflow std.		35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%	35%

Hydrology

	Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)	490		3,165		1,321		589	
Year to Date + Forecasted % of mean	41%		57%		49%		56%	

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.

4/16/2020

Estimated CVP Operations 50% Exceedance

Storages

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

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Trinity	**1975**	**1963**	**1876**	**1756**	**1631**	**1476**	**1324**	**1289**	**1276**	**1306**	**1361**	**1472**	**1596**
	Elev.	2338	2332	2323	2314	2301	2288	2285	2283	2286	2291	2301	2311
Whiskeytown	**211**	**238**	**238**	**238**	**238**	**238**	**238**	**206**	**206**	**206**	**206**	**206**	**206**
	Elev.	1209	1209	1209	1209	1209	1209	1199	1199	1199	1199	1199	1199
Shasta	**3600**	**3674**	**3578**	**3169**	**2688**	**2364**	**2231**	**2172**	**2252**	**2427**	**2818**	**3358**	**3898**
	Elev.	1035	1032	1015	993	977	970	967	971	981	1000	1023	1044
Folsom	**476**	**630**	**696**	**623**	**465**	**369**	**335**	**321**	**321**	**341**	**400**	**537**	**724**
	Elev.	432	439	431	412	398	393	391	391	394	403	421	442
New Melones	**1892**	**1854**	**1839**	**1790**	**1712**	**1646**	**1607**	**1580**	**1597**	**1620**	**1654**	**1708**	**1767**
	Elev.	1039	1037	1033	1025	1018	1014	1012	1013	1016	1019	1025	1030
San Luis	**344**	**326**	**184**	**82**	**31**	**25**	**97**	**229**	**371**	**587**	**805**	**930**	**966**
	Elev.	473	456	434	415	406	412	439	471	509	530	540	543
Total		8685	8411	7659	6765	6118	5832	5797	6022	6487	7244	8210	9157

Monthly River Releases (TAF/cfs)

Trinity	TAF	36	92	47	28	53	52	23	18	18	18	17	18
	cfs	**600**	**1,498**	**783**	**450**	**857**	**870**	**373**	**300**	**300**	**300**	**300**	**300**
Clear Creek	TAF	12	23	9	9	9	9	12	12	12	25	11	12
	cfs	**200**	**380**	**150**	**150**	**150**	**150**	**200**	**200**	**200**	**400**	**200**	**200**
Sacramento	TAF	416	523	714	744	575	387	338	238	215	215	222	295
	cfs	**7000**	**8500**	**12000**	**12100**	**9350**	**6500**	**5500**	**4000**	**3500**	**3500**	**4000**	**4800**
American	TAF	89	130	164	220	159	95	89	90	92	92	125	123
	cfs	**1500**	**2113**	**2750**	**3573**	**2583**	**1605**	**1451**	**1518**	**1500**	**1500**	**2250**	**2000**
Stanislaus	TAF	37	15	9	9	9	9	35	12	12	13	12	12
	cfs	**622**	**245**	**150**	**150**	**150**	**150**	**577**	**200**	**200**	**213**	**214**	**200**

Trinity Diversions (TAF)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Carr PP	105	99	93	99	100	99	23	25	9	10	2	5
Spring Crk. PP	**90**	**90**	**90**	**90**	**90**	**90**	**45**	**20**	**12**	**19.8**	**35**	**30**

Delta Summary (TAF)

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Tracy		115	66	181	267	265	260	265	201	255	260	200	136
USBR Banks		0	0	0	11	11	11	0	0	0	0	0	0
Contra Costa		12.7	12.7	9.8	11.1	12.7	14.0	16.8	18.4	18.3	14.0	14.0	12.7
Total USBR		128	79	191	289	289	285	282	219	273	274	214	149
Total Export COA Balance		11	12	17	17	17	20	20	0	0	0	0	0
Vernalis	TAF	115	95	56	48	46	51	104	83	83	92	111	57
Vernalis	cfs	1929	1552	940	784	752	856	1700	1393	1355	1498	1997	932
Old/Middle River Std.													
Old/Middle R. calc.	cfs	-1,940	-1,428	-2,895	-4,096	-4,507	-4,903	-5,885	-5,702	-6,598	-4,901	-4,975	-3,887
Computed DOI		14423	7808	7447	4994	3497	3009	4002	4505	7418	14445	19811	20725
Excess Outflow		6623	0	0	0	0	0	0	0	2912	8443	8411	9321
% Export/Inflow		15%	16%	24%	34%	42%	51%	57%	57%	52%	31%	25%	18%
% Export/Inflow std.		35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%	35%

Hydrology

	Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)	520		3,405		1,482		688	
Year to Date + Forecasted % of mean	43%		61%		54%		65%	

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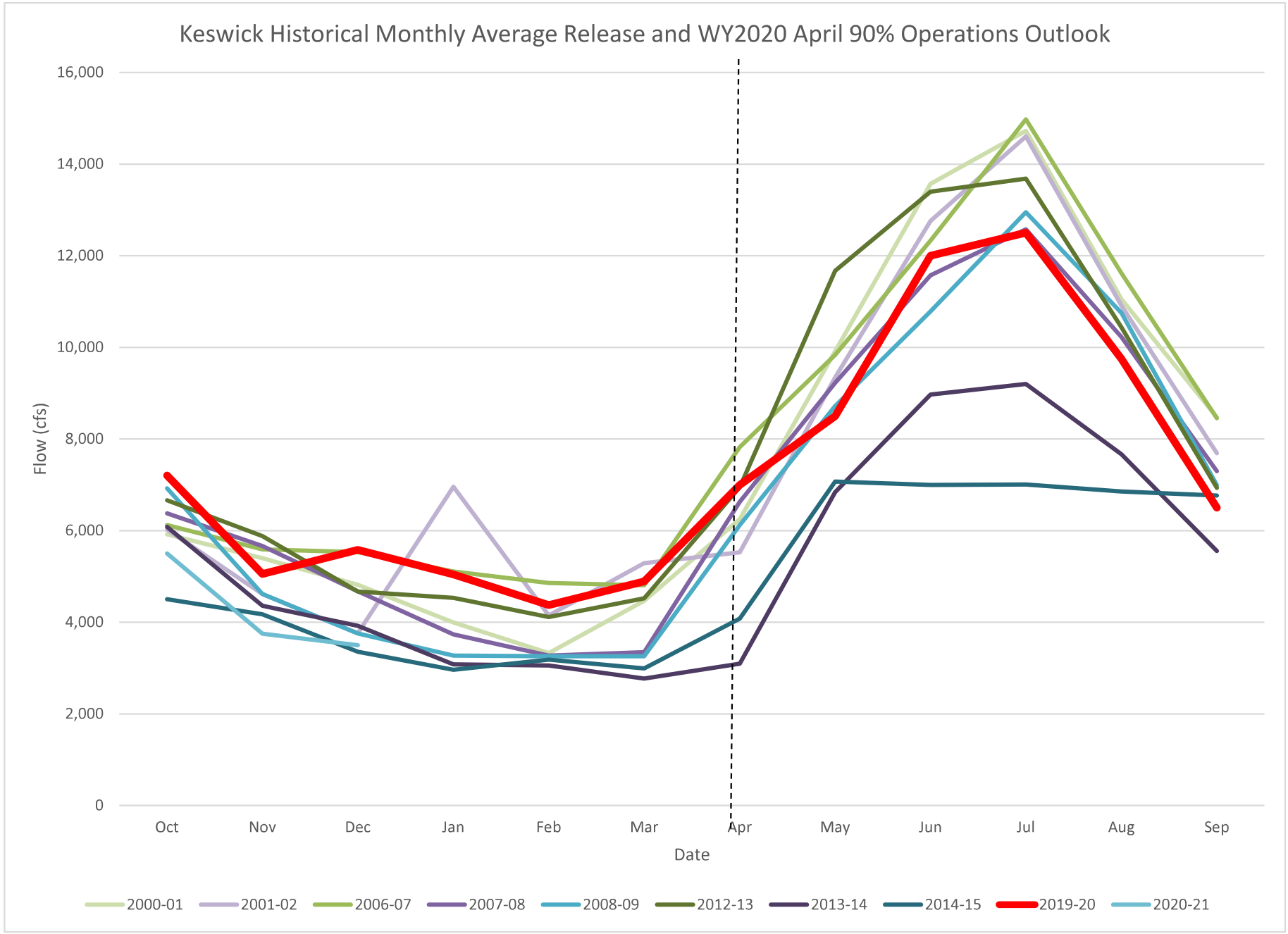
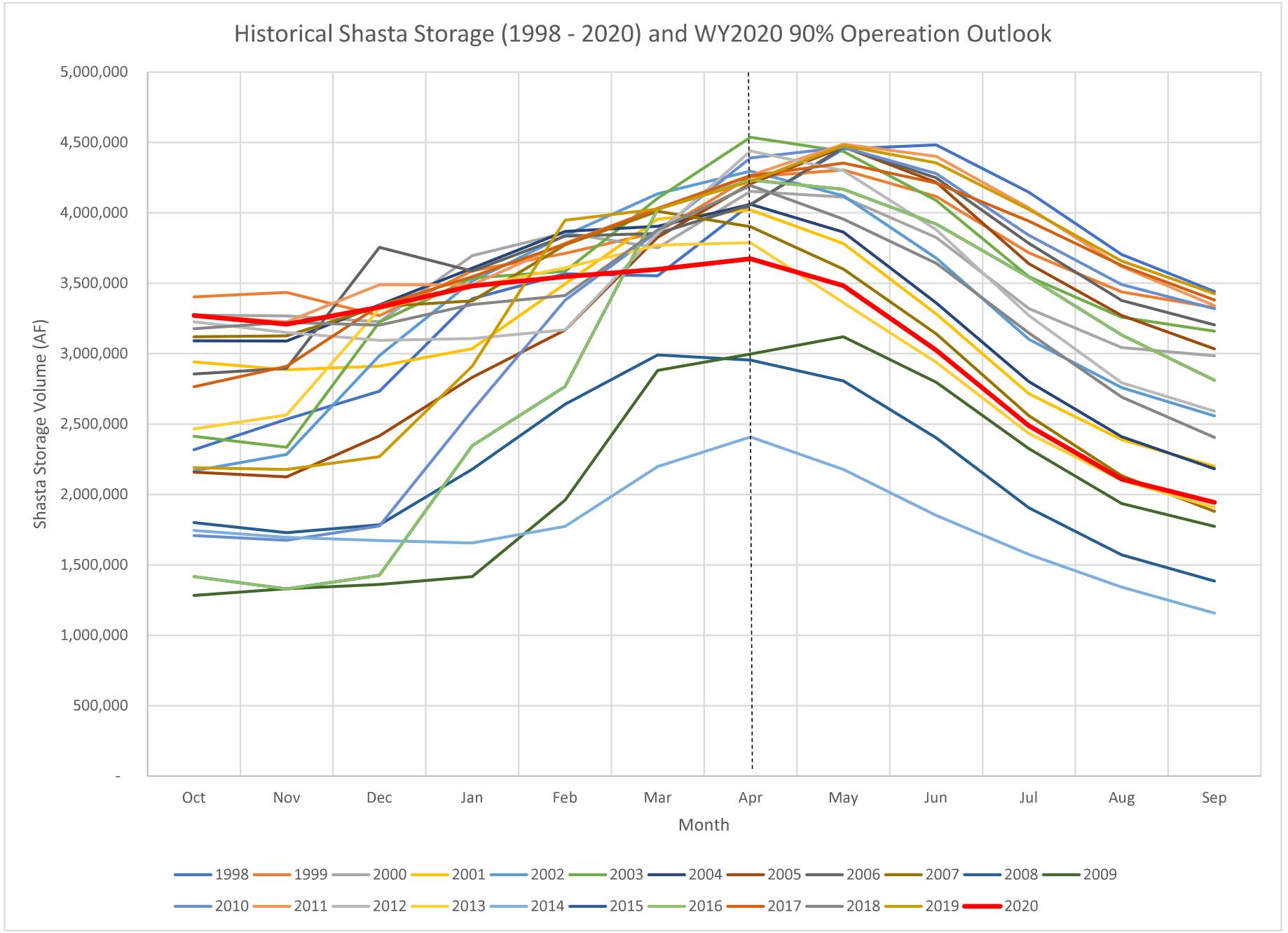
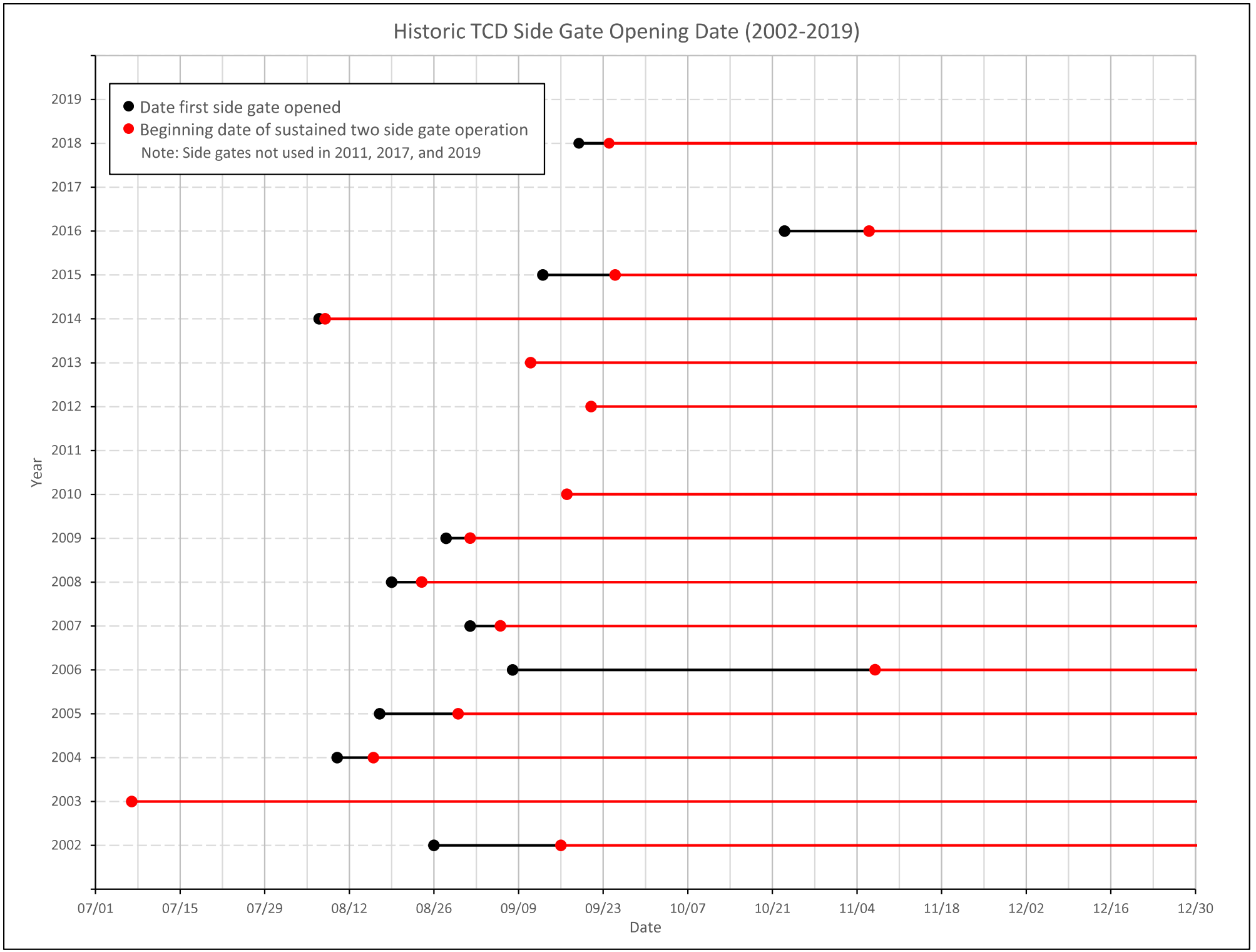
CVP releases or export values represent monthly averages.
CVP Operations are updated monthly as new hydrology information is made available December through May.

