LOWER AMERICAN RIVER FLOW MANAGEMENT STANDARD

TECHNICAL MEMORANDUM 1

PROJECT DESCRIPTION

MODIFIED FLOW MANAGEMENT STANDARD

Table of Contents

List of Figures

List of Tables

List of Acronyms

2006 FMS	2006 Lower American River Flow Management Standard
AF	acre-feet
AFRP	Anadromous Fish Restoration Program
ARG	Lower American River Group
ARI	American River Index
ATSP	Automated Temperature Selection Procedure
B120	Bulletin 120, Water Conditions in California
B2IT	(b)(2) Interagency Team
BO	Biological Opinion
CAMP	Comprehensive Assessment and Monitoring Protocols CDEC California Data Exchange Center
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CNRFC	California-Nevada River Forecast Center
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWT	coded-wire tags
D-893	State Water Resources Control Board Decision 893
Delta	Sacramento-San Joaquin River Delta
DWR	California Department of Water Resources
EID	El Dorado Irrigation District
EIR	Environmental Impact Report
EOD	End-of-December
EOM	End-of-May
FRI	Four Reservoir Index
iCPMM	Iterative Coldwater Pool Management Model
IFII	Impaired Folsom Inflow Index
MAF	million acre-feet
M&I	Municipal and Industrial
MFP	Middle Fork Project

Modified FMS	Modified Lower American River Flow Management Standard
MRR	Minimum Release Requirement
NMFS	National Marine Fisheries Service
OCAP	Operating Criteria and Plan
PCWA	Placer County Water Agency
RDPA	redd dewatering protective adjustments
Reclamation	U.S. Department of Interior, Bureau of Reclamation
RST	rotary screw trap
SMUD	Sacramento Metropolitan Utility District
SRA	shaded riverine aquatic
SRI	Sacramento River Index
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
UARP	Upper American River Project
UIFR	Unimpaired Inflow to Folsom Reservoir
USFWS	U.S. Department of Interior, Fish and Wildlife Service
Water Forum	Sacramento Water Forum
WOMT	Water Operations Management Team
WYTD	water-year-to-date
YOY	young-of-the-year

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1 INTRODUCTION

The American River (**Figure 1**) is the second largest tributary to the Sacramento River.

The U.S. Department of Interior, Bureau of Reclamation (Reclamation) operates Folsom and Nimbus dams on the American River as part of the Central Valley Project (CVP) to provide flood control and water for irrigation, municipal and industrial uses, hydroelectric power, recreation, water quality, and the protection of aquatic resources. Folsom Reservoir has a capacity of 977,000 acre-feet (AF).

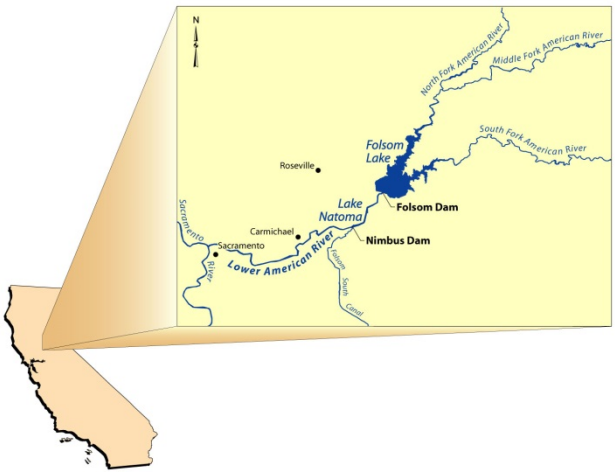


Figure 1. The American River.

Recent developments have demonstrated the need for an improved streamflow standard for Folsom and Nimbus dams and the lower American River. Hydrologic modeling associated with the Bay-Delta Conservation Plan, and later that project's iteration as the California WaterFix, have indicated that: (1) it is possible that, in the future, Folsom Reservoir could be drawn down to extremely low conditions in dry cycles; and (2) that project could exacerbate this problem. Severe drought conditions from 2012 through 2015 demonstrated that there already is an existing problem with maintaining adequate Folsom Reservoir storage during dry periods that could be exacerbated by California WaterFix, and detrimentally affect lower American River salmonid species (i.e., fall-run Chinook salmon and Central Valley steelhead). The Water Forum has developed the Modified Flow Management Standard (Modified FMS) to protect the lower American River's water supply and environmental resources, while avoiding re-directed impacts to the Sacramento River. The Modified FMS is described in this Technical Memorandum.

