

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 5 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 2021 is October 2020 through September 2021). 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. Supply volumes are provided in units of acre-feet (AF), converted from thousand acre-feet (TAF) for some data sources. 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 current and 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 for WY 1906-Present.	CDEC
Stony	Monthly FNF data for the Stony Creek subwatershed (at Black Butte Reservoir): - DWR subbasin UF4 for WY 1922-2014. - CNRFC station EPRC1 (daily TAF summed to monthly AF) with GF augmentation for WY 2015-Present.	DWR, CNRFC w/ staff adjustments
Cache	Monthly FNF data for the Cache Creek subwatershed (above Rumsey): - DWR subbasin UF3 for WY 1922-2014. - GF extrapolation based on Stony Creek for 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 for WY 1906-Present.	CDEC
Yuba	Monthly FNF data for the Yuba River subwatershed (near Smartville): - CDEC station YRS, sensor 65 for WY 1901-Present.	CDEC
Bear	Monthly FNF data for the Bear River subwatershed (near Wheatland): - DWR subbasin UF10 for WY 1922-2014. - GF extrapolation based on Yuba River for 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 for WY 1901-Present.	CDEC
Putah	Monthly FNF data for the Putah Creek subwatershed (near Winters): - DWR subbasin UF2 for WY 1922-2014. - GF extrapolation based on Stony Creek for 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 for WY 1922-2014. - CNRFC stations EDCC1+TCRC1+MLMC1+DCVC1+BKCC1 (daily TAF summed to monthly AF) with GF augmentation for 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 for WY 1922-2014. - GF extrapolation based on Sacramento, Feather, and American Rivers for 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 for WY 1922-2014. - CNRFC station BHNC1 (daily TAF summed to monthly AF) for 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 for WY 1901-Present.	CDEC
Fresno	Monthly FNF data for the Fresno River subwatershed (near Daulton or at Hidden Dam): - DWR subbasin UF21 for WY 1922-2014. - CNRFC station HIDC1 (daily TAF summed to monthly AF) for WY 2015-Present.	DWR, CNRFC
Merced	Monthly FNF data for the Merced River subwatershed (near Merced Falls): - CDEC station MRC, sensor 65 for WY 1901-Present.	CDEC
Tuolumne	Monthly FNF data for the Tuolumne River subwatershed (at La Grange Dam): - CDEC station TLG, sensor 65 for WY 1901-Present.	CDEC
Stanislaus	Monthly FNF data for the Stanislaus River subwatershed (below Goodwin Reservoir): - CDEC station SNS, sensor 65 for WY 1901-Present.	CDEC
Calaveras	Monthly FNF data for the Calaveras River subwatershed (at Jenny Lind or New Hogan Reservoir): - DWR subbasin UF15 for WY 1922-2014. - CNRFC station NHGC1 (daily TAF summed to monthly AF) for 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 for WY 1901-Present.	CDEC
Cosumnes	Monthly FNF data for the Cosumnes River subwatershed (at Michigan Bar): - CDEC station CSN, sensor 65 for 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 for 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 for 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 watershed supply which came from the Sacramento River watershed.	Calculated
% San Joaquin	The percent of the given month's total Delta watershed 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 for WY -1922-2014, removed outlying values >20 and averaged by month. - GF Cache = CSR*(EPRC1*SIF) for 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 for WYs 2013-2014, removed outlying values >6 and averaged by month. - GF Stony = SIF*EPRC1 for WY 2015-Present and Forecasts.	Calculated