4/21/2020


Keswick Historical Monthly Average Release and WY2020 April 90% Operations Outlook
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (cfs)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
2000-01
2001-02
2006-07
2007-08
2008-09
2012-13
2013-14
2014-15
2019-20
2020-21


Historical Shasta Storage (1998 - 2020) and WY2020 90% Opereation Outlook
Shasta Storage Volume (AF)
5,000,000
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


Historic TCD Side Gate Opening Date (2002-2019)
Date first side gate opened
Beginning date of sustained two side gate operation
Note: Side gates not used in 2011, 2017, and 2019
Year
2019
2018
2017
2016
2015
2014
2013
2012
2011
2010
2009
2008
2007
2006
2005
2004
2003
2002
07/01
07/15
07/29
08/12
08/26
09/09
09/23
10/07
10/21
11/04
11/18
12/02
12/16
12/30
Date

Northern CVP Water Temperature Report

April - 2020

BUREAU OF RECLAMATION

All Data in this Report is Preliminary and Subject to Change

DATE	Mean Daily Water Temperatures (°F)													Mean Daily Release (CFS)			Mean Daily Air Temperatures (°F)			
	TCD[1]	SHD	SPP[1]	KWK	SAC	CCR	BSF[2]	JLF	BND	RDB	IGO	LWS	-----	Shasta Generation	Spring Creek P.P.	Keswick Total	RDD	BSF	RDB	LWS
Mar	49.4	48.7	48.7	49.2	49.6	50.0	50.6	51.3	51.6	51.9	49.0	47.6	-	3693	969	4891	53.2	51.7	53.3	-
04/01	49.2	48.6	49.6	49.2	49.9	50.3	**51.5**	52.5	53.0	53.6	50.3	47.9	-	3219	1644	4949	50.5	49.9	52.6	-
04/02	# -	? 49.1	49.5	49.4	50.1	50.6	**51.4**	52.2	52.5	53.0	50.3	47.8	-	2731	1907	4958	53.0	52.2	53.5	-
04/03	# -	48.7	49.5	49.3	50.1	50.7	**51.7**	52.5	52.9	53.4	50.5	47.8	-	2795	1880	4956	50.5	50.7	52.9	-
04/04	# -	? 48.5	49.1	49.3	49.5	49.5	**50.2**	51.2	51.8	52.5	49.0	46.3	-	3249	1909	4961	46.0	45.3	47.1	-
04/05	# -	48.6	48.9	49.1	49.6	49.8	**50.1**	50.5	50.5	50.6	49.2	46.7	-	2635	1800	4958	51.0	51.8	51.4	-
04/06	# -	48.8	49.1	49.0	49.9	50.5	**51.3**	51.9	52.0	52.1	50.3	47.1	-	3127	1813	4794	54.0	51.3	52.1	-
04/07	# -	49.4	48.9	49.2	50.1	50.7	**52.3**	53.3	53.6	54.0	50.9	48.2	-	2592	1814	4610	54.5	53.5	54.9	-
04/08	! -	50.4	48.8	49.9	50.8	51.6	**53.5**	54.6	55.0	55.4	52.0	49.0	-	2496	1900	4493	66.5	61.0	62.1	-
04/09	50.8	50.5	48.6	49.8	50.6	51.3	**53.6**	55.1	55.8	56.2	50.8	49.7	-	2708	1830	4500	53.5	54.7	54.7	-
04/10	50.4	50.0	48.6	50.2	51.3	52.2	**54.1**	55.2	55.7	56.5	52.4	51.0	-	1952	1834	4478	63.0	61.9	63.2	-
04/11	51.0	49.9	48.8	50.5	51.6	52.7	**55.3**	56.8	57.4	58.1	52.6	51.4	-	2342	1944	4483	62.5	61.5	62.0	-
04/12	51.5	? 51.1	48.7	51.1	52.0	53.0	**55.7**	57.5	58.3	59.3	52.7	51.7	-	1911	1819	4478	65.5	65.1	66.0	-
04/13	51.5	? 50.6	48.8	51.3	52.1	52.9	**55.1**	56.5	57.1	58.2	51.5	50.8	-	3172	1368	4472	62.0	58.3	61.5	-
04/14	51.6	! -	48.9	50.9	51.9	52.8	**54.7**	55.9	56.4	57.4	51.5	49.8	-	3075	1797	4982	60.0	58.3	61.9	-
04/15	51.8	? 51.1	49.0	51.0	51.8	52.7	**54.7**	56.0	56.6	57.6	51.9	49.5	-	3328	1883	5466	64.5	62.3	62.5	-
04/16	52.5	? 51.6	? 49.0	51.5	52.3	53.2	**55.0**	56.4	56.9	57.8	52.3	49.7	-	3497	1866	5501	68.0	63.6	64.6	-
04/17	52.1	! -	49.0	51.4	52.3	53.2	**55.2**	56.6	57.1	58.0	52.1	49.0	-	3712	1888	5888	68.5	61.9	64.3	-
04/18	51.8	! -	? 49.0	51.6	52.1	52.7	**54.4**	55.7	56.4	57.6	51.8	49.0	-	3914	1850	6246	59.0	58.3	58.4	-
04/19	52.2	51.6	49.2	51.5	52.3	53.0	**54.5**	55.6	56.0	56.7	52.1	48.9	-	5252	1928	6676	59.5	59.4	59.5	-
04/20	52.5	51.6	49.2	51.4	52.0	52.5	**54.1**	55.3	55.7	56.7	51.8	49.6	-	4901	1933	6969	59.0	56.3	57.4	-
04/21	52.8	? 52.3	49.4	51.8	52.5	53.1	**54.6**	55.6	55.9	56.5	52.4	49.9	-	5127	1917	7466	63.0	60.9	62.1	-
04/22																				
04/23																				
04/24																				
04/25																				
04/26																				
04/27																				
04/28																				
04/29																				
04/30																				
-																				
Apr	51.6	50.1	49.0	50.4	51.2	51.9	53.5	54.6	55.1	55.8	51.4	49.1	-	3225	1834	5252	58.8	57.1	58.3	-
												Total CFS		67735	38524	110284				
												Total AF		134350	76411	218744				

Legend

? = 1-9 hours of data missing (Average includes estimations)
! = 10 or more hours of data missing (Average not calculated)
= Station out of service
↑ = Record high air temperature
↓ = Record low air temperature
= Monthly Averages

Notes

[1] Temperatures are weighted averages based on individual penstock flow and temperature
Highlighted cells in the TCD column indicate a TCD change was made on that day
[2] Current control point (see page 3 for more details)
[3] Column not used this month

DATE	Redding (RDD) Daily Air Temperatures (°F)																																			
	Actual			Forecasted																																		
	Previous Day			Current Day			1 Day			2 Days			3 Days			4 Days			5 Days			6 Days			7 Days			8 Days			9 Days			10 Days		
	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg
04/01	49	69	59.0	38	63	50.5	35	66	50.5	37	66	51.5	42	58	50.0	42	56	49.0	38	60	49.0	38	69	53.5	47	73	60.0	48	78	63.0	49	79	64.0	51	77	64.0
04/02	38	63	50.5	40	64	52.0	37	66	51.5	40	55	47.5	44	55	49.5	38	60	49.0	38	68	53.0	42	75	58.5	52	77	64.5	49	83	66.0	49	79	64.0	48	72	60.0
04/03	40	66	53.0	36	65	50.5	41	55	48.0	44	55	49.5	40	59	49.5	38	67	52.5	41	73	57.0	44	70	57.0	47	74	60.5	45	78	61.5	46	73	59.5	46	71	58.5
04/04	35	66	50.5	42	53	47.5	43	57	50.0	39	61	50.0	39	68	53.5	42	76	59.0	45	78	61.5	48	77	62.5	52	81	66.5	51	79	65.0	50	78	64.0	50	75	62.5
04/05	41	51	46.0	49	57	53.0	40	62	51.0	40	72	56.0	44	80	62.0	45	81	63.0	49	80	64.5	46	81	63.5	55	81	68.0	53	82	67.5	50	80	65.0	52	75	63.5
04/06	45	57	51.0	45	62	53.5	41	71	56.0	45	81	63.0	47	80	63.5	49	79	64.0	49	81	65.0	50	80	65.0	56	83	69.5	53	84	68.5	52	80	66.0	52	77	64.5
04/07	44	64	54.0	41	72	56.5	45	82	63.5	47	78	62.5	50	78	64.0	48	83	65.5	50	80	65.0	48	78	63.0	53	83	68.0	52	86	69.0	53	82	67.5	52	76	64.0
04/08	41	68	54.5	49	81	65.0	48	76	62.0	49	78	63.5	48	81	64.5	48	78	63.0	47	78	62.5	46	80	63.0	53	82	67.5	52	79	65.5	52	76	64.0	49	72	60.5
04/09	48	85	66.5	45	71	58.0	49	76	62.5	49	80	64.5	49	78	63.5	47	78	62.5	46	80	63.0	47	80	63.5	53	83	68.0	53	84	68.5	53	82	67.5	53	80	66.5
04/10	44	63	53.5	51	77	64.0	49	79	64.0	48	78	63.0	47	80	63.5	46	82	64.0	48	83	65.5	50	82	66.0	52	73	62.5	48	72	60.0	49	76	62.5	52	78	65.0
04/11	51	75	63.0	49	81	65.0	49	77	63.0	46	75	60.5	44	81	62.5	47	80	63.5	50	76	63.0	48	73	60.5	48	71	59.5	48	75	61.5	51	78	64.5	53	79	66.0
04/12	49	76	62.5	57	77	67.0	47	75	61.0	44	79	61.5	48	83	65.5	51	76	63.5	48	78	63.0	49	73	61.0	51	74	62.5	49	73	61.0	51	77	64.0	53	80	66.5
04/13	53	78	65.5	50	75	62.5	44	79	61.5	48	82	65.0	51	81	66.0	50	80	65.0	51	73	62.0	50	70	60.0	51	71	61.0	48	74	61.0	50	75	62.5	51	78	64.5
04/14	48	76	62.0	43	80	61.5	49	81	65.0	52	79	65.5	46	79	62.5	48	74	61.0	49	71	60.0	49	69	59.0	49	75	62.0	49	75	62.0	52	82	67.0	50	76	63.0
04/15	41	79	60.0	48	82	65.0	53	79	66.0	48	80	64.0	49	74	61.5	48	71	59.5	49	66	57.5	49	74	61.5	51	80	65.5	51	84	67.5	51	82	66.5	51	80	65.5
04/16	47	82	64.5	56	79	67.5	49	78	63.5	49	73	61.0	49	74	61.5	49	73	61.0	48	79	63.5	51	77	64.0	53	83	68.0	51	79	65.0	49	81	65.0	53	82	67.5
04/17	56	80	68.0	60	79	69.5	48	73	60.5	47	72	59.5	47	72	59.5	47	78	62.5	50	77	63.5	50	79	64.5	52	80	66.0	52	83	67.5	52	82	67.0	53	77	65.0
04/18	58	79	68.5	51	74	62.5	46	72	59.0	47	72	59.5	46	79	62.5	49	79	64.0	52	82	67.0	51	83	67.0	52	84	68.0	55	85	70.0	54	84	69.0	57	85	71.0
04/19	50	68	59.0	53	70	61.5	47	73	60.0	47	80	63.5	50	74	62.0	52	82	67.0	53	85	69.0	53	88	70.5	53	84	68.5	53	85	69.0	55	86	70.5	57	86	71.5
04/20	50	69	59.5	47	73	60.0	46	81	63.5	51	80	65.5	53	83	68.0	53	86	69.5	56	87	71.5	53	84	68.5	49	81	65.0	51	84	67.5	54	88	71.0	56	82	69.0
04/21	47	71	59.0	46	80	63.0	49	79	64.0	51	82	66.5	52	86	69.0	55	87	71.0	53	83	68.0	52	84	68.0	53	85	69.0	55	89	72.0	55	89	72.0	58	87	72.5
04/22	45	81	63.0	50	76	63.0	51	81	66.0	52	86	69.0	55	86	70.5	53	86	69.5	52	86	69.0	56	93	74.5	59	91	75.0	59	90	74.5	58	84	71.0	54	78	66.0
04/23																																				
04/24																																				
04/25																																				
04/26																																				
04/27																																				
04/28																																				
04/29																																				
04/30																																				
-																																				

