

# Technical Appendix A: Methodology Spreadsheet Description

This appendix outlines the process used to assess water supply and demand in the Sacramento-San Joaquin Delta (Delta) watershed and describes each input used for the analysis and output produced by the analysis. Each section of this document describes a separate tab in the Delta Water Unavailability Methodology Excel workbook (“spreadsheet”), the significance of each column, and data sources.

## Subwatersheds

This tab shows how Hydrologic Unit Code Level 8 (HUC8) watersheds from the U.S. Geological Survey (USGS) Watershed Boundary Database (WBD) are categorized into “subwatersheds” for the purpose of this analysis. It also indicates the primary watershed that each subwatershed is tributary to, as well as the subwatershed “type” (headwater or lower) assigned to each. These relationships underpin much of the analysis. A map of Delta subwatersheds can be found in Figure 3 of the main report.

Field Name(s)	Definition & Methodology	Data Source(s)
Watershed	The two primary river systems in the Delta watershed: Sacramento and San Joaquin.	USGS WBD
Subwatershed	An area encompassing one or more HUC8 watersheds, determined based on geospatial mapping of stream and diversion locations and the availability of full natural flow (FNF) supply locations (“gages”). Subwatershed is the smallest area over which water availability is determined.	Staff-determined

Field Name(s)	Definition & Methodology	Data Source(s)
Subwatershed Type	Subwatersheds are categorized as either “headwater” or “lower” for the purpose of this analysis: - A headwater subwatershed contains water demands which can only be met by water supplies within the subwatershed (i.e., there are no tributaries flowing into the subwatershed). - A lower subwatershed can receive water supplies from outside its boundaries (i.e., it is located downstream of the headwaters).	Staff-determined
HUC8	The boundaries of watersheds which contain land that all drains to the outlet, as delineated and classified by the USGS. This delineation provides a consistent boundary for classifying water supplies and demands for the analysis.	USGS WBD

To the right of the data table is a key for the various colors used for each tab of the spreadsheet. **Green tabs** contain data fields that can be updated or revised to change the analysis; cells with modifiable data are **highlighted green** throughout the spreadsheet. **Orange tabs** contain only a limited number of data fields that accept updates. **Red tabs** contain only data outputs and should not be modified.

## Supply Past Monthly

This tab contains historical monthly supply data for each of the 20 subwatersheds in the analysis, dating back as far as water year (WY) 1901 for some subwatersheds (NOTE: a water year runs from October of the previous year through September; e.g., WY 2020 is October 2019 through September 2020). Supply data consists of full natural flow (FNF, also known as “unimpaired flow”) data compiled from the California Data Exchange Center (CDEC), a March 2016 report from the Department of Water Resources (DWR) on unimpaired flows in the Central Valley from WY 1922-2014, and the California Nevada River Forecast Center (CNRFC). Direct links to individual gage datasets are provided in the spreadsheet. Supplies volumes are provided in units of acre-feet (AF). Certain fields are estimated or adjusted using gap-filling (GF) procedures, which are explained in the next section.

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Field Name(s)	Definition & Methodology	Data Source(s)
Year, WY, Month	The calendar year, water year, and calendar year month of the respective water supply volume. The dataset begins with water year 1901 (starting in October 1900) and continues through the end of water year 2021 (September 2021); data fields for future months are blank.	--
Sacramento Bend	Monthly FNF data for the Sacramento River at Bend subwatershed (including the Sacramento, McCloud, and Pit Rivers above Shasta Reservoir and Cow, Cottonwood, Battle, Clear, and Paynes Creeks): - CDEC station SBB, sensor 65, WY 1906-Present.	CDEC
Stony	Monthly FNF data for the Stony Creek subwatershed (at Black Butte Reservoir): - DWR subbasin UF4, WY 1922-2014. - CNRFC station EPRC1 (daily TAF summed to monthly AF) with GF augmentation, WY 2015-Present.	DWR, CNRFC w/ staff adjustments
Cache	Monthly FNF data for the Cache Creek subwatershed (above Rumsey): - DWR subbasin UF3, WY 1922-2014. - GF extrapolation based on Stony Creek, WY 2015-Present.	DWR, staff estimates
Upper Feather	Monthly FNF data for the Upper Feather River subwatershed (at Oroville Dam): - CDEC station FTO, sensor 65, WY 1906-Present.	CDEC
Yuba	Monthly FNF data for the Yuba River subwatershed (near Smartville): - CDEC station YRS, sensor 65, WY 1901-Present.	CDEC
Bear	Monthly FNF data for the Bear River subwatershed (near Wheatland): - DWR subbasin UF10, WY 1922-2014. - GF extrapolation based on Yuba River, WY 2015-Present.	DWR, staff estimates

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Field Name(s)	Definition & Methodology	Data Source(s)
Upper American	Monthly FNF data for the Upper American River subwatershed (at Folsom Dam): - CDEC station AMF, sensor 65, WY 1901-Present.	CDEC
Putah	Monthly FNF data for the Putah Creek subwatershed (near Winters or at Lake Berryessa): - DWR subbasin UF2, WY 1922-2014. - GF extrapolation based on Stony Creek, WY 2015-Present.	DWR, staff estimates
Upper Sacramento Valley	Monthly FNF data for the Upper Sacramento River Valley subwatershed (tributaries between Bend and Butte Slough, including Redbank, Elder, Thomes, Antelope, Mill, Deer, Big Chico, and Butte Creeks): - DWR subbasins UF5+UF7, WY 1922-2014. - CNRFC stations EDCC1+TCRC1+MLMC1+DCVC1+BKCC1 (daily TAF summed to monthly AF) with GF augmentation, WY 2015-Present.	DWR, CNRFC w/ staff adjustments
Sacramento Valley Floor	Monthly FNF data for the Sacramento Valley Floor subwatershed (minor east and west side tributaries between Stony Creek and the Delta, including tributaries to the Lower Feather and American Rivers): - DWR subbasin UF1, WY 1922-2014. - GF extrapolation based on Sacramento, Feather, and American Rivers, WY 2015-Present.	DWR, staff estimates
Sac Total	The sum of all subwatershed supplies in the Sacramento River watershed for the given month.	Calculated
Sac Complete Dataset?	Indicates if supply data values are present for all 10 subwatersheds in the Sacramento River watershed for the given month (TRUE/FALSE).	Calculated
Sac Water Year Type	Reconstructed water year hydrologic classification index for the Sacramento Valley, as published by DWR.	DWR

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Field Name(s)	Definition & Methodology	Data Source(s)
Chowchilla	Monthly FNF data for the Chowchilla River subwatershed (at Buchanan Reservoir): - DWR subbasin UF20, WY 1922-2014. - CNRFC station BHNC1 (daily TAF summed to monthly AF), WY 2015-Present.	DWR, CNRFC
Upper San Joaquin	Monthly FNF data for the Upper San Joaquin River subwatershed (at Friant Dam): - CDEC station SJF, sensor 65, WY 1901-Present.	CDEC
Fresno	Monthly FNF data for the Fresno River subwatershed (near Daulton or at Hidden Dam): - DWR subbasin UF21, WY 1922-2014. - CNRFC station HIDC1 (daily TAF summed to monthly AF), WY 2015-Present.	DWR, CNRFC
Merced	Monthly FNF data for the Merced River subwatershed (near Merced Falls): - CDEC station MRC, sensor 65, WY 1901-Present.	CDEC
Tuolumne	Monthly FNF data for the Tuolumne River subwatershed (at La Grange Dam): - CDEC station TLG, sensor 65, WY 1901-Present.	CDEC
Stanislaus	Monthly FNF data for the Stanislaus River subwatershed (below Goodwin Reservoir): - CDEC station SNS, sensor 65, WY 1901-Present.	CDEC
Calaveras	Monthly FNF data for the Calaveras River subwatershed (at Jenny Lind or New Hogan Reservoir): - DWR subbasin UF15, WY 1922-2014. - CNRFC station NHGC1 (daily TAF summed to monthly AF), WY 2015-Present.	DWR, CNRFC

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Field Name(s)	Definition & Methodology	Data Source(s)
Mokelumne	Monthly FNF data for the Mokelumne River subwatershed (near Mokelumne Hill): - CDEC station MKM, sensor 65, WY 1901-Present.	CDEC
Cosumnes	Monthly FNF data for the Cosumnes River subwatershed (at Michigan Bar): - CDEC station CSN, sensor 65, WY 1908-Present.	CDEC
San Joaquin Valley Floor	Monthly FNF data for the San Joaquin River Valley Floor subwatershed (including minor east and west side tributaries between the Chowchilla and American Rivers): - DWR subbasins UF12+UF17+UF24, WY 1922-2014. - CNRFC stations MPAC1+OWCC1+MEEC1 (daily TAF summed to monthly AF) + GF extrapolation based on Mokelumne, Cosumnes, San Joaquin, Merced, Tuolumne, and Stanislaus Rivers, WY 2015-Present.	DWR, CNRFC, staff estimates
SJ Total	The sum of all subwatershed supplies in the San Joaquin River watershed for the given month.	Calculated
SJ Complete Dataset?	Indicates if supply data values are present for all 10 subwatersheds in the San Joaquin River watershed for the given month (TRUE/FALSE).	Calculated
SJ Water Year Type	Reconstructed water year hydrologic classification index for the San Joaquin Valley, as published by DWR.	DWR
Total Supply	The sum of all water supplies in the Delta (Sacramento and San Joaquin River watersheds) for the given month.	Calculated
% Sacramento	The percent of the given month's total Delta supply which came from the Sacramento River watershed.	Calculated
% San Joaquin	The percent of the given month's total Delta supply which came from the San Joaquin River watershed.	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Delta Complete Dataset?	Indicates if supply data values are present for all 20 subwatersheds in the Delta watershed for the given month (TRUE/FALSE).	Calculated

## Supply Gap Filling (GF)

This tab contains monthly factors which are used to fill gaps in supply data for select subwatersheds, either to estimate missing past/forecasted data (extrapolation) or to adjust existing supply data (augmentation). These monthly average factors are computed based on supply data described in the previous section, and detailed methods for each subwatershed are described in the table below.