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Field Name(s)	Definition & Methodology	Data Source(s)
Bear-Yuba Ratio (BYR)	Monthly factor used to extrapolate the FNF supply for the Bear River subwatershed based on data for the Yuba River subwatershed: - BYR = DWR subbasin UF10 / CDEC station YRS for WY -1922-2014, removed outlying value >1 and averaged by month. - GF Bear = BYR*YRS for WY 2015-Present and Forecasts.	Calculated
Elder-Thomes Increase Factor (ETIF)	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): - ETIF = DWR subbasin UF5 / (CNRFC stations EDCC1+TCRC1) for WYs 2013-2014, removed outlying values >8 and averaged by month. - GF Upper Sacramento Valley West = ETIF*(EDCC1+TCRC1) for WY 2015-Present and Forecasts.	Calculated
Mill-Deer-Butte Increase Factor (MDBIF)	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): - MDBIF = DWR subbasin UF7 / (CNRFC stations MLMC1+DCVC1+BKCC1) for WYs 2013-2014, averaged by month. - GF Upper Sacramento Valley East = MDBIF*(MLMC1+DCVC1+BKCC1) for WY 2015-Present and Forecasts.	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"> - PSR = DWR subbasin UF2 / DWR subbasin UF4 for WY 1922-2014, removed outlying values of zero and averaged by month. - GF Putah = PSR*(EPRC1*SIF) for WY 2015-Present and Forecasts. 	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"> - SRVR = DWR subbasin UF1 / CDEC stations SBB+FTO+AMF for WY 1922-2014, removed outlying values >0.3 and averaged by month. - GF Sacramento Valley Floor = SRVR*(SBB+FTO+AMF) for WY 2015-Present and Forecasted. 	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"> - SJMCR = DWR subbasin UF12 / CDEC stations MKM+CSN for WY -1922-2014, removed outlying values >5 and averaged by month. - GF San Joaquin Valley Floor East = SJMCR*(MKM+CSN) for WY 2015-Present and Forecasted. 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
San Joaquin-Merced-Tuolumne-Stanislaus Ratio (SJMTSR)	<p>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):</p> <ul style="list-style-type: none"> - SJMTSR = DWR subbasin UF24 / CDEC stations SJF+MRC+TLG+SNS for WY - 1922-2014, removed outlying values >0.06 and averaged by month. - GF San Joaquin Valley Floor West = SJMTSR*(SJF+MRC+TLG+SNS) for 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 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) Sacramento Water Supply Index (SRWSI) and San Joaquin Water Supply Index (SJWSI), the California Nevada River Forecast Center (CNRFC), and gap-filled (GF) data for certain watersheds without published forecasts. 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 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 are updated at the beginning of each month. CNRFC forecasts are downloaded on the first of each month, while new B-120 SRWSI/SJWSI forecasts are published on the fifth business day of each month from December-May. 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 of 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. - When B-120 unavailable, CNRFC station BDBC1 (daily TCFS converted to monthly TAF).	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 (at Oroville): - B-120 SRWSI. - When B-120 unavailable, CNRFC station ORDC1 (daily TCFS converted to monthly TAF).	B-120
Yuba	Monthly FNF forecasts for the Yuba River subwatershed (near Smartville plus Deer Creek or Englebright Reservoir): - B-120 SRWSI. - When B-120 unavailable, CNRFC station HLEC1 (daily TCFS converted to monthly TAF).	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 (below Folsom Lake): - B-120 SRWSI. - When B-120 unavailable, CNRFC station FOLC1 (daily TCFS converted to monthly TAF).	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

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Field Name(s)	Definition & Methodology	Data Source(s)
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
Supply forecasts for all Sacramento subwatersheds are converted to AF.		
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 (inflow to Millerton Lake): - B-120 SJWSI. - When B-120 unavailable, CNRFC station FRAC1 (daily TCFS converted to monthly TAF).	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 (below Merced Falls or Exchequer Reservoir): - B-120 SJWSI. - When B-120 unavailable, CNRFC station EXQC1 (daily TCFS converted to monthly TAF).	B-120

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Field Name(s)	Definition & Methodology	Data Source(s)
Tuolumne	Monthly FNF forecasts for the Tuolumne River subwatershed (below La Grange Reservoir or New Don Pedro Reservoir): - B-120 SJWSI. - When B-120 unavailable, CNRFC station NDPC1 (daily TCFS converted to monthly TAF).	B-120
Stanislaus	Monthly FNF forecasts for the Stanislaus River subwatershed (below Goodwin Reservoir or New Melones Reservoir): - B-120 SJWSI. - When B-120 unavailable, CNRFC station NMSC1 (daily TCFS converted to monthly TAF).	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
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