Web Links

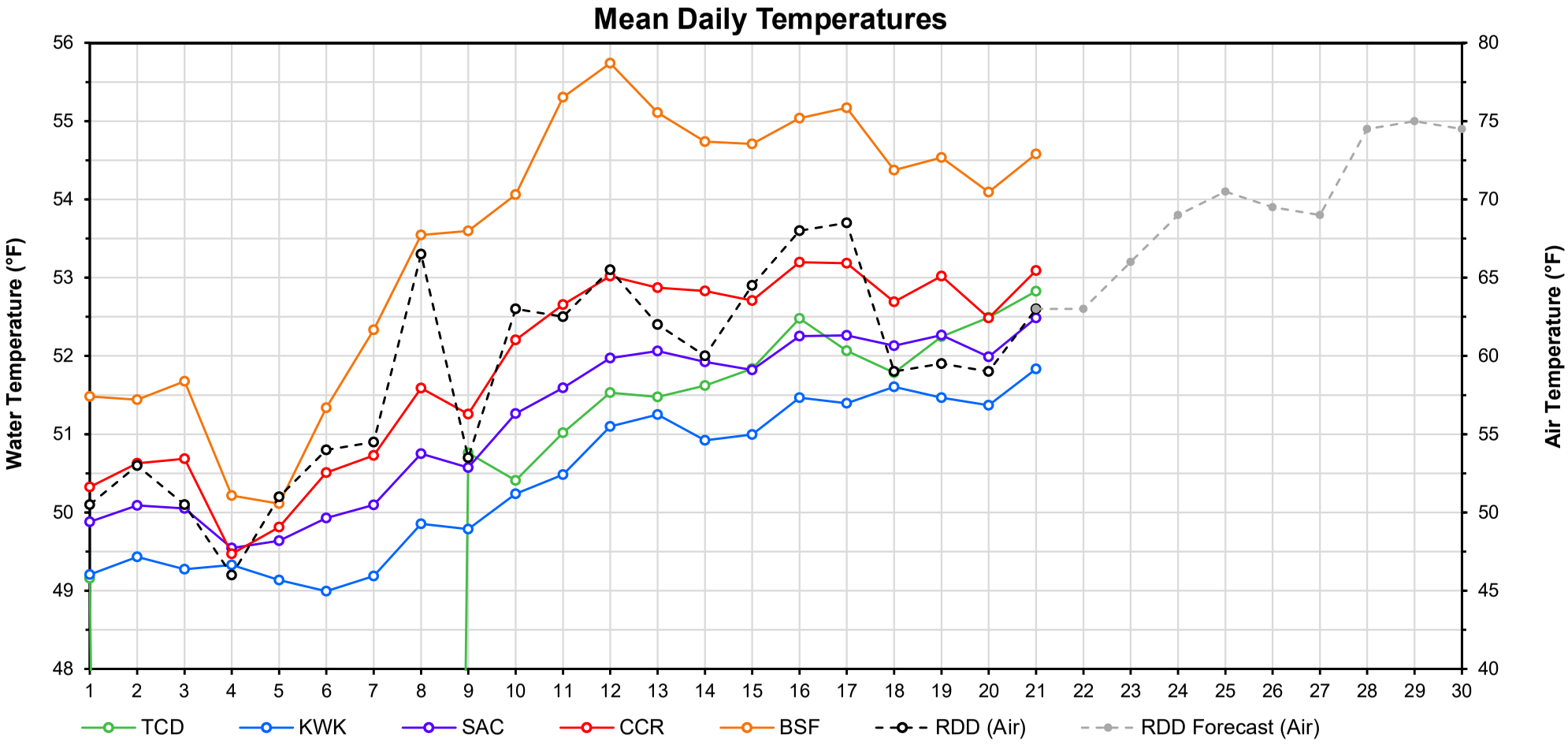
[10-Day Min/Max Forecast]

[Previous Days Min/Max Actuals]

Legend

NR = Forecasted temperatures not recorded

100 = Previous day actual temperatures in red and bolded indicate a record temperature for that date



Station Details			
Code	Body of Water	Location[1]	CDEC Link
TCD	N/A	Shasta Power Plant	N/A
SHD	Sacramento River	0.3 miles downstream of Shasta Power Plant	Click Here
SPP	N/A	Spring Creek Power Plant	N/A
KWK	Sacramento River	0.8 miles downstream of Keswick Dam	Click Here
SAC	Sacramento River	4.8 miles downstream of Keswick Dam	Click Here
CCR	Sacramento River	9.7 miles downstream of Keswick Dam	Click Here
BSF	Sacramento River	25 miles downstream of Keswick Dam	Click Here
JLF	Sacramento River	34 miles downstream of Keswick Dam	Click Here
BND	Sacramento River	41 miles downstream of Keswick Dam	Click Here
RDB	Sacramento River	58 miles downstream of Keswick Dam	Click Here
IGO	Clear Creek	7.3 miles downstream of Whiskeytown Dam	Click Here
LWS	Trinity River	1.1 miles downstream of Lewiston Dam	Click Here
DGC[2]	Trinity River	19 miles downstream of Lewiston Dam	Click Here
NFH[3]	Trinity River	38 miles downstream of Lewiston Dam	Click Here

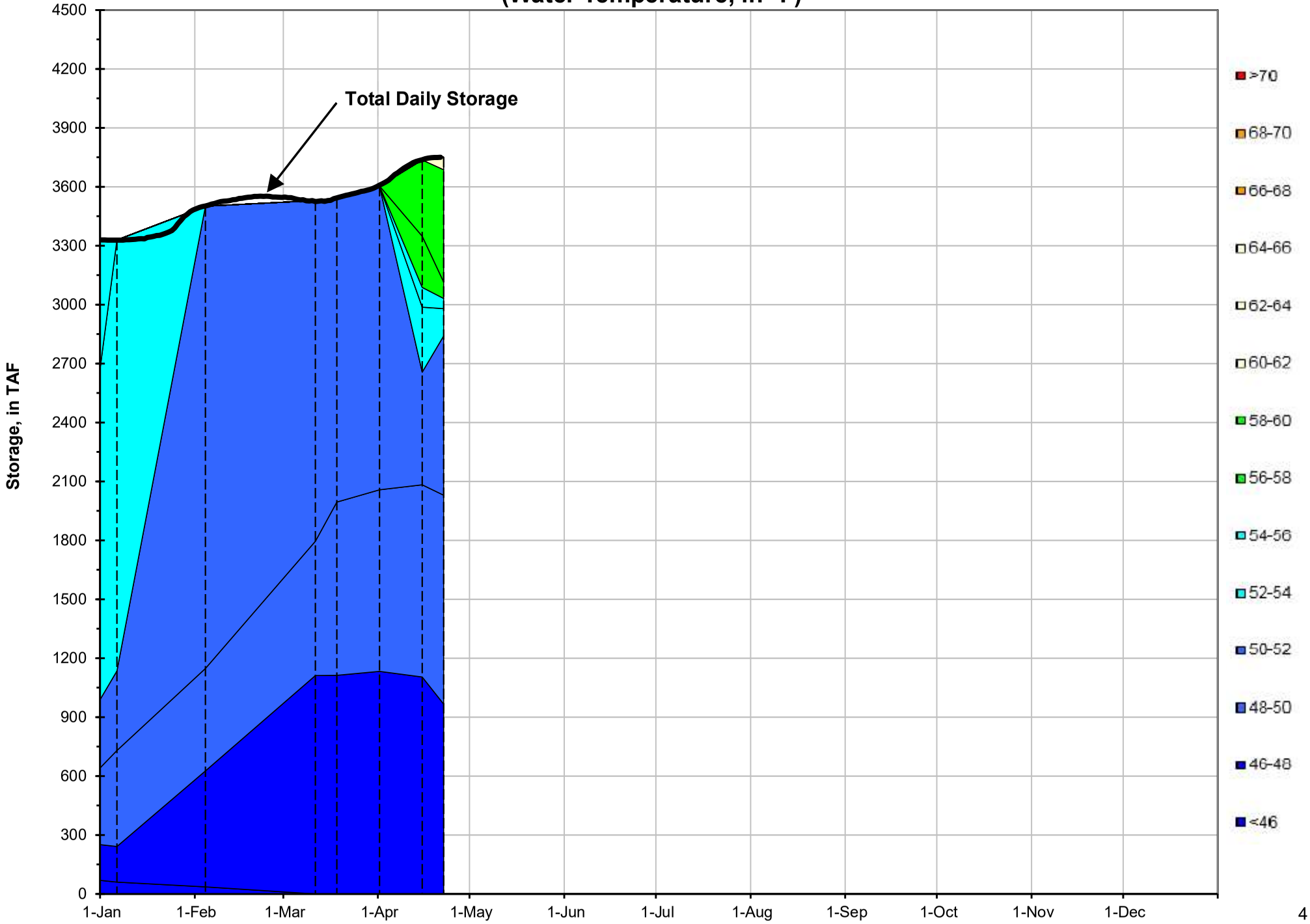
Temperature Control Point		
Point	Temp. (°F)	Begin Date
BSF	**56.0**	**5/25/2018**

Notes

[1] Distances are approximate
[2] DGC is only reported in September
[3] NFH is only reported in October, November and December

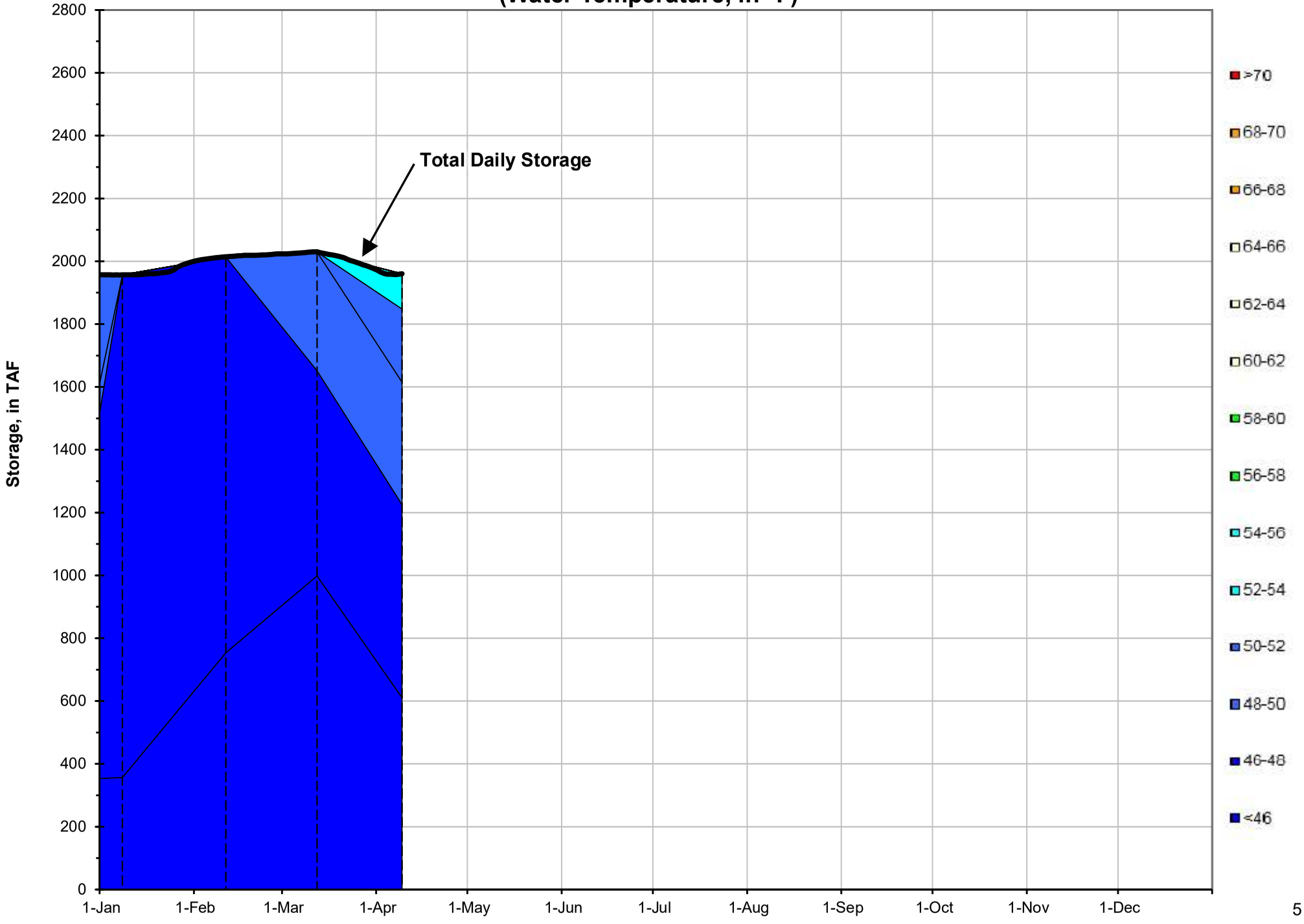
Latest Profile Date: 04/22/2020

Shasta Lake Isothermobaths - 2020
(Water Temperature, in °F)