Field Name(s)	Definition & Methodology	Data Source(s)
Month	Month of the calendar year for which the gap-filling factor applies.	--
Cache-Stony Ratio (CSR)	Monthly factor used to extrapolate the FNF supply for the Cache Creek subwatershed based on data for the Stony Creek subwatershed: - CSR = DWR subbasin UF3 / DWR subbasin UF4, WY -1922-2014, removed outlying values >20 and averaged by month. - GF Cache = CSR*(EPRC1*SIF), WY 2015-Present and Forecasts.	Calculated
Stony Increase Factor (SIF)	Monthly factor used to augment recent FNF supply values for the Stony Creek subwatershed to approximate the entire subwatershed's supply based on past DWR data (CNRFC station EPRC1 is located upstream of several tributaries): - SIF = DWR subbasin UF4 / CNRFC station EPRC1, WYs 2013-2014, removed outlying values >6 and averaged by month. - GF Stony = SIF*EPRC1, WY 2015-Present and Forecasts.	Calculated

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Field Name(s)	Definition & Methodology	Data Source(s)
Bear-Yuba Ratio (BYR)	<p>Monthly factor used to extrapolate the FNF supply for the Bear River subwatershed based on data for the Yuba River subwatershed (CNRFC station CFWC1 has only forecasted data):</p> <ul style="list-style-type: none"> <li>- BYR = DWR subbasin UF10 / CDEC station YRS, WY -1922-2014, removed outlying value &gt;1 and averaged by month.</li> <li>- GF Bear = BYR*YRS, WY 2015-Present.</li> </ul>	Calculated
Elder-Thomes Increase Factor (ETIF)	<p>Monthly factor used to augment recent FNF supply values for west side tributaries in the Upper Sacramento River Valley subwatershed to approximate the supply of all west side tributaries based on past DWR data (CNRFC stations EDCC1 and TCRC1 do not include all west side tributaries):</p> <ul style="list-style-type: none"> <li>- ETIF = DWR subbasin UF5 / (CNRFC stations EDCC1+TCRC1), WYs 2013-2014, removed outlying values &gt;8 and averaged by month.</li> <li>- GF Upper Sacramento Valley West = ETIF*(EDCC1+TCRC1), WY 2015-Present and Forecasts.</li> </ul>	Calculated
Mill-Deer-Butte Increase Factor (MDBIF)	<p>Monthly factor used to augment recent FNF supply values for east side tributaries in the Upper Sacramento River Valley subwatershed to approximate the supply of all east side tributaries based on past DWR data (CNRFC stations MLMC1, DCVC1, and BKCC1 do not include all east side tributaries):</p> <ul style="list-style-type: none"> <li>- MDBIF = DWR subbasin UF7 / (CNRFC stations MLMC1+DCVC1+BKCC1), WYs 2013-2014, averaged by month.</li> <li>- GF Upper Sacramento Valley East = MDBIF*(MLMC1+DCVC1+BKCC1), WY 2015-Present and Forecasts.</li> </ul>	Calculated



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Field Name(s)	Definition & Methodology	Data Source(s)
Putah-Stony Ratio (PSR)	<p>Monthly factor used to extrapolate the FNF supply for the Putah Creek subwatershed based on data for the Stony Creek subwatershed:</p> <ul style="list-style-type: none"> <li>- PSR = DWR subbasin UF2 / DWR subbasin UF4, WY 1922-2014, removed outlying values of zero and averaged by month.</li> <li>- GF Putah = PSR*(EPRC1*SIF), WY 2015-Present and Forecasts.</li> </ul>	Calculated
Sacramento Valley Ratio (SRVR)	<p>Monthly factor used to extrapolate the FNF supply for the Sacramento River Valley Floor subwatershed based on data for the Sacramento, Feather, and American Rivers (no recent or projected supply data exists for the Valley Floor):</p> <ul style="list-style-type: none"> <li>- SRVR = DWR subbasin UF1 / CDEC stations SBB+FTO+AMF, WY -1922-2014, removed outlying values &gt;0.3 and averaged by month.</li> <li>- GF Sacramento Valley Floor = SRVR*(SBB+FTO+AMF), WY 2015-Present and Forecasted.</li> </ul>	Calculated
San Joaquin-Mokelumne-Cosumnes Ratio (SJMCR)	<p>Monthly factor used to extrapolate the FNF supply for east side tributaries in the San Joaquin River Valley Floor subwatershed based on data for the Mokelumne and Cosumnes Rivers (no recent or projected supply data exists for the Valley Floor):</p> <ul style="list-style-type: none"> <li>- SJMCR = DWR subbasin UF12 / CDEC stations MKM+CSN, WY -1922-2014, removed outlying values &gt;5 and averaged by month.</li> <li>- GF San Joaquin Valley Floor East = SJMCR*(MKM+CSN), WY 2015-Present and Forecasted.</li> </ul>	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
San Joaquin-Merced-Tuolumne-Stanislaus Ratio (SJMTSR)	Monthly factor used to estimate the FNF supply for west side tributaries in the San Joaquin River Valley Floor subwatershed based on data for the San Joaquin, Merced, Tuolumne, and Stanislaus Rivers (no recent or projected supply data exists for the Valley Floor): - SJMTSR = DWR subbasin UF24 / CDEC stations SJF+MRC+TLG+SNS, WY -1922-2014, removed outlying values >0.06 and averaged by month. - GF San Joaquin Valley Floor West = SJMTSR*(SJF+MRC+TLG+SNS), WY 2015-Present and Forecasted.	Calculated

## Supply Adjust (SA)

This tab contains monthly instream flow requirements for each subwatershed, which are used to increase available supplies to account for the abandonment of these dedicated flows below their intended reach. Flow requirements are sourced from the Division’s Sacramento Valley Water Allocation Model (SacWAM) and Water Supply Effects (WSE) model. Only requirements which crossed subwatershed boundaries or ended near the bottom of a subwatershed (less than 30 river miles from its mouth) are included. If the instream flow reach ends higher up in the subwatershed, such that it may meet demand within that subwatershed itself, the abandoned instream flow is not considered in the analysis. The origin of each instream flow requirement is detailed in the ‘Note’ column.

All flow values in the Supply Adjust (SA) table are given in average cubic feet per second (CFS) by month, which are converted to acre-feet (AF) per month later in the analysis (see Headwater Reductions and Analysis Watersheds sections below). The supply contribution of each subwatershed to the watershed-wide analysis is represented by the greater of either the past or forecasted full natural flow (FNF, see next section) or the abandoned instream flow in this table for the respective subwatershed and month. In other words, during very dry conditions instream flows were assumed to consist of supplemental reservoir releases which would replace available natural flows when abandoned below their intended reach. During wet conditions instream flows were assumed to consist of bypassed natural flows, which would not contribute abandoned water in excess of FNF below their intended reach.

## Supply Forecast

This tab contains forecasted monthly supply data (FNF) for each of the 20 subwatersheds in the analysis. Like past supply data, forecasted values consist of full natural flow (FNF, also known as “unimpaired flow”) estimates published by other agencies. Sources include DWR’s Bulletin 120 Water Supply Forecast (B-120) for the Sacramento Water Supply Index (SRWSI) and the San Joaquin Water Supply Index (SJWSI), the California Nevada River Forecast Center (CNRFC), gap-filled (GF) data for certain watersheds without published forecasts, and supply adjustments (SA) to account for abandoned instream flow dedications (see previous sections). Direct links to individual forecast datasets are provided in the spreadsheet. Supplies volumes are provided in units of thousand acre-feet (TAF) and converted in the spreadsheet to acre-feet (AF).

This tab is grouped vertically into six tables, separated by black rows. Each table contains forecasted FNF values with a given percent exceedance probability: 10%, 25%, 50%, 75%, 90%, and 99%. Data fields for past months of the year reference the Past Supply Monthly tab, while forecast values for future months must be updated at the beginning of each month. CNRFC forecasts are downloaded on the first of each month, while new B-120 forecasts are published on the fifth business day of each month from December-June. CNRFC forecasts require additional intermediate data processing to convert from their default format of 39 daily forecast traces in thousands of cubic feet per second (TCFS) to monthly exceedance probabilities in TAF, which is done outside the spreadsheet.

