BUREAU OF RECLAMATION

# Sacramento River Temperature Task Group

**Thursday, February 27, 2020**

**1:00 pm – 3:00 pm  Joint Operations Center, 3310 El Camino, Sacramento CA**

**Conference Line: 877-417-6209  Participant Code: 1593030**

## Agenda

1. Introductions
2. Purpose and Objective
3. 2020 Meeting Logistics
4. Overview - Long Term Operations Implementation
5. Hydrology Update
6. Operations Update and Forecasts
    a. Storage/Release Management Conditions
    b. Temperature Management
7. River Fish Monitoring: carcass surveys, redd counts, stranding and dewatering surveys and sampling at rotary screw traps
8. Fish Distribution/Forecasts: Estimated percentage of the population upstream of Red Bluff Diversion Dame for steelhead, winter-run and spring-run Chinook salmon.
9. Seasonal Topics
10. Discussion
11. Review Action Items
12. Next Meeting Scheduling

# Tentative SRTTG Meeting Logistics

- 4th Wednesday of month SRTTG meeting materials
- 4th Thursday of month SRTTG meeting
- 7 days after SRTTG meeting post materials
- 7 days after SRTTG meeting distribute draft meeting notes
- 14 days after SRTTG meeting comments on draft meeting notes
- 21 days after SRTTG meeting post final meeting notes

February/March 2020 Example

| Sun | Mon | Tue | Wed | Thurs | Fri | Sat |
|---|---|---|---|---|---|---|
| 23 | 24 | 25 | 26<br>Meeting Materials | 27<br>SRTTG Meeting | 28 | 29 |
| 1 | 2 | 3 | 4 | 5<br>Post Materials<br>Draft Meeting Notes | 6 | 7 |
| 8 | 9 | 10 | 11 | 12<br>Meeting Notes Comments | 13 | 14 |
| 15 | 16 | 17 | 18 | 19<br>Post Final Meeting Notes | 20 | 21 |
| 22 | 23 | 24 | 25<br>Meeting Materials | 26<br>SRTTG Meeting | 27 | 28 |
| 29 | 30 | 31 | | | | |

# Tentative SRTTG Monitoring and Modeling Logistics

- 4th Wednesday of month SRTTG meeting materials
- 4th Thursday of month SRTTG meeting
- 4th Monday of month Temperature modeling complete
- 4th Wednesday of month Salmon mortality modeling complete
- 2nd Thursday through 3rd Wednesday Profile Monitoring window

February/March 2020 Example

| Sun | Mon | Tue | Wed | Thurs | Fri | Sat |
|---|---|---|---|---|---|---|
| 23 | 24 | 25 | 26<br>Meeting Materials | 27<br>SRTTG Meeting | 28 | 29 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9<br>B120 Hydrology | 10 | 11 | 12<br>Profile | 13<br>Profile | 14 |
| 15 | 16<br>Profile<br>CVP Ops Outlooks | 17<br>Profile | 18<br>Profile | 19 | 20 | 21 |
| 22 | 23<br>Temp Modeling | 24 | 25<br>Salmon Mort. Modeling Meeting Materials | 26<br>SRTTG Meeting | 27 | 28 |
| 29 | 30 | 31 | | | | |

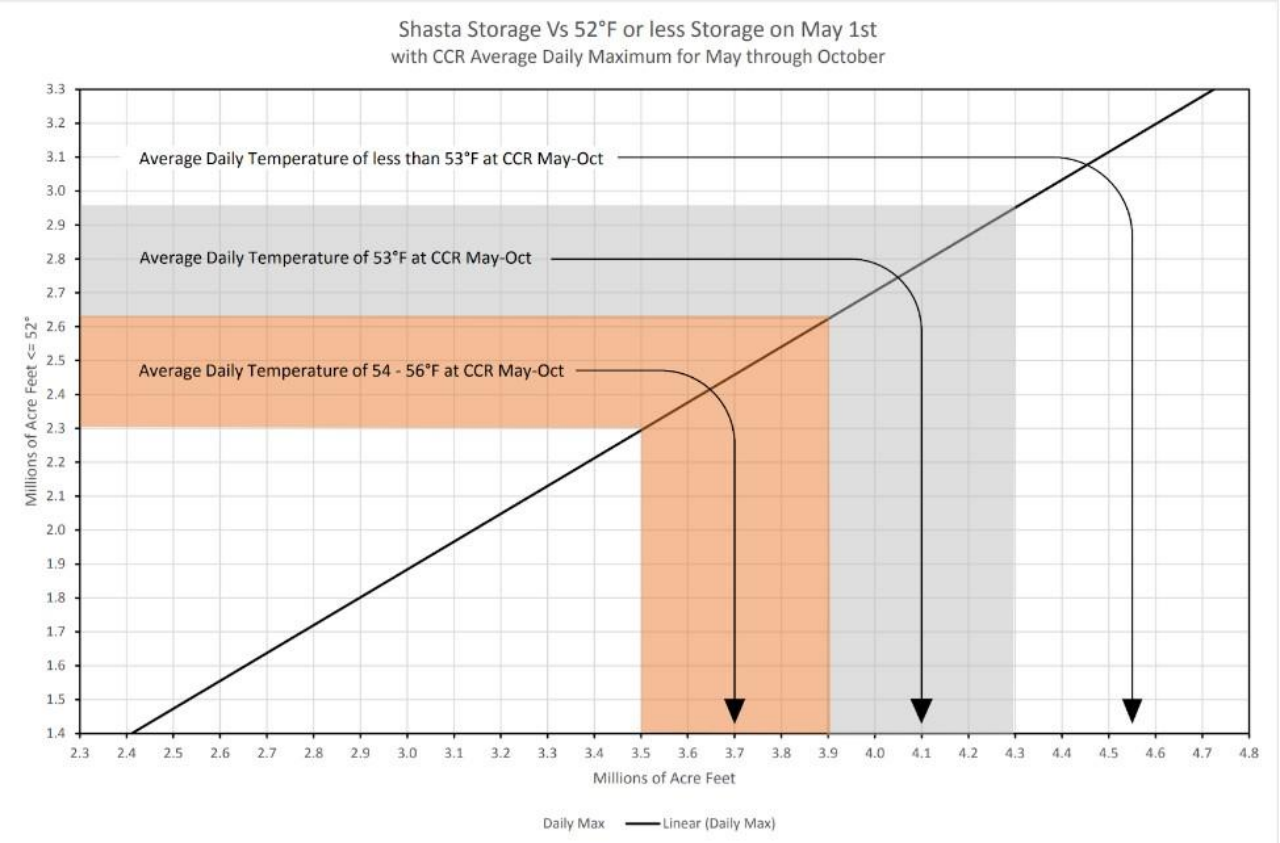



**Figure 4-2. Relationship between Temperature Compliance, Total Storage in Shasta Reservoir, and Cold Water Pool in Shasta Reservoir**

#### 4.10.1.4.1 Summer Cold Water Pool Management

Reclamation proposes to operate the TCD at Shasta Dam to continue providing temperature management in accordance with CVPIA 3406(b)(6) while minimizing impacts on power generation. Cold water pool is defined as the volume of water in Shasta Reservoir that is less than 52°F, which Reclamation would determine based on monthly (or more frequent) reservoir temperature profiles. The Sacramento River above Clear Creek (CCR) gage is a surrogate for the downstream extent of most Winter-Run Chinook Salmon redds. Temperature management would start on May 15, or when the SRTTG determines, based on real-time information, that Winter-Run Chinook Salmon have spawned, whichever is later. Temperature management would end October 31, or when the SRTTG determines based on real-time monitoring that 95 percent of Winter-Run Chinook Salmon eggs have hatched, and alevin have emerged, whichever is earlier. Real-time information will continue to be considered in this process, which includes redd, carcass, and juvenile surveys.

Reclamation proposes to address cold water management utilizing a tiered strategy that allows for strategically selected temperature objectives, based on projected total storage and cold water pool, meteorology, Delta conditions, and habitat suitability for incoming fish population size and location. The tiered strategy recognizes that cold water is a scarce resource that can be managed to achieve desired water temperatures for fisheries objectives. Figure 4-3 below shows examples of water temperatures at CCR under the four tiers, with arrows indicating how temperatures would change in different years with less May 1 forecasted cold water pool. The proposed tiers are described below, along with storage levels that are likely to provide for cold water management within the tier. Actual

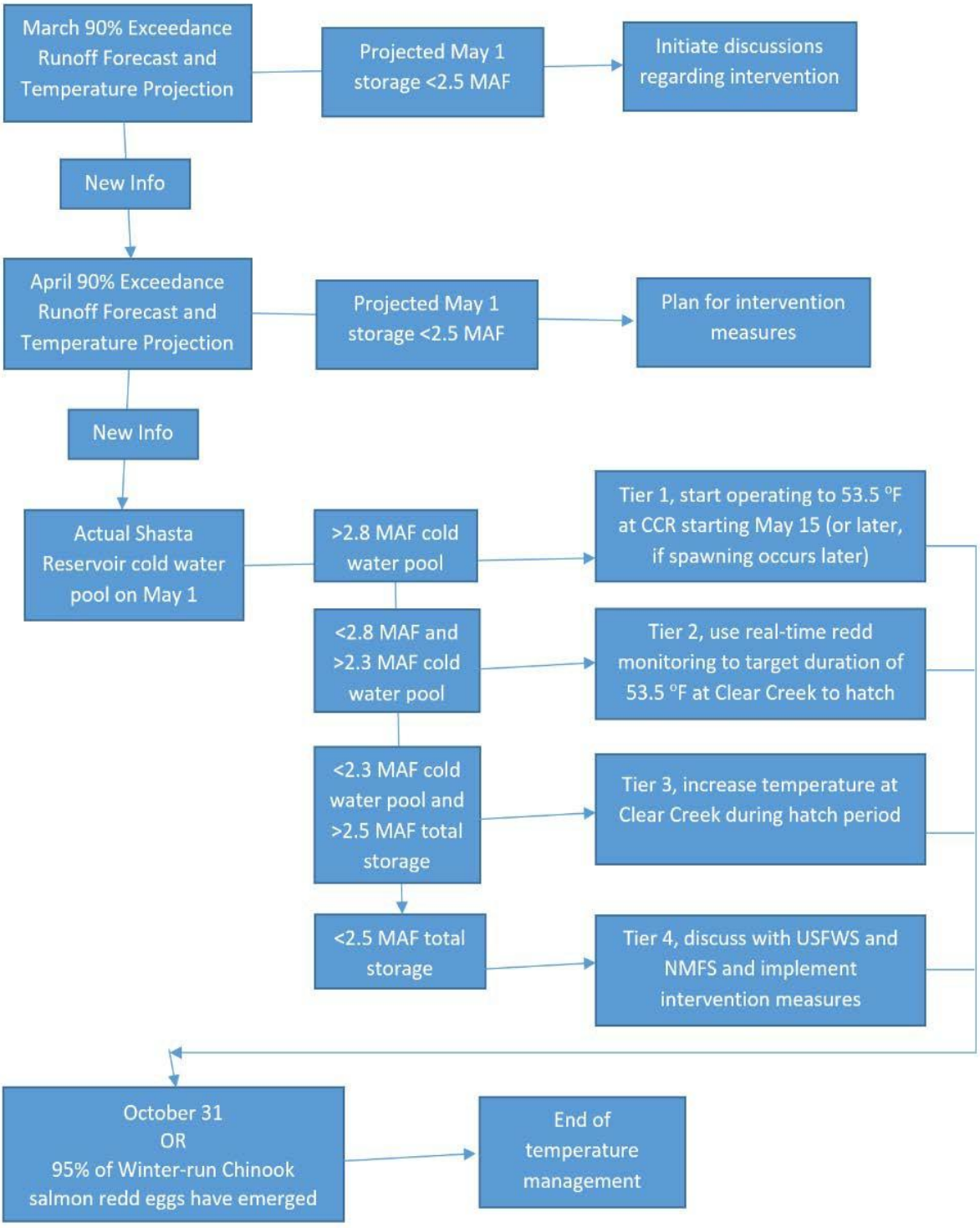



**Figure 4-4. Decision Tree for Shasta Reservoir Temperature Management**

Reclamation intends to collect temperature profile measurements for Shasta, Whiskeytown, and Trinity Reservoirs on the schedule shown in Table 4-9 and provide these to USFWS and NMFS if it is projected to be a Tier 4 year.

operations will depend upon the available cold water and modeling. In any given year, cold water pool and storage could result in Reclamation switching between tiers within the year if needed to optimally use the cold water pool. Coldwater pool management is proposed to start as early as May 15th, however temperatures at the start of the temperature management season are often lower than the target temperatures.

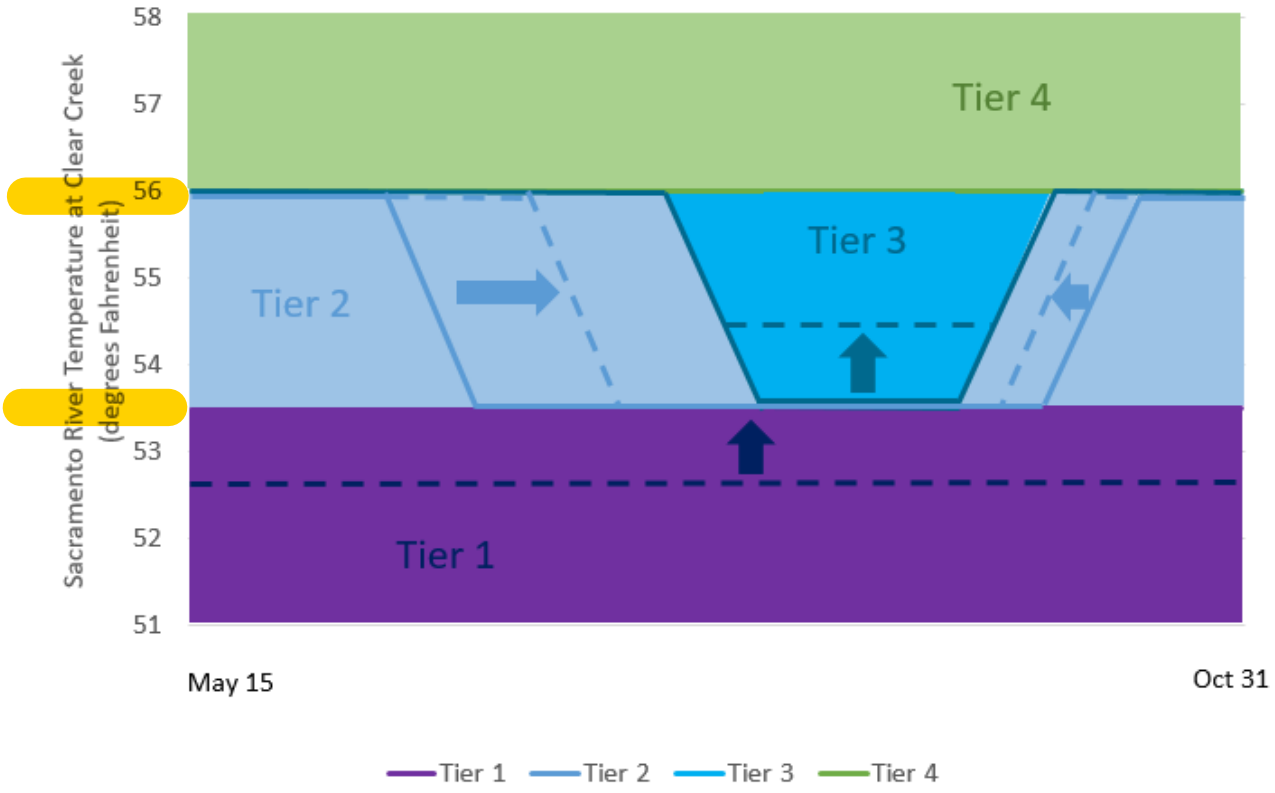



**Figure 4-3. Tiered Temperature Management Strategy**

- **Tier 1**. In years when Reclamation determines that cold water pool is sufficient (e.g., more than 2.8 MAF of cold water pool in Shasta Reservoir at the beginning of May or modeling suggests that a daily average temperature of 53.5°F at CCR can be maintained from May 15 to October 31), Reclamation proposes to operate to a daily average temperature of 53.5°F at the CCR gaging station to minimize temperature dependent mortality. Although Tier 1 years generally have sufficient cold water to maintain 53.5°F through October 31, the unknown meteorology continues to present a risk of temperatures rising above 53.5°F, particularly towards the end of the summer in September and October. Reclamation can generally manage these risks through real time operations of the TCD, although temporary exceedances may occur, and thus allowable tolerances will be identified in the annual temperature management plan through coordination with SRTTG.
- **Tier 2.** In years when cold water pool is insufficient to allow Tier 1 (e.g., less than 2.8 MAF of cold water pool in Shasta Reservoir at the beginning of May or modeling suggests that the 53.5°F at CCR cannot be maintained from May 15 to October 31), Reclamation would optimize use of cold water for Winter-Run Chinook Salmon eggs based on life-stage-specific requirements, reducing the duration of time of operating to 53.5°F target temperatures. Water temperatures at CCR would vary based on real-time monitoring of redd timing and lifestage-specific temperature