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Field Name(s)	Definition & Methodology	Data Source(s)
Supply forecasts for all San Joaquin subwatersheds are converted to AF.		
% Sacramento	The percent of total Delta watershed supply for the given month and forecast exceedance which came from the Sacramento River watershed.	Calculated
% San Joaquin	The percent of total Delta watershed 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 at Paskenta): - CNRFC stations EDCC1+TCRC1 (daily TCFS converted to monthly TAF).	CNRFC
Sacramento Minor Streams East	Original monthly FNF forecasts (pre- GF augmentation) for three east side streams in the Upper Sacramento River Valley subwatershed (Mill Creek at Los Molinos, Deer Creek at Vina, and Butte Creek at Chico): - 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 Creek at Mariposa Reservoir, Owens Creek at Owens Reservoir, and Bear Creek at McKee Road): - 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 are 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. Additional methods to assess water availability based on precipitation events or other forecasts may be used during the wet season.

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 helps 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 partway 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 are updated from the data sources linked in the middle table (NOTE: any negative reported values are 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)
Forecast	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.	--

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Field Name(s)	Definition & Methodology	Data Source(s)
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 with GF augmentation (original data to right of the main table).	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
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 with GF augmentation (original data to right of main table).	CNRFC w/ staff adjustments

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Field Name(s)	Definition & Methodology	Data Source(s)
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.	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
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

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Field Name(s)	Definition & Methodology	Data Source(s)
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-GF augmentation) for the Stony Creek subwatershed (at Black Butte Reservoir): - CNRFC station EPRC1.	CNRFC
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 at Paskenta): - 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 Creek at Los Molinos, Deer Creek at Vina, and Butte Creek at Chico): - CNRFC stations MLMC1, DCVC1, and BKCC1.	CNRFC

Field Name(s)	Definition & Methodology	Data Source(s)
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 Creek at Mariposa Reservoir, Owens Creek at Owens Reservoir, and Bear Creek at McKee Road): - 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. Technical Appendix B describes the process used to select these water right records and quality-control reported data to produce this dataset. In this tab each row quantifies water diversions (demand) for a single water right or claim in each month of the 2018 and 2019 calendar years, which are used as proxies for 2021 water demand in this analysis. Demand data are further adjusted in the Demand Separated tab (see next section) to account for water rights with diversion points in multiple subwatersheds and return flows.

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

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Field Name(s)	Definition & Methodology	Data Source(s)
Water Right Type	<p>Water right type (see Appendix B for additional information on the different Statement assigned categories):</p> <ul style="list-style-type: none"> - Appropriative: A post-1914 appropriative water right pursuant to a permit or license from the Board. - Statement of Div[ersion] and Use (Riparian): A riparian water right claim. - Statement of Div[ersion] and Use (Riparian/Pre-1914): A riparian and pre-1914 appropriative water right claim. - Statement of Div[ersion] and Use (Pre-1914): A pre-1914 appropriative water right claim. - Statement of Div[ersion] and Use (Reserved): A federal reserved water right claim. - Statement of Div[ersion] and Use (Other): Any other category of water right claim (e.g. court decreed/adjudicated or contract/agreement). - Statement of Div[ersion] and Use (Unclassified): A water right claim with an unspecified category. 	eWRIMS database w/ staff adjustments
Water Right Status	<p>Status of the water right or claim, according to the Board's records:</p> <ul style="list-style-type: none"> - Licensed: A post-1914 appropriative water right for which the Board has issued a license. - Permitted: A post-1914 appropriative water right for which the Board has issued a permit. - Claimed: A water right claimed by the owner (i.e., Statements of Diversion and Use) which the Board has not verified. 	eWRIMS database
Primary Owner	Name of the primary owner of the water right record.	eWRIMS database

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Field Name(s)	Definition & Methodology	Data Source(s)
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
Priority Date	<p>The priority date of the water right records (YYYY/MM/DD):</p> <ul style="list-style-type: none"> - Appropriative: Assumed to be the earlier of the Application Acceptance Date and Application Received Date attributes. - Statement of Div[ersion] and Use (Riparian): 'Riparian' and assumed to be senior to all non-Riparian demands. - Statement of Div[ersion] and Use (Riparian/Pre-1914, Pre-1914, Reserved, or Other): Assumed to be January 1st of the earliest claimed Year Diversion Commenced attribute, which is present in the Initial Statement of Diversion and Use and annual Supplemental Statements of Diversion and Use. Further adjusted in the Demand Separated tab for Riparian/Pre-1914 and Other Statements and Appropriative Project rights. 	eWRIMS database
Face Value (AFA)	The maximum annual amount of water authorized for diversion under an appropriative water right. Statements, including Riparian and Pre-1914 Appropriative claims, do not have an assigned face value; for the purposes of this analysis, their face value is assumed to be zero.	eWRIMS database

