SAN JOAQUIN RIVER RESTORATION PROGRAM

Bureau of Reclamation
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2016 Restoration Allocation & Default Flow Schedule

March 18, 2016

Introduction

The following transmits the 2016 Restoration Allocation and Default Flow Schedule to the Restoration Administrator for the San Joaquin River Restoration Program (SJRRP), consistent with the Restoration Flows Guidelines (RFG, December 2013). This Restoration Allocation and Default Flow Schedule provide the following:

- Forecasted Water Year Unimpaired Runoff: estimated flows that would occur absent regulation on the river. This runoff is utilized to identify the Restoration Year Type.
- Hydrograph Volumes: annual allocation hydrograph based on water year unimpaired inflow, utilizing the Method 3.1 with the Gamma pathway (RFG-Appendix C, Figure C-3) agreed to by the Parties in December 2008.
- Default Flow Schedule: the Restoration schedule in the absence of a recommendation from the Restoration Administrator.
- Additional Allocations: hypothetical Restoration release allocations that would result from 10th, 50th, 75th, and 90th percentiles unimpaired runoff.
- Unreleased Restoration Flows: amount of Restoration Flows not released due to channel capacity constraints and without delaying completion of Phase 1 improvements.
- Flow targets at Gravelly Ford: flows at the head of Reach 2 based on scheduled releases from Friant Dam less the assumed Holding Contract demands and losses in Exhibit B.
- Restoration Budget: volumes for the annual allocation, spring flexible flow, base flow, riparian recruitment, and fall flexible flow.
- Remaining Flexible Flow Volume: the amount of Restoration Flows released and the remaining volume available for scheduling.
- Operational Constraints: 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 RFGs, 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 recommend both an unconstrained and a capacity limited recommendation.

Forecast Unimpaired Runoff

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. The forecast of the unimpaired runoff determines the volume of Restoration Flows available (Restoration Allocation). Information for forecasting the unimpaired runoff primarily includes:

- The Bureau of Reclamation (Reclamation), Friant Division estimate of unimpaired runoff into Millerton Lake to support the water supply allocation[1];
- The Department of Water Resources (DWR) Water Supply Index forecast latest update on March 15, 2016 (published on March 17, 2016) for Water Year 2016 San Joaquin River inflow to Millerton Lake Unimpaired Flow[2], and/or the most current DWR Bulletin 120 Report[3];
- The National Weather Service (NWS) Ensemble Streamflow Prediction (ESP) Water Supply Forecast (Water Year 2016) for the San Joaquin River at Millerton Lake[4] (published daily);

Table 1 shows the 2016 San Joaquin River Water Year forecast at Millerton Lake, while Figure 1a and Figure 1b plot the forecast over time. Both the DWR and NWS forecasts are shown, with the addition of a smoothed NWS value that removes the day-to-day variance in the NWS forecast value. The smoothed numbers are calculated using a 7-day moving average, where the most recent value is given greater weight than each proceeding day. Figures 1a and 1b show that the DWR and NWS values were similar prior to March 1, increasing confidence in that forecast. Since March 1, substantial precipitation has fallen in the watershed and the NWS daily forecast has responded with an increase in forecast water supply. The B-120 updates published after March 1 have not shown the same increase.

The water year accumulated runoff at Friant Dam as of March 17th is 320 thousand acre-feet (TAF). This is 76% of average for this date, similar to the 50th percentile runoff forecast which is 84% of average. This convergence likely indicates that portions of the snowpack have begun to melt, causing the accumulated runoff at Friant to approach the forecasted value. Accumulated runoff is still slightly lower than the 50th percentile runoff forecast, and is expected to remain lower until the bulk of snowmelt occurs.

Table 1 — San Joaquin River Water Year Actuals and Forecast at Millerton Lake.