dependent mortality models, for example, Anderson (2017). The period of temperature management with 53.5°F at CCR would be centered on the projected time when the Winter-Run eggs have the highest dissolved oxygen requirement (37–67 days post fertilization). At 2.79 MAF of cold water pool, Reclamation would operate to 53.5°F from 37 days after the first observed redd to 67 days after the last observed redd, if this is earlier than October 31. The duration of the 53.5°F protection will decrease in proportion to the available cold water pool on May 1. Reclamation will determine this time period by running different temperature scenarios through the latest egg mortality model(s) and real-time monitoring of redds. Reclamation would operate to daily average temperatures at CCR during the temperature management season outside of the stage- specific critical window no warmer than 56°F Although Tier 2 years generally have sufficient cold water to maintain 56°F after the last observed red through October 31, the unknown meteorology continues to present a risk of temperatures rising above 56°F, particularly towards the end of the summer in September and October. Reclamation can generally manage these risks through real time operations of the TCD, although temporary exceedances may occur and thus allowable tolerances will be identified in the annual temperature management plan through coordination with the SRTTG.

- **Tier 3.** When Reclamation determines that life-stage-specific temperature targets cannot be met per (2) above (e.g., less than 2.3 MAF of cold water pool in Shasta Reservoir at the beginning of May or modeling suggests that cold water pool management at colder tiers would cause loss of temperature control late in the season), Reclamation proposes to use cold water pool releases to maximize Winter- Run Chinook Salmon redd survival by increasing the coldest water temperature target (see Figure 4-4 below). In Tier 3, the targeted temperature at CCR during the early and late periods of cold water pool management will not exceed a daily average of 56°F. Based on latest egg mortality models, real-time monitoring, and expected and current cold water availability, Reclamation would decrease the temperatures during the period of greatest temperature stress on early life stages to minimize adverse effects to the greatest extent possible. During this critical period, temperatures will be targeted between 53.5°F and 56°F. Tier 3 will be selected if Reclamation's temperature management plan indicates that temperatures can be maintained to at least 56°F at CCR, otherwise Reclamation would operate to Tier 4. Although Tier 3 years generally have sufficient cold water to maintain 56°F through October 31, the unknown meteorology continues to present a risk of temperatures rising above 56°F, particularly towards the end of the summer in September and October. Reclamation can generally manage these risks through real time operations of the TCD, although temporary exceedances may occur, and thus allowable tolerances will be identified in the annual temperature management plan through coordination with the SRTTG. If the temperature management plan indicates a higher risk of exceeding 56°F before October 1$^{st}$, this is an indication that the cold water pool may not support a warm early fall and will therefore be treated as a Tier 4 year for the purposes of intervention measures and early season discussions and coordination.
- **Tier 4.** If there is less than 2.5 MAF of total storage (note the use of "total" storage as opposed to the "cold water pool" used in the previous criteria) in Shasta Reservoir at the beginning of May, or if Reclamation cannot meet 56°F at CCR, Reclamation will attempt to operate to a less than optimal temperature target and period that is determined in real-time with technical assistance from NMFS and USFWS. Reclamation will explore improved coordination of downstream diversions, and the potential for demand shifting. In addition, Reclamation proposes to implement intervention measures (e.g., increasing hatchery intake and trap and haul, as described below).

At the March forecast (mid-March), if the forecasted Shasta Reservoir total storage is projected to be below 2.5 MAF at the beginning of May, Reclamation would initiate discussions with USFWS and NMFS on potential intervention measures should this low storage condition continue into April and

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

# DAILY CVP WATER SUPPLY REPORT

**FEBRUARY 25, 2020**

RUN DATE: February 26, 2020

## RESERVOIR RELEASES IN CUBIC FEET/SECOND

| RESERVOIR | DAM | WY 2019 | WY 2020 | 15 YR MEDIAN |
|---|---|---|---|---|
| TRINITY | LEWISTON | 300 | 298 | 301 |
| SACRAMENTO | KESWICK | 3,342 | 5,008 | 3,342 |
| FEATHER | OROVILLE (SWP) | 1,750 | 2,250 | 1,750 |
| AMERICAN | NIMBUS | 9,738 | 1,998 | 1,998 |
| STANISLAUS | GOODWIN | 1,505 | 2,009 | 378 |
| SAN JOAQUIN | FRIANT | 636 | 582 | 200 |

## 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 | 1,595 | 1,687 | 2,021 | 127 |
| SHASTA | 4,552 | 3,147 | 3,548 | 3,551 | 113 |
| FOLSOM | 977 | 479 | 604 | 457 | 95 |
| NEW MELONES | 2,420 | 1,515 | 2,004 | 1,945 | 128 |
| FED. SAN LUIS | 966 | 685 | 909 | 503 | 73 |
| TOTAL NORTH CVP | 11,363 | 7,422 | 8,752 | 8,477 | 114 |
| MILLERTON | 520 | 300 | 369 | 290 | 97 |
| OROVILLE (SWP) | 3,538 | 2,092 | 1,983 | 2,255 | 108 |

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

| RESERVOIR | CURRENT WY 2020 | WY 1977 | WY 1983 | 15 YR AVG | % OF 15 YR AVG |
|---|---|---|---|---|---|
| TRINITY | 182 | 55 | 713 | 386 | 47 |
| SHASTA | 1,556 | 1,124 | 4,044 | 2,209 | 70 |
| FOLSOM | 485 | 158 | 2,225 | 970 | 50 |
| NEW MELONES | 238 | ---- | 741 | 326 | 73 |
| MILLERTON | 315 | 99 | 1,100 | 332 | 95 |

## ACCUMULATED PRECIPITATION FOR WATER YEAR TO DATE IN INCHES

| RESERVOIR | CURRENT WY 2020 | WY 1977 | WY 1983 | AVG (N YRS) | % OF AVG | LAST 24 HRS |
|---|---|---|---|---|---|---|
| TRINITY AT FISH HATCHERY | 11.40 | 6.47 | 32.74 | 22.25 ( 58) | 51 | 0.00 |
| SACRAMENTO AT SHASTA DAM | 24.31 | 7.82 | 62.86 | 42.15 ( 63) | 58 | 0.00 |
| AMERICAN AT BLUE CANYON | 29.60 | 11.54 | 65.43 | 44.49 ( 45) | 67 | 0.00 |
| STANISLAUS AT NEW MELONES | 12.13 | ---- | 27.79 | 18.31 ( 42) | 66 | 0.00 |
| SAN JOAQUIN AT HUNTINGTON LK | 13.51 | 7.80 | 53.80 | 27.26 ( 45) | 50 | 0.00 |

# Upper Sacramento River Summary Conditions – February (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 precipitation
- Dry pattern persisting and February inflows falling below the 90% inflow exceedance probability estimates
- Current release from Keswick Dam: Ramping up from 5,000 cfs to 5,500 cfs beginning March 1st for SWRCB D1641 Delta Outflow requirements
- Long-term conservative (hydrology) projections suggest lower Shasta storage volumes

## Temperature Management:

- Temperature management: inactive
- Selective withdrawal: Rebuilding cold-water-pool reserves. All Upper and Middle gates open, when storage elevations are sufficient, the Middle gates will be closed. Long term conservative (hydrology) projections suggest difficulty reaching a TCD configuration with only the Top Gates.
- Meteorological Uncertainty: Shorter term forecasts (8-14 day) suggest below normal to near normal temperatures
- Longer term forecasts (three-month outlook) suggest above normal chances of warmer 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 February 2020

## 90% Runoff Exceedance Outlook

| End of Month Storage/Elevation | Feb | Mar | Apr | May | Jun | Jul |
|---|---|---|---|---|---|---|
| Shasta Volume (TAF) | 3556 | 3680 | 3764 | 3682 | 3289 | 2792 |
| Shasta Elevation (Feet) | 1031 | 1036 | 1039 | 1036 | 1020 | 998 |

| Monthly Average River Release | Feb | Mar | Apr | May | Jun | Jul |
|---|---|---|---|---|---|---|
| Sacramento (CFS) | 4370 | 4000 | 7000 | 7950 | 11900 | 12500 |
| Clear Creek (CFS) | 200 | 200 | 218 | 380 | 288 | 150 |

| Trinity Diversions | Feb | Mar | Apr | May | Jun | Jul |
|---|---|---|---|---|---|---|
| Carr Power Plant (TAF) | 8 | 63 | 120 | 107 | 125 | 120 |
| Spring Creek PP (TAF) | 10 | 70 | 90 | 90 | 110 | 110 |

## 50% Runoff Exceedance Outlook

| End of Month Storage/Elevation | Feb | Mar | Apr | May | Jun | Jul |
|---|---|---|---|---|---|---|
| Shasta Volume (TAF) | 3602 | 3959 | 4062 | 3981 | 3681 | 3126 |
| Shasta Elevation (Feet) | 1033 | 1046 | 1050 | 1047 | 1036 | 1013 |

| Monthly Average River Release | Feb | Mar | Apr | May | Jun | Jul |
|---|---|---|---|---|---|---|
| Sacramento (CFS) | 4000 | 5000 | 7000 | 8000 | 11000 | 13500 |
| Clear Creek (CFS) | 200 | 200 | 218 | 380 | 288 | 150 |

| Trinity Diversions | Feb | Mar | Apr | May | Jun | Jul |
|---|---|---|---|---|---|---|
| Carr Power Plant (TAF) | 0 | 85 | 61 | 49 | 121 | 99 |
| Spring Creek PP (TAF) | 35 | 110 | 40 | 40 | 110 | 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)

| | | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Trinity** | **1998** | **2045** | **2047** | **2009** | **1887** | **1728** | **1581** | **1406** | **1250** | **1213** | **1189** | **1199** | **1231** |
| | Elev. | 2344 | 2344 | 2342 | 2333 | 2321 | 2310 | 2295 | 2281 | 2277 | 2275 | 2276 | 2279 |
| **Whiskeytown** | **207** | **206** | **206** | **238** | **238** | **238** | **238** | **238** | **238** | **206** | **206** | **206** | **206** |
| | Elev. | 1199 | 1199 | 1209 | 1209 | 1209 | 1209 | 1209 | 1209 | 1199 | 1199 | 1199 | 1199 |
| **Shasta** | **3482** | **3556** | **3680** | **3764** | **3682** | **3289** | **2792** | **2434** | **2252** | **2142** | **2142** | **2226** | **2377** |
| | Elev. | 1031 | 1036 | 1039 | 1036 | 1020 | 998 | 981 | 971 | 965 | 965 | 970 | 978 |
| **Folsom** | **487** | **465** | **448** | **484** | **470** | **419** | **365** | **311** | **274** | **249** | **229** | **225** | **276** |
| | Elev. | 412 | 410 | 415 | 413 | 406 | 398 | 389 | 383 | 378 | 374 | 373 | 383 |
| **New Melones** | **1983** | **1924** | **1891** | **1821** | **1743** | **1668** | **1583** | **1512** | **1470** | **1434** | **1445** | **1459** | **1472** |
| | Elev. | 1045 | 1042 | 1036 | 1028 | 1021 | 1012 | 1004 | 1000 | 996 | 997 | 999 | 1000 |
| **San Luis** | **363** | **380** | **479** | **414** | **280** | **140** | **-23** | **-67** | **17** | **151** | **273** | **398** | **603** |
| | Elev. | 485 | 495 | 481 | 462 | 437 | 408 | 387 | 396 | 409 | 428 | 458 | 485 |
| **Total** | | 8575 | 8751 | 8729 | 8299 | 7481 | 6537 | 5833 | 5501 | 5394 | 5484 | 5713 | 6166 |

## 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 | 23 | 17 | 9 | 9 | 9 | 12 | 12 | 12 | 12 |
| | cfs | **200** | **200** | **218** | **380** | **288** | **150** | **150** | **150** | **200** | **200** | **200** | **200** |
| **Sacramento** | TAF | 243 | 246 | 416 | 489 | 708 | 768 | 615 | 416 | 369 | 268 | 246 | 246 |
| | cfs | **4370** | **4000** | **7000** | **7950** | **11900** | **12500** | **10000** | **7000** | **6000** | **4500** | **4000** | **4000** |
| **American** | TAF | 102 | 108 | 108 | 108 | 105 | 95 | 95 | 78 | 62 | 59 | 66 | 61 |
| | cfs | **1829** | **1750** | **1823** | **1765** | **1758** | **1550** | **1542** | **1305** | **1004** | **1000** | **1071** | **1000** |
| **Stanislaus** | TAF | 75 | 48 | 60 | 39 | 12 | 12 | 12 | 12 | 39 | 12 | 12 | 13 |
| | cfs | **1350** | **780** | **1004** | **631** | **200** | **200** | **200** | **200** | **635** | **200** | **200** | **219** |

## Trinity Diversions (TAF)

| | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Carr PP** | 8 | 63 | 120 | 107 | 125 | 120 | 121 | 100 | 23 | 26 | 12 | 3 |
| **Spring Crk. PP** | **10** | **70** | **90** | **90** | **110** | **110** | **110** | **90** | **45** | **20** | **12** | **10** |

## Delta Summary (TAF)

| | | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tracy** | | 99 | 190 | 45 | 46 | 115 | 111 | 193 | 255 | 260 | 176 | 158 | 240 |
| **USBR Banks** | | 0 | 0 | 0 | 0 | 0 | 7 | 7 | 7 | 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** | | 113 | 203 | 57 | 59 | 125 | 129 | 213 | 276 | 277 | 194 | 176 | 254 |
| **COA Balance** | | -21 | -21 | -17 | -6 | 0 | 21 | 11 | 46 | 17 | -42 | -42 | -42 |
| **Vernalis** | TAF | 145 | 134 | 119 | 100 | 43 | 45 | 40 | 46 | 108 | 83 | 83 | 92 |
| **Vernalis** | cfs | 2611 | 2179 | 2004 | 1631 | 721 | 737 | 655 | 772 | 1758 | 1393 | 1355 | 1504 |
| **Old/Middle River Std.** | | | | | | | | | | | | | |
| **Old/Middle R. calc.** | | -2,910 | -3,802 | -663 | -997 | -2,140 | -2,189 | -3,335 | -4,825 | -4,218 | -3,812 | -4,882 | -4,848 |
| **Computed DOI** | | 12463 | 9777 | 9901 | 7694 | 7094 | 4994 | 4002 | 3009 | 4002 | 4505 | 4506 | 7629 |
| **Excess Outflow** | | 1063 | 1236 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1627 |
| **% Export/Inflow** | | 26% | 35% | 9% | 12% | 18% | 20% | 32% | 50% | 49% | 46% | 57% | 47% |
| **% 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)** | 548 | | 3,373 | | 1,149 | | 611 | |
| Year to Date + Forecasted % of mean | 45% | | 61% | | 42% | | 58% | |

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.

