Bureau of Reclamation
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Updated 2021 Restoration Allocation & Default Flow Schedule

February 5, 2021

Introduction

The following transmits an initial 2021 Restoration Allocation and Default Flow Schedule to the Restoration Administrator for the San Joaquin River Restoration Program (SJRRP), consistent with the January 2020 (version 2.1) Draft Restoration Flow Guidelines (Guidelines). This Restoration Allocation and Default Flow Schedule provides the following:

- Forecasted water year Unimpaired Inflow: the estimated flows that would occur absent regulation on the river. This value is also known as the "Natural River" or "Unimpaired Runoff" or "Full Natural Flow," and is utilized to identify the water year type.
- Hydrograph Volumes: the annual allocation hydrograph based on water year unimpaired inflow, utilizing Method 3.1 with the Gamma Pathway (RFG-Appendix C, Figure C3) agreed to by the Parties in December 2008.
- Default Flow Schedule: the schedule of Restoration Flows in the absence of a recommendation from the Restoration Administrator.
- Additional Allocations: the hypothetical Restoration Allocations that would result from 10%, 50%, 75%, and 90% probability of exceedance of the Unimpaired Inflow forecast.
- Unreleased Restoration Flows: the amount of Restoration Flows not released due to channel capacity constraints, without delaying completion of Phase 1 improvements.
- Flow targets at Gravelly Ford: the flows at the head of Reach 2, and estimated scheduled releases from Friant Dam adjusted for the assumed Holding Contract demands and losses in Exhibit B.
- Restoration Budget: the volumes for the annual allocation, spring flexible flow, base flow, riparian recruitment, and fall flexible flow.
- Remaining Flow Volume: the volume of Restoration Flows released, the remaining volume available, and associated limitations and flexibility.
- Operational Constraints: the flow release limitations based on downstream channel capacity, regulatory, or legal constraints.

Consistent with Paragraph 18 of the Settlement, the Restoration Administrator shall make recommendations to the Secretary of the Interior concerning the manner in which the hydrographs shall be implemented. As described in the Guidelines, the Restoration Administrator is requested to recommend a flow schedule showing the use of the entire annual allocation during the upcoming Restoration Year, categorize all recommended flows by account, and Restoration Flow recommendation. If a recommendation is not provided by the Restoration Administrator, the Capacity Constrained Default Flow Schedule (Table 6b) will be implemented.

Reclamation released the Initial Restoration Allocation and Default Flow Schedule on January 21. Because hydrology has improved and results in a significant change or "step" in the Restoration Allocation, an updated issuance is being made. There are several complicated factors at play which can influence the 2021 Restoration Year schedule and Reclamation will be coordinating closely with the Restoration Administrator in response; therefore, Restoration Administrator is provided 15 calendar days until February 22 to respond with a full written recommendation.

Forecasted Unimpaired Inflow

Unimpaired Runoff represents the natural water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds (a.k.a "Unimpaired Inflow" or "Natural River" or "Full Natural Flow"). It is calculated for the period of a water year. The forecast of the Unimpaired Runoff determines the volume of Restoration Flows available for the Restoration Year (i.e. the Restoration Allocation). Information for forecasting the Unimpaired Runoff includes:

- Observation of Unimpaired Runoff into Millerton Lake to support the water supply allocation[1];
- The California Department of Water Resources (DWR) Bulletin 120 latest update for San Joaquin River inflow to Millerton Lake Unimpaired Flow, and/or the most current DWR Bulletin Water Supply Index (WSI)[3];
- The National Weather Service (NWS) Ensemble Streamflow Prediction (ESP) Water Supply Forecast for the San Joaquin River at Millerton Lake[5;]
- Other forecast models, ground-based observations, remotely-sensed observations, hydrologic models, analysis of historic patterns, and short-term weather forecasts as appropriate.

Table 1 shows the water year 2021 (October 1, 2020 to September 30, 2021) observed accumulated and forecasted water year Unimpaired Inflows at Millerton Lake. This table also includes the published DWR forecast, the DWR forecast adjusted for an expected runoff for the current month, the NWS forecast with and without a 7-day smoothing function applied to remove the day-to-day variance, and the NWS forecast with 7-day smoothing and adjustment for the expected runoff for the current month (Reclamation adjusts the DWR and NWS values by replacing the forecasted runoff for the current month with Reclamation's own estimate of runoff for the current month, which increases accuracy). Figure 1a plots DWR and NWS forecast values over the entire water year, while Figure 1b shows the most recent period in detail.

Table 1 — San Joaquin River Water Year Actuals and Forecasts at Millerton Lake, in Thousands of Acre-Feet (TAF)

	Forecast Exceedance Percentile				
	90%	**75**%	**50**%	**25**%	**10**%
Accumulated Unimpaired Runoff (“Natural River”) February 4, 2021 [1]	61.2 TAF				
Accumulated Unimpaired Runoff as percent of normal [2]	26%				
DWR, January 1, 2021 [3] (Published Value)	379	620	900	1469	2034
DWR, February 4, 2021 [4] (Runoff Adjusted)	392	606	865	1381	1877
NWS, February 4, 2021 (Published Daily Value [5])	506	639	888	1420	1830
Smoothed NWS, February 4, 2021 (7-day Smoothing [6])	571	753	1035	1574	1951
Smoothed NWS, February 4, 2021 (Runoff Adjusted [4])	570	752	1032	1572	1953

[1] http://www.usbr.gov/mp/cvo/vungvari/milfln.pdf

[2] Based on average accumulation of Unimparired Runoff

[3] B120: http://cdec.water.ca.gov/cgi-progs/iodir?s=b120, or B120 Update: http://cdec.water.ca.gov/cgi-progs/iodir_ss/b120up, or WSI: http://cdec.water.ca.gov/cgi-progs/iodir/WSI.2020

[4] The adjusted data has been updated with the actual unimpaired inflow through the current date and projected out for the remainder of the month.