Field Name(s)	Definition & Methodology	Data Source(s)
Year, Month, Date	The calendar year, calendar year month, and date of the respective water supply forecast.	--
Sacramento Bend	Monthly FNF forecasts for the Sacramento River at Bend subwatershed: - B-120 SRWSI, Sacramento River above Bend Bridge.	B-120
Stony	Monthly FNF forecasts for the Stony Creek subwatershed (at Black Butte Reservoir): - CNRFC station EPRC1 (daily TCFS converted to monthly TAF) with GF augmentation.	CNRFC w/ staff adjustments
Cache	Monthly FNF forecasts for the Cache Creek subwatershed (above Rumsey): - GF extrapolation based on Stony Creek.	Staff estimates

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Field Name(s)	Definition & Methodology	Data Source(s)
Upper Feather	Monthly FNF forecasts for the Upper Feather River subwatershed: - B-120 SRWSI, Feather River at Oroville.	B-120
Yuba	Monthly FNF forecasts for the Yuba River subwatershed: - B-120 SRWSI, Yuba River near Smartville plus Deer Creek.	B-120
Bear	Monthly FNF forecasts for the Bear River subwatershed (near Wheatland): - GF extrapolation based on Yuba River.	Staff estimates
Upper American	Monthly FNF forecasts for the Upper American River subwatershed: - B-120 SRWSI, American River below Folsom Lake.	B-120
Putah	Monthly FNF forecast for the Putah Creek subwatershed (near Winters): - GF extrapolation based on Stony Creek.	Staff estimates
Upper Sacramento Valley	Monthly FNF forecasts for the Upper Sacramento River Valley subwatershed (tributaries between Bend and Butte Slough, including Redbank, Elder, Thomes, Antelope, Mill, Deer, Big Chico, and Butte Creeks): - CNRFC stations EDCC1+TCRC1+MLMC1+DCVC1+BKCC1 (daily TCFS converted to monthly TAF) with GF augmentation.	CNRFC w/ staff adjustments
Sacramento Valley Floor	Monthly FNF forecasts for the Sacramento Valley Floor subwatershed (minor east and west side tributaries between Stony Creek and the Delta, including tributaries to the Lower Feather and American Rivers): - GF extrapolation based on Sacramento, Feather, and American Rivers.	Staff estimates
Sac Total	The sum of all subwatershed supplies in the Sacramento River watershed for the given month and forecast exceedance.	Calculated
Versions of the previous 11 Sacramento subwatershed columns, all converted to AF.		

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Field Name(s)	Definition & Methodology	Data Source(s)
Chowchilla	Monthly FNF forecasts for the Chowchilla River subwatershed (at Buchanan Reservoir): - CNRFC station BHNC1 (daily TCFS converted to monthly TAF).	CNRFC
Upper San Joaquin	Monthly FNF forecasts for the Upper San Joaquin River subwatershed: - B-120 SJWSI, San Joaquin River inflow to Millerton Lake.	B-120
Fresno	Monthly FNF forecasts for the Fresno River subwatershed (at Hidden Dam): - CNRFC station HIDC1 (daily TCFS converted to monthly TAF).	CNRFC
Merced	Monthly FNF forecasts for the Merced River subwatershed: - B-120 SJWSI, Merced River below Merced Falls.	B-120
Tuolumne	Monthly FNF forecasts for the Tuolumne River subwatershed: - B-120 SJWSI, Tuolumne River below La Grange Reservoir.	B-120
Stanislaus	Monthly FNF forecasts for the Stanislaus River subwatershed: - B-120 SJWSI, Stanislaus River below Goodwin Reservoir.	B-120
Calaveras	Monthly FNF forecasts for the Calaveras River subwatershed (New Hogan Reservoir): - CNRFC station NHGC1 (daily TCFS converted to monthly TAF).	CNRFC
Mokelumne	Monthly FNF forecasts for the Mokelumne River subwatershed (near Mokelumne Hill): - CNRFC station MHBC1 (daily TCFS converted to monthly TAF).	CNRFC
Cosumnes	Monthly FNF forecasts for the Cosumnes River subwatershed (at Michigan Bar): - CNRFC station MHBC1 (daily TCFS converted to monthly TAF).	CNRFC

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Field Name(s)	Definition & Methodology	Data Source(s)
San Joaquin Valley Floor	Monthly FNF forecasts for the San Joaquin River Valley Floor subwatershed (including minor east and west side tributaries between the Chowchilla and American Rivers): - CNRFC stations MPAC1+OWCC1+MEEC1 (daily TCFS converted to monthly TAF) + GF extrapolation based on Mokelumne, Cosumnes, San Joaquin, Merced, Tuolumne, and Stanislaus Rivers.	CNRFC, staff estimates
SJ Total	The sum of all subwatershed supplies in the San Joaquin River watershed for the given month and forecast exceedance.	Calculated
Versions of the previous 11 San Joaquin subwatershed columns, all converted to AF.		
% Sacramento	The percent of total Delta supply for the given month and forecast exceedance which came from the Sacramento River watershed.	Calculated
% San Joaquin	The percent of total Delta supply for the given month and forecast exceedance which came from the San Joaquin River watershed.	Calculated
Stony	Original monthly FNF forecasts (pre-GF augmentation) for the Stony Creek subwatershed (at Black Butte Reservoir): - CNRFC station EPRC1 (daily TCFS converted to monthly TAF).	CNRFC
Sacramento Minor Streams West	Original monthly FNF forecasts (pre- GF augmentation) for two west side streams in the Upper Sacramento River Valley subwatershed (Elder and Thomes Creeks): - CNRFC stations EDCC1+TCRC1 (daily TCFS converted to monthly TAF).	CNRFC

Field Name(s)	Definition & Methodology	Data Source(s)
Sacramento Minor Streams East	Original monthly FNF forecasts (pre- GF augmentation) for three east side streams in the Upper Sacramento River Valley subwatershed (Mill, Deer, and Butte Creeks): - CNRFC stations MLMC1+DCVC1+BKCC1 (daily TCFS converted to monthly TAF).	CNRFC
San Joaquin Valley Floor	Original daily FNF data (before being added to other GF extrapolated datasets) for three east side streams in the San Joaquin River Valley Floor subwatershed (Mariposa, Owens, and Bear Creeks): - CNRFC stations MPAC1+OWCC1+MEEC1 (daily TCFS converted to monthly TAF).	CNRFC

## Supply Daily Monitoring

This tab contains daily cumulative supply data (full natural flow, FNF) for a single month, which can be compared to the monthly water supply forecasts described in the previous section for the purpose of selecting the most appropriate supply forecast to use when issuing notices of water unavailability. There are inherent uncertainties in the forecasting of water supply, and daily water supplies may vary depending on changing conditions (e.g., precipitation, temperatures, or snowpack). Since supply forecasts are only updated at the beginning of each month, this daily cumulative data monitoring will help provide an indication of which forecast is likely to be the most accurate predictor of actual conditions as the month continues. If the daily cumulative FNF exceeds a given forecast only part-way through the month, the next highest forecast may be used to adjust the timing or scope of notices of water unavailability.

This tab is grouped vertically into three tables, separated by black rows:

1. The top table shows monthly forecasted FNF values for each subwatershed by exceedance, all in acre-feet (referencing the Supply Forecast tab). The cells in this table have conditional formatting to **highlight red** if the cumulative daily supply for that subwatershed (middle table) has exceeded the given monthly forecast.
2. The middle table shows the calculated total cumulative daily FNF for each subwatershed, all converted to acre-feet (AF).
3. The bottom table contains the daily FNF supply values, which must be updated regularly from the data sources linked in the middle table (NOTE: any negative

reported values should be changed to zero). These values are in the default units of each source: AF, thousand acre-feet (TAF), or cubic feet per second (CFS).

Unless otherwise noted, the below table defines fields from the bottom table in the spreadsheet. Values in the top table reference the previous Supply Forecast tab, while values in the middle table are computed from data in the bottom table.