1.1 EXISTING FLOW MANAGEMENT

The existing minimum instream flow requirements for the lower American River are those in the 2006 lower American River flow management standard (2006 FMS), which was developed jointly by Reclamation, the National Marine Fisheries Service (NMFS), the U.S. Department of Interior, Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and the Water Forum. Implemented beginning in 2006, the 2006 FMS prescribes minimum release requirements (MRR) at Nimbus Dam, based on the following hydrologic indices:

- Four Reservoir Index (FRI) for October through December
- Sacramento River Index (SRI) for January and February
- Impaired Folsom Inflow Index (IFII) for March through September

The applicable hydrologic index value is used to determine a monthly Index Flow using a family of five look-up curves. The look-up curves vary by season, depending on ideal fisheries habitat flow needs throughout the year, corresponding with the timing of specific lifestages of fall-run Chinook salmon and steelhead. The Index Flows are designed to consider fall-run Chinook salmon spawning habitat availability, steelhead spawning habitat availability, and juvenile salmon and steelhead rearing habitat conditions. The Index Flows are further subject to modification by prescriptive adjustments, and off-ramp and Conference Year conditions.

The 2006 FMS prescriptive adjustments, off-ramps, and Conference Year determinations, however, do not prevent storage in Folsom Reservoir from dropping to levels that could preclude diversions to municipal and industrial (M&I) water users from Folsom Reservoir, and that could adversely affect salmonids in the lower American River.

1.2 MODIFIED FMS

The Water Forum has developed the Modified FMS to provide greater protection of the American River Basin water resources for water supply and environmental purposes, while avoiding re-directed impacts to the Sacramento River. The description of how these objectives were achieved is included in the Water and Power Rationale and Biological Rationale documents and the tools used are outlined in Technical Memorandum 2-10.

The Modified FMS is comprised of the following major elements: (1) hydrologic indices; (2) a family of MRR curves; (3) an end-of-May reservoir storage requirement; (4) an end-of-December storage requirement; (5) redd dewatering protective adjustments; (6) a spring pulse flow event; (7) water temperature management requirements; (8) the Lower American River Group; and (9) operations forecasts by Reclamation. Because the Modified FMS is a modification of the 2006 FMS, not all of the Modified FMS's elements are new. Sections 2 through 6 below describe the new elements of the Modified FMS that have replaced or altered elements of the 2006 FMS. Sections 6 through 10 below describe elements of the Modified FMS that have been carried over from the 2006 FMS. All of these elements are described in more detail below and in the associated document entitled *Modified Flow Management Standard Proposed Water-Right Terms and Conditions, November 2017*. There also is an on-going monitoring and evaluation program in which the Water Forum participates that is expected to continue.

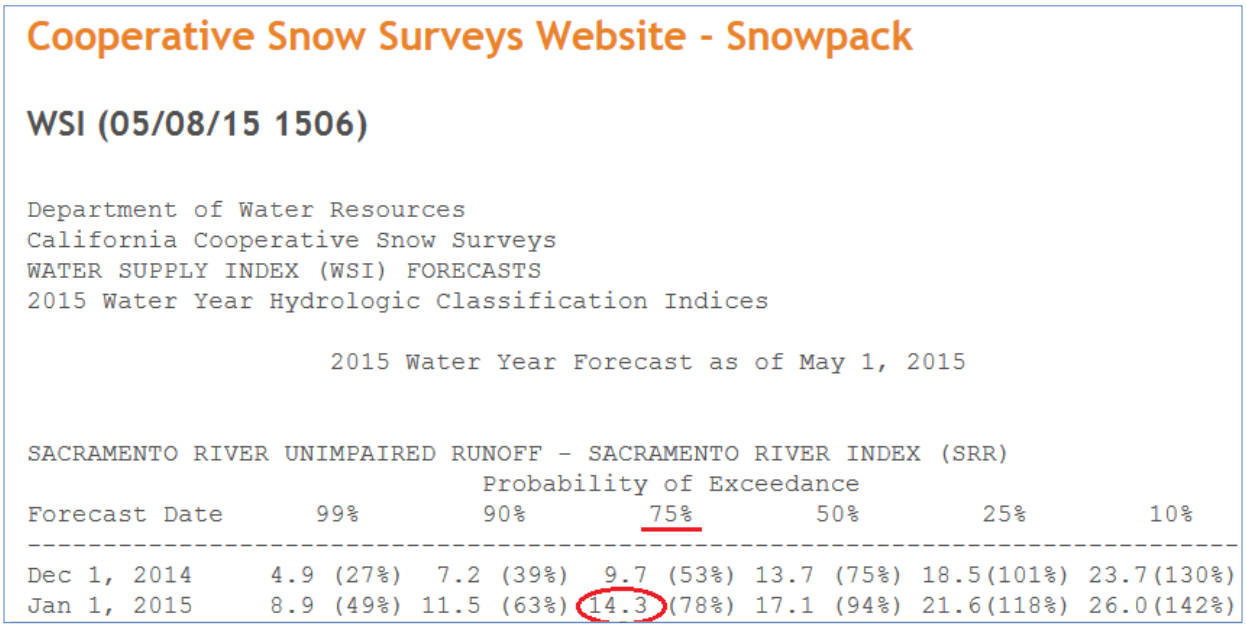
2 HYDROLOGIC INDICES

Hydrologic indices of water availability are used in the Modified FMS to scale the MRR flows to water year type. Lower MRRs are prescribed in drier years and higher MRRs are prescribed in wetter years. The MRRs are updated each month from January through May based on updated forecasts and indices for the water year. During the latter portion of the year (June through December), MRRs are based on the May index, because at that time the majority of the precipitation has occurred in the watershed (i.e., the amount of water available is fairly certain). The criteria used to develop the most appropriate hydrologic index were that the index was well established, publicly available or easy to calculate, accurate, available January through May, and updated monthly as the water year progressed. The two indices that were selected to specify the

MRR were the SRI for the month of January, and the ARI for the months of February through December. Each index is described below.