[5] http://www.cnrfc.noaa.gov/water_resources_update.php?stn_id=FRAC1&stn_id2=FRAC1&product=WaterYear

[6] The NWS smoothed data uses a 7-day triangular weighted moving average, where the most recent day (n) is given greater weight than each previous forecast day (n-1, 2, 3, etc.); this reduces noise stemming from ESP model input. The following formula is used: $((Forecast_n * 1) + (Forecast_{n-1} * 0.857) + (Forecast_{n-2} * 0.714) + (Forecast_{n-3} * 0.571) + (Forecast_{n-4} * 0.429) + (Forecast_{n-5} * 0.286) + (Forecast_{n-6} * 0.143)) / 4$

The 2021 Water Year has been quite dry, with the lack of precipitation and runoff trending close to the driest years on record. On January 27-30, the first major storm of the water year to impact the Central Sierra Nevada nearly tripled the snowpack. Snowpack currently extends down to about 4,000’ elevation. This storm added an average of 7” of snow water equivalent (SWE) and brought snowpack up to about 50% of April 1 average (Figure 2). Unimpaired runoff continues to be well below average at 26% of seasonal norms. This late January storm has all but eliminated the chance of a Critical-Low year type, which was set by the initial Restoration Allocation and should now be updated.

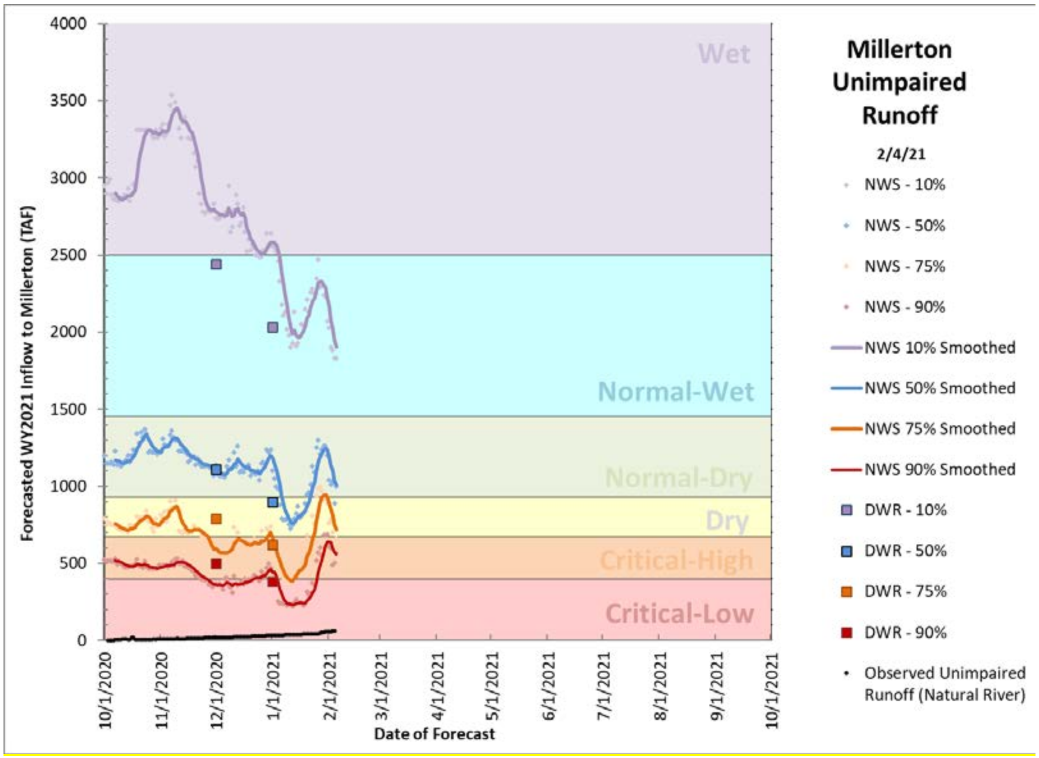

Figure 1a — Plot of 2021 Water Year forecasts, including both NWS Ensemble Streamflow Prediction Forecasts and DWR Forecasts