Field Name(s)	Definition & Methodology	Data Source(s)
Category	The exceedance probability of the given forecasted supply value (top table only).	--
Date	Days of the calendar year month over which water supply is being tracked. This tab can only track one month's supply at a time.	--
Sacramento Bend	Daily FNF data for the Sacramento River at Bend subwatershed: - CDEC station BND, sensor 8	CDEC
Stony	Daily FNF data for the Stony Creek subwatershed (at Black Butte Reservoir): - CNRFC station EPRC1 (original data to right of the main table) with GF augmentation.	CNRFC w/ staff adjustments
Cache	Daily FNF data for the Cache Creek subwatershed (above Rumsey): - GF extrapolation based on Stony Creek (with GF augmentation).	Staff estimates
Upper Feather	Daily FNF data for the Upper Feather River subwatershed (at Oroville Dam): - CDEC station ORO, sensor 8.	CDEC
Yuba	Daily FNF data for the Yuba River subwatershed (near Smartville): - CDEC station YRS, sensor 8.	CDEC
Bear	Daily FNF data for the Bear River subwatershed (near Wheatland): - GF extrapolation based on Yuba River.	Staff estimates
Upper American	Daily FNF data for the Upper American River subwatershed (at Lake Natoma): - CDEC station NAT, sensor 8.	CDEC



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Field Name(s)	Definition & Methodology	Data Source(s)
Putah	Daily FNF data for the Putah Creek subwatershed (near Winters): - GF extrapolation based on Stony Creek.	Staff estimates
Upper Sacramento Valley	Daily FNF data for the Upper Sacramento River Valley subwatershed (tributaries between Bend and Butte Slough, including Redbank, Elder, Thomes, Antelope, Mill, Deer, Big Chico, and Butte Creeks): - CNRFC stations EDCC1+TCRC1+MLMC1+DCVC1+BKCC1 (original data to right of main table) with GF augmentation.	CNRFC w/ staff adjustments
Sacramento Valley Floor	Daily FNF for the Sacramento Valley Floor subwatershed (minor east and west side tributaries between Stony Creek and the Delta, including tributaries to the Lower Feather and American Rivers): - GF extrapolation based on Sacramento, Feather, and American Rivers, WY 2015-Present.	Staff estimates
Sac Total	The sum of all subwatershed supplies in the Sacramento River watershed for the given day (all converted to AF).	Calculated
Chowchilla	Daily FNF data for the Chowchilla River subwatershed (at Buchanan Reservoir): - CNRFC station BHNC1.	CNRFC
Upper San Joaquin	Daily FNF data for the Upper San Joaquin River subwatershed (at Friant Dam): - CDEC station SJF, sensor 8.	CDEC
Fresno	Daily FNF for the Fresno River subwatershed (at Hidden Dam): - CNRFC station HIDC1.	CNRFC
Merced	Daily FNF for the Merced River subwatershed (at New Exchequer Dam/Lake McClure): - CDEC station EXC, sensor 8.	CDEC
Tuolumne	Daily FNF data for the Tuolumne River subwatershed (at La Grange Dam): - CDEC station TLG, sensor 8.	CDEC

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Field Name(s)	Definition & Methodology	Data Source(s)
Stanislaus	Daily FNF data for the Stanislaus River subwatershed (at Goodwin Dam): - CDEC station GDW, sensor 8.	CDEC
Calaveras	Daily FNF data for the Calaveras River subwatershed (at New Hogan Reservoir): - CNRFC station NHGC1.	CDEC
Mokelumne	Daily FNF data for the Mokelumne River subwatershed (near Mokelumne Hill): - CDEC station MKM, sensor 8.	CDEC
Cosumnes	Daily FNF data for the Cosumnes River subwatershed (at Michigan Bar): - CDEC station MHB, sensor 8.	CDEC
San Joaquin Valley Floor	Daily FNF data for the San Joaquin River Valley Floor subwatershed (including minor east and west side tributaries between the Chowchilla and American Rivers): - CNRFC stations MPAC1+OWCC1+MEEC1 (original data to right of main table) + GF extrapolation based on Mokelumne, Cosumnes, San Joaquin, Merced, Tuolumne, and Stanislaus Rivers.	CNRFC, staff estimates
SJ Total	The sum of all subwatershed supplies in the Sacramento River watershed for the given day (all converted to AF).	Calculated
Total Supply	The sum of all water supplies in the Delta (Sacramento and San Joaquin River watersheds) for the given day (all converted to AF).	Calculated
% Sacramento	The percent of the given month's total Delta supply which came from the Sacramento River watershed.	Calculated
% San Joaquin	The percent of the given month's total Delta supply which came from the San Joaquin River watershed.	Calculated
Stony	Original daily FNF data (pre-adjustment) for the Stony Creek subwatershed (at Black Butte Reservoir): - CNRFC station EPRC1.	CNRFC

Field Name(s)	Definition & Methodology	Data Source(s)
Sacramento Minor Streams West	Original daily FNF data (pre-GF augmentation) for two west side streams in the Upper Sacramento River Valley subwatershed (Elder and Thomes Creeks): - CNRFC stations EDCC1 and TCRC1.	CNRFC
Sacramento Minor Streams East	Original daily FNF data (pre-GF augmentation) for three east side streams in the Upper Sacramento River Valley subwatershed (Mill, Deer, and Butte Creeks): - CNRFC stations MLMC1, DCVC1, and BKCC1.	CNRFC
San Joaquin Valley Floor	Original daily FNF data (before being added to other GF extrapolated datasets) for three east side streams in the San Joaquin River Valley Floor subwatershed (Mariposa, Owens, and Bear Creeks): - CNRFC stations MPAC1, OWCC1, and MEEC1.	CNRFC

## Demand

This tab contains monthly water diversion (demand) data for active, consumptive water right records in the Delta watershed. This data originated from the State Water Board’s Electronic Water Rights Information Management System (eWRIMS) database, and Technical Appendix B provides detailed information regarding the process used to select these water right records. Within this tab, each row provides data on a single water right record and quantifies its total water diversions (demands) for each month during 2018 and 2019 after select quality control procedures. The diversions (demands) are further adjusted in the Demand Separated tab, which will be discussed later in this report, to account for water rights with diversion locations across multiple subwatersheds, return flows, etc. More information about the selection of these water right records and the quality control process conducted to review and correct the demand dataset as necessary is provided in section 2.2 of the main report and in Technical Appendix B.

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Field Name(s)	Definition & Methodology	Data Source(s)
Application ID	Water Right Application ID Number: each water right record on file with the State Water Board is assigned a unique Application ID Number.	eWRIMS database
Water Right Type	Water right record type: - Appropriative: A post-1914 appropriative water right pursuant to a permit or license from the Board. - Statement of Div (Diversion) and Use: A riparian or pre-1914 appropriative claim.	eWRIMS database
HUC4 Name	The Hydrologic Unit Code (HUC) level 4 subregion within which a water right record's point of diversion (POD) is located, as defined using the U.S. Geological Survey (USGS) Watershed Boundary Dataset (WBD). The HUC 4 watersheds located within the Delta watershed are the Sacramento River watershed and the San Joaquin River watershed. (NOTE: Some rights divert from multiple watersheds, so these values are modified and expanded upon in the Demand Separated tab.)	USGS WBD
In Legal Delta?	Indicates whether a water right record contains a POD that is located within the Sacramento-San Joaquin Legal Delta, as defined by the 1959 Delta Protection Act. (NOTE: Some right records contain PODs both outside of and within the Legal Delta. These are further examined in the Demand Separated tab.)	eWRIMS database
Face Value (AFA)	The maximum annual amount of water authorized for diversion under an appropriative water right. Riparian and pre-1914 appropriative claims do not have an assigned face value. The face value for these records is listed as zero for the purposes of this analysis.	eWRIMS database

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Field Name(s)	Definition & Methodology	Data Source(s)
HUC8 Name	The name of the HUC level 8 watershed within which the right record's POD is located, as defined using the USGS WBD. (NOTE: Some water right records include PODs located in multiple HUC8 watersheds, so these values are modified and expanded upon in the Demand Separated tab.)	eWRIMS database, USGS WBD
Priority Date	<p>The priority date of post-1914 water right records:</p> <ul style="list-style-type: none"> <li>- Appropriative: Priority date was determined based on the Application Acceptance Date and Application Received Date fields within the eWRIMS database. If an Application Acceptance Date and Application Received Date were both available for a particular water right record, the Priority Date was assigned as the earlier of the two dates.</li> <li>- Statements of Diversion and Use: Specific priority dates are not currently assigned to Statements of Diversion and Use included in the demand dataset, therefore, all were marked as "Statement." All Statements of Diversion and Use were considered to have priority dates that are senior to all post-1914 appropriative water rights.</li> </ul>	eWRIMS database
Primary Owner	Name of the primary owner of the water right record.	eWRIMS database
Beneficial Use(s)	Concatenated list of the beneficial use(s) of water associated with the water right record, as defined by Water Code §§ 660-669.	eWRIMS database

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Field Name(s)	Definition & Methodology	Data Source(s)
2018 Annual Diversion	The total reported diversion of the water right record in calendar year 2018. This value includes direct diversion and diversion to storage and is based on user-submitted information in annual reports. Values for select water right records were manually reviewed by staff and corrected as necessary.	eWRIMS database, with staff adjustments as necessary
Jan-Dec 2018 Diversion	The total reported diversion of the water right record in each month of calendar year 2018. This value includes direct diversion and diversion to storage and are based on user-submitted information in annual reports. Values for select water right records were manually reviewed by staff and corrected as necessary.	eWRIMS database, with staff adjustments as necessary
2018 Review	Indicates whether and how the 2018 reported diversion was reviewed or corrected by staff: - Estimated: Staff reviewed and corrected the user-reported diversion value. - Reviewed not changed: Staff reviewed the reported diversion value but did not apply a correction. - Not Reviewed: Staff did not manually review this annual report.	Staff-determined
2019 Annual Diversion	The total reported diversion of the water right record in calendar year 2019. This value includes direct diversion and diversion to storage and is based on user-submitted information in annual reports. Values for select water right records were manually reviewed and corrected by staff as necessary.	eWRIMS database with staff adjustments

Field Name(s)	Definition & Methodology	Data Source(s)
Jan-Dec 2019 Diversion	The total reported diversion of the water right record in each month of calendar year 2019. This value includes direct diversion and diversion to storage and are based on user-submitted information in annual reports. Values for select water right records were manually reviewed and corrected by staff as necessary.	eWRIMS database with staff adjustments
2019 Review	Indicates whether and how the 2019 reported diversion was reviewed or corrected by staff: - Estimated: Staff reviewed and corrected the user-reported diversion value. - Reviewed not change: Staff reviewed the reported diversion value but did not apply a correction. - Not Review: Staff did not manually review this annual report.	Staff-determined

## Demand Factors

This tab contains monthly factors which are used to adjust demand data to account for return flows within each subwatershed on a monthly basis. The factors, which include return flows from both agricultural and municipal water uses, are estimated using CalSim 3 results published by DWR. Results from WY 2014 are used, as its hydrology most closely matches forecasts for the remainder of 2021. Demand factors are calculated for each month in the Sacramento and San Joaquin River watersheds as the percent of diversion which returned as flow within the same month (Factor = Total Diversions / Total Return Flows) from May through September.