2.1 SACRAMENTO RIVER INDEX

The SRI, previously referred to as the "4 River Index" or "4 Basin Index," is published by the California Department of Water Resources (DWR) each year on December 1, January 1, February 1, March 1, April 1, and May 1 for several exceedance levels. The value of the SRI at 75% exceedance is used for determining the MRR in January (**Figure 2**). The SRI can be found at http://cdec.water.ca.gov/cgi-progs/iodir_ss/wsi. DWR computes the SRI by adding the forecasted unimpaired flow for the water year from the Sacramento River above Bend Bridge, the Feather River at Oroville, the Yuba River near Smartsville, and the American River below Folsom Reservoir.



Cooperative Snow Surveys Website - Snowpack

WSI (05/08/15 1506)

Department of Water Resources
California Cooperative Snow Surveys
WATER SUPPLY INDEX (WSI) FORECASTS
2015 Water Year Hydrologic Classification Indices

2015 Water Year Forecast as of May 1, 2015

SACRAMENTO RIVER UNIMPAIRED RUNOFF - SACRAMENTO RIVER INDEX (SRR)

	Probability of Exceedance					
Forecast Date	99%	90%	75%	50%	25%	10%
Dec 1, 2014	4.9 (27%)	7.2 (39%)	9.7 (53%)	13.7 (75%)	18.5(101%)	23.7(130%)
Jan 1, 2015	8.9 (49%)	11.5 (63%)	14.3 (78%)	17.1 (94%)	21.6(118%)	26.0(142%)

Figure 2. Excerpt from the California Data Exchange Center website showing the Sacramento River Index value at 75% exceedance.

2.2 AMERICAN RIVER INDEX

The ARI is a measure of the unimpaired inflow to Folsom Reservoir minus the amount of "spill" water that could not be captured at the reservoir (unimpaired runoff minus spill flows). The equations for calculating the ARI are provided in **Table 1**.

The unimpaired inflow used in the ARI is based on the DWR "Bulletin 120, Water Conditions in California" (B120) estimate of unimpaired water year runoff in the "American River below Folsom Lake." DWR initially publishes the B120 each year in early February, and subsequently publishes the March, April, and May B120 on the 6th working day of each month. Between the monthly B120 publications and after the May publication, DWR publishes weekly updates reflecting current snow pack and precipitation monitoring information. The final weekly update

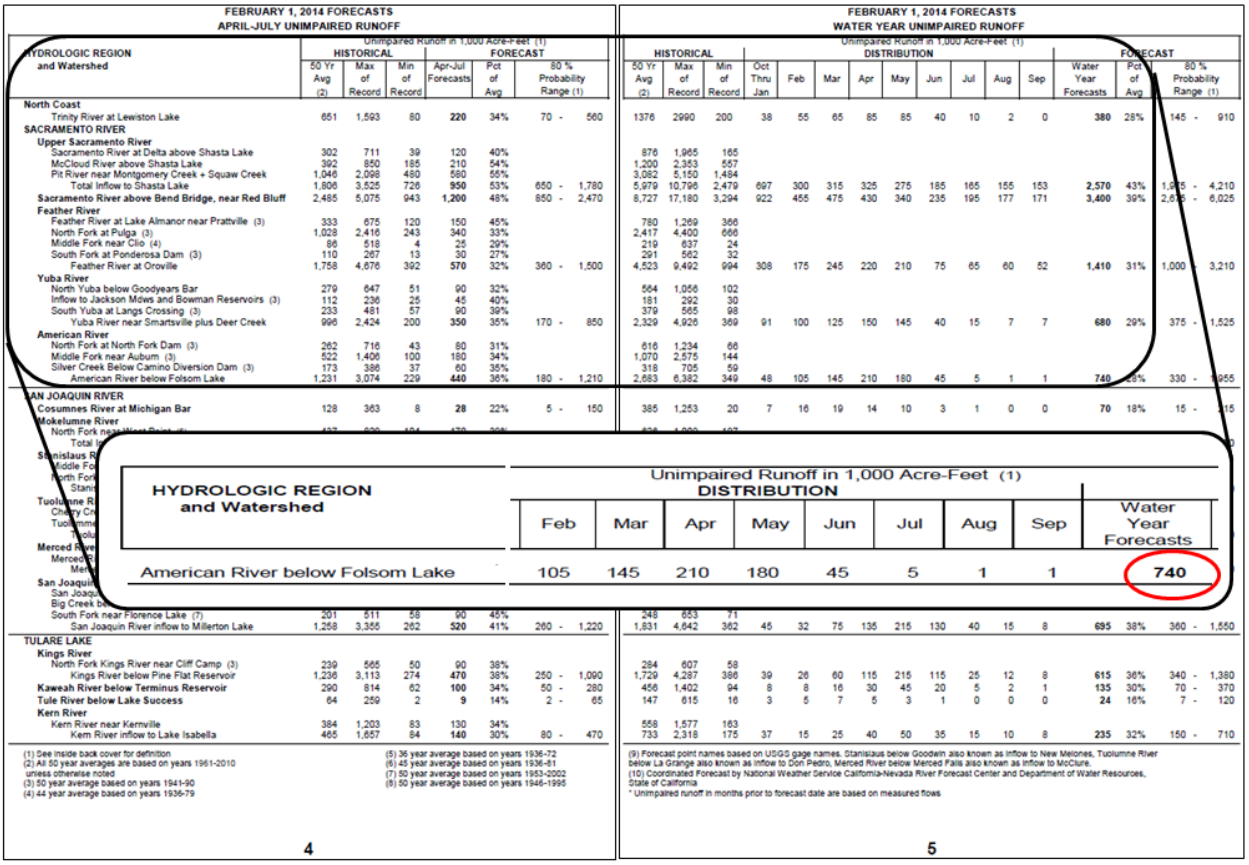
is typically released in early June, but depending on conditions, the release of weekly updates can extend into mid-or late-June.