Forecast Source	90%	75%	50%	10%
Accumulated "Full Natural" Runoff, March 17, 2016 [1]	320 TAF			
DWR, March 17, 2016[2]	1160TAF	1260 TAF	1445 TAF	2020 TAF
NWS, March 17, 2016 (Daily Value[4])	1400 TAF	1450 TAF	1540 TAF	1980 TAF
NWS, March 17, 2016 (7-day Smoothed Value[5])	1414 TAF	1469 TAF	1572 TAF	2037 TAF

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

[2] http://cdec.water.ca.gov/cgi-progs/iodir/WSI.2016

[3] http://cdec.water.ca.gov/cgi-progs/iodir?s=b120

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

[5] The NWS smoothed data uses a 7-day 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 us used: $((Forecast_n * 1) + (Forecast_{n-1} * 0.857) + (Forecast_{n-2} * 0.714) + (Forecast_{n-3} * 0.571) + (Forecast_{n-4} * 0.429) + (Forecast_{n-5} * 0.286) + (Forecast_{n-6} * 0.143)) / 4$

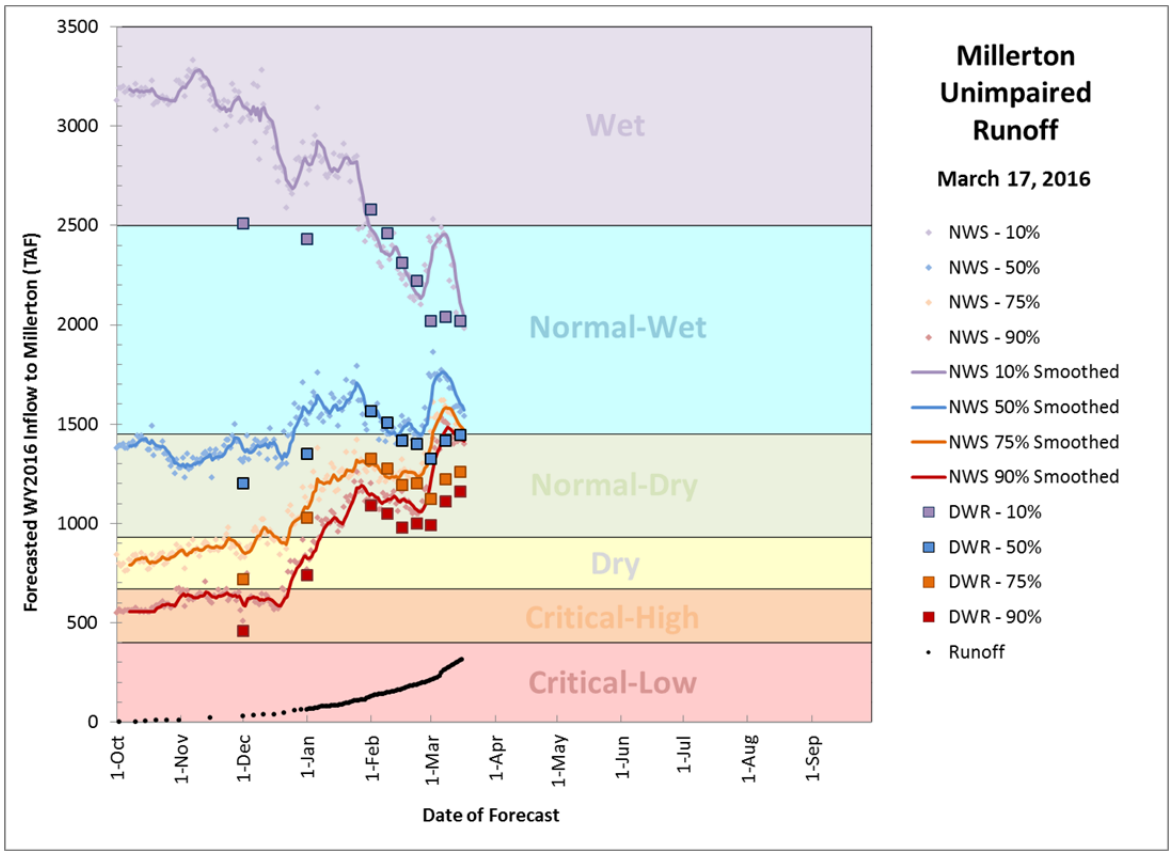

Figure 1a – Plot of Water Year 2016 forecasts, including both NWS Ensemble Streamflow Prediction Forecast and DWR Forecast