Field Name(s)	Definition & Methodology	Data Source(s)
2018/2019 Annual Diversion	The total reported diversion of the water right record in calendar year 2018 or 2019. These values include user-reported direct diversions and diversions to storage from annual reports. Values for select water right records were manually reviewed by staff and corrected as necessary.	eWRIMS database w/ staff adjustments
2018/2019 Review	Indicates whether and how the 2018 or 2019 reported diversion was reviewed or corrected by staff: - Estimated Downward: Staff reviewed and corrected the user-reported diversion value to be higher than reported. - Estimated Upward: Staff reviewed and corrected the user-reported diversion value to be lower than reported. - 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
Jan-Dec 2018/2019 Diversion	The total reported diversion of the water right record in each month of calendar year 2018 or 2019. These values include user-reported direct diversions and diversions to storage from annual reports. Values for select water right records were manually reviewed by staff and corrected as necessary.	eWRIMS database w/ staff adjustments

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. 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. Data used to determine

the factors, which include return flows from both agricultural and municipal water uses, were sourced from CalSim 3 results published by DWR. Results from WY 2014 are used, as its hydrology most closely matches forecasts for the remainder of WY 2021.

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 Sacramento Bend, 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 next 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 are split into multiple rows, one for each HUC8.	eWRIMS database

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Field Name(s)	Definition & Methodology	Data Source(s)
Water Right Type	Water right type, sourced from the Demand tab: - Appropriative: A post-1914 appropriative water right pursuant to a permit or license from the Board. - Statement of Div[ersion] and Use (Riparian): A riparian water right claim. - Statement of Div[ersion] and Use (Riparian/Pre-1914): A riparian and pre-1914 appropriative water right claim. - Statement of Div[ersion] and Use (Pre-1914): A pre-1914 appropriative water right claim. - Statement of Div[ersion] and Use (Reserved): A federal reserved water right claim. - Statement of Div[ersion] and Use (Other): Any other category of water right claim (e.g. court decreed/adjudicated or contract/agreement). - Statement of Div[ersion] and Use (Unclassified): A water right claim with an unspecified category.	eWRIMS database w/ staff adjustments
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.	eWRIMS database, USGS WBD

Field Name(s)	Definition & Methodology	Data Source(s)
Legal Delta?	Indicates if demand for that row occurs within the Legal Delta (TRUE/FALSE). Assigned in the eWRIMS database based on the location of water right POD(s) and validated to ensure only rows which account for Legal Delta demands are flagged as TRUE. Statements claiming only Riparian rights which are located in the Legal Delta are marked as FALSE (with a note in the Demand Comment column) because these demands are not prorated between watersheds per Board Order WR 89-8 (see Watershed Viz and Watershed Analysis sections).	eWRIMS database w/ staff adjustments
Priority Date	The priority date of a water right or claim, sourced from the Demand tab (YYYY/MM/DD), with some exceptions: - The priorities of Statements categorized as “Riparian”, “Riparian/Pre-1914” or “Other” are marked as ‘Riparian’ because the water right record does not contain sufficient information to further disaggregate their demands. They are conservatively assumed to have a more senior priority date than all appropriative water rights. ¹ - Project rights listed in Board Decision 1641 (excepting 2 New Melones Project rights, per Board Decision 1422) are marked as ‘Project’ and assumed to be junior to all other water rights.	eWRIMS database w/ staff adjustments
Priority Year	The year of the priority date, sourced from the previous column. Riparian or Project priorities are shown as blank.	eWRIMS database w/ staff adjustments

¹ For claims within the Legal Delta, this categorization of colorable riparian claims is consistent with recent judicial decisions (see e.g., *Modesto Irrigation District v. Heather Robinson Tanaka*, 48 Cal.App.5th 898 (2020)) and with the legal principles described in a memorandum dated December 15, 2017 regarding Issues Related to Overlap between Pre-1914 and Riparian Water Right Claims in the Delta and available on the website of the Office of the Delta Watermaster (Overlap Memo).