Table 1. Equations to calculate the American River Index.

Variable & Units	Equation/Calculation Method	Description and Citations
$ARI_{i,j}$ (TAF)	$ARI_{i,j} = B120\ WY\ Forecast_{i,j} - Folsom\ WYTD\ Spill_{i,j}$	American River Index for water year i estimated based on data available in month j.
B120 WY Forecast$_{i,j}$ (TAF)	Published Bulletin 120.	DWR Bulletin 120, 50% exceedance "water year forecast" in the "American River below Folsom Lake" for water year (WY) i published in month j.
Folsom WYTD Spill$_{i,j}$ (TAF)	$\sum_{k=Oct\ 1}^{End\ of\ Month\ j-1} (Spill_{k\ (cfs)} + ContReg_{k\ (cfs)})\ 0.001983$	The water-year-to-date (WYTD) i volume of the Folsom Dam spillway and/or control regulating discharge (ContReg) for each day k through the end of month j as reported by DWR's California Data Exchange Center website; where Spill = spillway discharge (cfs) and ContReg = control regulating discharge (cfs), but only control regulating discharges related to avoiding reservoir spills, not releases used for temperature control in the fall or other discretionary releases

B120 provides both a forecast of monthly unimpaired flows for the water year (October through September), a forecast of water year unimpaired runoff, commonly referred to as the median forecast, and an 80 percent probability range, that essentially defines the 10 percent and 90 percent exceedance levels. DWR's B120 publications can be found at http://cdec.water.ca.gov/snow/bulletin120/index.html. An excerpt of pages 4 and 5 from B120 is shown in **Figure 3**. The median value ("Water Year Forecast") is used in computing the ARI.

The amount of spill water in the ARI computation is the cumulative water-year-to-date (WYTD) amount of discharge from the Folsom Dam Spillway and the Control Regulating Gates as reported by DWR's California Data Exchange Center (CDEC) website (http://cdec.water.ca.gov/cgi-progs/queryCSV?station_id=FOL) as shown in **Figure 4**. However, only "Control Regulating Gate" discharges related to avoiding reservoir spills are used in the calculation, not releases used for temperature control in the fall (or other discretionary releases). The WYTD discharge is calculated from October 1 through the end of the month preceding the forecast (e.g., October 1 through January 31 for the February forecast).



FEBRUARY 1, 2014 FORECASTS
APRIL-JULY UNIMPAIRED RUNOFF

Unimpaired Runoff in 1,000 Acre-Feet (1)