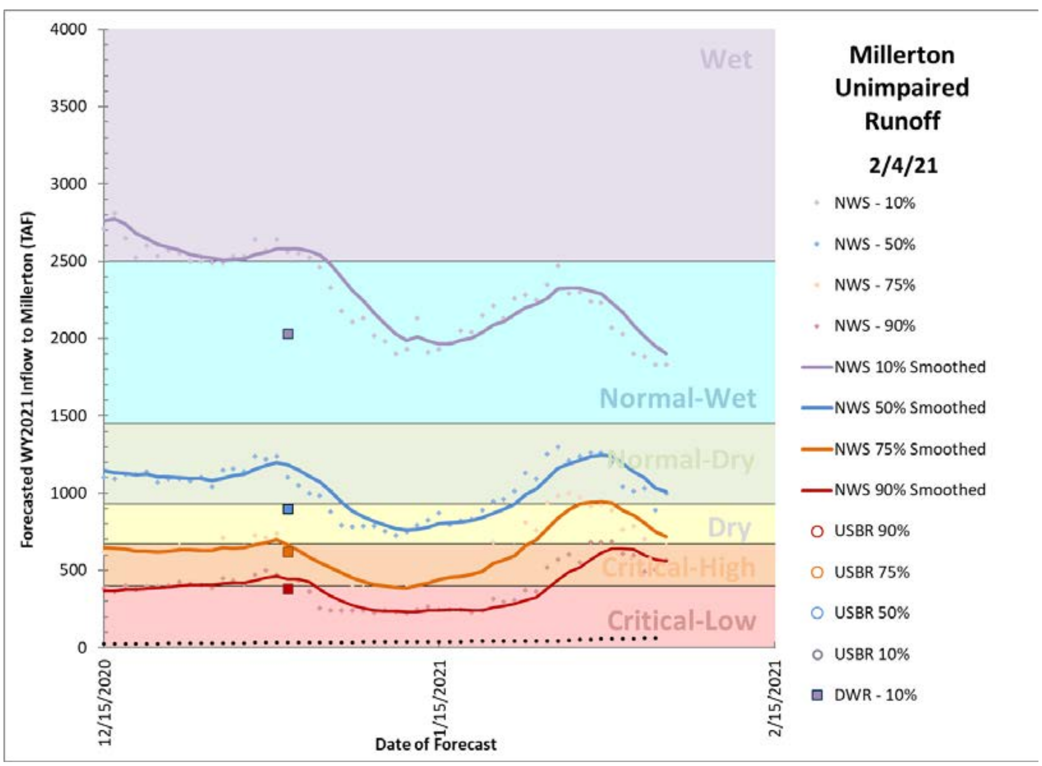

Figure 1b — Detail plot of most recent forecasts

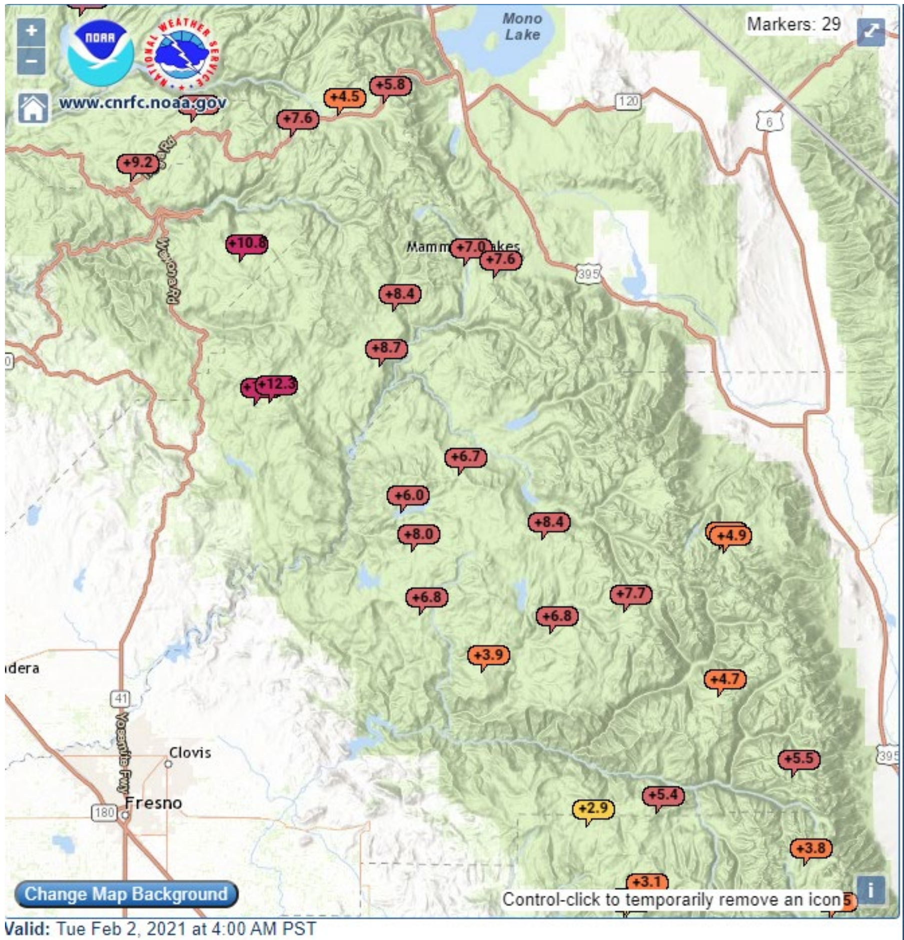

Figure 2 — Increase in Snow Water Equivalent across the period January 26 – February 2. The San Joaquin Watershed, northeast of Fresno, received over 7" of SWE.

The DWR Water Supply Index from January 1 was adjusted as shown in Table 1 for actual January runoff conditions. The DWR forecast is in general good agreement with the February 5 NWS runoff forecast from the California–Nevada River Forecast Center (CNRFC), although it somewhat less at all forecast exceedances which can be expected. The NWS CNRFC runoff forecast fully incorporates the late January storm and also incorporates the 16-day precipitation forecast.

Currently there are three snowpack models operating for the San Joaquin Watershed to further inform runoff forecasts. There is generally fair agreement between the NWS model maintained by the CNRFC and the NWS NOHRSC model. The CU Boulder "Real-time SWE" model is somewhat higher as is the typical bias of that third model. The models have reasonable agreement in the elevation distribution of snowpack, with the CNRFC model showing the least SWE between 8,000' and 14,000' and the CU Boulder model showing the most SWE at those elevations. Few snow course measurements from the early February snow survey were available at the time of this issuance, with available data supporting the NOHRSC model over the other two models and guiding Reclamation's consensus snowpack estimate of 690 TAF (Table 2).

Table 2 — Total snowpack volume (TAF of Snow Water Equivalent) depicted by two models and a consensus estimate for February 4, 2021.

Date	CNRFC	NOHRSC	CU Boulder	ARS iSnobal	Aerial Snow Survey (e.g. ASO)	Reclamation Consensus
Snow Water Equivalent Volume (TAF)	680	692	761 [8]	N/A [9]	N/A [10]	**690**

[8] CU Boulder “Real-time SWE” model was for February 1. The CU Boulder model does not estimate now below 5,000’ elevation and therefore is likely missing 20-30 TAF in its estimate.
[9] USDA-ARS “iSnobal” model will not be operational for the San Joaquin Watershed in 2021. Similar models are being investigated as a substitute.
[10] The first Aerial Snow Survey is scheduled until February 15–March 2, 2021

Snowpack SWE can be used to model future snowmelt runoff. Using a water budget model developed by Reclamation, the consensus snowpack conditions support a 90% exceedance of between 452 and 480 TAF. This value was used in part to guide how Reclamation combines multiple forecast sources into a single “hybrid” runoff forecast.