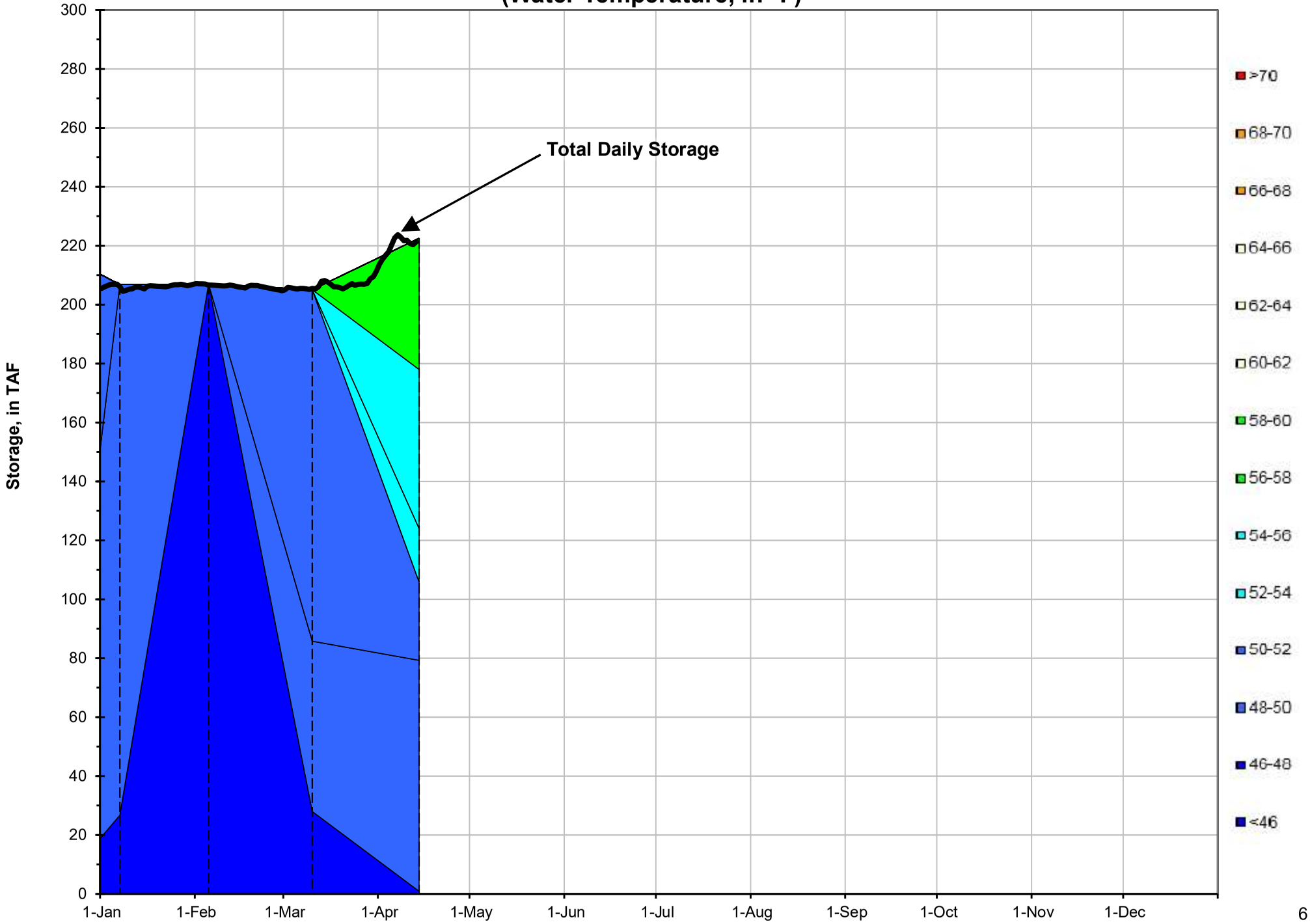
Latest Profile Date: 04/09/2020

Trinity Lake Isothermobaths - 2020
(Water Temperature, in °F)



Latest Profile Date: 04/14/2020

Whiskeytown Lake Isothermobaths - 2020
(Water Temperature, in °F)

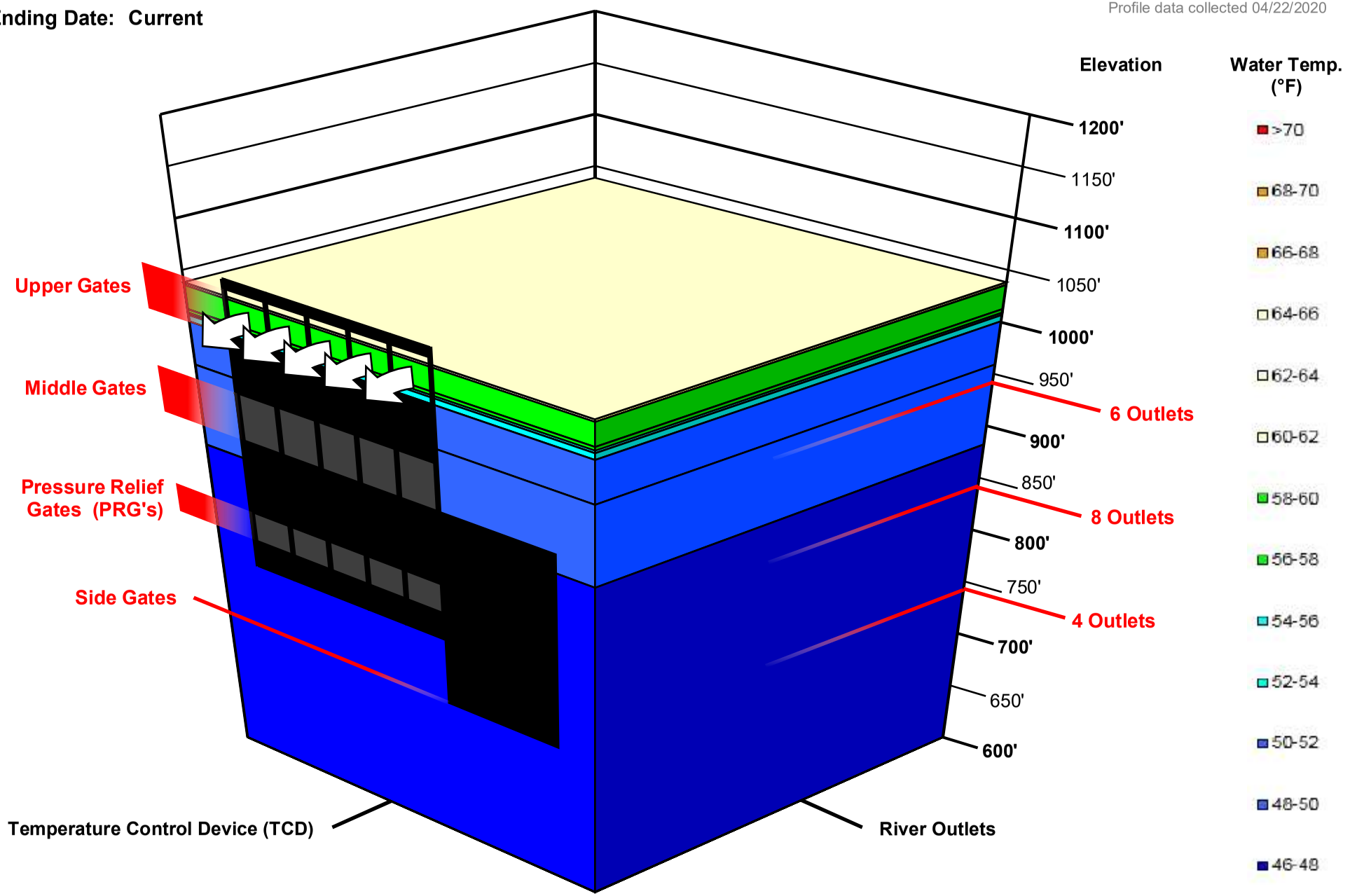


Shasta TCD Configuration

Starting Date: 4/7/2020

Ending Date: Current

Profile data collected 04/22/2020

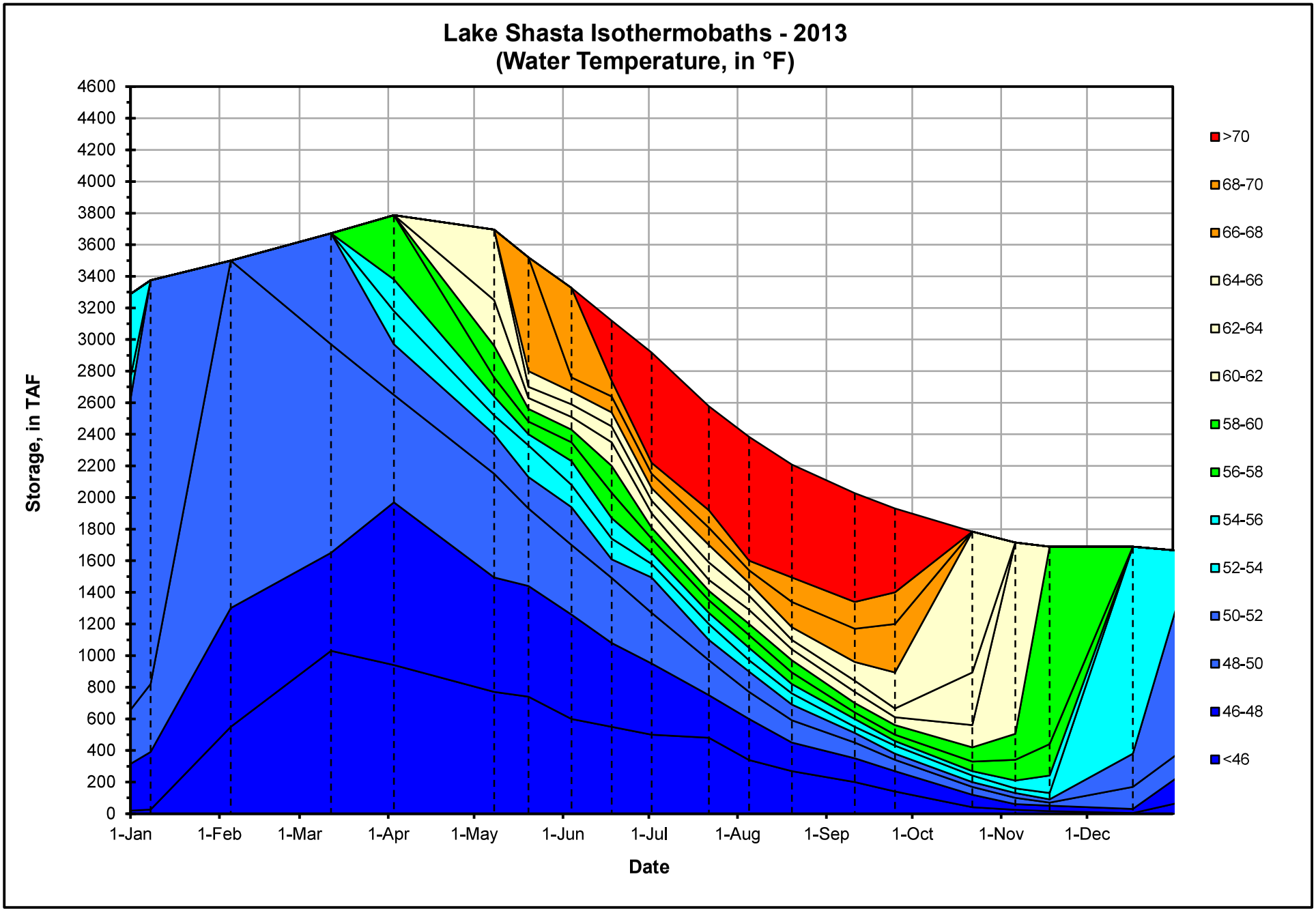


Arrows indicate open Gate or Outlet (i.e. Water flowing from this location)

CCR

Daily Avg		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Tot.	Valid[1]	172	177	177	177	177	177	176	177	177	174	177	177	177	177	177	177	176	177
	%	(97.2)	(100)	(100)	(100)	(100)	(100)	(99.4)	(100)	(100)	(98.3)	(100)	(100)	(100)	(100)	(100)	(100)	(99.4)	(100)
Exceedance Count / °F	52.0	97	61	124	135	145	112	138	133	89	135	154	152	93	98	135	172	176	177
	%	(56.4)	(34.5)	(70.1)	(76.3)	(81.9)	(63.3)	(78.4)	(75.1)	(50.3)	(77.6)	(87)	(85.9)	(52.5)	(55.4)	(76.3)	(97.2)	(100)	(100)
	52.5	65	9	116	119	105	101	131	103	37	130	151	144	65	56	82	165	176	177
	%	(37.8)	(5.1)	(65.5)	(67.2)	(59.3)	(57.1)	(74.4)	(58.2)	(20.9)	(74.7)	(85.3)	(81.4)	(36.7)	(31.6)	(46.3)	(93.2)	(100)	(100)
	53.0	45		79	92	63	83	96	89	9	119	149	140	32	27	31	154	173	177
	%	(26.2)		(44.6)	(52)	(35.6)	(46.9)	(54.5)	(50.3)	(5.1)	(68.4)	(84.2)	(79.1)	(18.1)	(15.3)	(17.5)	(87)	(98.3)	(100)
	53.5	33		53	56	24	65	72	82		96	145	133	8	4	3	129	172	177
	%	(19.2)		(29.9)	(31.6)	(13.6)	(36.7)	(40.9)	(46.3)		(55.2)	(81.9)	(75.1)	(4.5)	(2.3)	(1.7)	(72.9)	(97.7)	(100)
	54.0	14		30	48	10	29	62	67		66	132	118	6	2	1	98	172	177
	%	(8.1)		(16.9)	(27.1)	(5.6)	(16.4)	(35.2)	(37.9)		(37.9)	(74.6)	(66.7)	(3.4)	(1.1)	(0.6)	(55.4)	(97.7)	(100)
	54.5	1		2	41	2		58	39		44	111	97	2	1	1	56	167	176
	%	(0.6)		(1.1)	(23.2)	(1.1)		(33)	(22)		(25.3)	(62.7)	(54.8)	(1.1)	(0.6)	(0.6)	(31.6)	(94.9)	(99.4)
	55.0				29	2		50	30		25	82	50				20	161	170
	%				(16.4)	(1.1)		(28.4)	(16.9)		(14.4)	(46.3)	(28.2)				(11.3)	(91.5)	(96)
	55.5				12			42	16		15	56	33				7	134	162
	%				(6.8)			(23.9)	(9)		(8.6)	(31.6)	(18.6)				(4)	(76.1)	(91.5)
	56.0				1			29	2		7	45	21					90	143
	%				(0.6)			(16.5)	(1.1)		(4)	(25.4)	(11.9)					(51.1)	(80.8)
	56.5							19			2	40	16					67	114
	%							(10.8)			(1.1)	(22.6)	(9)					(38.1)	(64.4)
	57.0							1				35	9					53	77
	%							(0.6)				(19.8)	(5.1)					(30.1)	(43.5)
	57.5											30	3					51	28
	%											(16.9)	(1.7)					(29)	(15.8)
	58.0											8						47	7
	%											(4.5)						(26.7)	(4)

[1] A daily average is only calculated if 14 or more hours of data were collected that day.