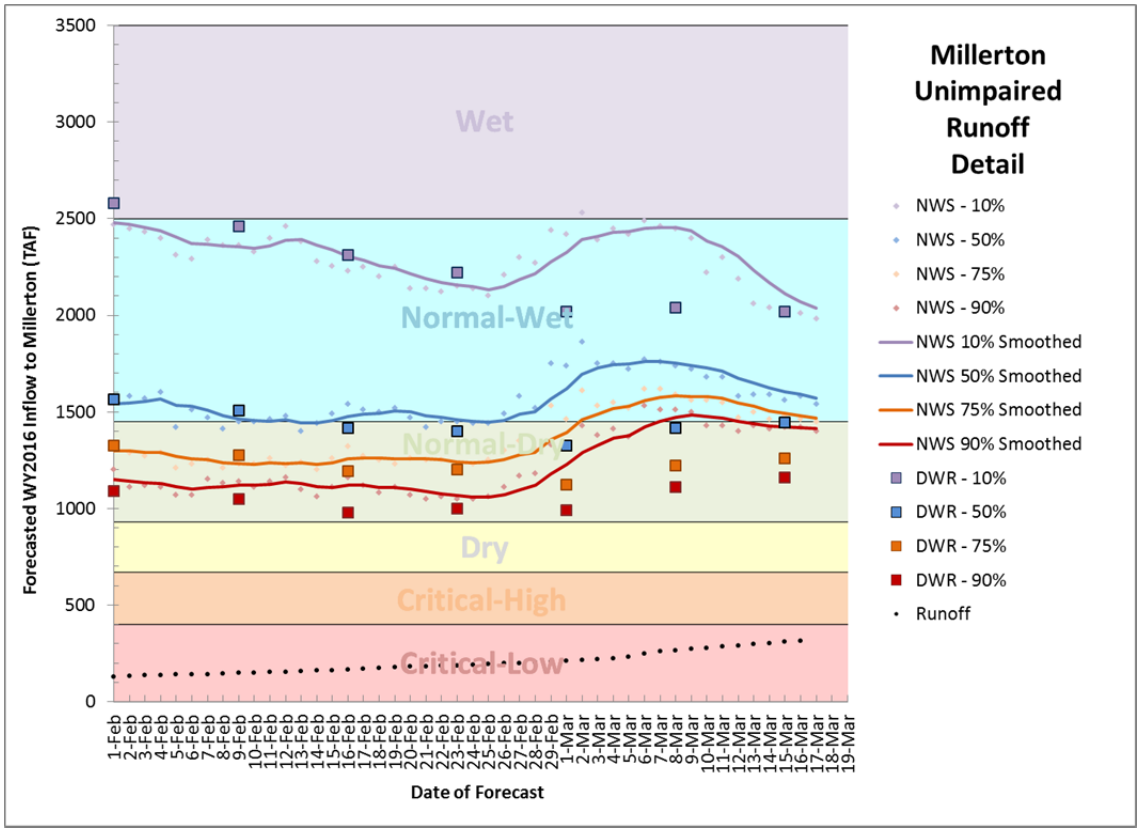

Figure 2b. Detail plot of most recent forecasts

In compliance with the RFGs directive to assess the best available records and forecast information, Reclamation has averaged the DWR and NWS forecasts in Table 1 to determine the Restoration Allocation (Table 2). The two primary forecast sources — DWR and NWS — were blended 50/50 to produce a single forecast value. Reclamation used the most recent forecasts – the DWR March 15 forecast and the NWS March 17 forecast, the latter being smoothed to reduce noise as described above. As the DWR forecast is older and may not incorporate recent precipitation, it is a lower value. Thus, blending 50/50 produces a conservative estimate. Future allocations may use a different approach to combining forecast information or incorporate more than two forecasts.

Table 2 —Unimpaired Inflow Forecast

Forecast Source	90%	75%	50%	10%
Combined Unimpaired Inflow Forecast (50% DWR / 50% NWS)	1287 TAF	1365 TAF	1509 TAF	2029 TAF

Restoration Allocation

A three-step process is used to determine the exceedance percentile required to determine the Restoration Allocation. This process is described in greater detail in the RFGs. Table 3 shows that based on the current Combined Unimpaired Inflow Forecast the 90th percentile forecast exceedance should be used for generating a Restoration Allocation.