Combining Forecasts

Staff from the South-Central California Area Office of Reclamation and SJRRP jointly track and evaluate the accuracy of runoff forecasts on a regular basis. Based on the age of these forecasts, the short-term and long-term weather forecasts, the climatological outlook, observed Unimpaired Inflow, and other available information, a hybrid forecast is generated. The weighting of the different components is regularly evaluated and selected using professional judgment and the best available information. **For the current allocation, the DWR “runoff adjusted” and NWS “smoothed runoff adjusted” forecasts are combined with a 50/50 blending respectively**. This results in the Hybrid Unimpaired Inflow Forecasts shown in Table 3.

Table 3 — Current Blending and Hybrid Unimpaired Inflow Forecast

	Forecast Probability of Exceedance using blending				
	90%	**75**%	**50**%	**25**%	**10**%
Blending Ratio (DWR/NWS)	50/50				
Hybrid Unimpaired Inflow Forecast (TAF)	459	657	926	1454	1892

This forecast blending produced on February 4 was chosen based on the historic performance of the DWR and NWS forecasts during this time of the year, the accuracy of these forecasts in predicting monthly unimpaired inflow over the recent months, snow measurements and snowpack models, application of hypothetical runoff ratios, the long-range forecast, historic analogs, the seasonal climate outlook, the age of the forecasts, and other performance factors. Reclamation put equal weight upon the forecasts. This blending is atypical as the CNRFC forecast is typically given greater weight in February. The reason for this equal weighting is the CNRFC’s perceived overreaction to the recent storm, which elevated runoff values above reasonable predictions.

Restoration Allocation

As per the Restoration Flow Guidelines, the **75% exceedance** forecast is used for the allocation under current hydrologic conditions to set the Restoration Flow Allocation. Table 4 below, from the Guidelines version 2.1, depicts the progression of forecast exceedance used to set the Restoration Allocation.

Table 4 — Guidance on Percent Exceedance Forecast to Use for Allocation

		Date of Forecast Used for the Allocation					
	Value (TAF)	**January**	**February**	**March**	**April**	**May**	**June**
If the 50% forecast is:	Above 2200	50	50	50	50	50	50
	1600 to 2200	75	75	50	50	50	50
	900 to 1599	75	75	75	50	50	50
	500 to 899	90	90	75	50	50	50
	Below 500	90	90	90	90	75	50

Applying the 50/50 forecast blending determined by Reclamation and, using the 75% exceedance forecast dictated by the Guidelines, Reclamation calculates an **Unimpaired Inflow hybrid forecast of 657 TAF** and a **Critical-High Water Year Type**. This provides a **Restoration Allocation of 70.919 Thousand Acre-Feet (TAF)** as measured at Gravelly Ford (GRF). Combined with Holding Contracts on the San Joaquin River, this equates to a **Friant Dam Release of 187.785 TAF**. Other hypothetical allocations are presented in Table 5 as grayed values and indicate the range of probable forecasts and the resulting Restoration Allocations.

Table 5 — SJRRP Water Year Type and Allocation for 2021 Restoration Year Shown with Other Hypothetical Values in Gray

	Forecast Probability of Exceedance using proposed blending				
	90%	**75%**	50%	25%	10%
Hybrid Unimpaired Inflow Forecast (TAF)	459	**657**	926	1454	1892
Water Year Type	Critical-High	**Critical-High**	Dry	Normal-Wet	Normal-Wet
Restoration Allocation at GRF (TAF)	70.919	**70.919**	212.462	283.915	345.277
Friant Dam Flow Releases (TAF)	187.785	**187.785**	329.407	400.860	462.222

Contractual Obligation Considerations

Consistent with Section 10004(j) of the San Joaquin River Restoration Settlement Act, the Settlement and the Settlement Act do not modify the rights and obligations of the United States under the Purchase Contract between Miller and Lux and the United States (Purchase Contract) and the Second Amended Exchange Contact between the United States, Department of the Interior, Bureau of Reclamation and Central California Irrigation District, San Luis Canal Company, Firebaugh Canal Water District, and Columbia Canal Company (Exchange Contract). Reclamation's obligations in the Purchase Contract and Exchange Contract remain unchanged. This is consistent with Condition 17 of Reclamation's Water Right Permit, as modified in 2013.

Conditions continue to be dry across the CVP with limited Delta pumping. Restoration staff will continue to coordinate with other units of the CVP and their potential to impact operations or allocations at Friant.

Default Flow Schedule

The Default Flow Schedule, derived from Exhibit B in the Settlement, identifies how Reclamation will schedule the Restoration Allocation for the current Water Year Type and Unimpaired Inflow volume absent a recommendation from the Restoration Administrator. The Guidelines provide detail on how a Default Flow Schedule is parsed from the allocation volume. This approved method of distributing water throughout the year is referred to as "Method 3.1" with the "gamma pathway."

Exhibit B Method 3.1 Default Flow Schedules

Table 6a shows the Basic Default Flow Schedule flows and corresponding Restoration Allocation volumes for the entire year absent channel capacity and seepage constraints, including total releases from Friant Dam and Restoration Flows releases in excess of Holding Contracts. Volume is distributed as various flow rates across the year as per the methods explained in the Restoration Flow Guidelines.

Table 6b shows the Capacity Constrained Default Flow Schedule volumes with all expected operational constraints, primarily controlled by seepage limitations in Reach 4A. Any volume within the Spring Flexible Flow Account and Fall Flexible Flow Account that cannot be released on the default schedule is shifted to times with available capacity as per the Guidelines. This Capacity Constrained Default Flow Schedule depicted in Table 6b will be implemented in the absence of a specific recommendation by the Restoration Administrator. With these known constraints, a Restoration Flow volume of **0 TAF** is generated that cannot be scheduled for release without a Water Supply Test. This volume would become Unreleased Restoration Flows (URFs) under the Capacity Constrained Default Flow Schedule. This is an estimated volume of water, actual URF volumes will depend on several factors including the Restoration Administrator Recommendation, flow schedule to-date, recapture of Restoration Flows at Mendota Pool, and real-time assessments of groundwater constraints.