Lake Shasta Isothermobaths - 2013
(Water Temperature, in °F)
Storage, in TAF
4600
4400
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
Date
>70
68-70
66-68
64-66
62-64
60-62
58-60
56-58
54-56
52-54
50-52
48-50
46-48
<46

April 22, 2020

Upper Sacramento River – April 2020 Preliminary Temperature Analysis

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

Model Run	Location	Apr	May	Jun	Jul	Aug	Sep*	Oct*
90% Hydrology 25% Historical Meteorology Targeting CCR Scenario 148	Keswick Dam KWK	53.6	54.1	52.7	53.2	53.2	See Fig. 9	See Fig. 9
	Sac. R. abv Clear Creek CCR	53.6	54.4	53.1	53.7	53.7	See Fig. 10	See Fig. 10
	Airport Road	53.8	54.8	53.6	54.3	54.4	n/a	n/a
	Balls Ferry BSF	54.7	56.0	54.6	55.3	55.4	See Fig. 11	See Fig. 11
90% Hydrology 25% Historical Meteorology Targeting CCR Scenario 23	Keswick Dam KWK	53.6	53.3	52.7	53.2	53.2	See Fig. 9	See Fig. 9
	Sac. R. abv Clear Creek CCR	53.6	53.6	53.1	53.7	53.7	See Fig. 10	See Fig. 10
	Airport Road	53.8	54.1	53.6	54.3	54.4	n/a	n/a
	Balls Ferry BSF	54.7	55.3	54.6	55.3	55.4	See Fig. 11	See Fig. 11
90% Hydrology 25% Historical Meteorology Targeting CCR Scenario 144	Keswick Dam KWK	53.6	53.7	52.7	53.2	53.3	See Fig. 9	See Fig. 9
	Sac. R. abv Clear Creek CCR	53.6	54.0	53.1	53.7	53.7	See Fig. 10	See Fig. 10
	Airport Road	53.8	54.5	53.6	54.3	54.4	n/a	n/a
	Balls Ferry BSF	54.7	55.7	54.6	55.3	55.4	See Fig. 11	See Fig. 11
90% Hydrology 25% Historical Meteorology Targeting CCR Scenario 145	Keswick Dam KWK	53.6	54.1	52.7	53.2	53.3	See Fig. 9	See Fig. 9
	Sac. R. abv Clear Creek CCR	53.6	54.4	53.1	53.6	53.7	See Fig. 10	See Fig. 10
	Airport Road	53.8	54.8	53.6	54.3	54.4	n/a	n/a
	Balls Ferry BSF	54.7	56.0	54.6	55.3	55.4	See Fig. 11	See Fig. 11

Summary of Shasta Lake Cold Water Pool and TCD Operation

Model Run	End of September Cold Water Pool <56°F (TAF)	First Side Gate Use (Date)	Full Side Gate Use (Date)
90%Hydro. - 25%Hist. Met. CCR Scenario 148	495	8/10	10/30
90%Hydro. - 25%Hist. Met. CCR Scenario 23	462	8/9	9/30
90%Hydro. - 25%Hist. Met. CCR Scenario 144	468	8/10	10/24
90%Hydro. - 25%Hist. Met. CCR Scenario 145	480	8/10	10/28

Model Run Date April 22, 2020

* The HEC5Q model output is displayed 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, ranges in possible outcomes are illustrated with the Fall Temperature Index (graphics above Figures 6-8). This relationship is an end of September Lake Shasta Volume less than 56°F and likely downstream temperature performance for the early fall months. Estimated temperatures for September and October may fall into a range indicated within the Fall Temperature Index (graphical chart), illustrating historical performance. However, this range should be viewed as an element of uncertainty based on past performance, not a simulation or projection of temperature management operations or results.

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 2. The relationship between end-of-September lake volume below 56°F and a downstream Sacramento River compliance location through fall is based on the Figures 3-5. Runs targeting temperature above Clear Creek confluence and at Balls Ferry target locations attempt to meet the April 15 – May 15 temperature target of 56°F at Balls Ferry.

Temperature Model Inputs, Assumptions, Limitations and Uncertainty:

1. The latest available profiles for Shasta, Trinity, and Whiskeytown were taken on April 15, April 9, and April 14, respectively. Model results are sensitive to initial reservoir temperature conditions and the model performs best under highly stratified conditions. The temperature profiles prior to May do not yet exhibit conditions for ideal model computations (still nearly isothermal conditions). The model performs well after the reservoir stratifies, typically in late spring (i.e. end of April). The concern this year is assuming over or under estimations with variable hydrologic and meteorological conditions and not capturing the stratification with sufficient detail to project into the future with confidence.
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 creek flows can cause significant additional warming in the upper Sacramento River during spring.
3. Operation is based on the April 2020 Operation Outlooks (monthly flows, reservoir release, and end-of-month reservoir storage) for the 90%- and 50%-exceedances (when available), with minor modifications to accommodate for within month real-time operations (e.g. flood operations, underestimated system demands/requirements, etc.). After September historical information is used for inflow. Trinity Lake inflows are updated with the CNRFC 90% runoff exceedance for the 90% and DWR Bulletin 120 for the 50% runoff exceedance studies. The Operation Outlook assumes a representation of the State and Federal regulatory environment under NMFS and FWS 2019 Biological Opinions.
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. Side-flows were adjusted to a 95% historical exceedance for both the 90% and 50% runoff exceedance studies.
6. Meteorological inputs represent historical (1985 – 2017) monthly mean equilibrium temperature exceedance at 25% and 50% (when

available) patterned after like months on a 6-hour time-step (for months prior to April). Assumed inflows temperature remain static inputs and do not vary with the assumed meteorology. Tools to use local three-month-temperature outlooks (L3MTO), driven by the NOAA NWS Climate Prediction Center (CPC) are used beginning in April.

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, which is still uncertain prior to the end of April.

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.

9. The model is specifically being applied to generate the most accurate results at the Sacramento River above Clear Creek confluence location (CCR).

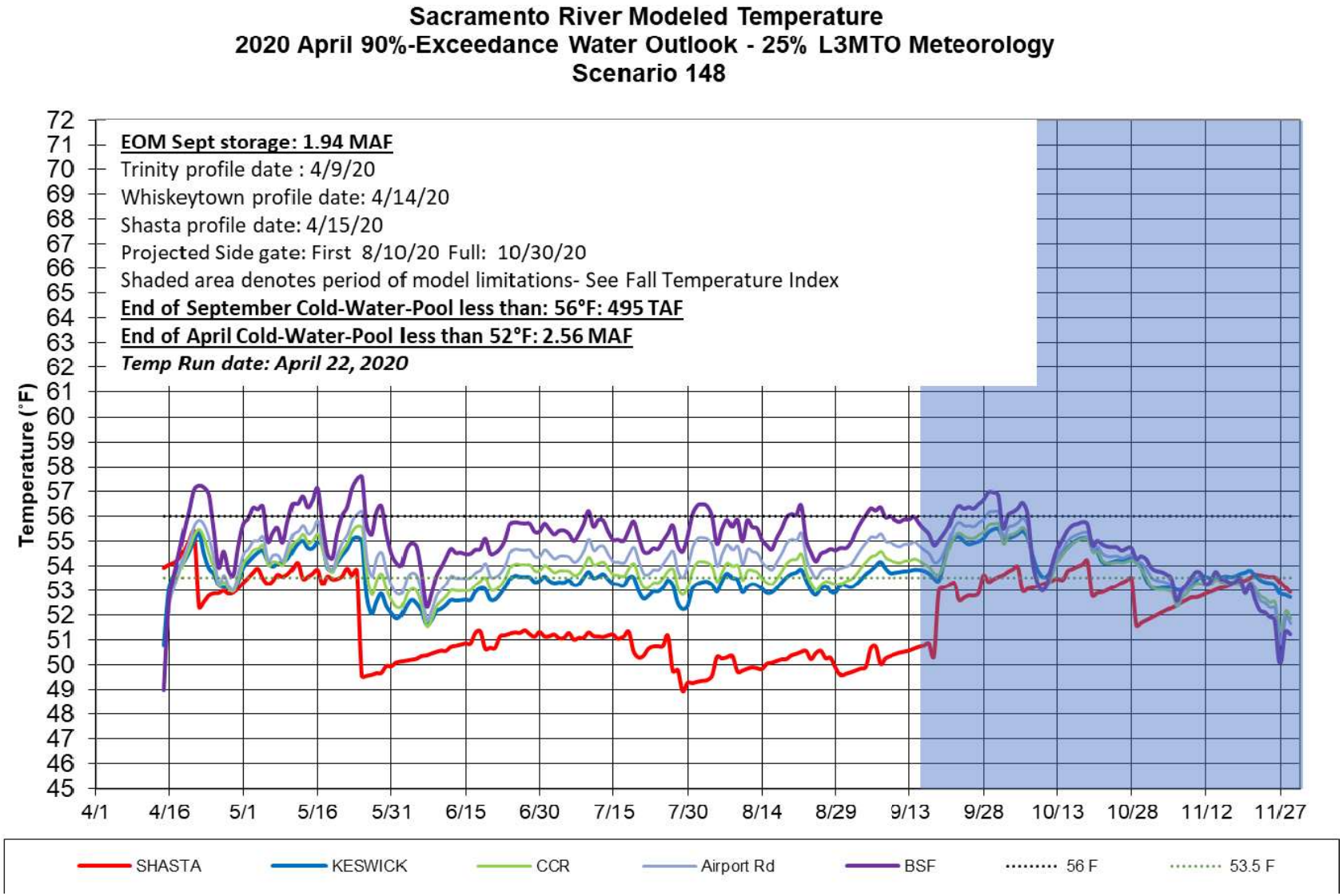


Figure 1. April 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% historical meteorology targeting CCR.

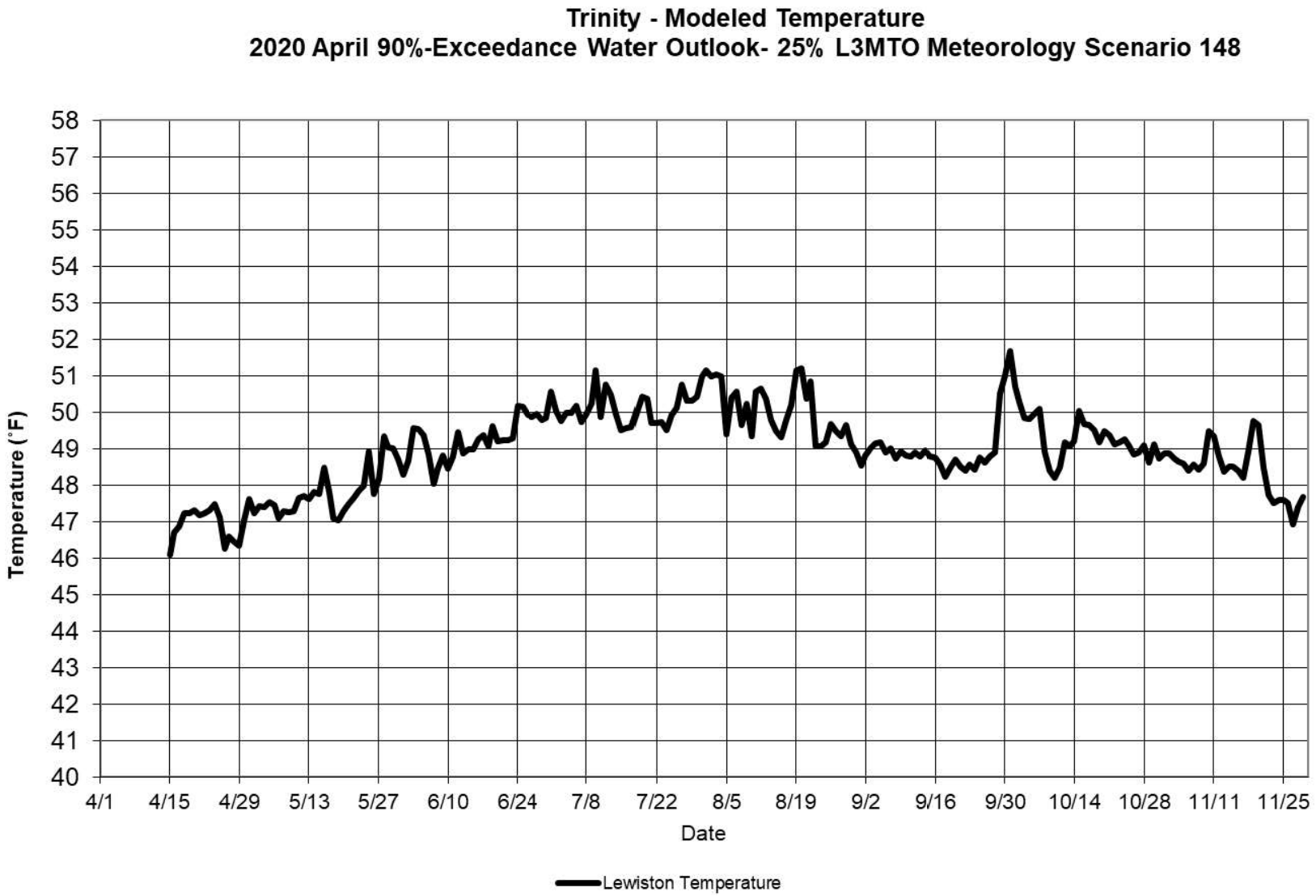


Figure 2. April 2020 simulated Trinity River temperatures 90% runoff exceedance hydrology and 25% historical meteorology