HYDROLOGIC REGION and Watershed	HISTORICAL 50 Yr Avg (2)	HISTORICAL Max of Record	HISTORICAL Min of Record	FORECAST Apr-Jul Forecasts	FORECAST Pct of Avg	FORECAST 80 % Probability Range (1)
North Coast						
Trinity River at Lewiston Lake	651	1,593	80	**220**	34%	70 - 560
SACRAMENTO RIVER						
Upper Sacramento River						
Sacramento River at Delta above Shasta Lake	302	711	39	120	40%	
McCloud River above Shasta Lake	392	850	185	210	54%	
Pit River near Montgomery Creek + Squaw Creek	1,046	2,098	480	580	55%	
Total Inflow to Shasta Lake	1,806	3,525	726	**950**	53%	650 - 1,780
Sacramento River above Bend Bridge, near Red Bluff	2,485	5,075	943	**1,200**	48%	850 - 2,470
Feather River						
Feather River at Lake Almanor near Prattville (3)	333	675	120	150	45%	
North Fork at Pulga (3)	1,028	2,416	243	340	33%	
Middle Fork near Clio (4)	86	518	4	25	29%	
South Fork at Ponderosa Dam (3)	110	267	13	30	27%	
Feather River at Oroville	1,758	4,676	392	**570**	32%	360 - 1,500
Yuba River						
North Yuba below Goodyears Bar	279	647	51	90	32%	
Inflow to Jackson Mdws and Bowman Reservoirs (3)	112	236	25	45	40%	
South Yuba at Langs Crossing (3)	233	481	57	90	39%	
Yuba River near Smartsville plus Deer Creek	996	2,424	200	**350**	35%	170 - 850
American River						
North Fork at North Fork Dam (3)	262	716	43	80	31%	
Middle Fork near Auburn (3)	522	1,406	100	180	34%	
Silver Creek Below Camino Diversion Dam (3)	173	386	37	60	35%	
American River below Folsom Lake	1,231	3,074	229	**440**	36%	180 - 1,210
SAN JOAQUIN RIVER						
Cosumnes River at Michigan Bar	128	363	8	**28**	22%	5 - 150
Mokelumne River						
North Fork near West Point (5)	[illegible]					
Total Inflow to Pardee Reservoir	[illegible]					
Stanislaus River						
Middle Fork	[illegible]					
North Fork	[illegible]					
Stanislaus River	[illegible]					
Tuolumne River						
Cherry Creek	[illegible]					
Tuolumne River	[illegible]					
Hetch Hetchy	[illegible]					
Merced River						
Merced River	[illegible]					
Merced	[illegible]					
San Joaquin River						
San Joaquin	[illegible]					
Big Creek below	[illegible]					
South Fork near Florence Lake (7)	201	511	58	90	45%	
San Joaquin River inflow to Millerton Lake	1,258	3,355	262	**520**	41%	260 - 1,220
TULARE LAKE						
Kings River						
North Fork Kings River near Cliff Camp (3)	239	565	50	90	38%	
Kings River below Pine Flat Reservoir	1,236	3,113	274	**470**	38%	250 - 1,090
Kaweah River below Terminus Reservoir	290	814	62	**100**	34%	50 - 280
Tule River below Lake Success	64	259	2	**9**	14%	2 - 65
Kern River						
Kern River near Kernville	384	1,203	83	130	34%	
Kern River inflow to Lake Isabella	465	1,657	84	**140**	30%	80 - 470

(1) See inside back cover for definition
(2) All 50 year averages are based on years 1961-2010 unless otherwise noted
(3) 50 year average based on years 1941-90
(4) 44 year average based on years 1936-79
(5) 36 year average based on years 1936-72
(6) 45 year average based on years 1936-81
(7) 50 year average based on years 1953-2002
(8) 50 year average based on years 1946-1995

4

FEBRUARY 1, 2014 FORECASTS
WATER YEAR UNIMPAIRED RUNOFF

Unimpaired Runoff in 1,000 Acre-Feet (1)

HYDROLOGIC REGION and Watershed	HISTORICAL 50 Yr Avg (2)	HISTORICAL Max of Record	HISTORICAL Min of Record	DISTRIBUTION Oct Thru Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	FORECAST Water Year Forecasts	FORECAST Pct of Avg	FORECAST 80 % Probability Range (1)
North Coast															
Trinity River at Lewiston Lake	1376	2990	200	38	55	65	85	85	40	10	2	0	**380**	28%	145 - 910
SACRAMENTO RIVER															
Upper Sacramento River															
Sacramento River at Delta above Shasta Lake	876	1,965	165												
McCloud River above Shasta Lake	1,200	2,353	557												
Pit River near Montgomery Creek + Squaw Creek	3,082	5,150	1,484												
Total Inflow to Shasta Lake	5,979	10,796	2,479	697	300	315	325	275	185	165	155	153	**2,570**	43%	1,915 - 4,210
Sacramento River above Bend Bridge, near Red Bluff	8,727	17,180	3,294	922	455	475	430	340	235	195	177	171	**3,400**	39%	2,615 - 6,025
Feather River															
Feather River at Lake Almanor near Prattville (3)	780	1,269	366												
North Fork at Pulga (3)	2,417	4,400	666												
Middle Fork near Clio (4)	219	637	24												
South Fork at Ponderosa Dam (3)	291	562	32												
Feather River at Oroville	4,523	9,492	994	308	175	245	220	210	75	65	60	52	**1,410**	31%	1,000 - 3,210
Yuba River															
North Yuba below Goodyears Bar	564	1,056	102												
Inflow to Jackson Mdws and Bowman Reservoirs (3)	181	292	30												
South Yuba at Langs Crossing (3)	379	565	98												
Yuba River near Smartsville plus Deer Creek	2,329	4,926	369	91	100	125	150	145	40	15	7	7	**680**	29%	375 - 1,525
American River															
North Fork at North Fork Dam (3)	616	1,234	66												
Middle Fork near Auburn (3)	1,070	2,575	144												
Silver Creek Below Camino Diversion Dam (3)	318	705	59												
American River below Folsom Lake	2,683	6,382	349	48	105	145	210	180	45	5	1	1	**740**	28%	330 - 1,955
SAN JOAQUIN RIVER															
Cosumnes River at Michigan Bar	385	1,253	20	7	16	19	14	10	3	1	0	0	**70**	18%	15 - 315
Mokelumne River															
North Fork near West Point (5)	[illegible]														
Total Inflow to Pardee Reservoir	[illegible]														
Stanislaus River															
Middle Fork	[illegible]														
North Fork	[illegible]														
Stanislaus River	[illegible]														
Tuolumne River															
Cherry Creek	[illegible]														
Tuolumne River	[illegible]														
Hetch Hetchy	[illegible]														
Merced River															
Merced River	[illegible]														
Merced	[illegible]														
San Joaquin River															
San Joaquin	[illegible]														
Big Creek below	[illegible]														
South Fork near Florence Lake (7)	248	653	71												
San Joaquin River inflow to Millerton Lake	1,831	4,642	362	45	32	75	135	215	130	40	15	8	**695**	38%	360 - 1,550
TULARE LAKE															
Kings River															
North Fork Kings River near Cliff Camp (3)	284	607	58												
Kings River below Pine Flat Reservoir	1,729	4,287	386	39	26	60	115	215	115	25	12	8	**615**	36%	340 - 1,380
Kaweah River below Terminus Reservoir	456	1,402	94	8	8	16	30	45	20	5	2	1	**135**	30%	70 - 370
Tule River below Lake Success	147	615	16	3	5	7	5	3	1	0	0	0	**24**	16%	7 - 120
Kern River															
Kern River near Kernville	558	1,577	163												
Kern River inflow to Lake Isabella	733	2,318	175	37	15	25	40	50	35	15	10	8	**235**	32%	150 - 710