**Estimated CVP Operations 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** | **1998** | **2068** | **2114** | **2196** | **2034** | **1911** | **1793** | **1639** | **1491** | **1455** | **1442** | **1472** | **1527** |
| | Elev. | 2346 | 2349 | 2354 | 2343 | 2335 | 2326 | 2314 | 2302 | 2299 | 2298 | 2301 | 2305 |
| **Whiskeytown** | **207** | **206** | **206** | **238** | **238** | **238** | **238** | **238** | **238** | **206** | **206** | **206** | **206** |
| | Elev. | 1199 | 1199 | 1209 | 1209 | 1209 | 1209 | 1209 | 1209 | 1199 | 1199 | 1199 | 1199 |
| **Shasta** | **3482** | **3602** | **3959** | **4062** | **3981** | **3681** | **3126** | **2709** | **2549** | **2459** | **2538** | **2682** | **3043** |
| | Elev. | 1033 | 1046 | 1050 | 1047 | 1036 | 1013 | 994 | 987 | 982 | 986 | 993 | 1010 |
| **Folsom** | **487** | **469** | **552** | **640** | **692** | **663** | **540** | **448** | **360** | **328** | **313** | **318** | **362** |
| | Elev. | 413 | 423 | 433 | 439 | 435 | 421 | 410 | 397 | 392 | 389 | 390 | 397 |
| **New Melones** | **1983** | **1955** | **1958** | **1871** | **1785** | **1709** | **1639** | **1577** | **1533** | **1493** | **1510** | **1534** | **1566** |
| | Elev. | 1048 | 1048 | 1040 | 1032 | 1025 | 1018 | 1011 | 1007 | 1002 | 1004 | 1007 | 1010 |
| **San Luis** | **363** | **397** | **543** | **532** | **402** | **215** | **80** | **52** | **121** | **252** | **391** | **609** | **804** |
| | Elev. | 484 | 499 | 494 | 465 | 436 | 402 | 380 | 391 | 421 | 444 | 475 | 501 |
| **Total** | | 8697 | 9332 | 9539 | 9133 | 8418 | 7417 | 6663 | 6291 | 6193 | 6400 | 6821 | 7507 |

## Monthly River Releases (TAF/cfs)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Trinity** | TAF | 17 | 18 | 32 | 258 | 47 | 28 | 53 | 52 | 23 | 18 | 18 | 18 |
| | cfs | **300** | **300** | **540** | **4,189** | **783** | **450** | **857** | **870** | **373** | **300** | **300** | **300** |
| **Clear Creek** | TAF | 11 | 12 | 13 | 23 | 17 | 9 | 9 | 9 | 12 | 12 | 12 | 25 |
| | cfs | **200** | **200** | **218** | **380** | **288** | **150** | **150** | **150** | **200** | **200** | **200** | **400** |
| **Sacramento** | TAF | 222 | 307 | 416 | 492 | 654 | 830 | 676 | 416 | 369 | 238 | 246 | 246 |
| | cfs | **4000** | **5000** | **7000** | **8000** | **11000** | **13500** | **11000** | **7000** | **6000** | **4000** | **4000** | **4000** |
| **American** | TAF | 97 | 108 | 105 | 108 | 119 | 184 | 154 | 149 | 108 | 105 | 108 | 108 |
| | cfs | **1750** | **1750** | **1765** | **1750** | **2005** | **3000** | **2500** | **2500** | **1750** | **1758** | **1750** | **1750** |
| **Stanislaus** | TAF | 43 | 32 | 91 | 76 | 41 | 15 | 15 | 15 | 48 | 12 | 12 | 14 |
| | cfs | **780** | **525** | **1537** | **1242** | **690** | **250** | **250** | **250** | **774** | **200** | **200** | **226** |

## Trinity Diversions (TAF)

| | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Carr PP** | 0 | 85 | 61 | 49 | 121 | 99 | 100 | 99 | 23 | 25 | 9 | 10 |
| **Spring Crk. PP** | **35** | **110** | **40** | **40** | **110** | **90** | **90** | **90** | **45** | **20** | **12** | **19.8** |

## Delta Summary (TAF)

| | | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tracy** | | 128 | 250 | 127 | 88 | 121 | 210 | 254 | 260 | 265 | 201 | 260 | 240 |
| **USBR Banks** | | 0 | 0 | 0 | 0 | 0 | 13 | 13 | 13 | 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** | | 142 | 263 | 139 | 101 | 131 | 234 | 280 | 287 | 282 | 219 | 278 | 254 |
| **COA Balance** | | 2 | 2 | 10 | 10 | 0 | 0 | 0 | 0 | 23 | 0 | 0 | 0 |
| **Vernalis** | TAF | 127 | 140 | 181 | 175 | 88 | 54 | 52 | 57 | 117 | 83 | 83 | 93 |
| **Vernalis** | cfs | 2293 | 2282 | 3038 | 2843 | 1480 | 884 | 852 | 956 | 1897 | 1393 | 1355 | 1511 |
| **Old/Middle River Std.** | | | | | | | | | | | | | |
| **Old/Middle R. calc.** | cfs | -3,261 | -4,946 | -2,284 | -1,330 | -4,128 | -5,041 | -5,702 | -6,929 | -7,237 | -5,896 | -6,723 | -5,033 |
| **Computed DOI** | | 11400 | 16934 | 11094 | 9777 | 7396 | 7223 | 5889 | 4455 | 4994 | 4992 | 8508 | 15519 |
| **Excess Outflow** | | 0 | 5515 | 0 | 163 | 0 | 211 | 211 | 219 | 0 | 0 | 2505 | 9516 |
| **% Export/Inflow** | | 29% | 29% | 23% | 17% | 34% | 35% | 41% | 54% | 58% | 56% | 49% | 30% |
| **% 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)** | 804 | | 3,864 | | 1,466 | | 711 | |
| Year to Date + Forecasted % of mean | 67% | | 70% | | 54% | | 67% | |

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.

# Northern CVP Water Temperature Report

## February - 2020



| 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 |
| Jan | 51.1 | | 50.3 | 47.9 | 50.1 | 50.1 | 50.0 | 49.8 | 49.7 | 49.9 | 49.6 | 47.2 | 43.4 | - | 4522 | 184 | 5043 | 47.8 | 46.8 | 48.0 | - |
| 02/01 | 50.2 | | 49.5 | 47.9 | 49.6 | 49.7 | 49.6 | **50.0** | 50.3 | 50.6 | 50.8 | 47.6 | 44.8 | - | 4415 | 37 | 5050 | 50.5 | 47.8 | 51.7 | - |
| 02/02 | 50.2 | | 49.5 | 47.4 | 49.6 | 49.7 | 49.5 | **49.8** | 50.0 | 50.2 | 49.8 | 47.2 | 43.6 | - | 4090 | 102 | 4848 | 49.5 | 48.4 | 49.7 | - |
| 02/03 | # | - | 49.3 | 48.3 | 49.2 | 49.3 | 48.9 | **48.5** | 48.3 | 48.5 | 48.5 | 46.1 | 42.4 | - | 3992 | 44 | 4580 | 44.0 | 41.0 | 43.6 | - |
| 02/04 | # | - | 49.4 | 48.1 | 49.0 | 49.0 | 48.6 | **47.8** | 47.4 | 47.5 | 47.3 | 46.1 | 42.2 | - | 5648 | 49 | 4374 | 48.5 | 44.8 | 45.4 | - |
| 02/05 | # | - | 49.3 | 47.3 | 48.9 | 49.0 | 48.9 | **48.2** | 47.8 | 47.8 | 47.2 | 46.7 | 42.5 | - | 4127 | 217 | 4203 | 52.0 | 45.8 | 48.4 | - |
| 02/06 | # | - | 49.2 | 48.1 | 49.1 | 49.4 | 49.7 | **49.2** | 48.9 | 48.9 | 48.3 | 47.4 | 43.1 | - | 3522 | 39 | 4006 | 56.5 | 50.5 | 51.8 | - |
| 02/07 | # | - | 49.1 | 48.3 | 49.2 | 49.5 | 49.8 | **49.7** | 49.8 | 49.9 | 49.6 | 47.5 | 43.7 | - | 3520 | 37 | 3935 | 51.0 | 47.5 | 49.3 | - |
| 02/08 | # | - | 49.0 | 48.3 | 49.3 | 49.5 | 49.7 | **49.6** | 49.6 | 49.8 | 49.7 | 47.1 | 43.0 | - | 3455 | 37 | 3929 | 49.5 | 47.3 | 50.3 | - |
| 02/09 | # | - | 49.2 | 48.3 | 49.1 | 49.3 | 49.3 | **48.9** | 48.8 | 48.8 | 48.7 | 46.7 | 42.6 | - | 3422 | 37 | 3988 | 54.0 | 52.8 | 53.9 | - |
| 02/10 | # | - | 49.2 | 48.4 | 49.0 | 49.3 | 49.5 | **49.3** | 49.2 | 49.3 | 48.9 | 46.8 | 42.4 | - | 4272 | 37 | 3987 | 61.5 | 60.3 | 59.8 | - |
| 02/11 | # | - | 49.2 | 48.3 | 49.1 | 49.5 | 49.8 | **49.9** | 50.1 | 50.2 | 49.9 | 47.2 | 42.7 | - | 3865 | 37 | 4031 | 61.5 | 59.3 | 60.8 | - |
| 02/12 | # | - | 49.0 | 48.4 | 49.4 | 49.7 | 50.0 | **50.2** | 50.5 | 50.8 | 50.7 | 47.4 | 43.0 | - | 3472 | 37 | 4036 | 57.5 | 54.1 | 58.8 | - |
| 02/13 | # | - | 49.0 | 48.3 | 49.3 | 49.6 | 49.9 | **49.9** | 50.2 | 50.4 | 50.4 | 46.9 | 43.1 | - | 3418 | 37 | 4048 | 49.5 | 47.1 | 50.3 | - |
| 02/14 | # | - | 48.9 | 47.9 | 49.3 | 49.6 | 50.0 | **50.1** | 50.3 | 50.5 | 50.3 | 47.2 | 43.6 | - | 3243 | 105 | 4049 | 52.5 | 48.2 | 50.5 | - |
| 02/15 | # | - | 48.8 | 47.9 | 49.2 | 49.5 | 49.9 | **50.1** | 50.5 | 50.7 | 50.5 | 47.4 | 43.9 | - | 3325 | 67 | 3988 | 51.0 | 50.0 | 51.4 | - |
| 02/16 | # | - | 48.9 | 48.4 | 49.3 | 49.6 | 50.1 | **51.1** | 51.6 | 51.8 | 51.4 | 48.2 | 45.5 | - | 3996 | 37 | 3996 | 58.0 | 57.5 | 57.5 | - |
| 02/17 | # | - | 48.9 | 48.4 | 49.2 | 49.5 | 49.9 | **50.3** | 51.0 | 51.4 | 51.4 | 47.7 | 45.3 | - | 3444 | 37 | 3996 | 55.5 | 53.3 | 55.9 | - |
| 02/18 | # | - | 49.2 | 48.3 | 49.1 | 49.4 | 49.6 | **49.8** | 50.1 | 50.3 | 50.3 | 47.3 | 43.8 | - | 3197 | 37 | 3986 | 52.5 | 49.5 | 52.3 | - |
| 02/19 | # | - | 49.1 | 47.6 | 48.9 | 49.2 | 49.5 | **49.5** | 49.8 | 50.0 | 49.9 | 47.2 | 43.6 | - | 3771 | 121 | 3961 | 50.5 | 46.4 | 50.0 | - |
| 02/20 | # | - | 48.9 | 47.5 | 49.0 | 49.3 | 49.5 | **49.7** | 49.9 | 50.1 | 49.8 | 47.3 | 44.3 | - | 3376 | 315 | 3962 | 52.0 | 48.2 | 51.3 | - |
| 02/21 | # | - | ? 48.7 | 48.7 | 49.1 | 49.3 | 49.5 | **49.8** | 50.3 | 50.6 | 50.3 | 47.7 | 44.5 | - | 4110 | 37 | 4355 | 55.5 | 50.7 | 55.6 | - |
| 02/22 | # | - | ? 49.0 | 48.5 | 49.1 | 49.6 | 50.0 | **50.2** | 50.5 | 50.7 | 50.7 | 48.0 | 44.6 | - | 4422 | 37 | 4417 | 57.5 | 51.7 | 57.0 | - |
| 02/23 | # | - | ? 48.6 | 48.6 | 49.1 | 49.3 | 49.6 | **50.3** | 50.9 | 51.2 | 51.1 | 47.7 | 45.3 | - | 4423 | 37 | 4993 | 50.0 | 48.1 | 50.0 | - |
| 02/24 | # | - | ? 48.8 | 48.4 | 49.1 | 49.5 | 49.8 | **50.1** | 50.5 | 50.8 | 50.8 | 47.7 | 45.7 | - | 4369 | 15 | 5014 | 55.0 | 52.0 | 55.4 | - |
| 02/25 | # | - | ? 48.9 | - | 49.0 | 49.5 | 49.9 | **50.5** | 51.1 | 51.4 | 51.2 | 48.2 | 45.9 | - | 4863 | 0 | 5008 | 63.5 | 59.3 | 62.6 | - |
| 02/26 | | | | | | | | | | | | | | | | | | | | | |
| 02/27 | | | | | | | | | | | | | | | | | | | | | |
| 02/28 | | | | | | | | | | | | | | | | | | | | | |
| 02/29 | | | | | | | | | | | | | | | | | | | | | |
| - | | | | | | | | | | | | | | | | | | | | | |
| - | | | | | | | | | | | | | | | | | | | | | |
| Feb | 50.2 | | 49.1 | 48.1 | 49.2 | 49.4 | 49.6 | 49.7 | 49.9 | 50.1 | 49.9 | 47.3 | 43.8 | - | 3910 | 64 | 4270 | 53.6 | 50.5 | 52.9 | - |
| | | | | | | | | | | | | | | Total CFS | 97757 | 1592 | 106740 | | | | |
| | | | | | | | | | | | | | | Total AF | 193897 | 3158 | 211714 | | | | |