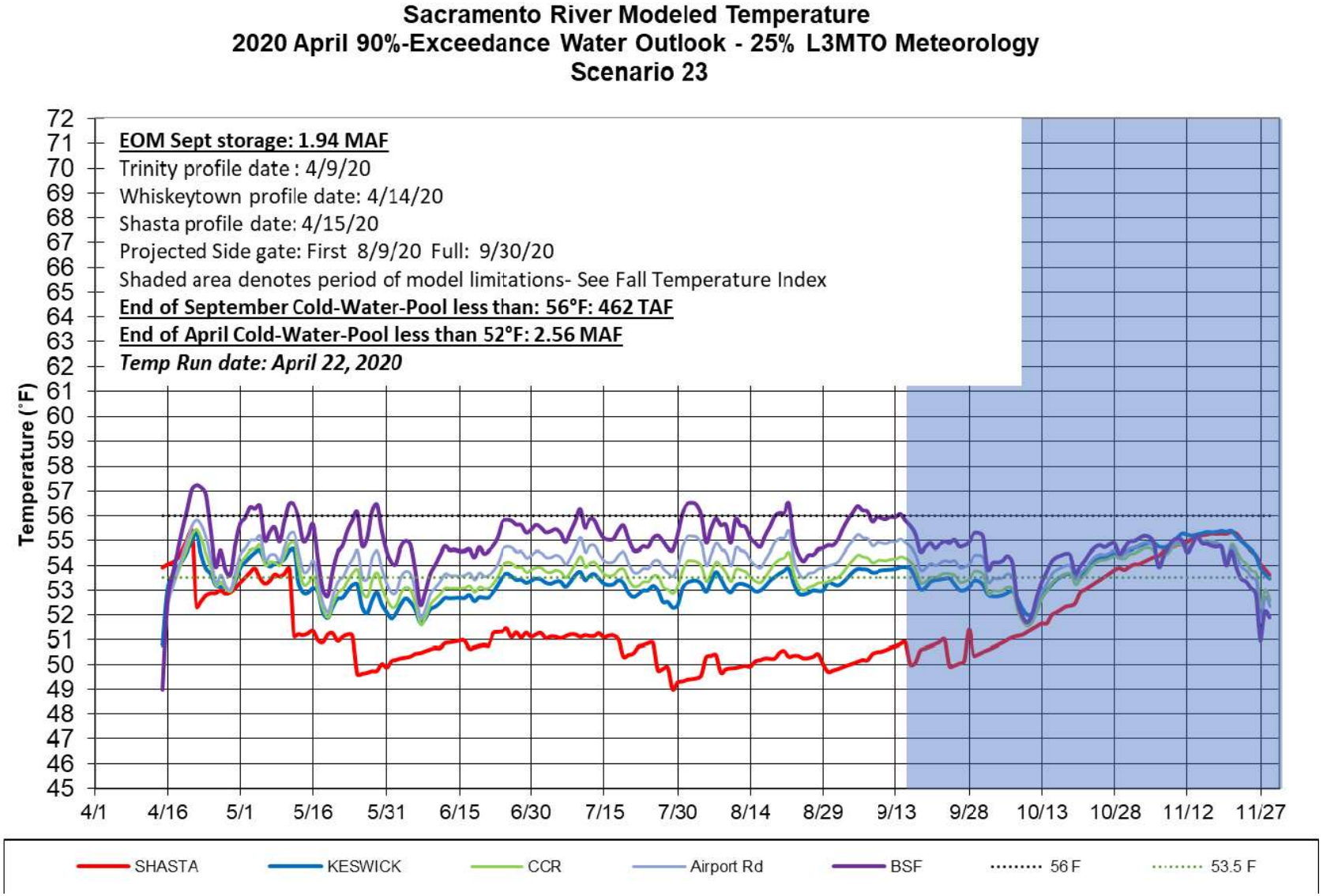


Figure 3. April 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% historical meteorology targeting CCR.

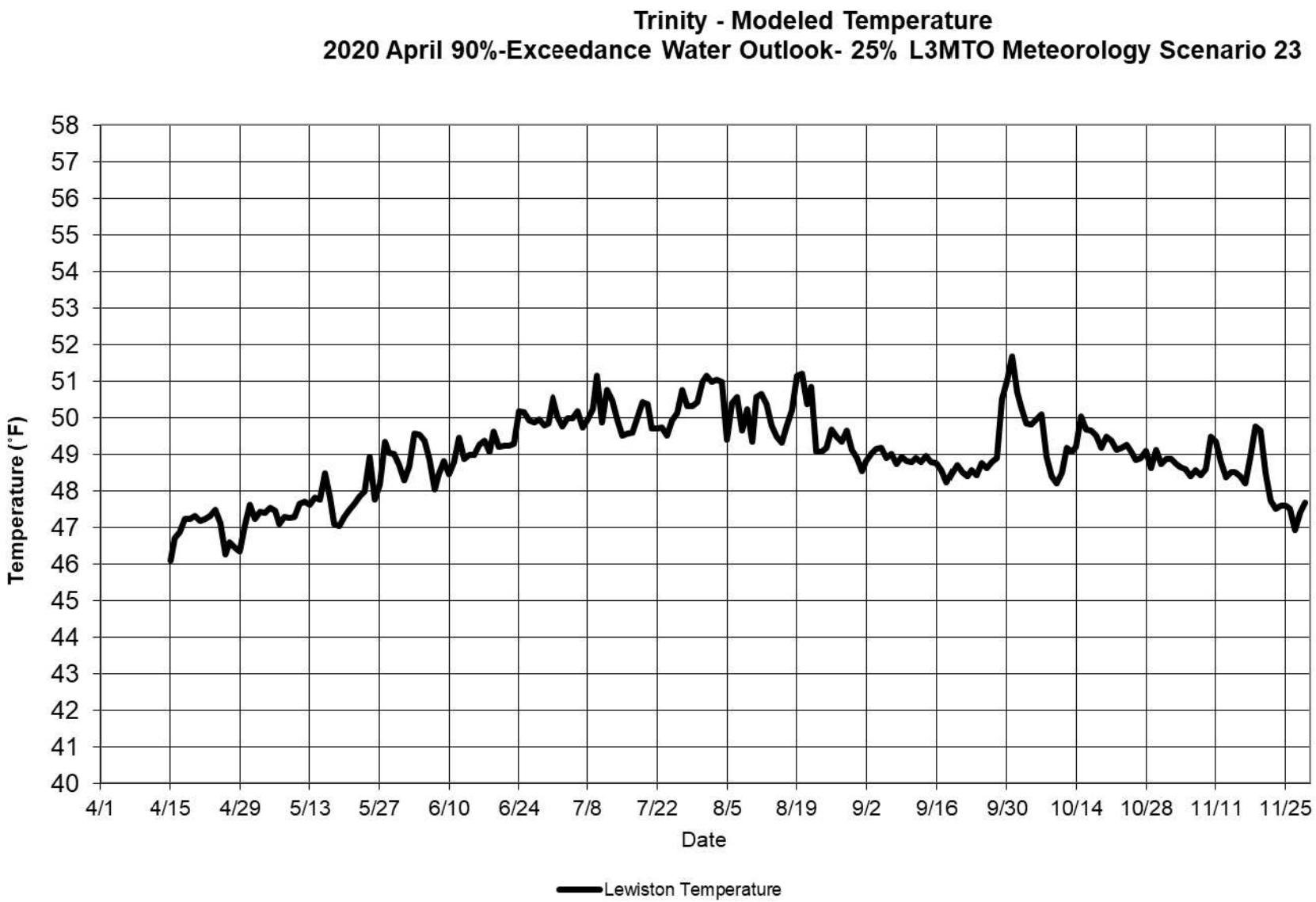


Figure 4. April 2020 simulated Trinity River temperatures 90% runoff exceedance hydrology and 25% historical meteorology

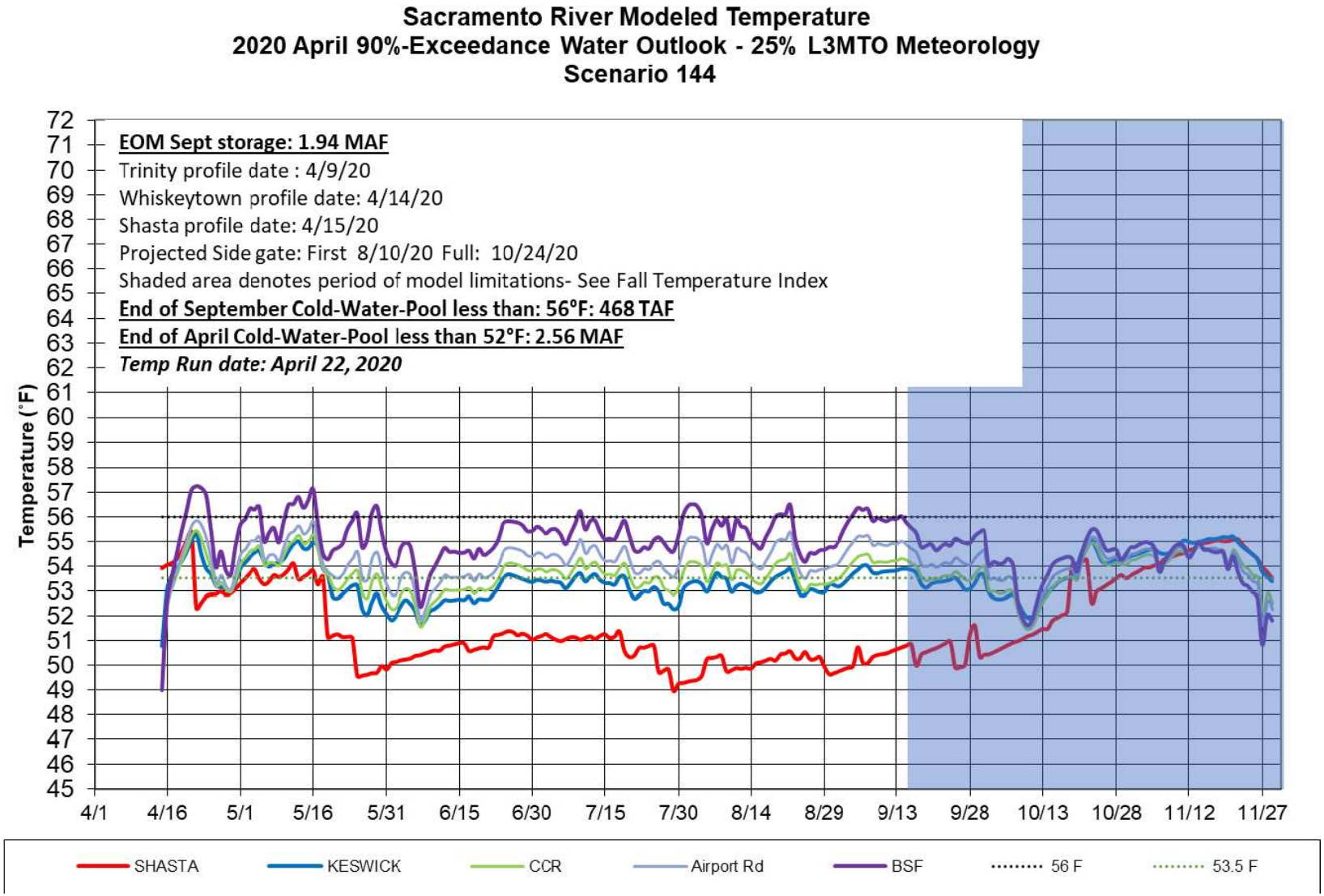


Figure 5. April 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% historical meteorology targeting CCR.

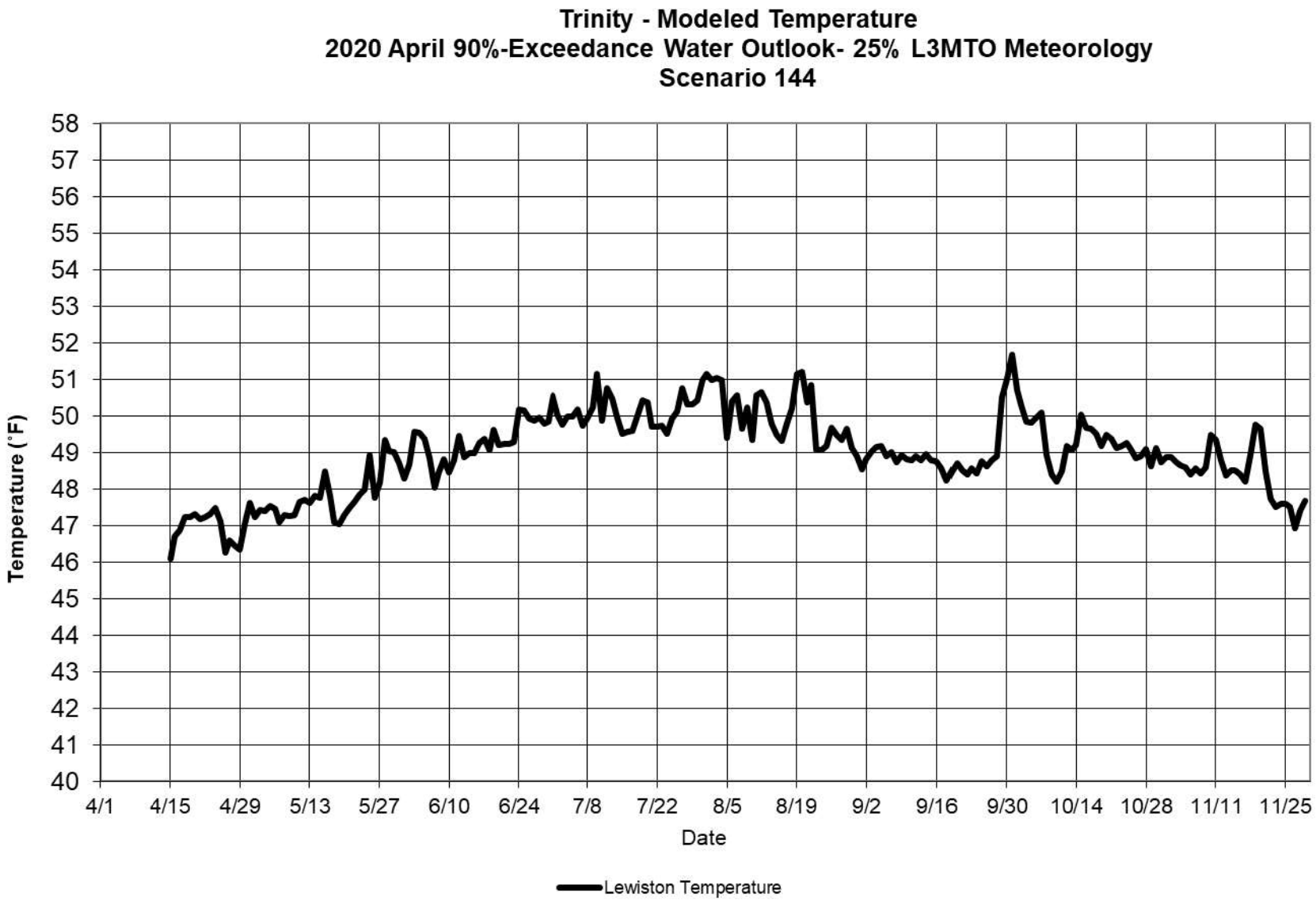


Figure 6. April 2020 simulated Trinity River temperatures 90% runoff exceedance hydrology and 25% historical meteorology