Table 6a — Basic Default Flow Schedule

Flow Period	Flow (cfs)				Volume (TAF)	
	Friant Dam Release	Holding Contracts [11]	Flow Target at GRF	Restoration Flow at GRF	Friant Dam Release	Restoration Flow at GRF
Mar 1 – Mar 15	500	130	375	370	*14.876*	*11.008*
Mar 16 – Mar 31	1500	130	1375	1370	*47.603*	*43.478*
Apr 1 – Apr 15	200	150	55	50	*5.950*	*1.488*
Apr 16 – Apr 30	200	150	55	50	*5.950*	*1.488*
May 1 – May 28	215	190	30	25	*11.940*	*1.388*
May 29 – Jun 30	215	190	30	25	*14.073*	*1.636*
July 1 – July 29	255	230	30	25	*14.668*	*1.438*
Jul 30 – Aug 31	255	230	30	25	*16.691*	*1.636*
Sep 1 – Sep 30	260	210	55	50	*15.471*	*2.975*
Oct 1 – Oct 31	160	160	5	0	*9.838*	*0.000*
Nov 1 – Nov 6	400	130	275	270	*4.760*	*3.213*
Nov 7 – Nov 10	120	120	5	0	*0.952*	*0.000*
Nov 11 – Nov 30	120	120	5	0	*4.760*	*0.000*
Dec 1 – Dec 31	120	120	5	0	*7.379*	*0.000*
Jan 1 – Jan 31	110	100	15	10	*6.764*	*0.615*
Feb 1 – Feb 28	110	100	15	10	*6.109*	*0.555*
				Totals	***187.785***	***70.919***

Table 6b — Capacity Constrained Default Flow Schedule

Flow Period	Flow (cfs)				Volume (TAF)		
	Friant Dam Release	Holding Contracts [11]	Flow Target at GRF	Restoration Flow at GRF	Friant Dam Release	Restoration Flow at GRF	Unreleased Restoration Flow [12]
Mar 1 – Mar 15	551	130	426	421	*16.387*	*12.519*	*0*
Mar 16 – Mar 31	551	130	426	421	*17.480*	*13.354*	*0*
Apr 1 – Apr 15	571	150	426	421	*16.982*	*12.519*	*0*
Apr 16 – Apr 30	571	150	426	421	*16.982*	*12.519*	*0*
May 1 – May 28	333	190	148	143	*18.490*	*7.938*	*0*
May 29 – Jun 30	215	190	30	25	*14.073*	*1.636*	*0*
July 1 – July 29	255	230	30	25	*14.668*	*1.438*	*0*
Jul 30 – Aug 31	255	230	30	25	*16.691*	*1.636*	*0*
Sep 1 – Sep 30	260	210	55	50	*15.471*	*2.975*	*0*
Oct 1 – Oct 31	160	160	5	0	*9.838*	*0.000*	*0*
Nov 1 – Nov 6	400	130	275	270	*4.760*	*3.213*	*0*
Nov 7 – Nov 10	120	120	5	0	*0.952*	*0.000*	*0*
Nov 11 – Nov 30	120	120	5	0	*4.760*	*0.000*	*0*
Dec 1 – Dec 31	120	120	5	0	*7.379*	*0.000*	*0*
Jan 1 – Jan 31	110	100	15	10	*6.764*	*0.615*	*0*
Feb 1 – Feb 28	110	100	15	10	*6.109*	*0.555*	*0*
				Totals	***187.785***	***70.919***	***0***

[11] In recent years, Holding Contract demands have been higher than assumed under Exhibit B of the Settlement, in which case, flows at Friant are increased to achieve the Gravelly Ford Flow Target.

[12] This estimate of URF volume is based on the most constraining reach, with Spring Flexible Flows redistributed March 1 through May 28 as necessary and Fall Flexible Flows redistributed Sept 3 through December 28 as necessary up to channel capacity constraints. Actual URF volume will depend on the Restoration Administrator's recommendations.

Exhibit B Restoration Flow Budget

Table 7 shows the components of the annual water budget for March 1, 2021, through February 28, 2022 (i.e. the Restoration Year). The Continuity Flow Account, Spring Flexible Flow Account, Riparian Recruitment Flow Account, and Fall Flexible Flow Account reflect the Exhibit B hydrograph for the current Restoration Allocation. The expected 116.866 TAF for Holding Contracts is shown. The volume for each flow account may change with subsequent Restoration Allocations.

Table 7 — Restoration Budget with Flow Accounts

<table>
<tr><th rowspan="2">Period</th><th rowspan="2">Holding Contract Demand (TAF)</th><th colspan="4">Restoration Flow Accounts</th></tr>
<tr><th>Continuity Flow Account</th><th>Spring Flexible Flow Account</th><th>Riparian Recruitment Flow Account</th><th>Fall Flexible Flow Account</th></tr>
<tr><td>Feb 1 – Feb 28</td><td>–</td><td>0</td><td rowspan="3">40.959</td><td>–</td><td>–</td></tr>
<tr><td>Mar 1 – Apr 30</td><td>16.920</td><td>16.502</td><td>–</td><td>–</td></tr>
<tr><td>May 1 – May 28</td><td>10.552</td><td>1.388</td><td rowspan="2">0</td><td>–</td></tr>
<tr><td>May 29 – Jul 29</td><td>25.666</td><td>3.074</td><td>–</td><td>–</td></tr>
<tr><td>Jul 30 – Aug 31</td><td>15.055</td><td>1.636</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>Sep 1 – Sep 30</td><td>12.496</td><td>2.975</td><td>–</td><td>–</td><td rowspan="3">0.595</td></tr>
<tr><td>Oct 1 – Nov 30</td><td>17.098</td><td>2.618</td><td>–</td><td>–</td></tr>
<tr><td>Dec 1 – Dec 31</td><td>7.378</td><td>0</td><td>–</td><td>–</td></tr>
<tr><td>Jan 1 – Feb 28</td><td>11.702</td><td>1.170</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">116.866 [13]</td><td>29.365</td><td>40.959</td><td>0</td><td>0.595</td></tr>
<tr><td colspan="4">70.919 (Base Flow Volume)</td></tr>
<tr><td></td><td colspan="5">187.785 (Friant Release Volume)</td></tr>
</table>

[13] In recent years, Holding Contract demands have been higher than assumed under Exhibit B of the Settlement, in which case, flows at Friant are increased to achieve the Gravelly Ford Flow Target.