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

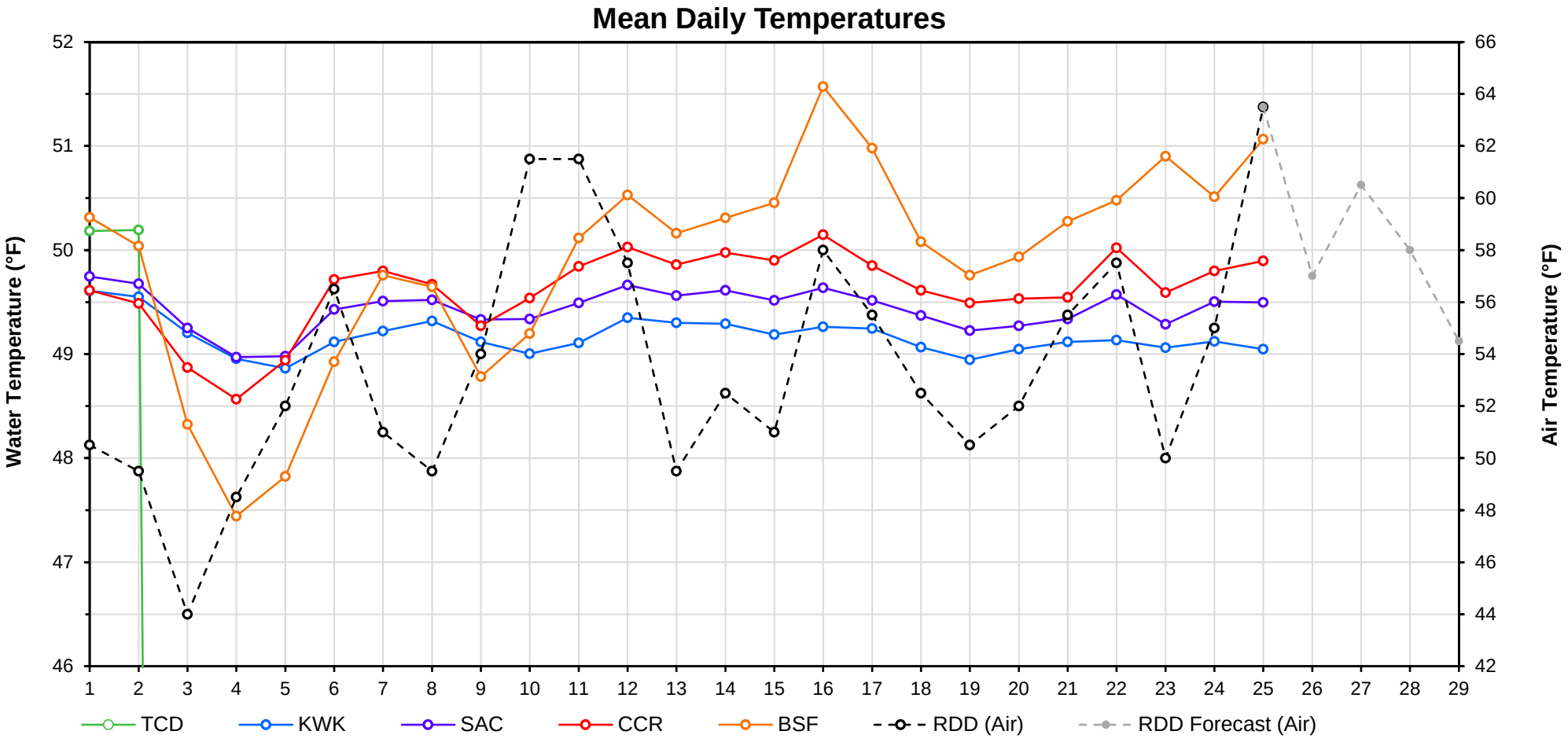
| DATE | Redding (RDD) Daily Air Temperatures (°F) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual | | | Forecasted | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 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 |
| 02/01 | 42 | 69 | 55.5 | 40 | 66 | 53.0 | 44 | 54 | 49.0 | 32 | 51 | 41.5 | 31 | 56 | 43.5 | 36 | 61 | 48.5 | 40 | 65 | 52.5 | 41 | 64 | 52.5 | 40 | 59 | 49.5 | 34 | 60 | 47.0 | 35 | 59 | 47.0 | 37 | 58 | 47.5 |
| 02/02 | 40 | 61 | 50.5 | 45 | 54 | 49.5 | 31 | 52 | 41.5 | 32 | 56 | 44.0 | 37 | 63 | 50.0 | 40 | 66 | 53.0 | 40 | 69 | 54.5 | 41 | 59 | 50.0 | 34 | 56 | 45.0 | 34 | 64 | 49.0 | 33 | 59 | 46.0 | 38 | 58 | 48.0 |
| 02/03 | 42 | 57 | 49.5 | 38 | 53 | 45.5 | 32 | 56 | 44.0 | 35 | 64 | 49.5 | 39 | 69 | 54.0 | 41 | 70 | 55.5 | 40 | 64 | 52.0 | 38 | 61 | 49.5 | 46 | 65 | 55.5 | 36 | 58 | 47.0 | 35 | 56 | 45.5 | 39 | 59 | 49.0 |
| 02/04 | 34 | 54 | 44.0 | 42 | 57 | 49.5 | 39 | 65 | 52.0 | 41 | 69 | 55.0 | 42 | 70 | 56.0 | 41 | 65 | 53.0 | 38 | 61 | 49.5 | 41 | 64 | 52.5 | 38 | 60 | 49.0 | 36 | 54 | 45.0 | 35 | 56 | 45.5 | 37 | 61 | 49.0 |
| 02/05 | 41 | 56 | 48.5 | 47 | 63 | 55.0 | 38 | 67 | 52.5 | 41 | 67 | 54.0 | 40 | 60 | 50.0 | 39 | 58 | 48.5 | 37 | 62 | 49.5 | 37 | 61 | 49.0 | 34 | 53 | 43.5 | 34 | 54 | 44.0 | 33 | 58 | 45.5 | 38 | 60 | 49.0 |
| 02/06 | 43 | 61 | 52.0 | 39 | 68 | 53.5 | 41 | 68 | 54.5 | 40 | 60 | 50.0 | 40 | 60 | 50.0 | 40 | 64 | 52.0 | 40 | 63 | 51.5 | 37 | 57 | 47.0 | 41 | 60 | 50.5 | 31 | 57 | 44.0 | 34 | 58 | 46.0 | 40 | 61 | 50.5 |
| 02/07 | 38 | 75 | 56.5 | 35 | 72 | 53.5 | 39 | 60 | 49.5 | 39 | 60 | 49.5 | 40 | 67 | 53.5 | 41 | 70 | 55.5 | 41 | 68 | 54.5 | 41 | 69 | 55.0 | 45 | 74 | 59.5 | 43 | 71 | 57.0 | 44 | 69 | 56.5 | 44 | 65 | 54.5 |
| 02/08 | 34 | 68 | 51.0 | 34 | 61 | 47.5 | 38 | 61 | 49.5 | 40 | 68 | 54.0 | 41 | 70 | 55.5 | 39 | 68 | 53.5 | 40 | 64 | 52.0 | 39 | 60 | 49.5 | 41 | 59 | 50.0 | 37 | 61 | 49.0 | 40 | 64 | 52.0 | 40 | 67 | 53.5 |
| 02/09 | 33 | 66 | 49.5 | 47 | 62 | 54.5 | 38 | 69 | 53.5 | 43 | 71 | 57.0 | 40 | 68 | 54.0 | 40 | 65 | 52.5 | 39 | 61 | 50.0 | 38 | 61 | 49.5 | 44 | 65 | 54.5 | 37 | 67 | 52.0 | 40 | 66 | 53.0 | 40 | 68 | 54.0 |
| 02/10 | 46 | 62 | 54.0 | 52 | 71 | 61.5 | 41 | 71 | 56.0 | 41 | 70 | 55.5 | 40 | 63 | 51.5 | 38 | 60 | 49.0 | 38 | 58 | 48.0 | 41 | 60 | 50.5 | 40 | 61 | 50.5 | 43 | 65 | 54.0 | 42 | 66 | 54.0 | 40 | 69 | 54.5 |
| 02/11 | 50 | 73 | 61.5 | 57 | 73 | 65.0 | 40 | 69 | 54.5 | 38 | 65 | 51.5 | 39 | 65 | 52.0 | 38 | 62 | 50.0 | 41 | 61 | 51.0 | 37 | 60 | 48.5 | 42 | 67 | 54.5 | 39 | 65 | 52.0 | 41 | 65 | 53.0 | 41 | 69 | 55.0 |
| 02/12 | 49 | 74 | 61.5 | 48 | 71 | 59.5 | 38 | 67 | 52.5 | 39 | 68 | 53.5 | 39 | 63 | 51.0 | 43 | 61 | 52.0 | 38 | 61 | 49.5 | 37 | 63 | 50.0 | 42 | 68 | 55.0 | 35 | 67 | 51.0 | 36 | 67 | 51.5 | 41 | 68 | 54.5 |
| 02/13 | 42 | 73 | 57.5 | 34 | 68 | 51.0 | 39 | 69 | 54.0 | 40 | 66 | 53.0 | 45 | 63 | 54.0 | 38 | 61 | 49.5 | 38 | 65 | 51.5 | 39 | 66 | 52.5 | 39 | 65 | 52.0 | 39 | 67 | 53.0 | 41 | 64 | 52.5 | 42 | 66 | 54.0 |
| 02/14 | 33 | 66 | 49.5 | 37 | 67 | 52.0 | 40 | 66 | 53.0 | 44 | 65 | 54.5 | 38 | 62 | 50.0 | 38 | 64 | 51.0 | 38 | 67 | 52.5 | 38 | 66 | 52.0 | 41 | 67 | 54.0 | 42 | 66 | 54.0 | 42 | 69 | 55.5 | 42 | 69 | 55.5 |
| 02/15 | 37 | 68 | 52.5 | 37 | 65 | 51.0 | 45 | 65 | 55.0 | 40 | 63 | 51.5 | 37 | 67 | 52.0 | 38 | 67 | 52.5 | 39 | 68 | 53.5 | 40 | 70 | 55.0 | 42 | 65 | 53.5 | 43 | 58 | 50.5 | 39 | 61 | 50.0 | 37 | 68 | 52.5 |
| 02/16 | 37 | 65 | 51.0 | 37 | 64 | 50.5 | 41 | 65 | 53.0 | 36 | 66 | 51.0 | 37 | 67 | 52.0 | 39 | 67 | 53.0 | 40 | 70 | 55.0 | 41 | 71 | 56.0 | 45 | 65 | 55.0 | 42 | 62 | 52.0 | 38 | 65 | 51.5 | 37 | 69 | 53.0 |
| 02/17 | 48 | 68 | 58.0 | 48 | 67 | 57.5 | 38 | 66 | 52.0 | 36 | 67 | 51.5 | 38 | 66 | 52.0 | 38 | 71 | 54.5 | 41 | 71 | 56.0 | 44 | 63 | 53.5 | 47 | 65 | 56.0 | 40 | 66 | 53.0 | 40 | 68 | 54.0 | 41 | 68 | 54.5 |
| 02/18 | 45 | 66 | 55.5 | 51 | 66 | 58.5 | 34 | 67 | 50.5 | 39 | 68 | 53.5 | 39 | 72 | 55.5 | 41 | 72 | 56.5 | 43 | 63 | 53.0 | 36 | 59 | 47.5 | 33 | 59 | 46.0 | 36 | 61 | 48.5 | 37 | 65 | 51.0 | 39 | 66 | 52.5 |
| 02/19 | 39 | 66 | 52.5 | 35 | 68 | 51.5 | 39 | 69 | 54.0 | 41 | 74 | 57.5 | 41 | 73 | 57.0 | 42 | 65 | 53.5 | 41 | 66 | 53.5 | 41 | 69 | 55.0 | 39 | 70 | 54.5 | 41 | 72 | 56.5 | 42 | 71 | 56.5 | 43 | 71 | 57.0 |
| 02/20 | 33 | 68 | 50.5 | 36 | 68 | 52.0 | 42 | 73 | 57.5 | 43 | 73 | 58.0 | 42 | 67 | 54.5 | 44 | 72 | 58.0 | 44 | 74 | 59.0 | 44 | 74 | 59.0 | 47 | 75 | 61.0 | 44 | 71 | 57.5 | 45 | 67 | 56.0 | 45 | 71 | 58.0 |
| 02/21 | 35 | 69 | 52.0 | 36 | 73 | 54.5 | 42 | 73 | 57.5 | 42 | 66 | 54.0 | 40 | 73 | 56.5 | 44 | 77 | 60.5 | 44 | 76 | 60.0 | 45 | 77 | 61.0 | 46 | 73 | 59.5 | 42 | 66 | 54.0 | 45 | 67 | 56.0 | 43 | 67 | 55.0 |
| 02/22 | 36 | 75 | 55.5 | 41 | 75 | 58.0 | 39 | 65 | 52.0 | 37 | 72 | 54.5 | 43 | 77 | 60.0 | 44 | 76 | 60.0 | 44 | 78 | 61.0 | 43 | 75 | 59.0 | 47 | 73 | 60.0 | 44 | 74 | 59.0 | 47 | 75 | 61.0 | 47 | 74 | 60.5 |
| 02/23 | 41 | 74 | 57.5 | 40 | 67 | 53.5 | 37 | 72 | 54.5 | 43 | 77 | 60.0 | 43 | 76 | 59.5 | 44 | 80 | 62.0 | 43 | 76 | 59.5 | 43 | 69 | 56.0 | 45 | 59 | 52.0 | 42 | 69 | 55.5 | 47 | 71 | 59.0 | 46 | 72 | 59.0 |
| 02/24 | 38 | 62 | 50.0 | 37 | 72 | 54.5 | 44 | 77 | 60.5 | 44 | 77 | 60.5 | 43 | 80 | 61.5 | 44 | 75 | 59.5 | 44 | 68 | 56.0 | 41 | 64 | 52.5 | 44 | 65 | 54.5 | 40 | 70 | 55.0 | 44 | 68 | 56.0 | 40 | 69 | 54.5 |
| 02/25 | 36 | 74 | 55.0 | 44 | 77 | 60.5 | 42 | 74 | 58.0 | 43 | 79 | 61.0 | 43 | 75 | 59.0 | 46 | 66 | 56.0 | 40 | 61 | 50.5 | 40 | 69 | 54.5 | 43 | 67 | 55.0 | 43 | 63 | 53.0 | 38 | 65 | 51.5 | 36 | 73 | 54.5 |
| 02/26 | 49 | 78 | 63.5 | 39 | 75 | 57.0 | 42 | 79 | 60.5 | 42 | 74 | 58.0 | 45 | 64 | 54.5 | 38 | 60 | 49.0 | 39 | 69 | 54.0 | 42 | 69 | 55.5 | 42 | 70 | 56.0 | 41 | 72 | 56.5 | 44 | 72 | 58.0 | 45 | 71 | 58.0 |
| 02/27 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 02/28 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 02/29 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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 |