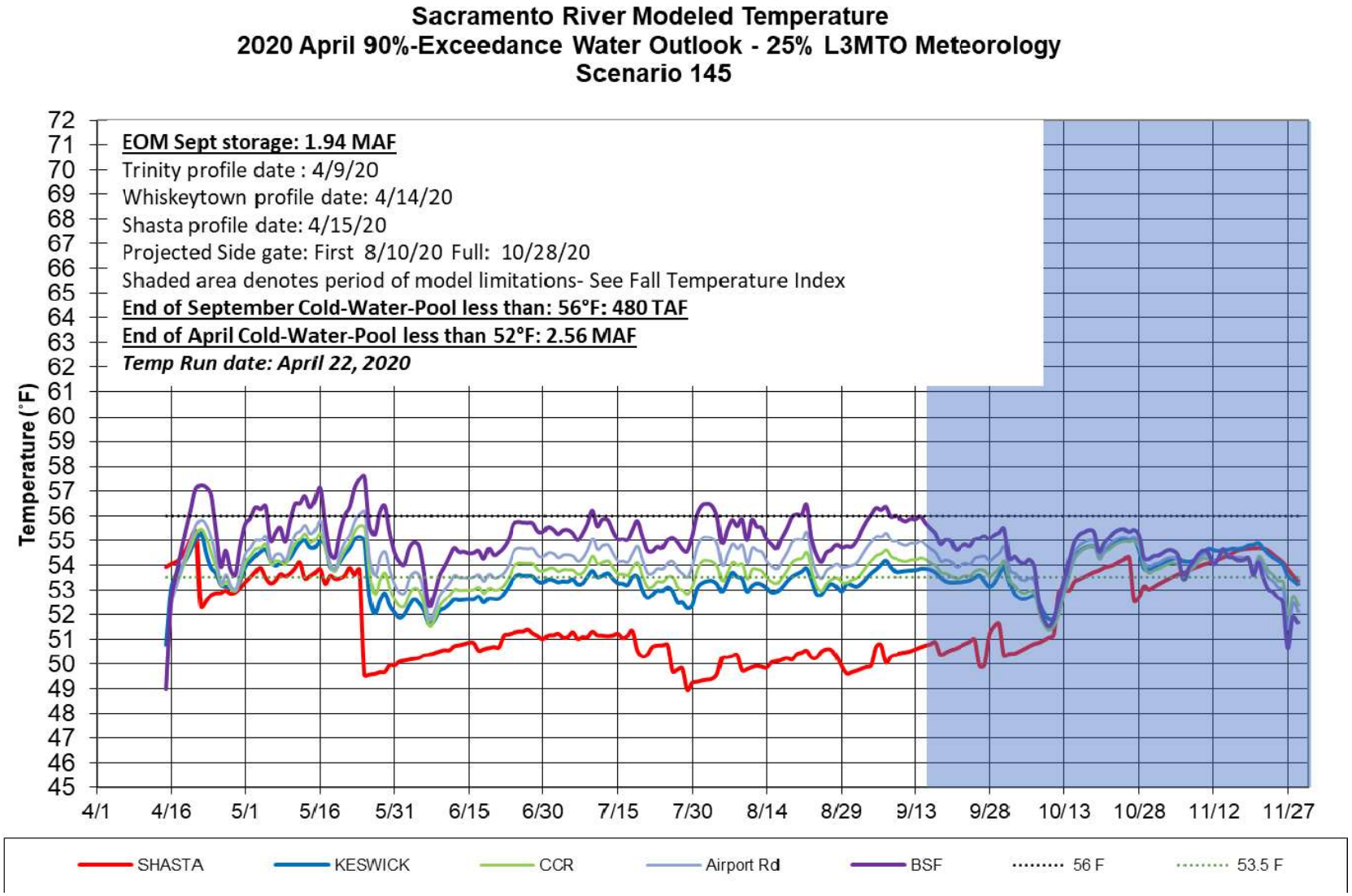


Figure 7. April 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% historical meteorology targeting CCR.

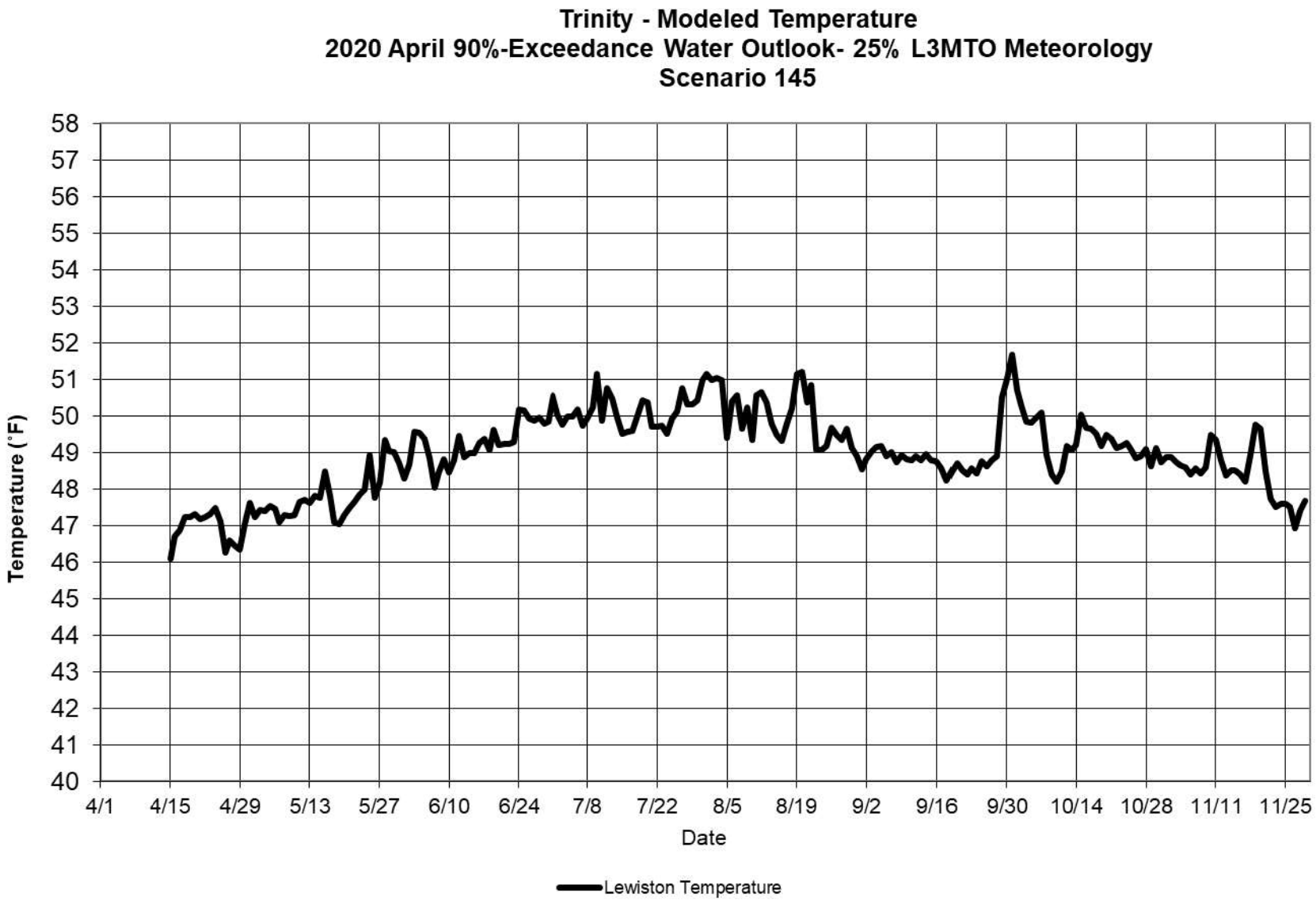


Figure 8. April 2020 simulated Trinity River temperatures 90% runoff exceedance hydrology and 25% historical meteorology

Figures 9-11 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 reaches.
3. Based on these records and estimates, the charts below illustrate a range of uncertainty in the expected river temperatures based on the end-of-September lake volume less than 56˚F.

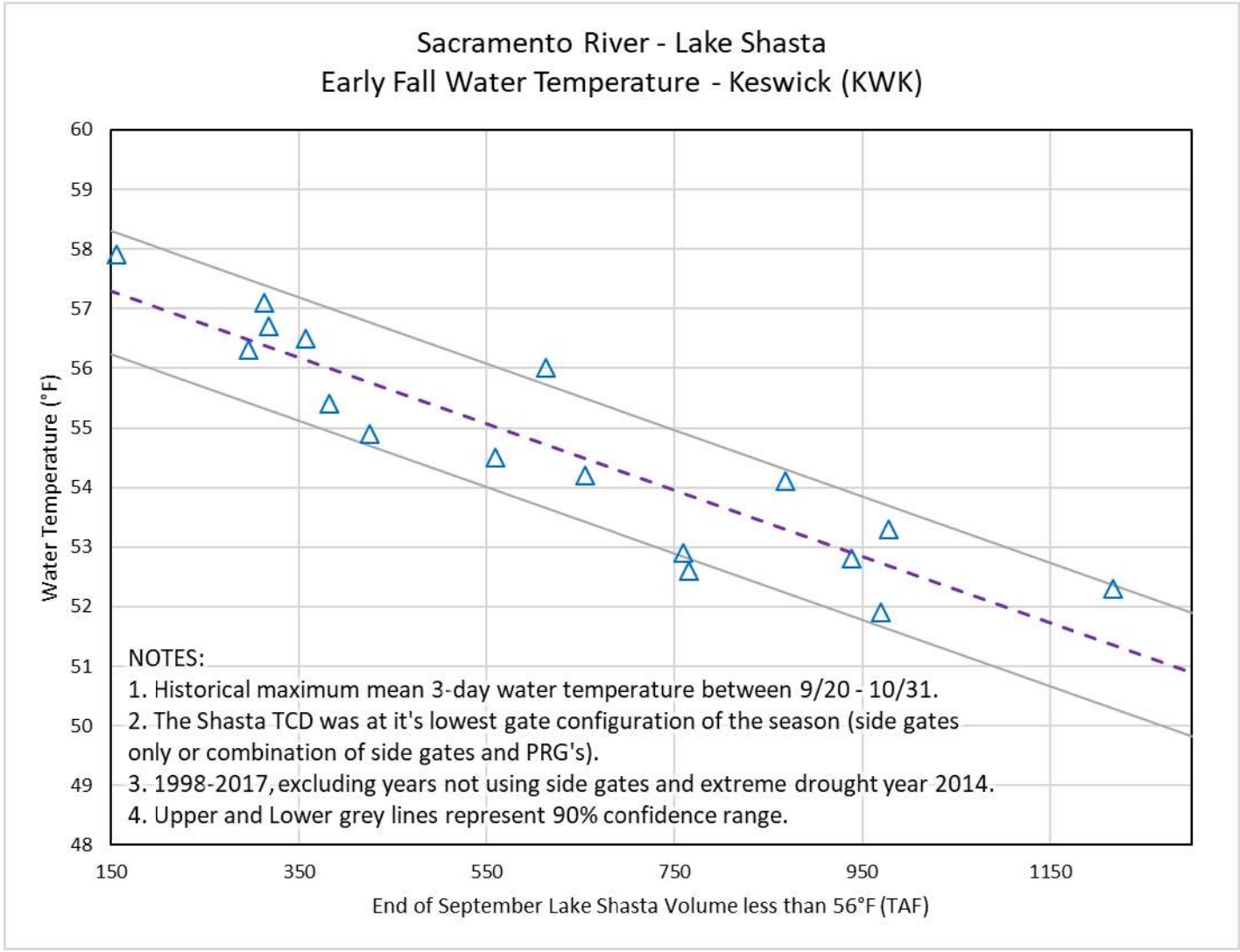


Figure 9. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Keswick water temperature.

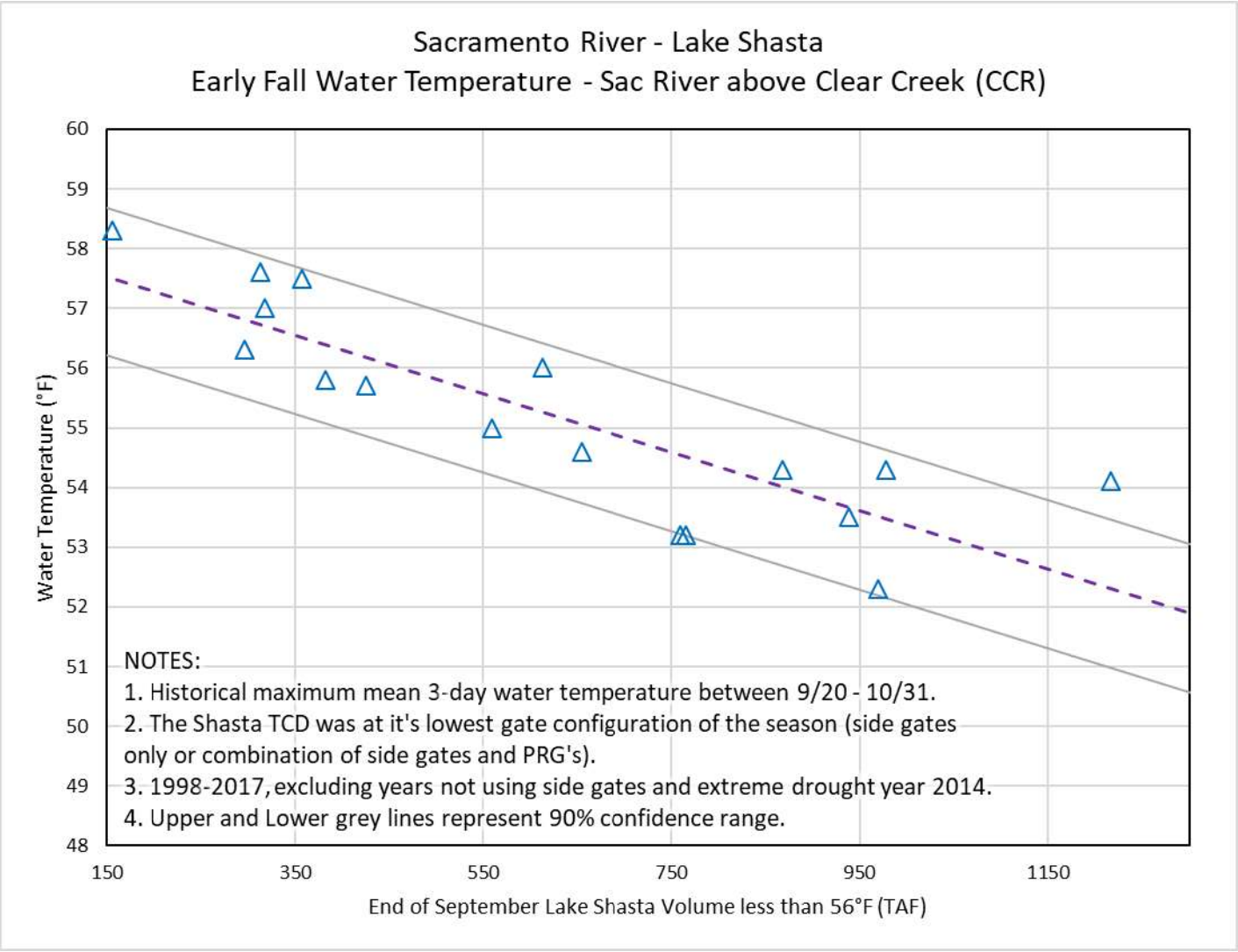


Figure 10. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Sacramento River above Clear Creek confluence water temperature.