[14] Buffer Flow volumes are based on actual releases, and are not an allocated volume per se.

Remaining Flow Volumes

The amount of water remaining for scheduling is the volume of flows released from Friant Dam in excess of releases required to meet Holding Contract demands, less past releases. Table 8 tracks these balances among the four flow accounts. Tracking these four flow accounts is necessary for application of the Water Supply Test. The releases to date volumes are derived from quality-assurance/quality-control daily average data when available, and partly from provisional data posted to CDEC, and thus may have future adjustments. Such adjustments may also affect the remaining flow volume.

Table 8 — Estimated Restoration Flow Volume Remaining and Released to Date

Flow Account		Yearly Allocation [15] (TAF)	Released to Date [16] (TAF)	Remaining Flow Volume (TAF)
Base Flows	Continuity Flow Account (Mar 1 — Feb 28)	*29.365*	*0*	*29.365*
	Spring Flexible Flows (Mar 1 – Apr 30)	*40.959*	*0*	*40.959*
	Riparian Recruitment Flows (May 1 — Jul 29)	*0*	*0*	*0*
	Fall Flexible Flows (Oct 1 – Nov 30)	*0.595*	*0*	*0.595*
Buffer Flows		—	*0*	—
Unreleased Restoration Flows (Sales and Exchanges)		—	*0*	*0*
Unreleased Restoration Flows (Returned Exchanges)		—	*0*	*0*
Purchased Water		—	*0*	*0*
		Totals:	***0***	***70.919***

[15] These Flow Volumes assume no channel constraints, as measured at Gravelly Ford.

[16] As of 2/4/2021

Operational Constraints

Operating criteria, such as channel conveyance capacity, ramping rate constraints, scheduled maintenance, reservoir storage, contractual obligations, and downstream seepage concerns, may restrict the release of Restoration Flows. Table 9 summarizes known 2021 operational constraints.

Table 9 — Summary of Operational Constraints

Type of Constraint	Period	Flow Limitation

Levee Stability	Currently in effect	1,210 cfs in Reach 2B
	Currently in effect	1,070 cfs in Eastside Bypass
Channel Conveyance / Seepage Limitation	Currently in effect, see latest Flow Bench Evaluation for precise values	Reach 2A: 800 – 820 cfs @ GRF
		Reach 3: 850 cfs @ MEN
		Reach 4A: 260 – 300 cfs @ SDP
Merced NWR weir Removal	June – September 2021	100 cfs 3-day average flow rate in Eastside Bypass
USFWS Biological Opinion	Until consultation for "Phase 2"	1,660 cfs of Restoration Flows at Friant Dam (interpreted as 1,655 cfs at Gravelly Ford)

The 2021 Channel Capacity Report identifies a maximum flow in Reach 2B of 1,210 cfs due to levee stability constraints. This results in a maximum release from Friant Dam between 1,310 cfs and 1,540 cfs depending on the time of year. The 2021 Restoration Year Channel Capacity Report also identifies a maximum flow in the Middle Eastside Bypass of 1,070 cfs due to levee stability constraints. These values are unchanged from 2019. Reach O levee improvements were completed in 2020 and will allow an overall increase in then-existing capacity of the Middle Eastside Bypass to be documented in the 2022 Channel Capacity Report.

In 2020, multiple flow benches were conducted to verify expected seepage thresholds in Reach 2A and Reach 3. Analysis revealed a seepage limitation of 800 to 820 cfs in Reach 2A (measured at the GRF gauge) and 850 cfs in Reach 3 (measured at the MEN gauge). These seepage limitations fluctuate with prevailing groundwater conditions and may be slightly lower or higher at a given time. The limitation in Reach 3 must accommodate both Restoration Flows and diversion to Arroyo Canal, thus Reach 3 is currently the limiting reach in certain times of the year. SJRRP will coordinate with the Restoration Administrator on specific flow schedules that are close to these limits. Flow – groundwater relationships from October 2019 through January 2020 were examined to determine a new seepage limitation in Reach 4A. For the current Reach 4A seepage limitation, wells installed in 2017 and later were incorporated into the analysis. Inclusion of these additional data points revealed that the seepage limitation is a lower flow rate than previously expected. Ongoing examination of a flow bench conducted in late February has not been completed, and when resolved may provide a narrower range of values for the seepage limitation in Reach 4A.

Reclamation will inform the Restoration Administrator of any changes to groundwater conditions that are likely to result in a reduction in scheduled Restoration Flows, will implement monitoring of groundwater conditions as necessary, and will adjust Friant Dam releases and/or Mendota Pool recapture (as preferred by the Restoration Administrator) to stay within seepage and channel capacity constraints.

Removal of the Merced National Wildlife Refuge weir is expected to take place between June and September. Based on the current information, a limitation of 100 cfs is expected. This limitation is based on a 3-day running average, allowing short period excursions of up to 120 cfs. This timing and rate of this flow limitation may be refined or negotiated closer to the project period.

2021 Allocation History

The Restoration Allocation will be adjusted multiple times between the date of the initial allocation and the final allocation; issuances will generally take place on a monthly schedule but may also be issued based on rapidly changing hydrologic conditions. The next Restoration Allocation is scheduled to be issued between February 10 and February 18. The Restoration Administrator is responsible for contingency planning and managing releases to stay within the current allocation to the extent possible, pursuant to the Restoration Flow Guidelines. Table 10 summarizes the Allocation History for this Restoration Year.