All values in the Demand Factor table are given as multipliers (i.e., a demand factor of 0.6 means that the analysis will reduce demands within the given subwatershed in the given month by 40%). Demand values in the analysis are adjusted by multiplying monthly demand for a given water right by the monthly factor for the appropriate subwatershed where it diverts. The 2021 Methodology currently only applies demand factors to reduce demands within lower valley portions of the Delta watershed (the Upper Sacramento Valley, Sacramento Valley Floor, and San Joaquin Valley Floor subwatersheds) because return flows from diversions within headwater subwatersheds are not expected to be available within the same subwatershed (i.e., they return further

downstream on the valley floor). Demand adjustments are done in the Demand Separated tab of the spreadsheet (see Demand Separated section).

## Demand Separated

This tab contains monthly demand data for water rights in the Delta watershed, which are modified from the Demand tab (see previous section) to account for return flows and water rights with points of diversion (PODs) in multiple subwatersheds. This demand separation is necessary because annual water right reports, and thus the data in the Demand tab of the spreadsheet, are provided for each water right rather than each POD. While the data necessary to separate demands originated from the Division's eWRIMS database, staff judgement is required to develop the Demand Weights listed in this tab based on the nature of PODs associated with each right. Demand adjustments to account for return flows are sourced from the Demand Factors tab of the spreadsheet. Each row quantifies monthly demands from a single water right's POD(s) within a single HUC8.

Field Name(s)	Definition & Methodology	Data Source(s)
Application ID	Application ID of the water right, sourced from the Demand tab. Water rights with PODs in multiple HUC8s and water rights in the Legal Delta are split into multiple rows: one for each HUC8, and one for each watershed for Legal Delta rights.	eWRIMS database
HUC8	The name of the Hydrologic Unit Code Level 8 where demand in the row is located. Water right PODs are automatically assigned a HUC8 value in eWRIMS based on their location. This tab contains additional detail not found in the Demand tab, splitting rights that have PODs in multiple HUC8s into multiple rows (one for each HUC8).	eWRIMS database, USGS WBD
Subwatershed	Subwatershed where demand in the row is located. Sourced from the Subwatersheds tab based on the HUC8 value.	Staff-determined
Watershed	The watershed in which the demand occurs: the Sacramento River watershed or the San Joaquin River watershed. Sourced from the Subwatersheds tab based on the HUC8 value.	USGS WBD



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Field Name(s)	Definition & Methodology	Data Source(s)
Legal Delta?	Indicates if demand for that row occurs within the Legal Delta (TRUE/FALSE). Based on the In Legal Delta value from the Demand tab and validated to ensure only rows which account for Legal Delta demands are flagged as TRUE.	eWRIMS database w/ staff adjustments
Statement Demand?	Whether the application ID is associated with a riparian or pre-1914 claim (Yes/No). Water demands associated with these claims are referred to as "Statement Demand". Based on the Application ID.	Staff-determined
Priority Date	The verified priority date of a water right, sourced from the Demand tab. The priorities of Project rights listed in Board Decision 1641 (excepting 2 New Melones Project rights, per Board Decision 1422) are manually changed to 4/1/2021.	eWRIMS database w/ staff adjustments
Demand Weight	<p>The percent of the specified water right's demand which occurs within the specified HUC8:</p> <ul style="list-style-type: none"> <li>- Demand Weight = number of PODs within the respective HUC8 divided by the total number of PODs. Only active PODs that are not Points of Rediversion or Points of Offstream Storage are considered in this calculation.</li> <li>- The sum of Demand Weights for most water rights is equal to one (see exceptions in next column).</li> </ul>	Staff-determined

Field Name(s)	Definition & Methodology	Data Source(s)
Demand Comment	Additional detail about the Demand Weight or other aspects of the demand: - Has POD(s) outside Delta watershed: The water right has one or more associated PODs which divert from streams outside the Delta watershed (sum of Demands Weights is less than one). - Inactive: The POD in the specified HUC8 is not actively used (Demand Weight is zero). - Point of Rediversion/Offstream Storage: The POD does not divert natural flow (Demand Weight is zero). - Project: The water right is listed in Board Decision 1641, so its Priority Date is set to 4/1/2021. Also indicates actual water right Priority Date, sourced from Demand tab.	Staff-determined
January-December 2018	Monthly demands of the specified water right within the specified HUC8, calculated as follows: (Application ID Demand for month of 2018, sourced from Demand tab) * (Demand Factor for subwatershed and month, sourced from Supply Adjust tab) * (Demand Weight)	Calculated
January-December 2019	Monthly demands of the specified water right within the specified HUC8, calculated as follows: (Application ID Demand for month of 2019, sourced from Demand tab) * (Demand Factor for subwatershed and month, sourced from Supply Adjust tab) * (Demand Weight)	Calculated

## Headwater Reductions

This tab compiles supply and demand data from each subwatershed in the Delta watershed and: 1) reduces any demands that cannot be met in headwater subwatersheds so that they are not reflected in the watershed-wide analysis, and 2) removes both supply and demand for any headwater subwatersheds considered to be disconnected from the Delta watershed because supplies are insufficient to meet all

senior demands. Supply data is sourced from the Supply Forecast tab of the spreadsheet, while demand data is sourced from the Demand Separated tab of the spreadsheet.

Field Name(s)	Definition & Methodology	Data Source(s)
Subwatershed	Smallest area over which water availability is determined, based on one or more HUC8s. Sourced from the Demand Separated tab.	Staff-determined
Subwatershed Type	Subwatersheds are categorized as either “headwater” or “lower” for the purpose of this analysis: - A headwater subwatershed contains water demands which can only be met by water supplies within the subwatershed (i.e., there are no tributaries flowing into the subwatershed). - A lower subwatershed can receive water supplies from outside its boundaries (i.e., it is located downstream of the headwaters).	Staff-determined
Watershed	The two primary river systems in the Delta: Sacramento and San Joaquin.	USGS WBD
Concatenate	Combined text of Subwatershed, Watershed, and Month, separated by “ ”.	--
MonthNum and Months	The calendar year month (either number or three-letter abbreviation) of the respective water supply and demand.	--
Statement Demand (for both 2018 and 2019 Demand datasets)	The sum of demand for all Statements for the respective subwatershed, month, and demand year, excluding demands in the Legal Delta. Sourced from the Demand Separated tab.	RMS w/ staff adjustments

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Field Name(s)	Definition & Methodology	Data Source(s)
1914-1919, 1920s, 1930s, 1940s, 1950s, 1960s, 1970s, 1980s, 1990s, 2000s, and 2010s Demand (for both 2018 and 2019 Demand datasets)	The sum of demand for all Post-1914 Appropriative rights with a priority date within the specified decade for the respective subwatershed, month, and demand year, excluding demands in the Legal Delta. Sourced from the Demand Separated tab.	RMS w/ staff adjustments
Project Demand (for both 2018 and 2019 Demand datasets)	The sum of demand for all Project water rights which export water outside the Delta watershed for the respective subwatershed, month, and demand year, excluding demands in the Legal Delta. Sourced from the Demand Separated tab.	RMS w/ staff adjustments
Supply Forecast 10% Exceedance	Supply for the respective subwatershed and month. For past months, the actual value from the Supply Past Monthly tab is shown. For future months, the forecasted supply with a 10% exceedance probability from the Supply Forecast tab is shown.	CDEC, B-120, CNRFC, staff estimates
Supply Forecast 50% Exceedance	Supply for the respective subwatershed and month. For past months, the actual value from the Supply Past Monthly tab is shown. For future months, the forecasted supply with a 50% exceedance probability from the Supply Forecast tab is shown.	CDEC, B-120, CNRFC, staff estimates
Supply Forecast 90% Exceedance	Supply for the respective subwatershed and month. For past months, the actual value from the Supply Past Monthly tab is shown. For future months, the forecasted supply with a 90% exceedance probability from the Supply Forecast tab is shown.	CDEC, B-120, CNRFC, staff estimates
Supply Forecast 99% Exceedance	Supply for the respective subwatershed and month. For past months, the actual value from the Supply Past Monthly tab is shown. For future months, the forecasted supply with a 99% exceedance probability from the Supply Forecast tab is shown.	CDEC, B-120, CNRFC, staff estimates