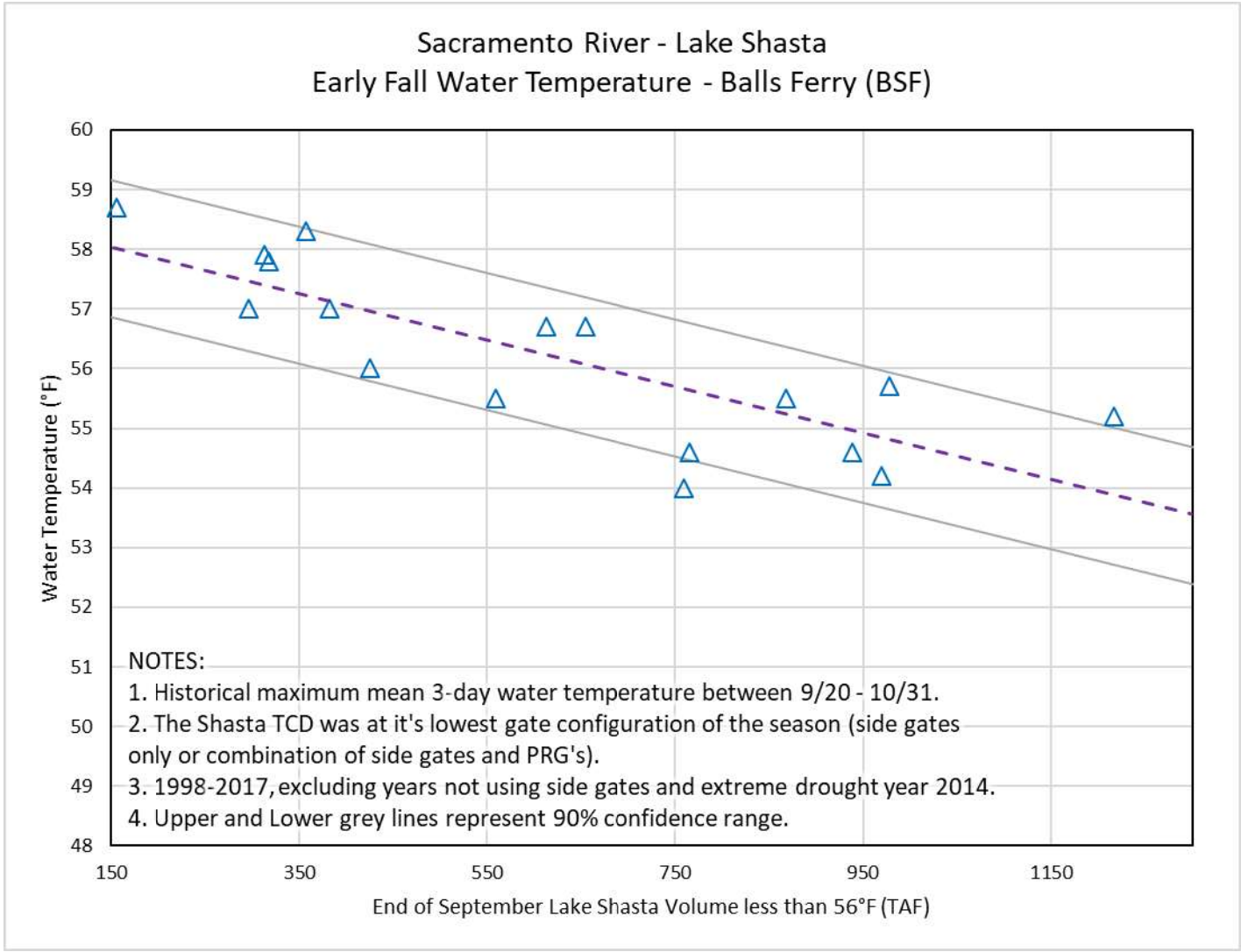
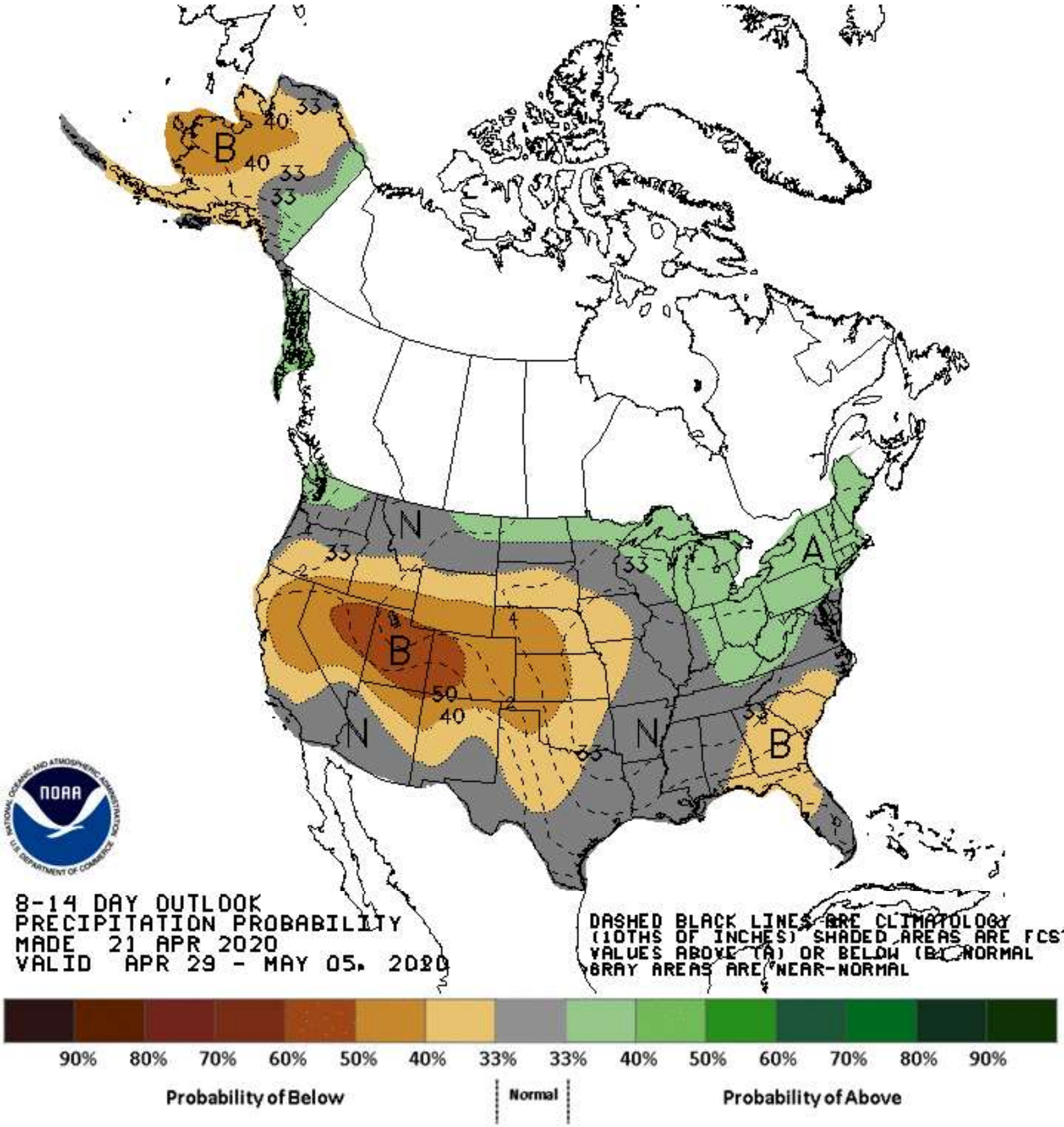


Figure 11. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Balls Ferry water temperature.

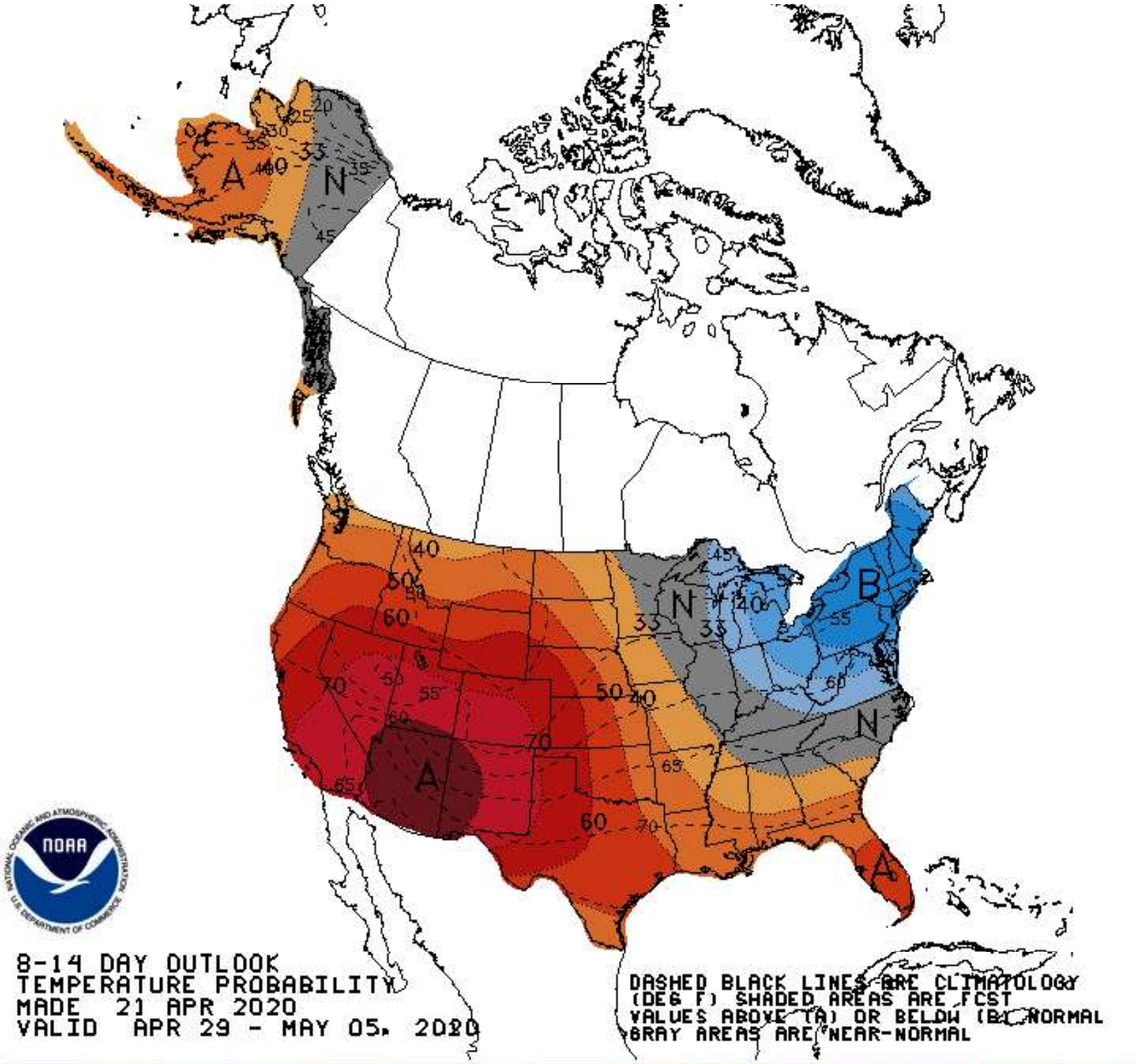


8-14 DAY OUTLOOK
PRECIPITATION PROBABILITY
MADE 21 APR 2020
VALID APR 29 - MAY 05, 2020

DASHED BLACK LINES ARE CLIMATOLOGY
(10THS OF INCHES) SHADED AREAS ARE FCS
VALUES ABOVE (A) OR BELOW (B) NORMAL
GRAY AREAS ARE NEAR-NORMAL

90% 80% 70% 60% 50% 40% 33% 33% 40% 50% 60% 70% 80% 90%

Probability of Below | Normal | Probability of Above



8-14 DAY OUTLOOK
TEMPERATURE PROBABILITY
MADE 21 APR 2020
VALID APR 29 - MAY 05, 2020

DASHED BLACK LINES ARE CLIMATOLOGY (DEG F) SHADED AREAS ARE FCST VALUES ABOVE (A) OR BELOW (B) NORMAL
GRAY AREAS ARE NEAR-NORMAL

90% 80% 70% 60% 50% 40% 33% 33% 40% 50% 60% 70% 80% 90%

Probability of Below | Normal | Probability of Above