Table 10 — Allocation History

Allocation Type	Issue Date	Forecast Blending Applied	Unimpaired Inflow Forecast (at forecast exceedance)	Restoration Allocation at Gravelly Ford	Restoration Flows and URFs Released
Initial	January 21, 2021	30/70	296 TAF (@ 90%)	0 TAF	0 (thru 1/20/2021)
Update	February 5, 2021	50/50	657 TAF (@ 75%)	70.919 TAF	0 (thru 2/4/2021)

Appendix A: Abbreviations, Acronyms, and Glossary

af	Acre-feet
ARS	USDA Agricultural Research Service
ASO	Airborne Snow Observatory
CALSIM	California Statewide Integrated Model
CCID	Central California Irrigation District
CDEC	California Data Exchange Center
cfs	cubic feet per second
CVP	Central Valley Project
Delta	Sacramento–San Joaquin Delta
DWR	California Department of Water Resources
ESP	Ensemble Streamflow Prediction
Exhibit B	Exhibit B of the Settlement depicting Default Hydrograph
GRF	Gravelly Ford Flow Gauge
Guidelines	Restoration Flow Guidelines
LSJLD	Lower San Joaquin Levee District
NASA	National Aeronautics and Space Administration
NWS	National Weather Service
QA/QC	Quality Assurance/Quality Control (i.e. finalized)
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
Restoration Year	the cycle of Restoration Flows, March 1 through February 28/29
RWA	SJRRP Reclaimed Water Account
Secretary	U.S. Secretary of the Interior
Settlement	Stipulation of Settlement in *NRDC, et al., v. Kirk Rodgers, et al.*
SJREC	San Joaquin River Exchange Contractors
SJRRP	San Joaquin River Restoration Program
SLCC	San Luis Canal Company
SWE	Snow Water Equivalent
TAF	thousand acre–feet
URF	Unreleased Restoration Flows
WSI	DWR Water Supply Index
WY	water year, October 1 through September 30

Appendix B: Previous Year (2019) Flow Accounting

Table B — Restoration Flow Accounting and Unreleased Restoration Flows, and Holding Contracts, for the period February 2019 through February 2020. Flood management releases to San Joaquin River occurred during March, April, May, June, and July. This accounting includes 1.905 TAF that was generated in the 2019 Restoration Year and advanced into the final days of February 2019 (to the 2018 Restoration Year) and a flood spill of 22.509 TAF of URFs in July.

<table>
<tr><th rowspan="2">Flow Period</th><th rowspan="2">Gravelly Ford 5 cfs requirement (TAF)</th><th colspan="7">Released Restoration Flow Volumes (TAF)</th><th rowspan="2">URFs (TAF)</th></tr>
<tr><th>Spring Flexible Flow</th><th>Summer Base Flow</th><th>Fall Flexible Flow</th><th>Winter Base Flow</th><th>Riparian Recruitment Flow</th><th>Buffer Flow</th><th>Flexible Buffer Flow</th></tr>
<tr><td>Feb 1 – Feb 28</td><td>–</td><td>1.905</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>Mar 1 – Mar 31</td><td>15.886</td><td>20.291</td><td>–</td><td>–</td><td>–</td><td>–</td><td>0</td><td>–</td><td>138.949</td></tr>
<tr><td>Apr 1 – Apr 30</td><td>0.276</td><td>20.158</td><td>–</td><td>–</td><td>–</td><td>–</td><td>0</td><td>–</td><td>80.000</td></tr>
<tr><td>May 1 – May 31</td><td>44.031</td><td>5.708</td><td>9.838</td><td>–</td><td>–</td><td rowspan="4">17.799</td><td rowspan="2">0</td><td rowspan="5">0</td><td>80.006</td></tr>
<tr><td>Jun 1 – Jun 30</td><td>10.102</td><td>–</td><td>9.164</td><td>–</td><td>–</td><td>23.999</td></tr>
<tr><td>Jul 1 – Jul 31</td><td>7.462</td><td>–</td><td>7.379</td><td>–</td><td>–</td><td>0</td><td>26.509</td></tr>
<tr><td>Aug 1 – Aug 31</td><td>10.873</td><td>–</td><td>11.633</td><td>–</td><td>–</td><td>0</td><td>14.244</td></tr>
<tr><td>Sep 1 – Sep 30</td><td>11.413</td><td>–</td><td>11.623</td><td>–</td><td>–</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>Oct 1 – Oct 31</td><td>11.117</td><td>–</td><td>–</td><td>12.732</td><td>–</td><td>–</td><td>0</td><td rowspan="3">0</td><td>–</td></tr>
<tr><td>Nov 1 – Nov 30</td><td>10.364</td><td>–</td><td>–</td><td>13.896</td><td>–</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>Dec 1 – Dec 31</td><td>9.429</td><td>–</td><td>–</td><td>14.392</td><td>–</td><td>–</td><td>0</td><td>–</td></tr>
<tr><td>Jan 1 – Jan 31</td><td>9.749</td><td>–</td><td>–</td><td>–</td><td>15.602</td><td>–</td><td>0</td><td>–</td><td>–</td></tr>
<tr><td>Feb 1 – Feb 28</td><td>11.060</td><td>0</td><td>–</td><td>–</td><td>17.153</td><td>–</td><td>0</td><td>–</td><td>2.053</td></tr>
<tr><td rowspan="5"></td><td rowspan="4">151.761</td><td>19.454</td><td>49.637</td><td>41.020</td><td>32.755</td><td>17.799</td><td rowspan="2">0.000</td><td rowspan="3"></td><td rowspan="3">365.760</td></tr>
<tr><td colspan="5">190.666</td></tr>
<tr><td colspan="6">190.666</td></tr>
<tr><td colspan="8">556.426
(2019 Allocation: 556.542 + 0 Returned Exchange = error of 0.116 TAF)</td></tr>
<tr><td colspan="9">708.187</td></tr>
</table>

Note: minor changes to 2019 data was made in September of 2020 and is reflected here.