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<b>Field Name(s)</b>	<b>Definition &amp; Methodology</b>	<b>Data Source(s)</b>
Discontinuity? (2018 Demand, 90% Exceedance Supply)	Whether a given headwater subwatershed is considered disconnected from the Delta watershed in a given month (Yes/No). A headwater subwatershed is considered disconnected when the supply is insufficient to meet all senior water right demands, based on Supply Forecast 90% Exceedance and 2018 Statement Demand values.	Staff-determined
2018 Total Demand	The sum of 2018 Statement and all Post-1914 Appropriative Demand values, including Project Demand, for the respective subwatershed and month.	Calculated
2018 Reduced Demand for Discontinuity & Unmet Demand (90% Exceedance Supply)	2018 demands for the respective subwatershed and month, eliminating any demand which cannot physically be met by available supply: - In headwater subwatersheds, the lesser of 2018 Total Demand or 90% Supply Forecast 90% Exceedance. - In disconnected headwater subwatersheds, equal to zero. - In lower subwatersheds, the 2018 Total Demand (no reduction due to supply).	Calculated
Discontinuity? (2019 Demand, 90% Exceedance Supply)	Whether a given headwater subwatershed is considered disconnected from the Delta watershed in a given month (Yes/No). A headwater subwatershed is considered disconnected when the supply is insufficient to meet all senior water right demands, based on Supply Forecast 90% Exceedance and 2019 Statement Demand values.	Staff-determined
2019 Total Demand	The sum of 2019 Statement and all Post-1914 Appropriative Demand values, including Project Demand, for the respective subwatershed and month.	Calculated

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Field Name(s)	Definition & Methodology	Data Source(s)
2019 Reduced Demand for Discontinuity & Unmet Demand (90% Exceedance Supply)	2019 demands for the respective subwatershed and month, eliminating any demand which cannot physically be met by available supply: <ul style="list-style-type: none"> <li>- In headwater subwatersheds, the lesser of 2019 Total Demand or 90% Supply Forecast 90% Exceedance.</li> <li>- In disconnected headwater subwatersheds, equal to zero.</li> <li>- In lower subwatersheds, the 2019 Total Demand (no reduction due to supply).</li> </ul>	Calculated
Supply Forecast 90% Exceedance with Headwater Abandoned Flow Replacement	Supply for the respective subwatershed and month which contributes to the Delta watershed. The greater of either the Supply Forecast 90% Exceedance value or the abandoned flow for the respective subwatershed and month (sourced from the Supply Adjust tab, converted to acre-feet per month).	B-120, CNRFC, staff estimates
2018 Reduced Supply for Discontinuity (90% Exceedance with Abandoned Flow Replacement)	When discontinuity is found for the respective subwatershed and month based on 2018 demand data (i.e., Discontinuity? 2018 = Yes), both supply and demand are removed from the watershed-wide analysis. This column sets supplies for disconnected headwater subwatersheds to zero.	Calculated
2019 Reduced Supply for Discontinuity (90% Exceedance with Abandoned Flow Replacement)	When discontinuity is found for the respective subwatershed and month based on 2019 demand data (i.e., Discontinuity? 2019 = Yes), both supply and demand are removed from the watershed-wide analysis. This column sets supplies for disconnected headwater subwatersheds to zero.	Calculated

## Subwatershed Viz

This tab compiles supply and demand data from each subwatershed in the Delta watershed to generate the interactive Headwater Subwatershed Analysis visualization at:

[https://www.waterboards.ca.gov/waterrights/water\\_issues/programs/drought/drought\\_to\\_ols\\_methods/delta\\_method.html](https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/drought_to_ols_methods/delta_method.html)

Field Name(s)	Definition & Methodology	Data Source(s)
Subwatershed	Smallest area over which water availability is determined, based on one or more HUC8s. Sourced from the Demand Separated tab.	Staff-determined
Subwatershed Type	Subwatersheds are categorized as either “headwater” or “lower” for the purpose of this analysis: - A headwater subwatershed contains water demands which can only be met by water supplies within the subwatershed (i.e., there are no tributaries flowing into the subwatershed). - A lower subwatershed can receive water supplies from outside its boundaries (i.e., it is located downstream of the headwaters).	Staff-determined
Watershed	The two primary river systems in the Delta: Sacramento and San Joaquin.	USGS WBD
MonthNum and Months	The calendar year month (either number or three-letter abbreviation) of the respective water supply and demand.	--
Discontinuity?	Whether a given headwater subwatershed is considered disconnected from the Delta watershed in a given month based on a given year of demand data (Yes/No). Sourced from the “Discontinuity?” column in the Headwater Reductions tab.	Staff-determined

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Field Name(s)	Definition & Methodology	Data Source(s)
Demand Type	Demand category, based on water right priority. Statement Demand refers to demand by riparian and pre-1914 claims. Appropriative demands are largely separated by priority decade, except for demand by the Central Valley Project and the State Water Project (Project Demand).	eWRIMS w/ staff adjustments
Demand Year	Calendar year on which demand data is based (2018 or 2019).	RMS
Demand	Monthly total demand for the respective subwatershed, month, demand year, and Demand Type, prior to the elimination of unmet headwater demand and demand in disconnected subwatersheds. Sourced from the Demand columns in the Headwater Reductions tab.	RMS w/ staff adjustments
Cumulative Demand for Subwatershed & Month	Total cumulative demand for the respective subwatershed, month, and demand year. Added from most senior to most junior rights.	Calculated
Demand After Reduction (90% Exceedance Supply)	Monthly demand for the respective subwatershed, month, and demand year, after unmet headwater demand and demand in disconnected subwatersheds are removed. If Cumulative Demand exceeds the available supply, the remaining supply is credited towards the last added (senior) demand type and later (junior) demands are zero.	Calculated
Supply After Reduction (90% Exceedance Supply)	Monthly supply for the respective subwatershed and month (past months from the Supply Past Monthly tab, future months from the Supply Forecast tab). Set to zero if Discontinuity?=Yes.	Calculated



Field Name(s)	Definition & Methodology	Data Source(s)
2021 Supply 10% Exceedance	Supply for the respective subwatershed and month. For past months, the actual value from the Supply Past Monthly tab is shown. For future months, the forecasted supply with a 10% exceedance probability from the Supply Forecast tab is shown.	CDEC, B-120, CNRFC, staff estimates
2021 Supply 50% Exceedance	Supply for the respective subwatershed and month. For past months, the actual value from the Supply Past Monthly tab is shown. For future months, the forecasted supply with a 50% exceedance probability from the Supply Forecast tab is shown.	CDEC, B-120, CNRFC, staff estimates
2021 Supply 90% Exceedance	Supply for the respective subwatershed and month. For past months, the actual value from the Supply Past Monthly tab is shown. For future months, the forecasted supply with a 90% exceedance probability from the Supply Forecast tab is shown.	CDEC, B-120, CNRFC, staff estimates
2021 Supply 99% Exceedance	Supply for the respective subwatershed and month. For past months, the actual value from the Supply Past Monthly tab is shown. For future months, the forecasted supply with a 99% exceedance probability from the Supply Forecast tab is shown.	CDEC, B-120, CNRFC, staff estimates
Watershed Supply Summary Table (Watershed, MonthNum, Month, Supply Type, Supply)	Monthly supply statistics for the Sacramento River and San Joaquin River watersheds. Sourced from the Supply Past Monthly and Supply Forecast tabs to compare median hydrologic conditions of past wet years and critically dry years to 90% exceedance forecasts for 2021.	CDEC, B-120, CNRFC, staff estimates

## Watershed Viz

This tab compiles supply and demand data used to assess water unavailability at the watershed level. Formulas in this tab: 1) remove any demands that cannot be met in headwater subwatersheds, 2) remove both supply and demand for any disconnected

headwater subwatersheds, and 3) distribute demand within the Legal Delta between the Sacramento River and the San Joaquin River watersheds before producing final supply and demand values that populate the interactive Watershed Analysis visualization at:

[https://www.waterboards.ca.gov/waterrights/water\\_issues/programs/drought/drought\\_to\\_ols\\_methods/delta\\_method.html](https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/drought_to_ols_methods/delta_method.html)

Field Name(s)	Definition & Methodology	Data Source(s)
Watershed	The two primary river systems in the Delta: Sacramento and San Joaquin.	USGS WBD
Month	The calendar year month of the respective water supply and demand.	--
Supply Ratio	The percent of supply that the respective watershed (Sacramento River or San Joaquin River) contributes to the Delta watershed in the respective month. Based on 90% exceedance supply forecasts, including the greater of FNF or subwatershed abandoned flow, and calculated after supplies from disconnected subwatersheds are removed based on demands in the respective year. Sourced from the 2018 and 2019 Reduced Supply for Discontinuity columns in the Headwater Reduction tab.	Calculated
Demand Type	Demand category, based on water right priority. Statement Demand refers to demand by riparian and pre-1914 claims. Appropriative demands are largely separated by priority decade, except for demand by the Central Valley Project and the State Water Project (Project Demand).	eWRIMS w/ staff adjustments
Demand Year	Calendar year on which demand data is based (2018 or 2019).	RMS
Headwater Demand Reduction	The amount of demand removed from the watershed-wide analysis due to reduction of demands that cannot be met by supplies in headwater subwatersheds. Sourced from the Subwatershed Viz tab: Headwater Demand Reduction = Demand column – Demand after Reduction	Calculated