Table 3 — Allocation Determination Steps

Allocation Step	Result
1. 50th Percentile Forecast compared to average	Below Average
2. Pattern Year Type	Normal-Dry
3. Option 1D Percentile Exceedance for this period	90

Using the 90th percentile forecast exceedance value of 1287 TAF, the Water Year Type for Restoration Flows is **Normal-Dry**. **The Restoration Allocation is 261.4 TAF as measured at Gravelly Ford, combined with Holding Contracts on the San Joaquin River, this equates to a Friant Dam Release of 378.4 TAF**. Other hypothetical allocations are presented in Table 4 as grayed values. These may be useful for contingency planning should the forecast change over time.

Table 4 — Restoration Flow Water Year Type and Allocation shown with Other Hypothetical Values in Gray

Forecast Source	90%	75%	50%	10%
Water Year Type	Normal-Dry	Normal-Dry	Normal-Wet	Wet
Combined Unimpaired Runoff Forecast (TAF)	1287	1365	1509	2029
Friant Dam Releases (TAF)	378.4	388.9	408.6	481.4
Restoration Allocation @ Gravelly Ford (TAF)	261.4	271.9	291.6	364.5

TAF = thousand acre-feet

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. As a result, if a situation were to occur where the Restoration Flows conflicted with Reclamation making necessary deliveries under the Purchase Contract and Exchange Contract, Reclamation would make water available to meet the contractual requirements and/or refrain from making releases under the Settlement.

In determining whether to release Restoration Flows, Reclamation considers its ability to meet senior obligations in the Purchase Contract and Exchange Contract. Reclamation continues to have concerns regarding our ability to meet Purchase Contract and Exchange Contract requirement of a maximum contract entitlement not to exceed 840,000 acre-feet from constrained Delta supplies. We are working with the Exchange Contractors to meet their schedule from Delta supplies; however, the four consecutive years of drought and associated constrained Delta supplies continue to substantially reduce Reclamation's ability to satisfy our Exchange Contract obligations solely from Delta supplies. The potential result of a shortfall in Delta deliveries to satisfy the Exchange Contract could result in fulfilling the remainder of their contract from Millerton Reservoir supplies. Reclamation will continue to communicate with the Restoration Administrator as additional information on Exchange Contractor releases and CVP hydrologic and operational factors becomes available.

Reclamation requests that the Restoration Administrator provide a flow recommendation, assuming a Normal-Dry restoration water year type and the allocation volumes described herein, by **March 28, 2016**. Reclamation will follow the process in the RFGs and review the recommendation in anticipation of commencing Restoration Flows as soon as possible afterward. This Restoration Allocation does not imply that other contractual obligations have been met.

Default Flow Schedule

The Default Flow Schedule identifies how Reclamation will schedule the Restoration Allocation for the current water year type and runoff volume absent a recommendation from the Restoration Administrator, consistent with the Settlement. This schedule has been modified to reflect the operational constraints outlined in the section below, primarily a 1,120 cfs capacity constraint in Reach 2B. Subsequent default schedules will be derived from new flow forecasts and will be modified based on the restoration flow volume remaining for the year.

Table 5—Exhibit B Method 3.1 "Default" Hydrograph Volumes

Flow Period	Releases from Friant Dam (cfs)	Flows Targets at Gravelly Ford (cfs)	Restoration Flows at Gravelly Ford (cfs)	Friant Release Volume (TAF)	Restoration Flow Volume at Gravelly Ford (TAF)
Mar 1 - Mar 15	500	375	370	14.9	11.0
Mar 16 - Mar 31	1390	1265	1260	44.1	40.0
Apr 1 - Apr 15	1390	1245	1240	41.4	36.9
Apr 16 - Apr 30	790	645	640	23.5	19.1
May 1 - Jun 30	350	165	160	42.3	19.4
Jul 1 - Aug 31	350	125	120	43.0	14.8
Sept 1 - Sept 30	350	145	140	20.8	8.3
Oct 1 - Oct 31	350	195	190	21.5	11.7
Nov 1 - Nov 6	700	575	570	8.3	6.8
Nov 7 - Nov 10	700	575	570	5.6	4.5
Nov 11 - Dec 31	350	235	230	35.4	23.3
Jan 1 - Feb 28	350	255	250	41.0	29.3
	Estimated Unreleased Restoration Flows			**36.5**	**36.5**
				Total = 378.4	**Total = 261.4**

cfs=cubic feet per second
TAF = thousand acre-feet

Exhibit B Method 3.1 Hydrograph Volumes

Table 5 shows the Exhibit B Method 3.1 hydrograph volumes and corresponding Restoration Allocation volumes for the entire year, including total releases from Friant Dam and Restoration Flows releases in excess of Holding Contracts. This default hydrograph will be implemented in the absence of a specific recommendation by the Restoration Administrator.