(9) Forecast point names based on USGS gage names. Stanislaus below Goodwin also known as inflow to New Melones, Tuolumne River below La Grange also known as inflow to Don Pedro, Merced River below Merced Falls also known as inflow to McClure.
(10) Coordinated Forecast by National Weather Service California-Nevada River Forecast Center and Department of Water Resources, State of California.
* Unimpaired runoff in months prior to forecast date are based on measured flows

5

HYDROLOGIC REGION and Watershed	Unimpaired Runoff in 1,000 Acre-Feet (1) DISTRIBUTION Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Water Year Forecasts
American River below Folsom Lake	105	145	210	180	45	5	1	1	**740**

Figure 3. Excerpt from Bulletin 120 showing the water year 50% exceedance forecast ("Water Year Forecasts" column) of unimpaired flow in the "American River below Folsom Lake" circled in red.

FOLSOM LAKE

Map of surrounding area

Station ID	FOL	**Elevation**	466' ft
River Basin	AMERICAN R	**County**	SACRAMENTO
Hydrologic Area	SACRAMENTO RIVER	**Nearby City**	FOLSOM
Latitude	38.68300	**Longitude**	-121.18300
Operator	US Bureau of Reclamation	**Data Collection**	

Additional types of information available: Dam Information | Reservoir Information

The following data types are available online. Select one of the links below to retrieve recent data.

Sensor Description	Duration	Plot	Data Collection	Data Available
DISCHARGE, POWER GENERATION, cfs	(daily)	(DIS PWR)	DATA XCHG-USBR	04/01/2000 to present.
DISCHARGE, PUMPING, cfs	(daily)	(DC PUMP)	DATA XCHG-USBR	02/01/1995 to present.
DISCHARGE, SPILLWAY, cfs	(daily)	(SPILL)	DATA XCHG-USBR	04/01/2000 to present.
DISCHARGE,CONTROL REGULATING, cfs	(daily)	(RIV REL)	DATA XCHG-USBR	04/01/2000 to present.

Figure 4. Excerpt from the California Data Exchange Center website for the Folsom (FOL) Station showing hyperlinks to the daily flow data for the "Spillway" and "Control Regulating" discharges.

The ARI is initially determined in early February when the February B120 is released. The ARI is then updated for each B120 publication for the months of March, April, and May, and subsequent updates after the May publication, by subtracting the spills through the end of the preceding month from the B120 forecast (e.g., for the May ARI, October 1 through April 30 spills are subtracted from the May B120 forecast). The ARI value computed from the final B120 update each year is the final ARI for the year and remains in effect until the end of December.

3 DETERMINATION OF THE MONTHLY MINIMUM RELEASE REQUIREMENTS

The monthly MRR at Nimbus Dam is determined using SRI index values (for January) and ARI index values (for February through December), and the MRR implementation curves. **Table 2** summarizes the specified values associated with points A, B, and C in **Figures 5** through **10**, which show the specific MRR implementation curves for various months of the year. The MRR for index values between points specified on the table are calculated by linearly interpolating between specified points. At any point on the curves, the MRR value would specify the minimum release, but would not preclude releases at rates above the MRR.

Table 2. Summary of Hydrologic Indices and specified values for the Minimum Release Requirements.