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Field Name(s)	Definition & Methodology	Data Source(s)
Demand w/o Legal Delta (Headwater Reduced)	Total demand for the respective watershed, month, and demand year, excluding demand in the Legal Delta. Sourced from the Demand Separated tab: Demand w/o Legal Delta (Headwater Reduced) = total watershed demand – demand from PODs in the Legal Delta (Legal Delta=TRUE) – Headwater Demand Reduction	Calculated
Legal Delta Demand	Demand for PODs within the Legal Delta for the respective month and demand type. Sourced from the Demand Separated tab.	eWRIMS w/ staff adjustments
Prorated Legal Delta Demand by Watershed	Demand for PODs within the Legal Delta for the respective watershed, month, and demand type. Legal Delta demands are distributed between the Sacramento River and San Joaquin River watersheds based on the percent of supply that each contributes in a given month (based on the 90% exceedance supply forecast, accounting for supply reductions due to disconnection and the replacement of abandoned instream flows in excess of subwatershed FNF): Prorated Legal Delta Demand by Watershed = Supply Ratio * Legal Delta Demand In other words, if the Sacramento River watershed constitutes 80% of Delta watershed supply in a given month, then 80% of Legal Delta demand is charged against the Sacramento River watershed supply for that month and 20% is charged against San Joaquin River watershed.	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Total Watershed Demand	Total demand for the respective watershed, month, and demand year after Legal Delta demand has been distributed between the two watersheds: Total Watershed Demand = Demand w/o Legal Delta (Headwater Reduced) + Prorated Legal Delta Demand by Watershed	Calculated
Total Watershed Supply	Total supply for the respective watershed and month after excluding supply from disconnected subwatersheds. Sourced from the 2018 and 2019 Reduced Supply for Discontinuity columns in the Headwater Reduction tab.	Calculated

## Analysis Headwaters

This tab contains a tabular version of the water supply and demand visualizations for 14 headwater subwatersheds in the Delta watershed. In each, past and forecasted supplies are used to determine water availability for each water right in order of priority date. Rights which are not expected to have water available to meet their demands due to limited local supplies are flagged for the receipt of a notice of water unavailability, and these unmet demands are excluded from the Watershed Analysis (see next section). If the Headwaters Analysis indicates that any Statements of Diversion and Use (senior demands) would face water unavailability, all supplies and demands from that subwatershed are excluded from its respective Watershed Analysis. In other words, these streams are assumed to not have connectivity to the Delta watershed due to senior demands exceeding all available water supplies.

This analysis is set-up for each headwater subwatershed as follows:

1. The water rights listed in the Demand Separated tab of the spreadsheet are grouped by subwatershed.
2. Any rights located in the Legal Delta are excluded (this only occurs in the furthest downstream reaches of the Putah Creek, Stanislaus River, Calaveras River, and Cosumnes River headwater subwatersheds). Water availability for these rights is only analyzed in the Watershed Analysis, as they are assumed to have access to water from both the Sacramento and San Joaquin Rivers and not be limited by local supplies.
3. Any duplicate rights within each subwatershed are merged (this only occurs in the Sacramento River above Bend and Upper American River headwater

subwatersheds, where there are rights that divert from multiple HUC8s within the same subwatershed).

4. Rights within each subwatershed are sorted by priority date, with the most senior rights on top. All Statements are assumed to have senior priority over all post-1914 appropriative rights.
5. On a monthly basis for each right within a subwatershed, each of the following parameters is calculated or determined: demand, cumulative supply available, water availability (i.e., will this right receive a notice of water unavailability?), demand met, and demand unmet.

This tab is grouped into sixteen tables. The fourteen tables on the left, separated by black rows, contain the analysis for each headwater subwatershed: Sacramento River above Bend, Stony Creek, Cache Creek, Upper Feather River, Yuba River, Bear River, Upper American River, Putah Creek, Upper San Joaquin River, Merced River, Tuolumne River, Stanislaus River, Calaveras River, and Cosumnes River.

The upper table on the right side of this tab indicates the supply forecast exceedance and monthly supply volumes used for each individual subwatershed, sourced from the Supply Forecast tab. The lower table on the right side of this tab indicates if any statements within each subwatershed faced water unavailability in each month (i.e., if the subwatershed’s supplies and demands should be excluded from the Watershed Analysis due to lack of connectivity with the Delta watershed). These cells have conditional formatting to **highlight red** if the subwatershed lacks connectivity.

NOTE: To save computation time, this tab contains largely static values. The first row of the top table (or the first two rows of the 2021 Supply Cumulative column), **highlighted in blue**, contain sample formulas described in detail in the table below.

Field Name(s)	Definition & Methodology	Data Source(s)
Subwatershed	Smallest area over which water availability is determined, based on one or more HUC8s. This tab contains data for only headwater subwatersheds (see Subwatersheds section), sourced from the Demand Separated tab.	Staff-determined
Application ID	Application ID of each water right, sourced from the Demand Separated tab. Any duplicate Application IDs within a single subwatershed are merged.	eWRIMS database
Primary Owner	Name of the primary owner of the water right or water right claim, sourced from the Demand tab.	eWRIMS database

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Field Name(s)	Definition & Methodology	Data Source(s)
Priority Date	The verified priority date of a water right, sourced from the Demand Separated tab. Project rights listed in Board Decision 1641 are assigned a 4/1/2021 priority date. Claimed water rights are marked as “Statement” and assumed to be senior to all post-1914 appropriative rights.	eWRIMS database w/ staff adjustments
2018 Demand, Jan-Sep	Monthly demands by each water right in the respective subwatershed, summed from the Demand Separated tab. Excludes any demands in the Legal Delta.	RMS w/ staff adjustments
2021 Supply Cumulative, Jan-Sep	Available water supply to meet each water right’s Demand, calculated as follows: - For the first water right in each subwatershed, equal to the subwatershed’s monthly supply from the upper-right table in the spreadsheet. - For the next water right, the Supply Cumulative available to the previous right minus the previous rights’ Demand Potentially Met in Subwatershed (see below). - Continued for each next junior water right, until all Demands are accounted for or there is no remaining water supply available.	CDEC, B-120, CNRFC, staff estimates, staff-determined
Water Unavailable? Jan-Sep	If water is anticipated to be unavailable to the respective water right in the respective month. Determined if Demand exceeds Supply Cumulative (TRUE/FALSE). These cells have conditional formatting to <b>highlight red</b> if water is unavailable for a given right and month.	Staff-determined

Field Name(s)	Definition & Methodology	Data Source(s)
Demand Potentially Met in Subwatershed, Jan-Sep	Amount of each right's Demand which can be met by available supply within a given month, calculated as follows: - If Supply Cumulative > Demand, equal to Demand. - If $0 < \text{Supply Cumulative} < \text{Demand}$ , equal to Supply Cumulative (Water Unavailable, but a portion of Demand can be met). - If Supply Cumulative = 0, equal to zero (Water Unavailable).	Calculated
Demand Unmet in Subwatershed, Jan-Sep	Amount of each right's Demand which cannot be met by available water supply within a given month, calculated as follows: - If Demand Potentially Met = Demand, equal to zero. - If Demand Potentially Met < Demand, equal to Demand – Demand Potentially Met. - If Demand Potentially Met = 0, equal to Demand.	Calculated

## Analysis Watersheds

This tab contains a tabular version of the Sacramento and San Joaquin Watershed-wide water supply and demand visualizations. In each watershed, total forecasted supplies are used to determine water availability for each right in order of priority date. Demands compared in this analysis include those in headwater subwatersheds which may be met by local supplies (see previous section), as well as all demands located in lower subwatersheds and within the Legal Delta. Rights which are not expected to have water available to meet their demands are flagged for the receipt of a notice of water unavailability. This is in addition to notices identified in the Headwater Subwatershed Analysis; while there may be enough water present locally to meet a given demand, those supplies may not actually be available if they are needed to supply more senior rights further downstream in the watershed. Headwater subwatersheds where Statements of Diversion and Use (senior demands) may receive notices have their supplies and demands removed from the Watershed Analysis.

This analysis is set-up for each watershed as follows:

1. The water rights listed in the Demand Separated tab of the spreadsheet are grouped by watershed. Rights within the Legal Delta are present in both watersheds so that they can be prorated to each based on available supplies.
2. Any duplicate rights within each subwatershed are merged (this occurs only in the Sacramento River above Bend, Upper American River, Upper Sacramento Valley, Sacramento Valley Floor, and San Joaquin Valley Floor subwatersheds, where some rights divert from multiple HUC8s within the same subwatershed).
3. Rights within each watershed are sorted by priority date, with the most senior rights on top. All Statements are assumed to have senior priority over all post-1914 appropriative rights.
4. On a monthly basis for each right within a watershed, each of the following parameters is calculated or determined: demand (both total and headwater subwatershed demand which can potentially be met by local supplies), cumulative supply available, water availability (i.e., will this right receive a notice of water unavailability?), demand met, and demand unmet.