Due to levee stability related channel capacity constraints in Reach 2B that constrain Friant Dam releases, Restoration Flows of 36.5 TAF are generated that are not scheduled in the above default flow schedule and would become Unreleased Restoration Flows under the default hydrograph.

Exhibit B Restoration Flow Budget

Table 6 shows the components of the restoration budget for March 1, 2016, through February 28, 2017. The base flow allocation, spring flexible flow, and fall flexible flow reflect the Exhibit B hydrograph for a Normal-Dry water year type. The riparian recruitment component is without any balance because the Restoration Year Type is Normal-Dry. The estimated total releases at Friant consists of 116,945 acre-feet release for Holding Contracts, 224,897 acre-feet of Restoration Flows as measured at Gravelly Ford, and 36,516 acre-feet of URFs, for a total Restoration Allocation of 378,358 acre-feet at Friant Dam. The total flow volume for Restoration

Flows as well as various accounting flow components may change as current unimpaired flow forecasts are updated.

Table 6 – Restoration Budget with Flow Accounts

Schedule Start Date	Friant Restora-tion Flow (cfs)	Gravelly Ford Flow Targets (cfs)	Holding Contract Demand (cfs)	Holding Contract Demand (af)	Base Flow (af)	Spring Flexible Flow (af)	Fall Flexible Flow (af)	Riparian Recruit-ment Flow (af)	Buffer Flow* (af)	Flexible Buffer Flows (af)
Mar. 1	500	375	130	3,868	0	11,008	-	-	1,488	0
Mar. 16	1390	1265	130	4,126	0	39,987	-	-	4,411	0
Apr. 1	1390	1245	150	4,463	0	36,893	-	-	4,136	0
Apr. 16	790	645	150	4,463	0	19,052	-	-	2,351	0
May 1	350	165	190	10,552	8,886	-	-	0	1,944	5,000
May 29	350	165	190	12,436	10,473	-	-	-	2,291	
Jul. 1	350	125	230	28,284	14,757	-	-	-	4,304	
Sep. 1	350	145	210	12,496	8,331	-	-	-	2,083	7,081
Oct. 1	350	195	160	9,838	0	-	11,683	-	2,152	
Nov. 1	700	575	130	1,547	0	-	6,783	-	833	
Nov. 7	700	575	130	1,031	0	-	4,522	-	555	
Nov. 11	350	235	120	4,760	0	-	9,124	-	1,388	
Dec. 1	350	235	120	7,379	14,142				2,152	
Jan. 1	350	255	100	6,149	15,372	-	-	-	2,152	0
Feb. 1	350	255	100	5,554	13,884	-	-	-	1,944	0

cfs=cubic feet per second
af = acre-feet
* = includes buffer flows on unreleased volume due to channel capacity constraint

Remaining Flexible Flow Volume

The Friant release for accounting uses the most recent flow schedule. The amount of water remaining for flexible flow scheduling is the volume of flexible flow water in excess of releases required to meet riparian demands, less past releases. Table 7 shows the estimated remaining volume.

Table 7 – Estimated Flexible Flow Volume Remaining

Flow Account	Yearly Allocation (af)	Release up to Date[1] (af)	Remaining Flow Volume (af)
Spring Flexible Flow + Base Flow (March 1-May 1, 2016)	106,940	4,695	102,245
Riparian Recruitment	0	0	0
Fall Flexible Flow (October 1-November 30, 2016)	32,112	0	32,112
Buffer Flow	34,184	0	34,184
Purchased Water	0	0	0

af= acre-feet

[1] As of 3/18/2016 at 12:00 AM

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 8 summarizes known 2016 operational constraints.