Months	Hydrologic Index Used	Point A		Point B		Point C	
		Index Value (TAF)	MRR Value (cfs)	Index Value (TAF)	MRR Value (cfs)	Index Value (TAF)	MRR Value (cfs)
Jan	SRI	5,500	500	7,800	800	11,500	1,750
Feb – Mar	ARI	800		1,000		1,958	1,750
Apr – Jun						2,210	1,500
Jul – Sep[1]						1,958	1,750
Oct				1,500		1,914	1,500
Nov – Dec						2,210	2,000

[1]The July through September curve includes an additional point between points B and C, corresponding to an ARI of 1,200 TAF and an MRR of 1,500 cfs.

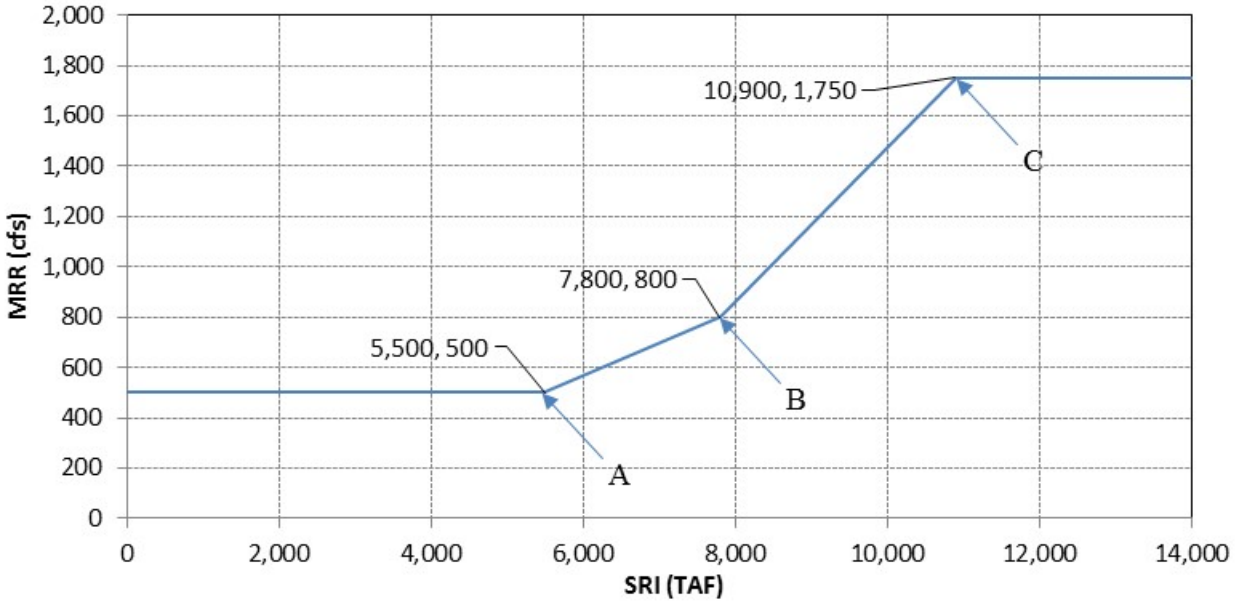


Figure 5. Relationship between the Sacramento River Index and monthly Minimum Release Requirements for January.

For January, the following equations can be used to determine the MRR for a given SRI:

- If SRI <= 5,500 TAF, then MRR = 500 cfs
- If 5,500 TAF < SRI <= 7,800 TAF, then MRR = 0.1304 * SRI -217 cfs
- If 7,800 TAF < SRI <= 11,500 TAF, then MRR = 0.2568 * SRI -1203 cfs
- If SRI > 11,500 TAF, then MRR = 1,750 cfs

In recognition of the uncertainty associated with the SRI forecast, the January MRR is not allowed to be greater than the December MRR.