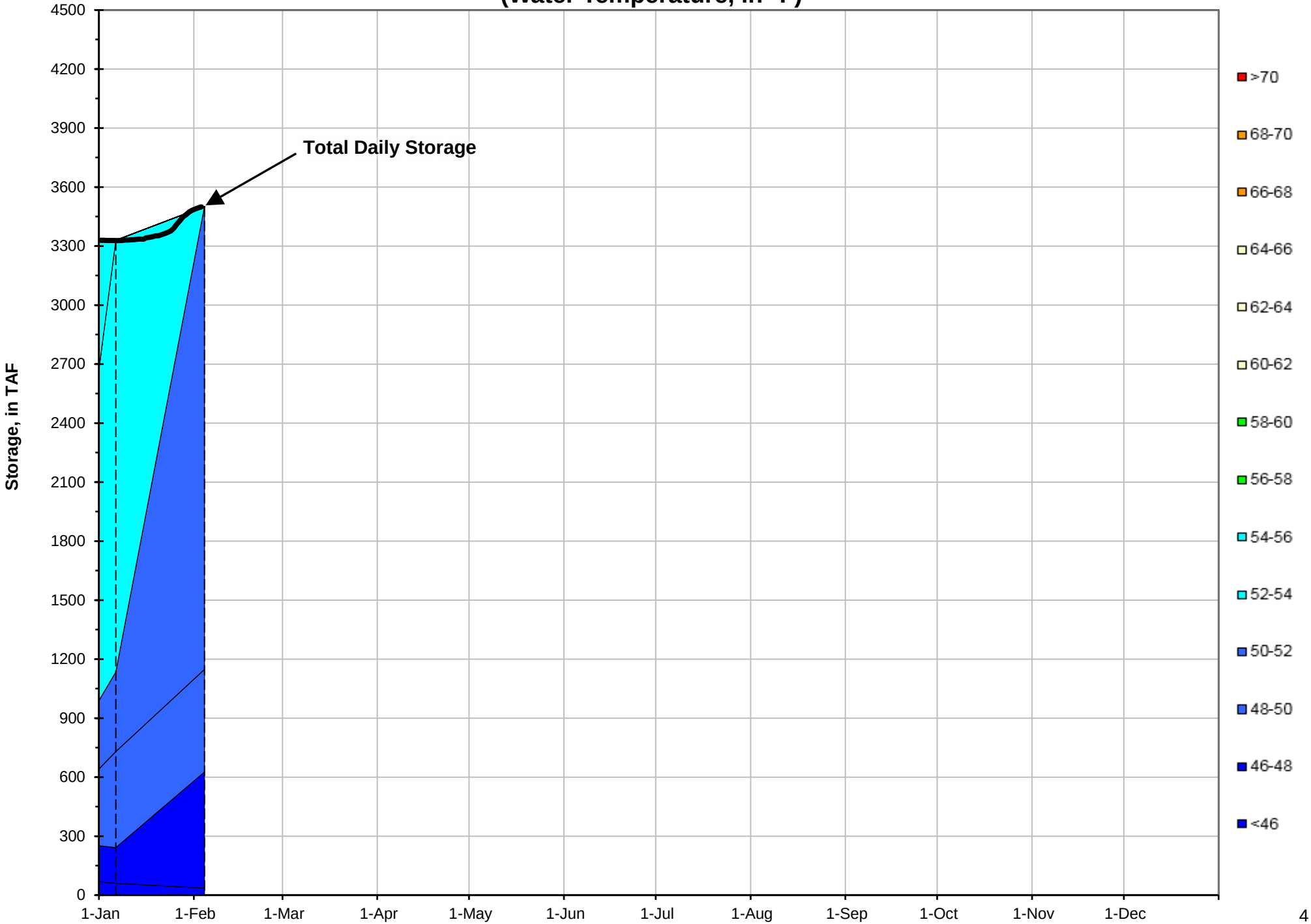
| Temperature Control Point | | |
|---|---|---|
| Point | Temp. (°F) | Begin Date |
| **BSF** | **56.0** | **05/25/2018** |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Notes