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Field Name(s)	Definition & Methodology	Data Source(s)
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"> - Demand Weight = (number of PODs within the respective HUC8) / (total number of PODs). Only active PODs that are not Points of Rediversion or Points of Offstream Storage are considered in this calculation. - The sum of Demand Weights for most water rights is equal to one (see exception in next column). 	Staff-determined
Demand Comment	<p>Additional detail about the Demand Weight or other aspects of the demand:</p> <ul style="list-style-type: none"> - 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). - In Legal Delta but not prorated between watersheds: The POD in the specified HUC8 is located within the Legal Delta but is associated with a Statement claiming only riparian rights. Per Board Order WR 89-8, the riparian demand is not prorated between watersheds. - 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 'Project.' Also indicates actual water right Priority Date, sourced from Demand tab. 	Staff-determined

Field Name(s)	Definition & Methodology	Data Source(s)
January-December 2018/2019	Monthly demands of the specified water right within the specified HUC8, calculated as follows: (Application ID Demand for month of 2018 or 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 local supplies are insufficient to meet all riparian 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

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Field Name(s)	Definition & Methodology	Data Source(s)
MonthNum and Month	The calendar year month (either number or three-letter abbreviation) of the respective water supply and demand.	--
Riparian Demand 2018	The sum of calendar year 2018 demand for all Riparian water right claims (Water Right Type = Riparian, Riparian/Pre-1914, or Other Statements) for the respective subwatershed and month, excluding demands in the Legal Delta. Sourced from the Demand Separated tab.	eWRIMS database w/ staff adjustments
Pre-1914 Demand 2018	The sum of calendar year 2018 demand for all pre-1914 appropriative water right claims (Water Right Type = Pre-1914 or Unclassified Statements) for the respective subwatershed, month, and demand year, excluding demands in the Legal Delta. Sourced from the Demand Separated tab.	eWRIMS database w/ staff adjustments
1914-1919, 1920s, 1930s, 1940s, 1950s, 1960s, 1970s, 1980s, 1990s, 2000s, and 2010s Demand 2018	The sum of calendar year 2018 demand for all Post-1914 Appropriative rights (Water Right Type = Reserved Statement or Appropriative) with a priority date within the specified decade for the respective subwatershed and month, excluding demands in the Legal Delta. Sourced from the Demand Separated tab.	eWRIMS database w/ staff adjustments
Project Demand 2018	The sum of calendar year 2018 demand for all Project water rights which export water outside the Delta watershed for the respective subwatershed and month, excluding demands in the Legal Delta. Sourced from the Demand Separated tab.	eWRIMS database w/ staff adjustments
2019 demand data is disaggregated in the same manner as 2018 demand data.		
Supply Forecast 10%, 50%, 90% or 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 the respective exceedance probability from the Supply Forecast tab is shown.	CDEC, B-120, CNRFC, staff estimates

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Field Name(s)	Definition & Methodology	Data Source(s)
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 (using the 90% exceedance forecast for future months) is insufficient to meet the 2018 demands of all riparian claims of right in the subwatershed.	Staff-determined
2018 Total Demand	The sum of 2018 all demand values 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: <ul style="list-style-type: none"> - 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
2019 demand data is summed and analyzed for discontinuity in the same manner as 2018 demand data.		
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

Field Name(s)	Definition & Methodology	Data Source(s)
2018/2019 Reduced Supply for Discontinuity (90% Exceedance with Abandoned Flow Replacement)	When discontinuity is found for the respective subwatershed and month based on demand data from the respective year (i.e., Discontinuity? = 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

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

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Field Name(s)	Definition & Methodology	Data Source(s)
MonthNum and Month	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
Demand Type	Demand category, based on water right priority. Post-1914 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 of demand data (2018 or 2019).	eWRIMS database
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.	eWRIMS database w/ staff adjustments
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