Table 8 – Summary of Operational Constraints

Constraint	Period	Flow Limitation
Seepage Easements / Environmental Commitments	Currently in place until further notice	0 cfs below Sack Dam
Eastside Bypass Maintenance for Sand Removal	June 1 – August 30	0 cfs below Sack Dam

At this time, channel capacity, seepage constraints, and environmental commitments prevent any flows below Sack Dam. In addition, summer construction on the Eastside Bypass will require zero flows below Sack Dam. Reclamation is actively working on addressing these issues and expects to be able to pass at least 50 cfs below Sack Dam no later than completion of the summer construction on the Eastside Bypass.

Reclamation will complete a Flow Bench Evaluation prior to any increases below Sack Dam to verify the allowed flow increase. Once flows are allowed, an initial 50 cfs will be allowed to pass below Sack Dam while monitoring groundwater levels for two weeks. Upon completion of an

additional seepage easement, which is expected to be acquired by late spring, approximately 300 cfs will be allowable past Sack Dam. Only after groundwater levels have stabilized below thresholds, Reclamation will perform another Flow Bench Evaluation to evaluate an increase to 150 cfs, if the Restoration Administrator requests such an increase. After two weeks at 150 cfs and groundwater stabilization, Reclamation will evaluate an increase to 300 cfs. After two weeks at 300 cfs and groundwater stabilization, Reclamation will complete another Flow Bench Evaluation to evaluate whether any additional increase can be made while maintaining groundwater levels below thresholds. These incremental releases allow groundwater levels in monitoring wells to respond to 6 inch changes in water surface elevation in the river, as based on one-dimensional hydraulic modeling shown in Figure 2, and avoid potential groundwater seepage impacts. Future Restoration Allocations will provide updates to seepage limitations.

In addition, the 2016 Restoration Year Channel Capacity Report identifies a maximum flow in Reach 2B of 1,120 cfs. This results in a maximum release from Friant Dam between 1,360 cfs and 1,490 cfs depending on the time of year. Reclamation will coordinate with the Restoration Administrator through the biweekly Flow Scheduling Subgroup conference calls and on an as-needed basis to update these constraints.

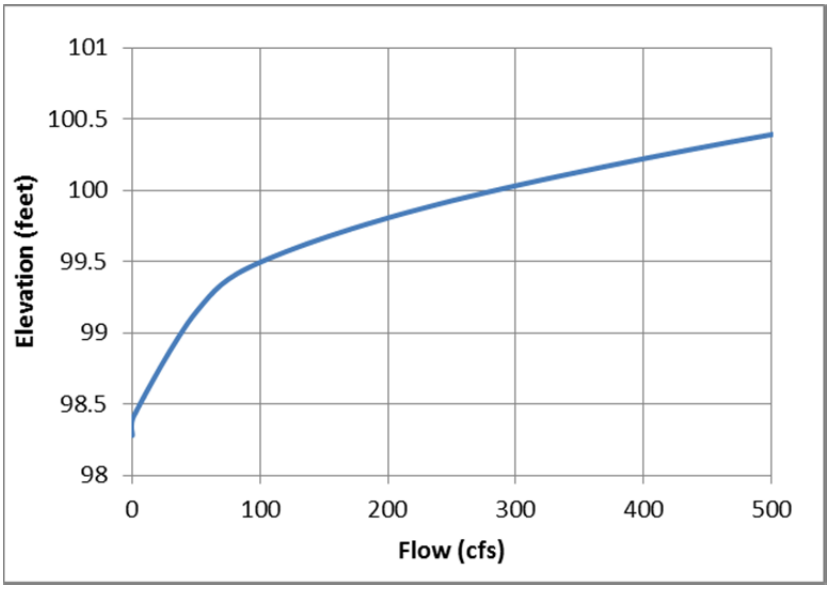

Figure 2 – Rating Curve at El Nido Road in the Eastside Bypass

A sand removal project in the Eastside Bypass will affect any potential flows below Sack Dam during the summer months. The two-month construction project is anticipated to commence July 1, 2016 and requires drying the channel starting June 1, 2016. Therefore, flows below Sack Dam should be 0 cfs from June 1 through September 1, 2016. If construction is completed sooner than anticipated, flows may begin again before September 1, 2016. Resuming flows below Sack Dam would be completed in a ramp-up similar to that described above.

All of these operational constraints will be evaluated in the April Restoration Allocation update and adjusted as necessary based on the most current information.