This tab is grouped into four tables. The two tables on the left, separated by black rows, contain the analysis for the Sacramento and San Joaquin River watersheds. The upper table on the right side of this tab indicates the supply forecast exceedance and monthly supply volumes used for each individual subwatershed, which are summed to a total for each watershed. Monthly supply ratios for the Delta watershed are calculated for each watershed for the purpose of Legal Delta demand proration. The lower table on the right side of this tab indicates any headwater subwatersheds whose supplies and demands were excluded if any statements were flagged for receipt of a notice of water unavailability (sourced from the Analysis Headwaters tab). These cells have conditional formatting to **highlight red** if the subwatershed was excluded.

NOTE: To save computation time, this tab contains largely static values. The first row of the top table (or the first two rows of the 2021 Supply Cumulative column), **highlighted in orange**, contain sample formulas described in detail in the table below.

Field Name(s)	Definition & Methodology	Data Source(s)
Watershed	The watershed in which the demand occurs, Sacramento River or San Joaquin River. Sourced from the Demand Separated tab. Legal Delta demands are present in both watersheds, with their demands prorated between them.	USGS WBD
Subwatershed	Smallest area over which water availability is determined, based on one or more HUC8s. Sourced from the Demand Separated tab.	Staff-determined



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Field Name(s)	Definition & Methodology	Data Source(s)
Application ID	Application ID of each water right, sourced from the Demand Separated tab. Any duplicate Application IDs within a single subwatershed are merged.	eWRIMS database
Primary Owner	Name of the primary owner of the water right or water right claim, sourced from the Demand tab.	eWRIMS database
Priority Date	The verified priority date of a water right, sourced from the Demand Separated tab. Project rights listed in Board Decision 1641 are assigned a 4/1/2021 priority date. Claimed water rights are marked as "Statement" and assumed to be senior to all post-1914 appropriative rights.	eWRIMS database w/ staff adjustments
Legal Delta?	If demand for that row occurs within the Legal Delta (TRUE/FALSE), sourced from the Demand Separated tab. Each water right located in the Legal Delta is present in both the Sacramento and San Joaquin Watershed Analyses.	eWRIMS database w/ staff adjustments
Headwater Subwatershed?	If demand for that row occurs within a headwater subwatershed (TRUE/FALSE), sourced from the Subwatersheds tab.	Staff-determined
2018 Demand, Jan-Sep	Monthly demands by each water right in the respective subwatershed, summed from the Demand Separated tab. If the right is located in the Legal Delta, the demand is multiplied by the respective watershed's supply ratio for the respective month (from the upper-right table in the spreadsheet) in order to prorate these demands between both watersheds.	RMS w/ staff adjustments

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Field Name(s)	Definition & Methodology	Data Source(s)
Water Unavailable in Subwatershed? Jan-Sep	If water is anticipated to be unavailable in a headwater subwatershed (TRUE/FALSE): <ul style="list-style-type: none"> <li>- If located in a headwater subwatershed, sourced from Water Unavailable? value in Analysis Headwaters tab.</li> <li>- FALSE if located in a lower subwatershed.</li> </ul> These cells have conditional formatting to <b>highlight red</b> if water is unavailable for a given right and month.	Staff-determined
Demand Potentially Met in Subwatershed, Jan-Sep	Monthly demands by each water right which can physically be met within the respective subwatershed: <ul style="list-style-type: none"> <li>- If any statements received notices in the given headwater subwatershed and month, equal to zero (see lower table to right in spreadsheet).</li> <li>- If located in a headwater subwatershed and not zero, equal to Demand Potentially Met in Subwatershed value from Analysis Headwaters tab.</li> <li>- If located in a lower subwatershed, equal to 2018 Demand.</li> </ul>	Calculated
2021 Supply Cumulative, Jan-Sep	Available water supply to meet each water right's Demand Potentially Met, calculated as follows: <ul style="list-style-type: none"> <li>- For the first water right in each watershed, equal to the total watershed monthly supply from the upper-right table in the spreadsheet.</li> <li>- For the next water right, the Supply Cumulative available to the previous right minus the previous right's Demand Met in Watershed (see below).</li> <li>- Continued for each next junior water right, until all Demands are accounted for or there is no remaining water supply available.</li> </ul>	CDEC, B-120, CNRFC, staff estimates

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Field Name(s)	Definition & Methodology	Data Source(s)
Water Unavailable in Watershed? Jan-Sep	If water is anticipated to be unavailable to the respective water right in the respective month. Determined if Demand Potentially Met exceeds Supply Cumulative (TRUE/FALSE). These cells have conditional formatting to <b>highlight red</b> if water is unavailable for a given right and month.	Staff-determined
Demand Met in Watershed, Jan-Sep	Amount of each right's Demand Potentially Met which can be met by available supply within a given month, calculated as follows: - If Supply Cumulative > Demand Potentially Met, equal to Demand Potentially Met. - If 0 < Supply Cumulative < Demand Potentially Met, equal to Supply Cumulative (Water Unavailable, but a portion of Demand can be met). - If Supply Cumulative = 0, equal to zero (Water Unavailable).	Calculated
Demand Unmet in Watershed, Jan-Sep	Amount of each right's Demand which will be unmet by available water supply within a given month, calculated as follows: - If Demand Met = Demand Potentially Met, equal to zero. - If Demand Met < Demand Potentially Met, equal to Demand Potentially Met – Demand Met. - If Demand Met = 0, equal to Demand Potentially Met.	Calculated
Water Unavailable? Jan-Sep	If the water right is anticipated to receive a notice of water unavailability in the given month, either from the Headwaters Analysis (Water Unavailable in Subwatershed?) or Watershed Analysis (Water Unavailable in Watershed?). These cells have conditional formatting to <b>highlight red</b> if water is unavailable for a given right and month.	Staff-determined

## Analysis Legal Delta

This tab contains information on water rights located in the Legal Delta. Because these rights are assumed to have access to supplies from both the Sacramento and San Joaquin Rivers to meet their demands (see 2018 Demand column in Analysis Watersheds tab), this tab quantifies total demands and demands met from each watershed to identify which rights may receive notices of water unavailability. Water rights in the Legal Delta will only receive a notice if water is anticipated to be unavailable from both watersheds. This tab does not contain any new analysis, it only compiles values from the Analysis Watersheds tab for rights located in the Legal Delta. Duplicate rights were merged in this tab, so each row represents a single water right.

NOTE: To save computation time, this tab contains largely static values. The first row of the table, **highlighted in blue**, contain sample formulas described in detail in the table below.

Field Name(s)	Definition & Methodology	Data Source(s)
Application ID	Application ID of each water right, sourced from the Demand Separated tab.	eWRIMS database
Primary Owner	Name of the primary owner of the water right or water right claim, sourced from the Demand tab.	eWRIMS database
Priority Date	The verified priority date of a water right, sourced from the Demand Separated tab. Project rights listed in Board Decision 1641 are assigned a 4/1/2021 priority date. Claimed water rights are marked as "Statement" and assumed to be senior to all post-1914 appropriative rights.	eWRIMS database w/ staff adjustments
2018 Sacramento Demand, Jan-Sep	Monthly demands by each water right from the Sacramento River watershed, sourced from the 2018 Demand column of the Analysis Watersheds tab.	RMS w/ staff adjustments
2018 San Joaquin Demand, Jan-Sep	Monthly demands by each water right from the San Joaquin River watershed, sourced from the 2018 Demand column of the Analysis Watersheds tab.	RMS w/ staff adjustments

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Field Name(s)	Definition & Methodology	Data Source(s)
Water Unavailable from Sacramento? Jan-Sep	If the water right is anticipated to face water unavailability from the Sacramento River watershed in a given month (Water Unavailable?), sourced from the Water Unavailable? column of the Analysis Watersheds tab. These cells have conditional formatting to <b>highlight red</b> if water is unavailable for a given right and month.	Staff-determined
Water Unavailable from San Joaquin? Jan-Sep	If the water right is anticipated to face water unavailability from the San Joaquin River watershed in a given month (Water Unavailable?), sourced from the Water Unavailable? column of the Analysis Watersheds tab. These cells have conditional formatting to <b>highlight red</b> if water is unavailable for a given right and month.	Staff-determined
Sacramento Demand Met, Jan-Sep	Amount of each right's Demand in the Sacramento River watershed which can be met by available supplies, sourced from the Analysis Watersheds tab.	Staff-determined
San Joaquin Demand Met, Jan-Sep	Amount of each right's Demand in the San Joaquin River watershed which can be met by available supplies, sourced from the Analysis Watersheds tab.	Staff-determined
Water Unavailable? Jan-Sep	If the water right is anticipated to face water unavailability from both the Sacramento and San Joaquin River watersheds in a given month, meaning it would receive a notice of water unavailability. These cells have conditional formatting to <b>highlight red</b> if water is unavailable for a given right and month.	Staff-determined