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

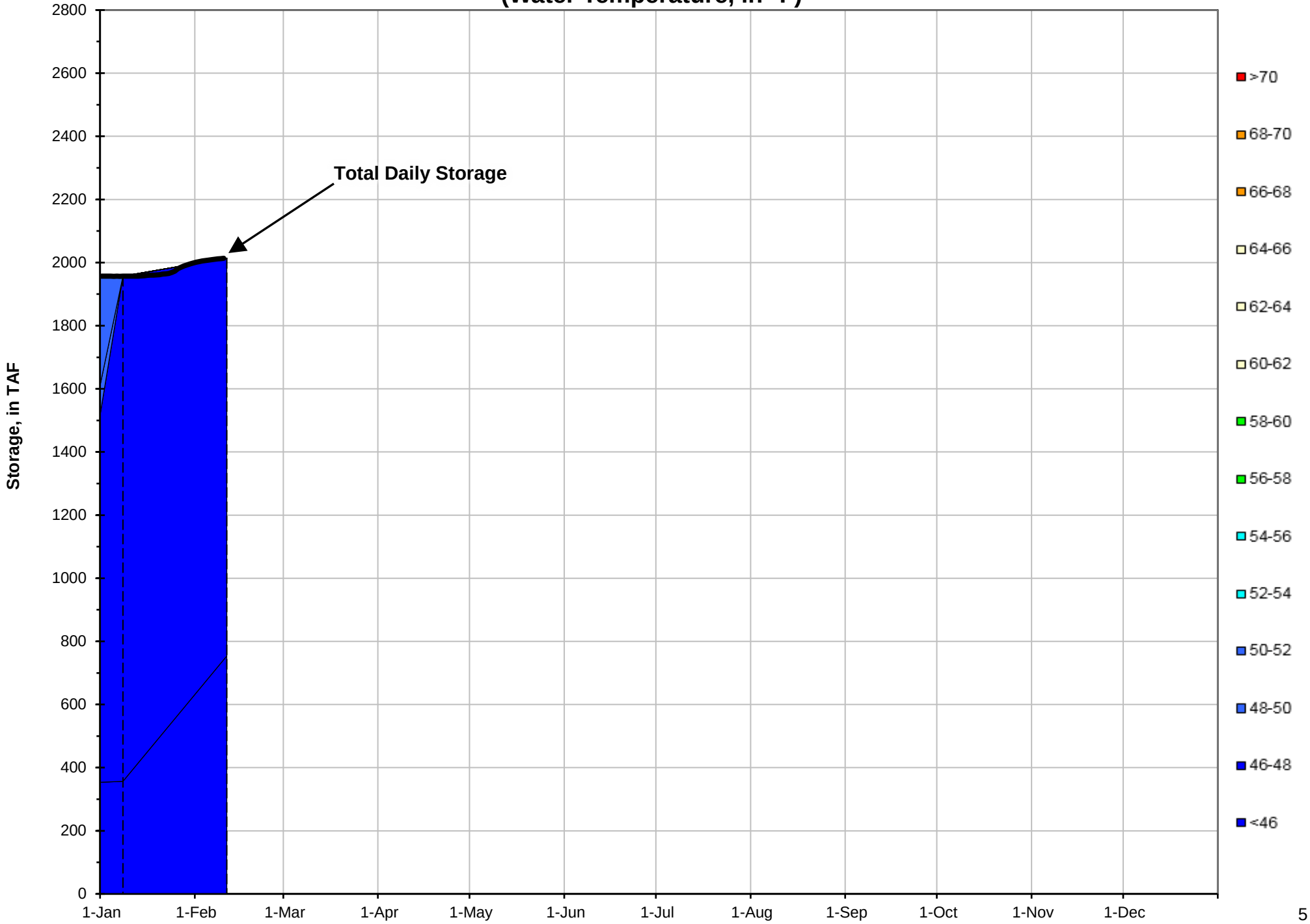
Latest Profile Date: 02/04/2020

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



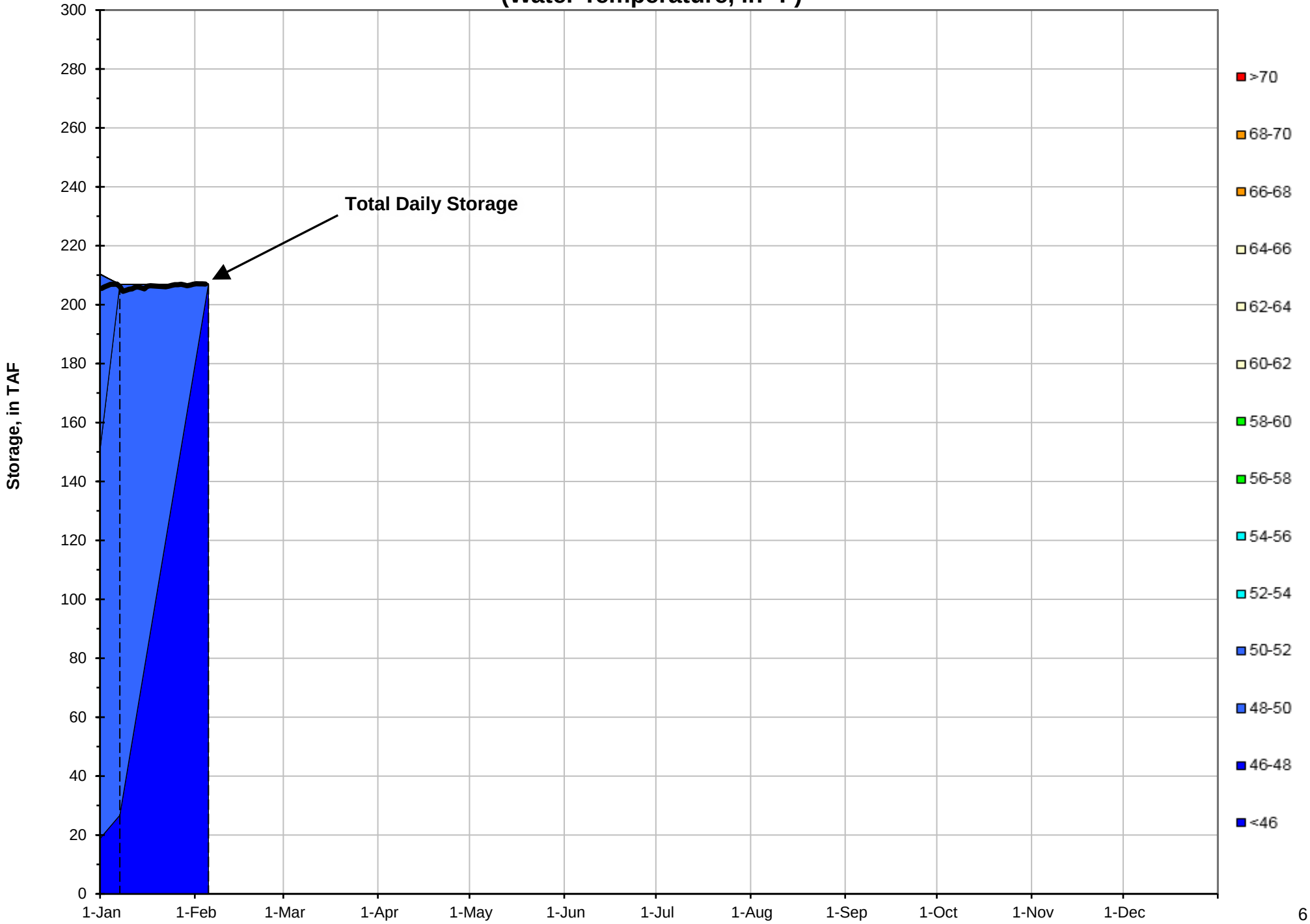
Latest Profile Date: 02/11/2020

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



Latest Profile Date: 02/05/2020

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

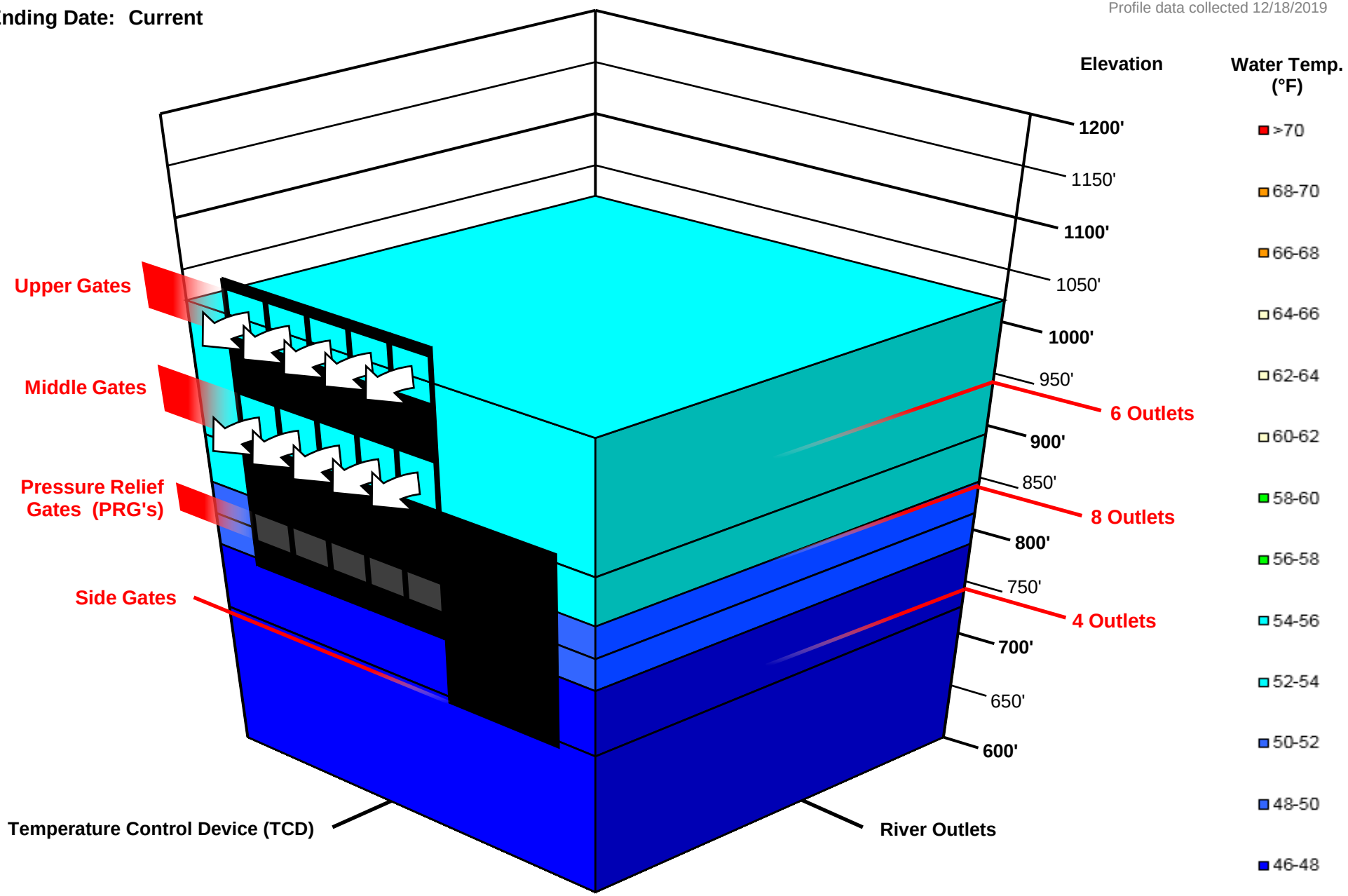


# Shasta TCD Configuration

**Starting Date:** 12/19/2019

**Ending Date:** Current

Profile data collected 12/18/2019




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

**February 26, 2020**

# Upper Sacramento River – February 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 at 53.5°F | Keswick Dam KWK | 53.5 | 53.2 | 53.0 | 53.1 | 54.0 | See Fig. 3 | See Fig. 3 |
| | Sac. R. abv Clear Creek CCR | 53.7 | 53.7 | 53.5 | 53.5 | 54.4 | See Fig. 4 | See Fig. 4 |
| | Airport Road | 54.0 | 54.3 | 54.0 | 54.1 | 55.0 | n/a | n/a |
| | Balls Ferry BSF | 55.2 | 55.8 | 55.1 | 55.1 | 56.0 | See Fig. 5 | See Fig. 5 |
| | | | | | | | | |
| 90% Hydrology 25% Historical Meteorology Targeting CCR at 56°F | Keswick Dam KWK | 54.0 | 54.6 | 54.6 | 55.6 | 55.7 | See Fig. 3 | See Fig. 3 |
| | Sac. R. abv Clear Creek CCR | 54.2 | 55.0 | 55.0 | 56.0 | 56.0 | See Fig. 4 | See Fig. 4 |
| | Airport Road | 54.5 | 55.5 | 55.5 | 56.5 | 56.6 | n/a | n/a |
| | Balls Ferry BSF | 55.6 | 56.9 | 56.5 | 57.4 | 57.5 | See Fig. 5 | See Fig. 5 |

**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 at 53.5°F | 147 | 7/16 | 8/2 |
| 90%Hydro. - 25%Hist. Met. CCR at 56°F | 469 | 9/8 | 10/30 |

Model Run Date February 25, 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. The end of September cold-water-pool volumes were insufficient to confidently sustain the temperature targets into the late fall period for the sustained Clear Creek target at 53.5°F.

**Temperature Model Inputs, Assumptions, Limitations and Uncertainty:**

1. The latest available profiles for Shasta, Trinity, and Whiskeytown were taken on February 4, February 11, and February 4, 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 February 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% 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, 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).

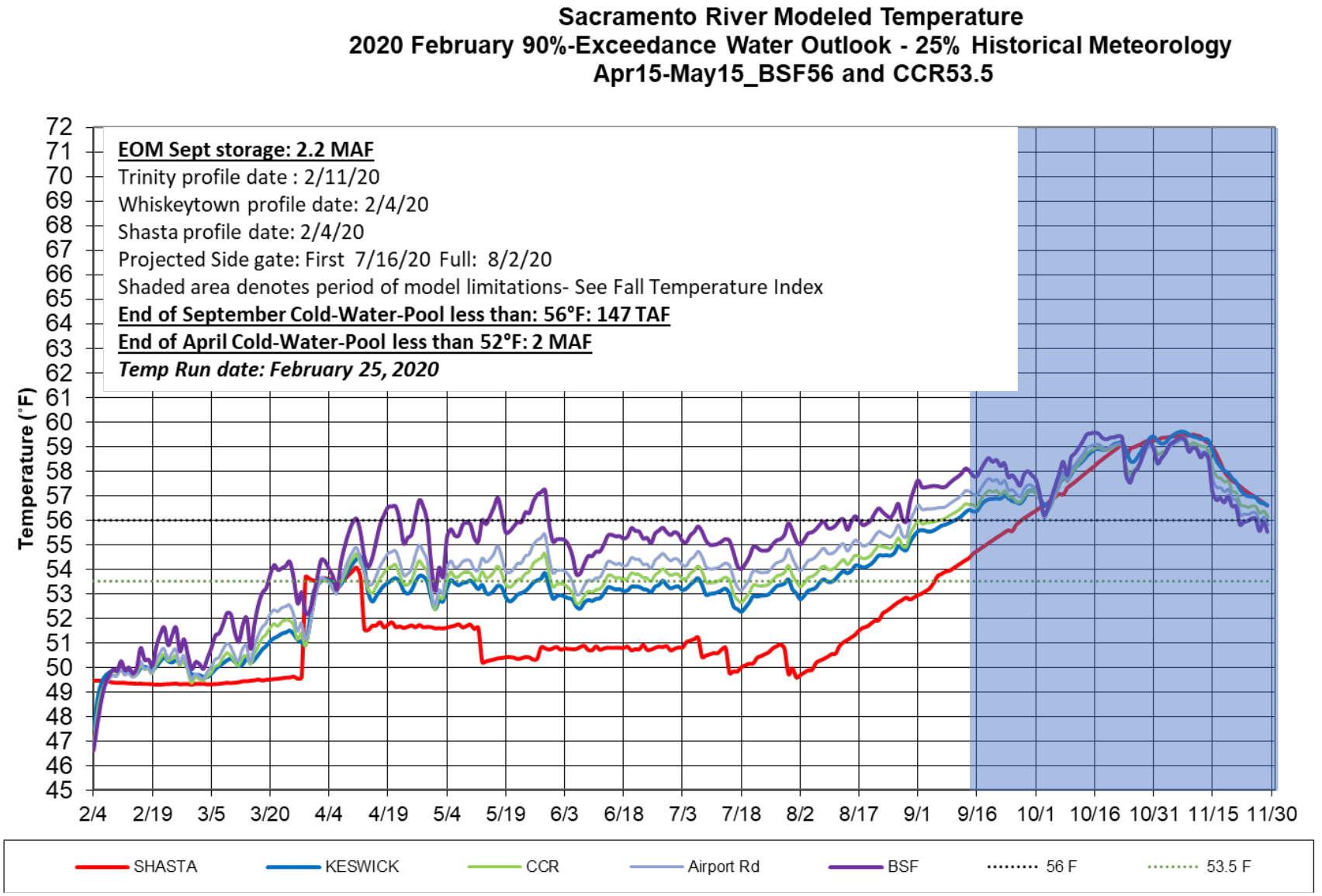



**Figure 1**. February 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% historical meteorology targeting CCR at 53.5°F.

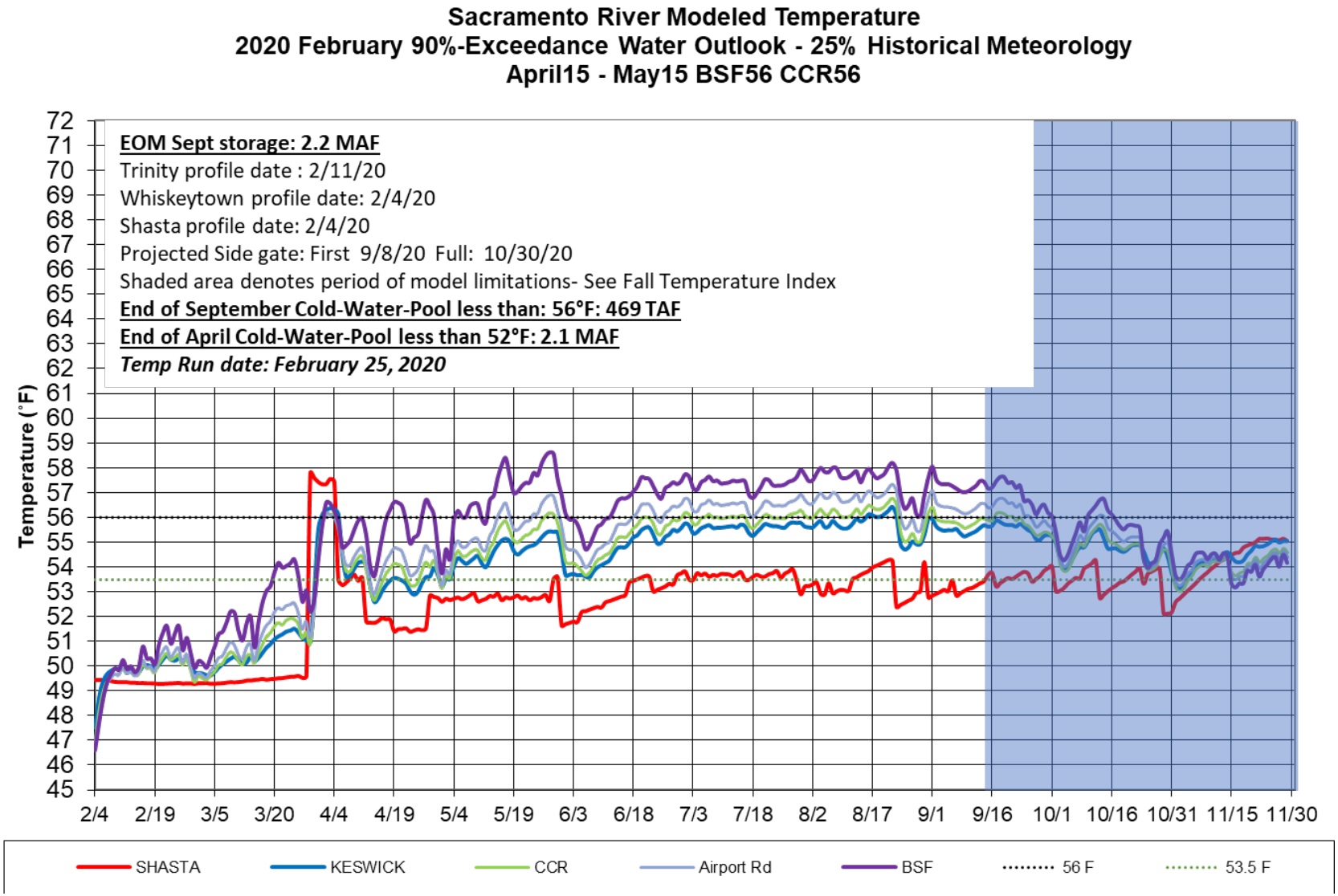



**Figure 2**. February 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% historical meteorology targeting CCR at 56°F.

**Figures 3-5 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 reachs.
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.