Field Name(s)	Definition & Methodology	Data Source(s)
2021 Supply 10%, 50% 90%, and 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 the respective exceedance probability from the Supply Forecast tab is shown (NOTE: supply is available to all demand types by priority; values are shown only in the Riparian Demand rows due to Tableau plotting limitations).	CDEC, B-120, CNRFC, staff estimates
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
Cumulative Demand for Subwatershed & Month	Total cumulative demand for the respective subwatershed, month, and demand year (used as an intermediate calculation to inform the Demand After Reduction value). Added from most senior to most junior rights.	Calculated
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

Field Name(s)	Definition & Methodology	Data Source(s)
Watershed	The two primary river systems in the Delta: Sacramento and San Joaquin.	USGS WBD
MonthNum and Month	The calendar year month of the respective water supply and demand.	--
Delta Watershed 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 for 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. Post-1914 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 of demand data (2018 or 2019).	eWRIMS database
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 (Legal Delta? = TRUE) for the respective month and demand type. Sourced from the Demand Separated tab.	eWRIMS w/ staff adjustments
Legal Delta Demand Prorated by Watershed	Demand for PODs within the Legal Delta (Legal Delta? = TRUE) for the respective watershed, month, and demand type. Legal Delta demands are prorated 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 = Delta 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 the 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 prorated between the two watersheds: Total Watershed Demand = Demand w/o Legal Delta (Headwater Reduced) + Legal Delta Demand Prorated 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 (NOTE: supply is available to all demand types by priority; values are shown only in the Riparian Demand rows due to Tableau plotting limitations).	Calculated

Daily Supply Viz

This tab compiles monthly supply data from the Supply Forecast tab and daily supply data from the Supply Daily Monitoring tab to produce a comparison between monthly forecasts and cumulative daily supply, which may be used to adjust the timing or scope of notices of water unavailability. This data populates the interactive Watershed Analysis Weekly Supply Updates visualization at:

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)
Date	Individual days of the current month.	--
Watershed	The two primary river systems in the Delta: Sacramento and San Joaquin.	USGS WBD

Field Name(s)	Definition & Methodology	Data Source(s)
Daily Cumulative	The cumulative total supply (sum of respective date and all previous days of the month) for the respective watershed, in acre-feet. Equal to '#N/A' if supply data are not available for all subwatersheds in the respective watershed (i.e., dates in the future). Sourced from the Supply Daily Monitoring tab.	CDEC, CNRFC, staff estimates
Fcast 99%, 90%, 75%, 50%, 25%, and 10% exc	Monthly forecasted supply for the respective watershed and exceedance probability, in acre-feet, Equal to the same value for all days of the month in order to plot as a horizontal line. Sourced from the Supply Forecast tab.	B-120, CNRFC, staff estimates

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 Riparian claims of right (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 (Legal Delta? = TRUE) 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 first: Riparian, Pre-1914 Appropriative, Appropriative, Project (see the explanations of Statement assigned categories and priority assumptions in the Demand and Demand Separated sections). All Riparian claims of right are assumed to have senior priority over all pre-1914 appropriative claims, which are in turn assumed to have 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 Riparian claims 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

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Field Name(s)	Definition & Methodology	Data Source(s)
Primary Owner	Name of the primary owner of the water right or water right claim, sourced from the Demand tab.	eWRIMS database
Water Right Type	Water right type, sourced from the Demand tab: Appropriative or Statement of Div[ersion] and Use (Riparian, Riparian/Pre-1914, Pre-1914, Reserved, Other, or Unclassified).	eWRIMS database w/ staff adjustments
Priority Date	The priority date of a water right or claim, sourced from the Demand tab (YYYY/MM/DD). Riparian, Riparian/Pre-1914, and Other Statements are denoted as 'Riparian' priority and are assumed to be senior to all other demands, while Project rights listed in Board Decision 1641 are denoted as 'Project' priority and are assumed to be junior to all other demands.	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.	eWRIMS database 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

Field Name(s)	Definition & Methodology	Data Source(s)
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 highlight red if water is unavailable for a given right and month.	Staff-determined
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 (i.e., Water Unavailable, but a portion of Demand can be met). - If Supply Cumulative = 0, equal to zero (i.e., 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 senior demands (Priority Date = Riparian) 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 (Legal Delta? = TRUE) 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 subwatershed are sorted by priority date, with the most senior rights first: Riparian, Pre-1914 Appropriative, Appropriative, Project (see the explanations of Statement assigned categories and priority assumptions in the Demand and Demand Separated sections). All Riparian claims of right are assumed to have senior priority over all pre-1914 appropriative claims, which are in turn assumed to have 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 Riparian claims 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 blue**, contain sample formulas described in detail in the table below.