Appendix C: History of Millerton Unimpaired Runoff

Table C — Water Year Totals in Thousand Acre-Feet

Water Year [1]	Unimpaired Runoff [2] (Natural River)	SJRRP Water Year Type [3]	Water Year [1]	Unimpaired Runoff [2] (Natural River)	SJRRP Water Year Type [3]	Water Year [1]	Unimpaired Runoff [2] (Natural River)	SJRRP Water Year Type [3]
1931	480.2	Critical-High	1963	1,945.266	Normal-Wet	1995	3,876.370	Wet
1932	2,047.4	Normal-Wet	1964	922.351	Dry	1996	2,200.707	Normal-Wet
1933	1,111.4	Normal-Dry	1965	2,271.191	Normal-Wet	1997	2,817.670	Wet
1934	691.5	Dry	1966	1,298.792	Normal-Dry	1998	3,160.759	Wet
1935	1,923.2	Normal-Wet	1967	3,233.097	Wet	1999	1,527.040	Normal-Wet
1936	1,853.3	Normal-Wet	1968	861.894	Dry	2000	1,735.653	Normal-Wet
1937	2,208.0	Normal-Wet	1969	4,040.864	Wet	2001	1,065.318	Normal-Dry
1938	3,688.4	Wet	1970	1,445.837	Normal-Dry	2002	1,171.457	Normal-Dry
1939	920.8	Dry	1971	1,416.812	Normal-Dry	2003	1,449.954	Normal-Dry
1940	1,880.6	Normal-Wet	1972	1,039.249	Normal-Dry	2004	1,130.823	Normal-Dry
1941	2,652.5	Wet	1973	2,047.585	Normal-Wet	2005	2,826.872	Wet
1942	2,254.0	Normal-Wet	1974	2,190.308	Normal-Wet	2006	3,180.816	Wet
1943	2,053.7	Normal-Wet	1975	1,795.922	Normal-Wet	2007	684.333	Dry
1944	1,265.4	Normal-Dry	1976	629.234	Critical-High	2008	1,116.790	Normal-Dry
1945	2,134.633	Normal-Wet	1977	361.253	Critical-Low	2009	1,455.379	Normal-Wet
1946	1,727.115	Normal-Wet	1978	3,402.805	Wet	2010	2,028.706	Normal-Wet
1947	1,121.564	Normal-Dry	1979	1,829.988	Normal-Wet	2011	3,304.824	Wet
1948	1,201.390	Normal-Dry	1980	2,973.169	Wet	2012	831.582	Dry
1949	1,167.008	Normal-Dry	1981	1,067.757	Normal-Dry	2013	856.626	Dry
1950	1,317.457	Normal-Dry	1982	3,317.171	Wet	2014	509.579	Critical-High
1951	1,827.254	Normal-Wet	1983	4,643.090	Wet	2015	327.410	Critical-Low
1952	2,840.854	Wet	1984	2,042.750	Normal-Wet	2016	1,300.986	Normal-Dry
1953	1,226.830	Normal-Dry	1985	1,135.975	Normal-Dry	2017	4,395.400	Wet
1954	1,313.993	Normal-Dry	1986	3,031.600	Wet	2018	1,348.979	Normal-Dry
1955	1,161.161	Normal-Dry	1987	756.853	Dry	2019	2,734.772	Wet
1956	2,959.812	Wet	1988	862.124	Dry	2020	886.025	Dry
1957	1,326.573	Normal-Dry	1989	939.168	Normal-Dry			
1958	2,631.392	Wet	1990	742.824	Dry			
1959	949.456	Normal-Dry	1991	1,027.209	Normal-Dry			
1960	826.021	Dry	1992	807.759	Dry			
1961	647.428	Critical-High	1993	2,672.322	Wet			
1962	1,924.066	Normal-Wet	1994	824.097	Dry			

[1] Water year is from Oct 1 through Sept 30, for example the 2010 water year began Oct 1, 2009. Unimpaired Runoff is based on Reclamation calculations, and hypothetical water year types are shown here; actual Restoration water year types are based on the final allocation, which may sometimes differ slightly from the calculated water year total.

[2] Also known as "Natural River" or "Unimpaired Inflow into Millerton" – This is the total runoff that would flow into Millerton Lake if there were no dams or diversions upstream. There was a lower level of precision prior to 1945.

[3] The six SJRRP Water Year Types are based on unimpaired inflow and are not updated as climatology changes. Critical-Low= <400 TAF, Critical-High=400-669.999 TAF, Dry= 670-929.999 TAF, Normal-Dry 930-1449.999, Normal-Wet 1450-2500, Wet>2500

Appendix D: Final Restoration Allocations and Error

Table D — History of Restoration Allocations

Year	Type	Date of Final Allocation Issuance[2]	Unimpaired Runoff Forecast in Final Allocation (TAF)	Restoration Allocation in Final Issuance (TAF)	Observed Unimpaired Runoff on Sep. 30 (TAF)	Error (Unimpaired Runoff / Allocation)
2009	Interim Flows			261.5	1,455.379	—
2010	Interim Flows			98.2	2,028.706	—
2011	Interim Flows			152.4	3,304.824	—
2012	Interim Flows			183	831.582	—
2013	Interim Flows			65.5	856.626	—
2014	Restoration Flows	Mar 3	518	0 [1]	509.579	+8.421 / 0 [1]
2015	Restoration Flows	Sep 28	327	0	327.410	-0.410 / 0
2016	Restoration Flows	Sep 30	1300.986	263.295	1,300.986	0 / 0
2017	Restoration Flows	Jul 10	4,444	556.542	4,395.400	+48.600 / 0
2018	Restoration Flows	May 22	1,427	280.258	1,348.979	+78.021 / +10.503
2019	Restoration Flows	May 20	2,690	556.542	2,734.772	-44.772 / 0
2020	Restoration Flows	June 19	880	202.197	886.025	-6.025 / -1.345

[1] No water was provided under this Critical-High designation due to necessity for Friant Dam to release flows for the Exchange Contract.

[2] In 2018 with the completion of Version 2.0 of the Restoration Flows Guidelines, the date of final Restoration Allocation issuance was advanced from September 30 to either May or June.