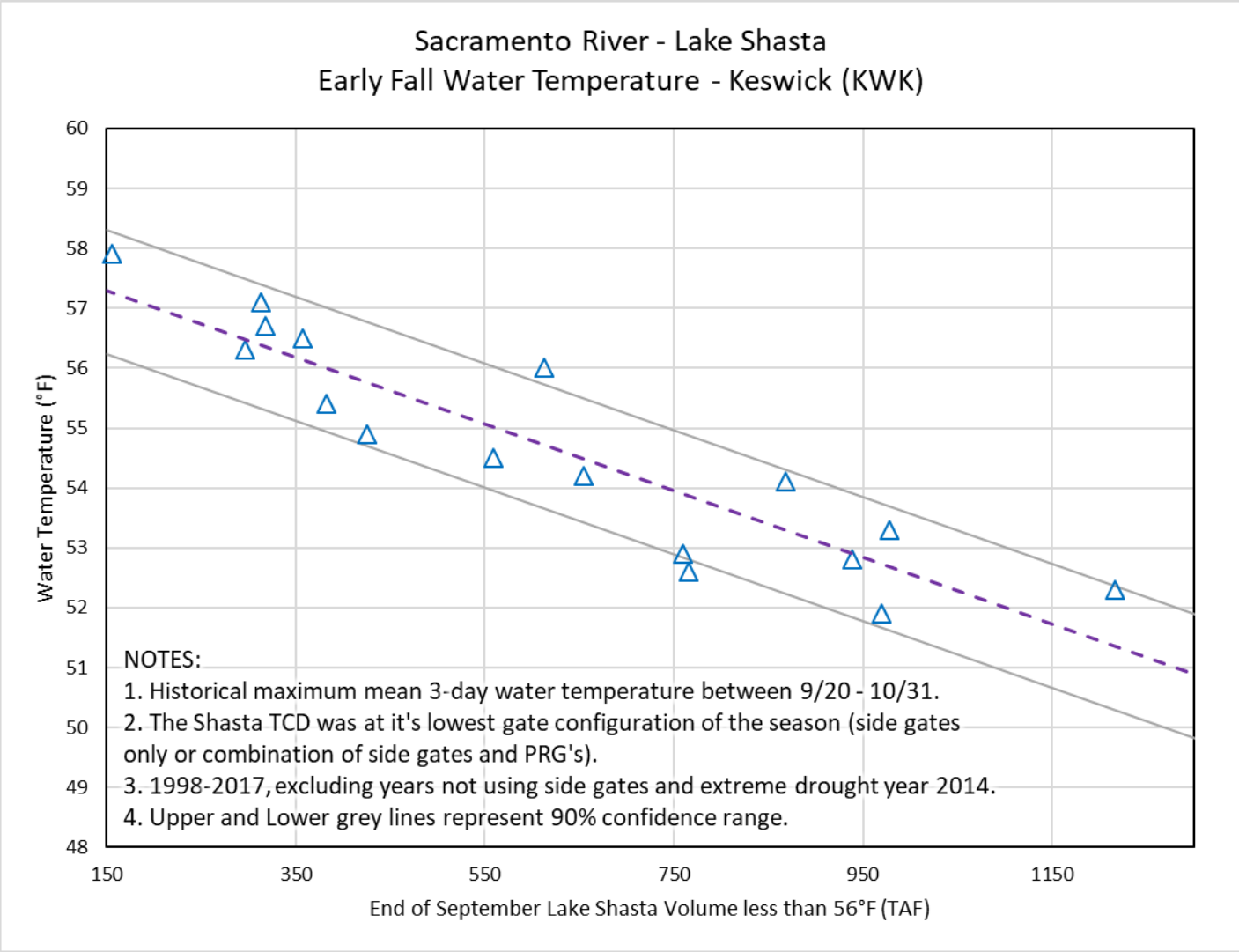



**Figure 3.** Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Keswick water temperature.

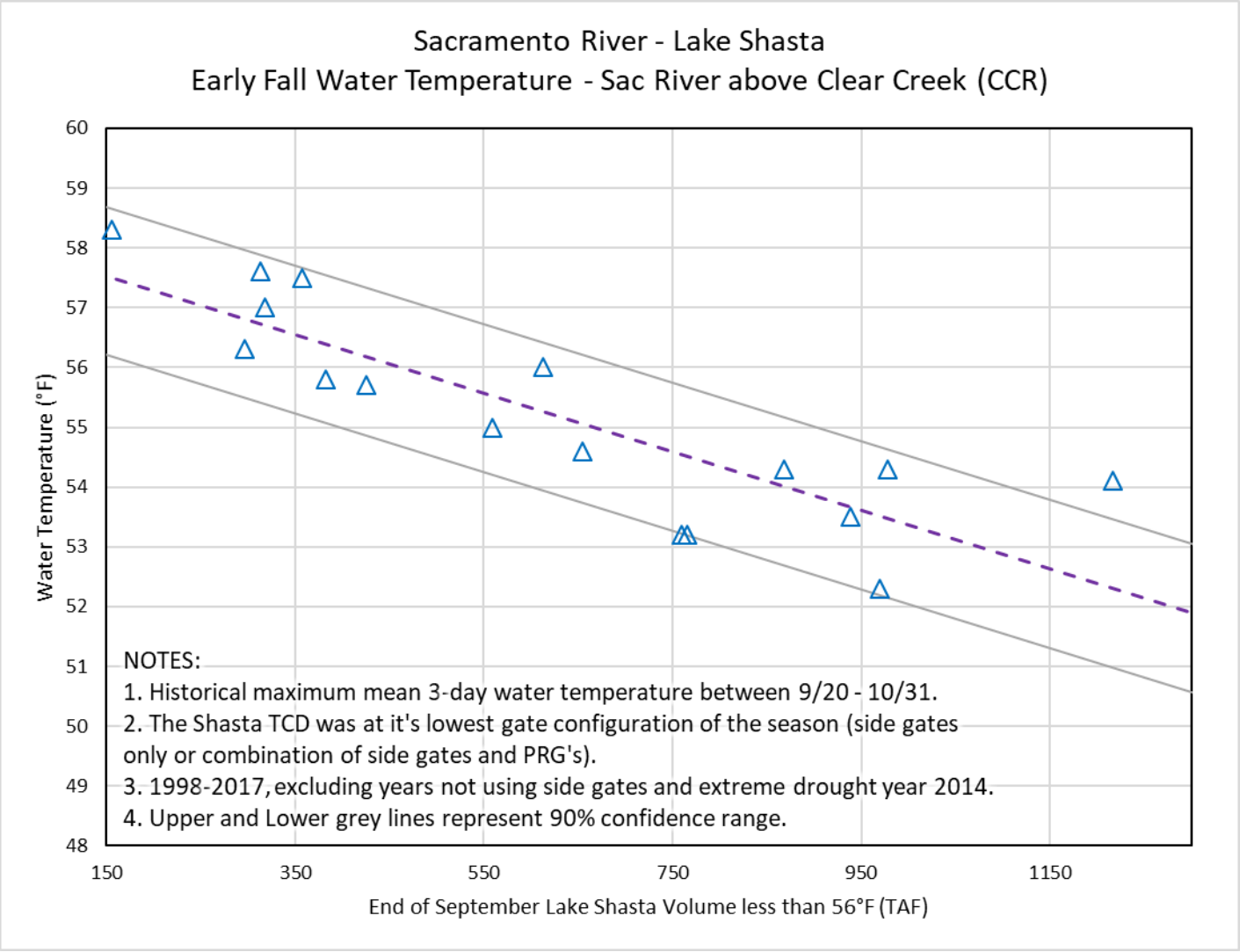



**Figure 4**. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Sacramento River above Clear Creek confluence water temperature.

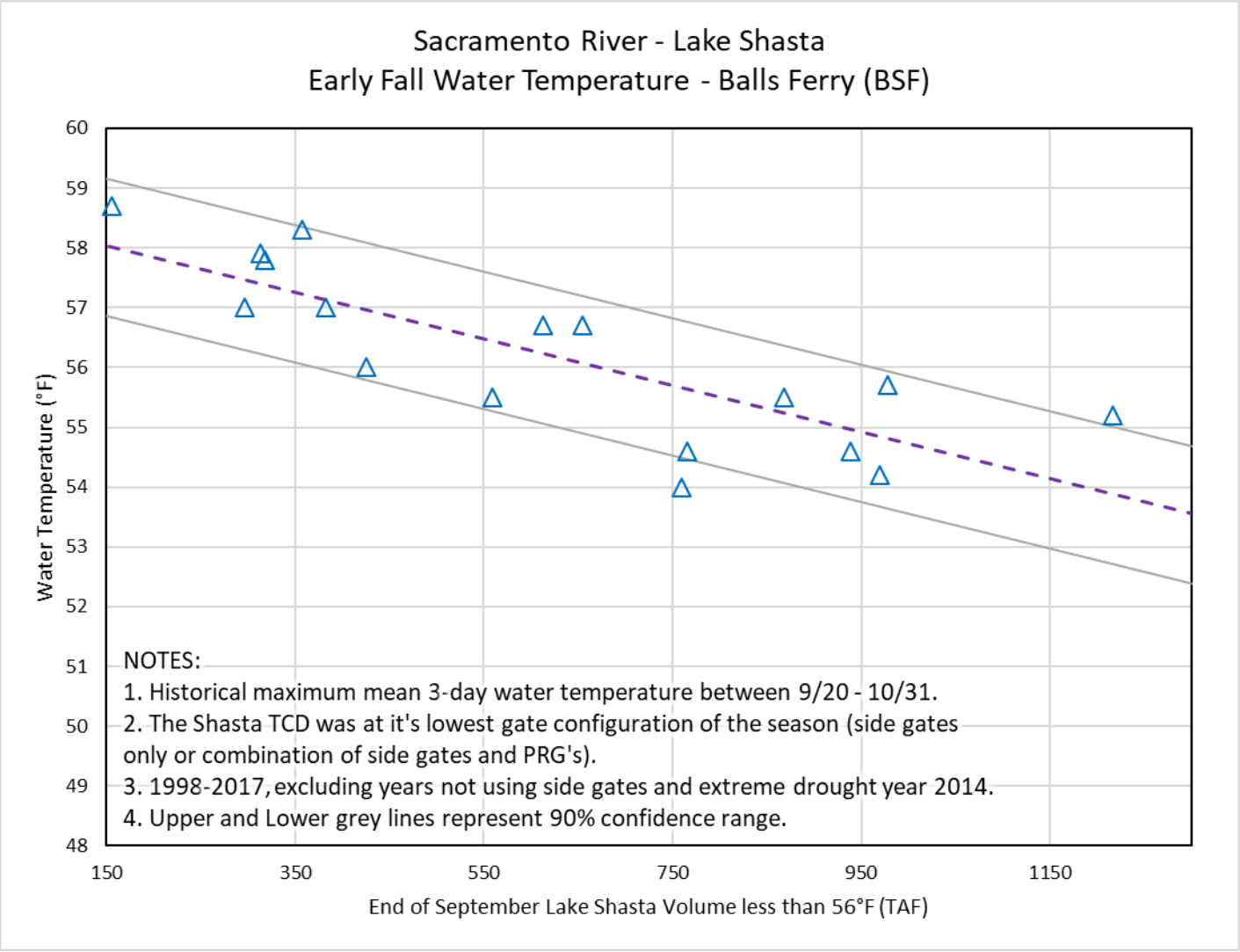



**Figure 5.** Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Balls Ferry water temperature.

We've finished the February 25, 2020 Bulletin 120 (B120) forecast update.
The forecast includes observed conditions through the morning of February 25, 2020.

The forecasts are posted at: http://cdec.water.ca.gov/b120up.html

**Forecast Summary:**
The projected median April-July (AJ) runoff in the major Sierra river basins ranges from 35 percent of average for the Tule River basin to 71 percent of average for the total inflow to Shasta Lake. All forecasts decreased compared to last week's February 18, 2020 B120 forecast update.

**Runoff:**
Flow rates are steady and nearly identical to last week.

February full natural flow rates updated through February 25, 2020:

| River Basin | Percent of Historic Average |
|---|---|
| **Trinity** | **32** |
| **Shasta Inflow** | **39** |
| **Sacramento at Bend Bridge** | **37** |
| **Feather** | **32** |
| **Yuba** | **28** |
| **American** | **23** |
| **Cosumnes** | **13** |
| **Mokelumne** | **29** |
| **Stanislaus** | **29** |
| **Tuolumne** | **22** |
| **Merced** | **19** |
| **San Joaquin** | **30** |
| **Kings** | **39** |
| **Kaweah** | **31** |
| **Tule** | **25** |
| **Kern** | **59** |

**Precipitation:**
All three precipitation indices are still well below the average for February. Both the 5 & 6 stations have accumulated precipitation.

The accumulated average to date precipitation for Water Year 2020 and month to date are shown in the table below

| Region/Index | WY-to-date precipitation as a percent of average (inches) through February 26, 2020 | Month-to-date precipitation as a percent of month total (inches) through February 26, 2020 |
|---|---|---|
| Northern Sierra 8-Station Index | **50 (17.8 inches)** | **0 (0.0 inches)** |
| San Joaquin 5-Station Index | **42 (11.4 inches)** | **4 (0.3 inches)** |

| | | |
|---|---|---|
| Tulare Basin 6-Station Index | 46 (8.7 inches) | 12 (0.6 inches) |

**Snowpack:**

The Statewide snowpack based on snow sensors is 11.5 inches which corresponds to 40 percent of the April 1 average. Since the last forecast, the Statewide snowpack snow water content has only lost 0.4 of an inch.

The snowpack as of the morning of February 26, 2020 stands at the following (based on snow sensors):

| Region | Snow Water Content (inches) | % of Average (Apr 1) | % of Average (Feb 26) |
|---|---|---|---|
| Northern | 13.2 | 45 | 51 |
| Central | 11.8 | 39 | 46 |
| Southern | 9.2 | 36 | 43 |
| Statewide | 11.5 | 40 | 47 |

**Weather and Climate Outlooks:**

According to CNRFC 6 day forecast, dry weather with above average temperatures are forecasted for the State through Friday. Cooling temperatures with scattered mountain showers possible over the weekend. Daytime high temperatures will generally be around 7 to 15 degrees above normal through Friday. Over the weekend, American, Feather, and Yuba basins are expected to receive 0.2 inches of precipitation on average. During the same period, San Joaquin, Tulare, and Upper Sacramento basins are expected to receive under 0.1 inches of precipitation. Statewide, freezing elevations will be above 8,000 feet through Friday and then decrease to around 6,000 feet over the weekend.

The NWS Climate Prediction Center (CPC) one-month outlook for March 2020 issued on February 20, 2020, points to increased chances of above normal temperatures all across the State. The same outlook suggests increased chances of below normal precipitation all across the State.

The CPC three-month (March-April-May) outlook, issued on February 20, 2020, points to increased chances of above normal temperatures all across the State. The same outlook suggests increased chances of below normal precipitation all across the State.

According to the latest El Niño/Southern Oscillation (ENSO) discussion issued by the Climate Prediction Center on February 24, 2020, ENSO-neutral conditions are present. Equatorial sea surface temperatures are near-to-above average across the Pacific Ocean. ENSO-neutral is favored through Northern Hemisphere spring 2020 (~60% chance), continuing through summer 2020 (~50% chance).

**Next Update:**

Both a B120 forecast and a Water Supply Index (WSI) forecast for conditions as of March 1, 2020 will be available by Monday, March 9, 2020. If you have any questions regarding this forecast, please contact a member of the Snow Surveys and Water Supply Forecasting section.

**Important Links:**

**Full Natural Flow Data**:
Daily FNF
http://cdec.water.ca.gov/reportapp/javareports?name=FNF
Monthly FNF

http://cdec.water.ca.gov/reportapp/javareports?name=FNFSUM
Seasonal FNF
http://cdec.water.ca.gov/reportapp/javareports?name=FLOWOUT

**Precipitation Data:**
Latest Northern Sierra 8-Station Precipitation Index
http://cdec.water.ca.gov/cgi-progs/products/TAB_ESI.pdf
Latest San Joaquin 5-Station Precipitation Index
http://cdec.water.ca.gov/cgi-progs/products/TAB_FSI.pdf
Latest Tulare Basin 6-Station Precipitation Index
http://cdec.water.ca.gov/cgi-progs/products/TAB_TSI.pdf

**Snow Data:**
Latest Snow Sensor Report
http://cdec.water.ca.gov/reportapp/javareports?name=PAGE6
Latest Statewide Summary of Snow Water Equivalents
http://cdec.water.ca.gov/snowapp/sweq.action

**Extended Regional Forecasts:**
California Nevada River Forecast Center 6 Day QPF and Snow Level Forecast
http://www.cnrfc.noaa.gov/awipsProducts/RNOHD6RSA.php
Climate Prediction Center One-Month Outlook Forecasts
http://www.cpc.ncep.noaa.gov/products/predictions/30day/
Climate Prediction Center Three-Month Outlook Forecasts
http://www.cpc.ncep.noaa.gov/products/predictions/long_range/seasonal.php?lead=1
U.S. Seasonal Drought Outlook
http://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_summary.html
Weather Forecast Office California Service Area-Products
http://www.cnrfc.noaa.gov/forecasts.php
El Niño Southern Oscillation (ENSO) Conditions and Weekly Discussion (including La Niña)
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf

**Bulletin 120:**
Historical forecast error plots can now be accessed at the link below. The plots compare actual and forecasted Bulletin 120 runoff projections for individual basins through WY 2018.
Historical Forecast Error Plots
http://cdec.water.ca.gov/snow/bulletin120/B120_error_fcast_plots.html