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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 (Legal Delta? = TRUE) 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
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
Water Right Type	Water right type, sourced from the Demand tab: Appropriative or Statement of Div[ersion] and Use (Riparian, Riparian/Pre-1914, Pre-1914, Reserved, Other, or Unclassified).	eWRIMS database w/ staff adjustments
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 priority date of a water right or claim, sourced from the Demand tab (YYYY/MM/DD). Riparian, Riparian/Pre-1914, and Other Statements are denoted as 'Riparian' priority and assumed to be senior to all other demands, while Project rights listed in Board Decision 1641 are denoted as 'Project' priority and are assumed to be junior to all other demands.	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

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Field Name(s)	Definition & Methodology	Data Source(s)
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 (Legal Delta? = TRUE), 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.	eWRIMS database w/ staff adjustments
Water Unavailable in Subwatershed? Jan-Sep	If water is anticipated to be unavailable in a headwater subwatershed (TRUE/FALSE): - If located in a headwater subwatershed, equal to the Water Unavailable? value in the Analysis Headwaters tab for the respective right and month. - FALSE if located in a lower subwatershed. These cells have conditional formatting to highlight red 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: - If any Riparian Statements received notices in the given headwater subwatershed and month, equal to zero (see lower table to right in spreadsheet). - If located in a headwater subwatershed and nonzero, equal to the Demand Potentially Met in Subwatershed value in the Analysis Headwaters tab for the respective right and month. - If located in a lower subwatershed, equal to 2018 Demand.	Calculated

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Field Name(s)	Definition & Methodology	Data Source(s)
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"> - For the first water right in each watershed, equal to the total watershed 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 right's Demand Met in Watershed (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
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 highlight red 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: <ul style="list-style-type: none"> - If Supply Cumulative > Demand Potentially Met, equal to Demand Potentially Met. - If $0 < \text{Supply Cumulative} < \text{Demand Potentially Met}$, equal to Supply Cumulative (i.e., Water Unavailable, but a portion of Demand can be met). - If Supply Cumulative = 0, equal to zero (i.e., Water Unavailable). 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Demand Unmet in Watershed, Jan-Sep	<p>Amount of each right's Demand which can be physically met in the watershed that will be unmet by available water supply within a given month, calculated as follows:</p> <ul style="list-style-type: none"> - 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	<p>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 highlight red if water is unavailable for a given right and month.</p>	Staff-determined
Demand Deficit, Jan-Sep	<p>Amount of each right's total Demand which will be unmet, either by unavailable headwater subwatershed supply or by overall watershed supply, within a given month. Calculated as follows:</p> <ul style="list-style-type: none"> - If Subwatershed is disconnected, equal to Demand Unmet in Subwatershed from the Headwater Analysis tab. - If Subwatershed is not disconnected, equal to Demand Unmet in Watershed. 	Calculated

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. Per State Water Board Order WR 89-8, this analysis assumes that demands by Statements of Diversion and Use claiming only Riparian water rights can only be met by supply from

the watershed in which they are located; therefore, they are excluded from all demand proration between watersheds and are not listed in this tab.

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 (Legal Delta? = TRUE in the Demand Separated tab). Duplicate rights were merged in this tab, so each row represents a single water right's total demand.

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 priority date of a water right or claim, sourced from the Demand tab (YYYY/MM/DD). Riparian/Pre-1914 and Other Statements are denoted as 'Riparian' priority and assumed to be senior to all other demands, while Project rights listed in Board Decision 1641 are denoted as 'Project' priority and are assumed to be junior to all other demands.	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.	eWRIMS database 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.	eWRIMS database 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, sourced from the Water Unavailable? column of the Analysis Watersheds tab. These cells have conditional formatting to highlight red 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, sourced from the Water Unavailable? column of the Analysis Watersheds tab. These cells have conditional formatting to highlight red 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 highlight red if water is unavailable for a given right and month.	Staff-determined