**Snow Surveys Staff Contact Information:**


| | | |
|---|---|---|
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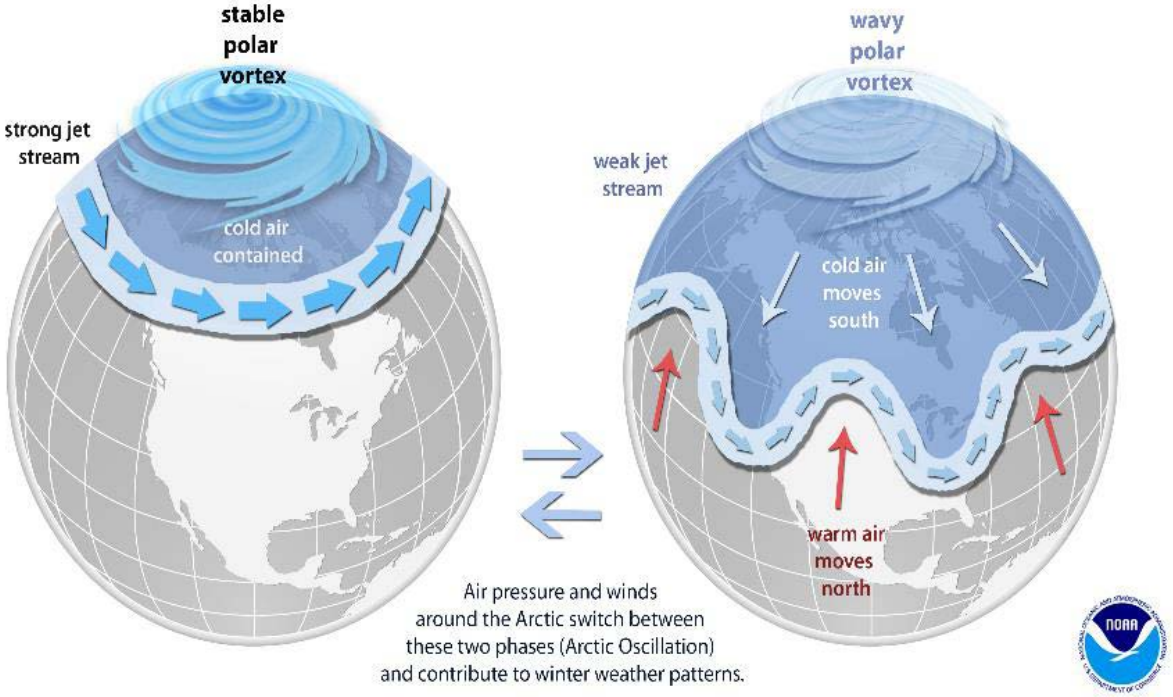
| Andy Reising | andrew.reising@water.ca.gov | (916) 574-2181 |
| Ashok Bathulla | ashok.bathulla@water.ca.gov | (916) 574-2634 |
| Lauren Miller | lauren.miller@water.ca.gov | (916) 574-1433 |

**Why is it so dry? One player may be the Positive Arctic Oscillation (AO)**

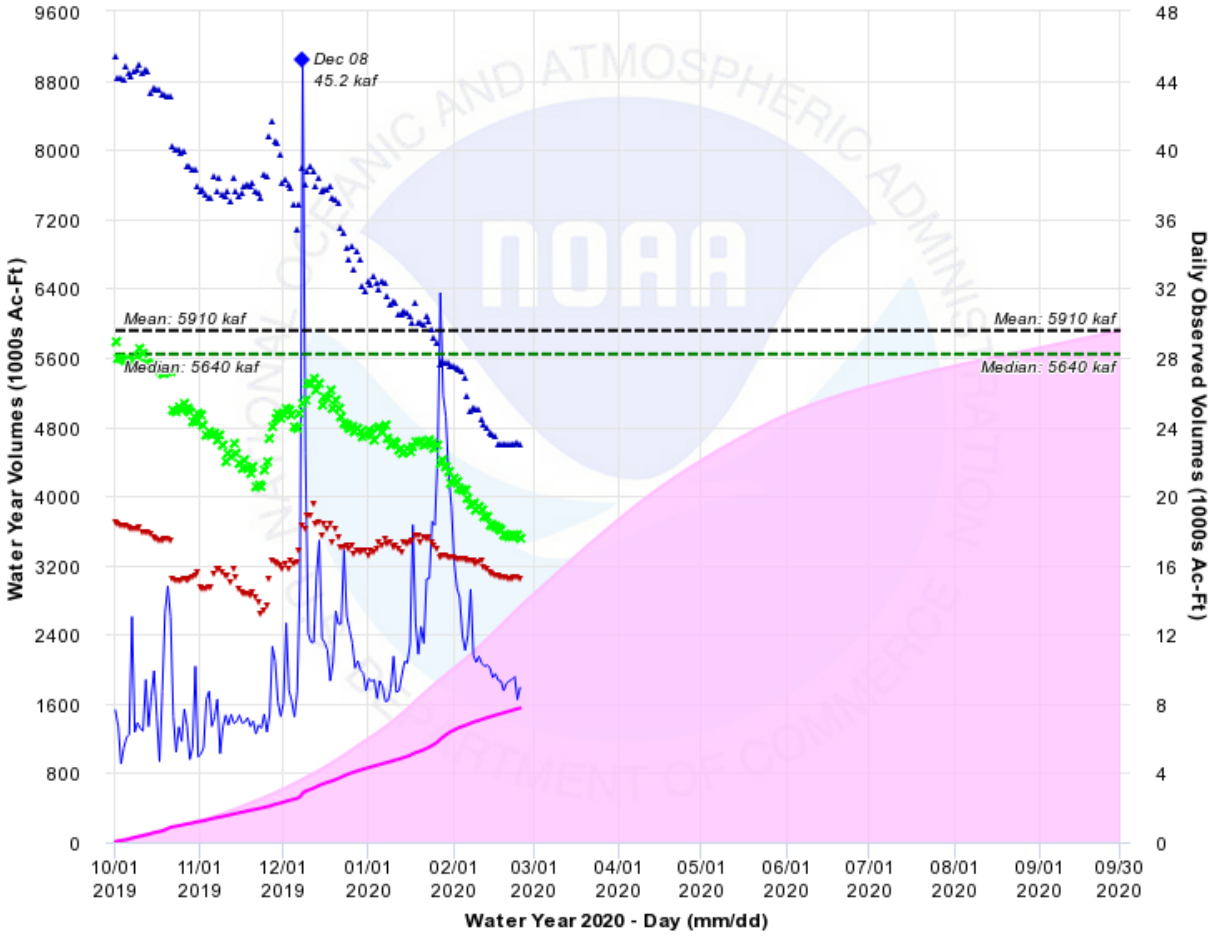
**Positive AO = Stable Polar Vortex** **Negative AO = Wavy Polar Vortex**



## SACRAMENTO - SHASTA DAM (SHDC1) 02/25/2020

**Most Probable: 3520 kaf | 59% of Average | 62% of Median**

Created: 02/25/2020 at 08:00 AM PST



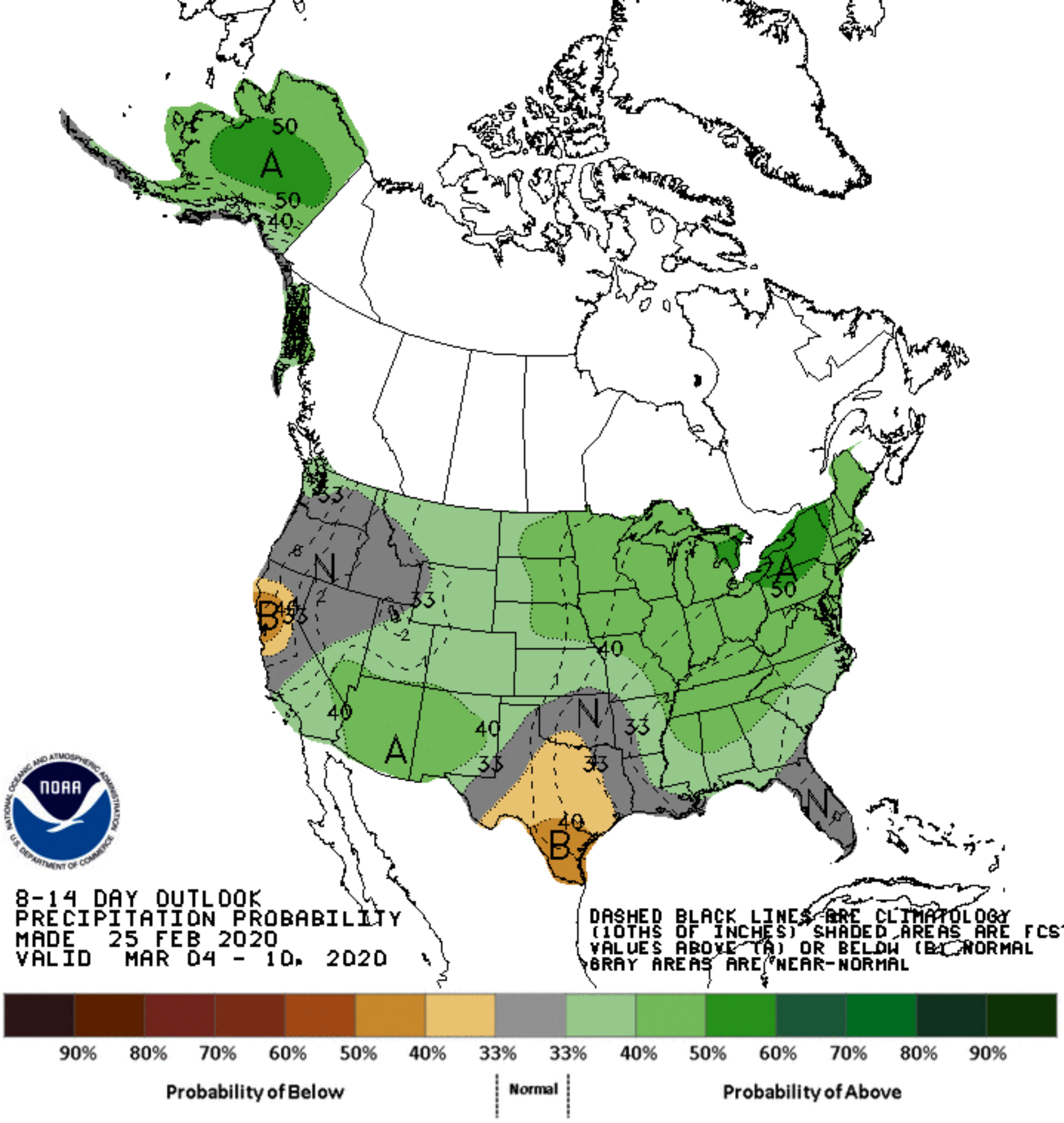

**Observed to Date Percent of Average: 57% (1550 kaf) Water Year to Date Average: 2720 kaf**

**Historical Water Year Vol Max: 10800 kaf in 1974 Historical Water Year Vol Min: 2480 kaf in 1924**

WY Volume Average | WY Volume Median | WY to Date Obs | WY to Date Avg | Daily Obs

Obs Peak | ESP WY Vol Fcst 10% | ESP WY Vol Fcst 25% | ESP WY Vol Fcst 50% | ESP WY Vol Fcst 75%

ESP WY Vol Fcst 90%

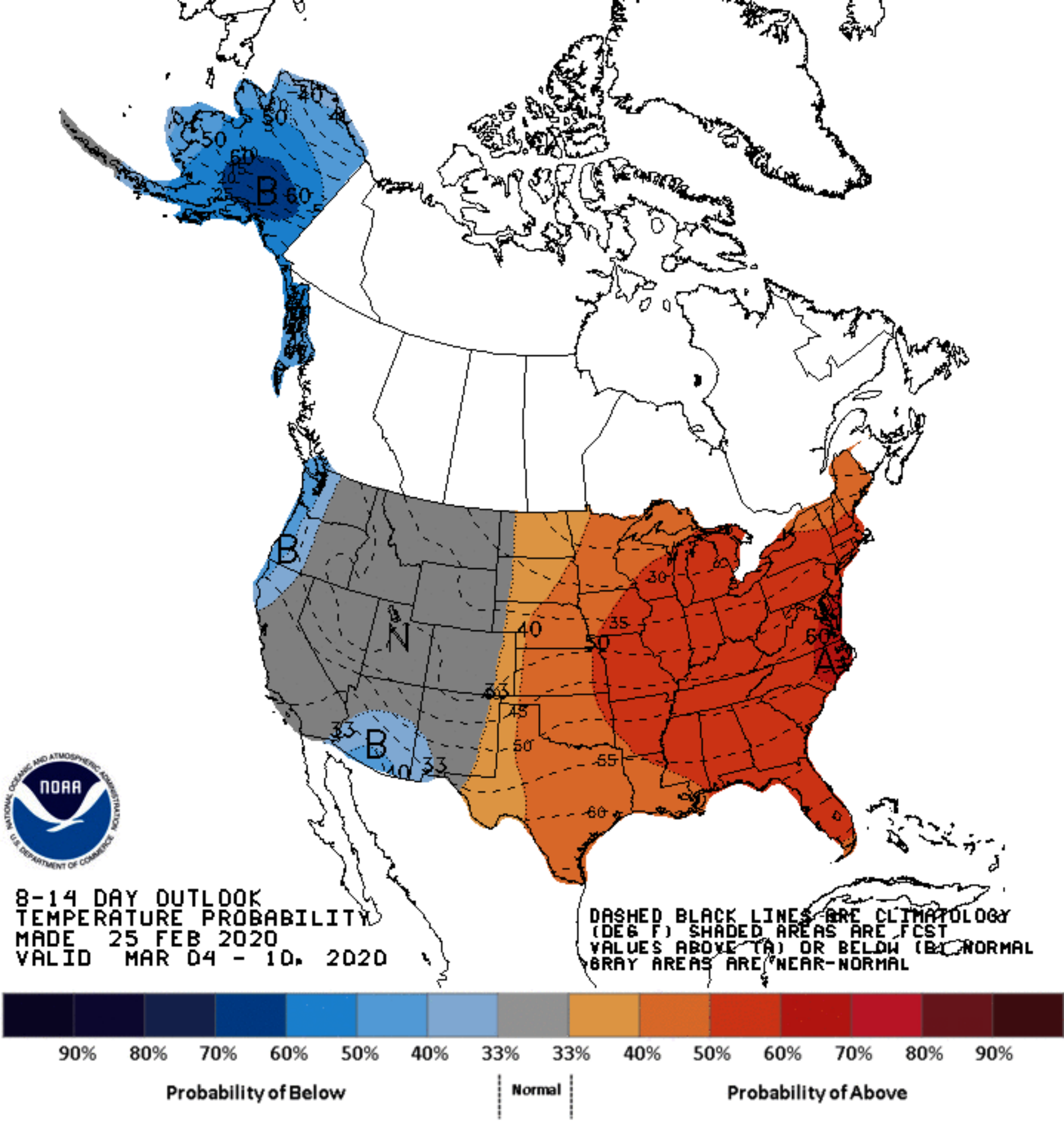



8-14 DAY OUTLOOK
PRECIPITATION PROBABILITY
MADE 25 FEB 2020
VALID MAR 04 - 10, 2020

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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8-14 DAY OUTLOOK
TEMPERATURE PROBABILITY
MADE 25 FEB 2020
VALID MAR 04 - 10, 2020
DASHED BLACK LINES ARE CLIMATOLOGY (DEG F) SHADED AREAS ARE FCST VALUES ABOVE (A) OR BELOW (B) NORMAL
GRAY AREAS ARE NEAR-NORMAL
NOAA
90% 80% 70% 60% 50% 40% 33% 33% 40% 50% 60% 70% 80% 90%
Probability of Below
Normal
Probability of Above