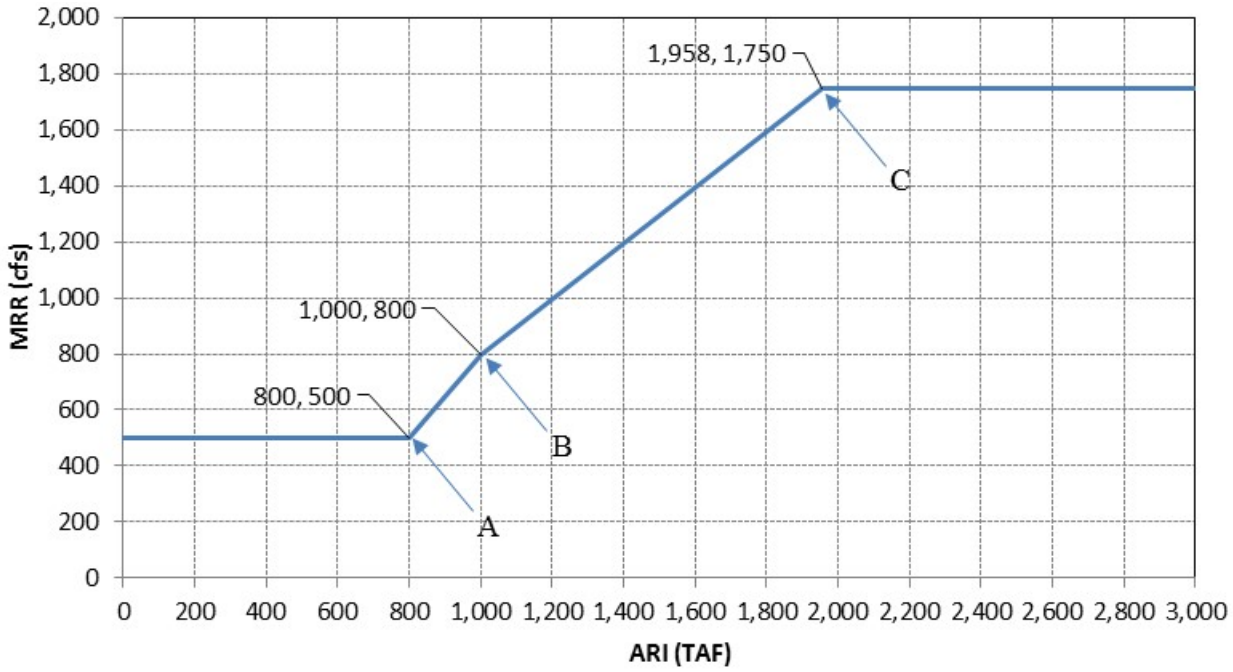


Figure 6. Relationship between the American River Index and monthly Minimum Release Requirements for February and March.

For February through March, the following equations can be used to determine the MRR for a given ARI:

- If ARI <= 800 TAF, then MRR = 500 cfs
- If 800 TAF < ARI <= 1,000 TAF, then MRR = 1.500 * ARI -700 cfs
- If 1,000 TAF < ARI <= 1,958 TAF, then MRR = 0.9916 * ARI -192 cfs
- If ARI > 1,958 TAF, then MRR = 1,750 cfs

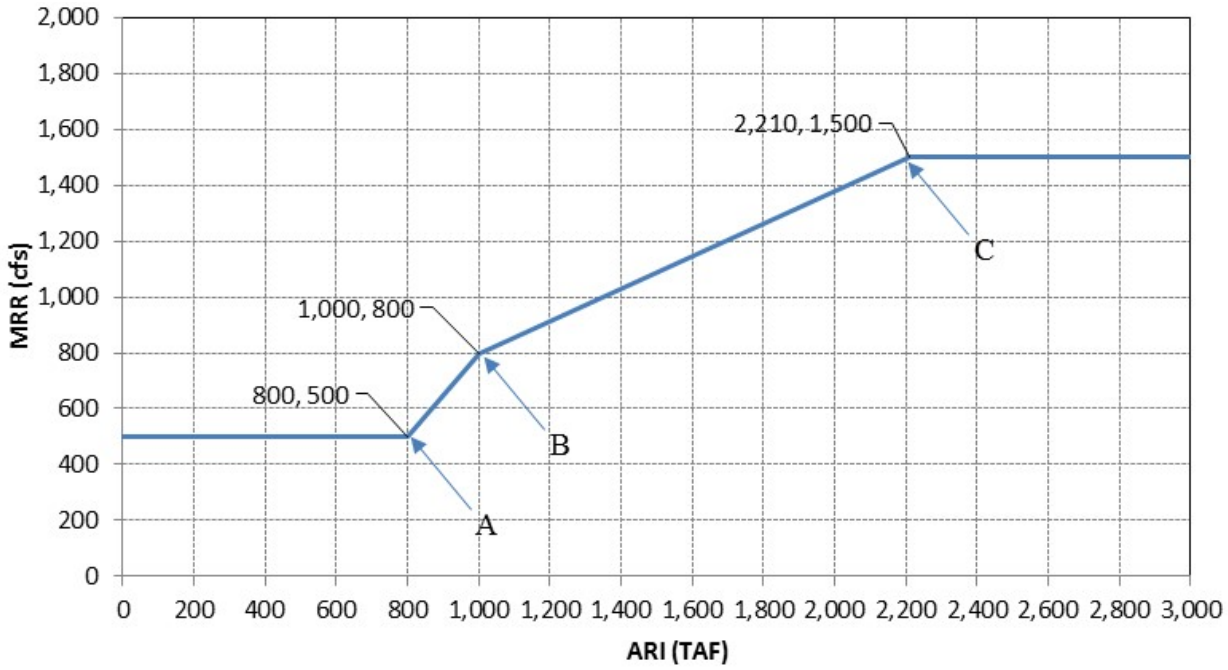


Figure 7. Relationship between the American River Index and monthly Minimum Release Requirements for April through June.

For April through June, the following equations can be used to determine the MRR for a given ARI:

- If ARI <= 800 TAF, then MRR = 500 cfs
- If 800 TAF < ARI <= 1,000 TAF, then MRR = 1.500 * ARI -700 cfs
- If 1,000 TAF < ARI <= 2,210 TAF, then MRR = 0.579 * ARI + 221 cfs
- If ARI > 2,210 TAF, then MRR = 1,500 cfs

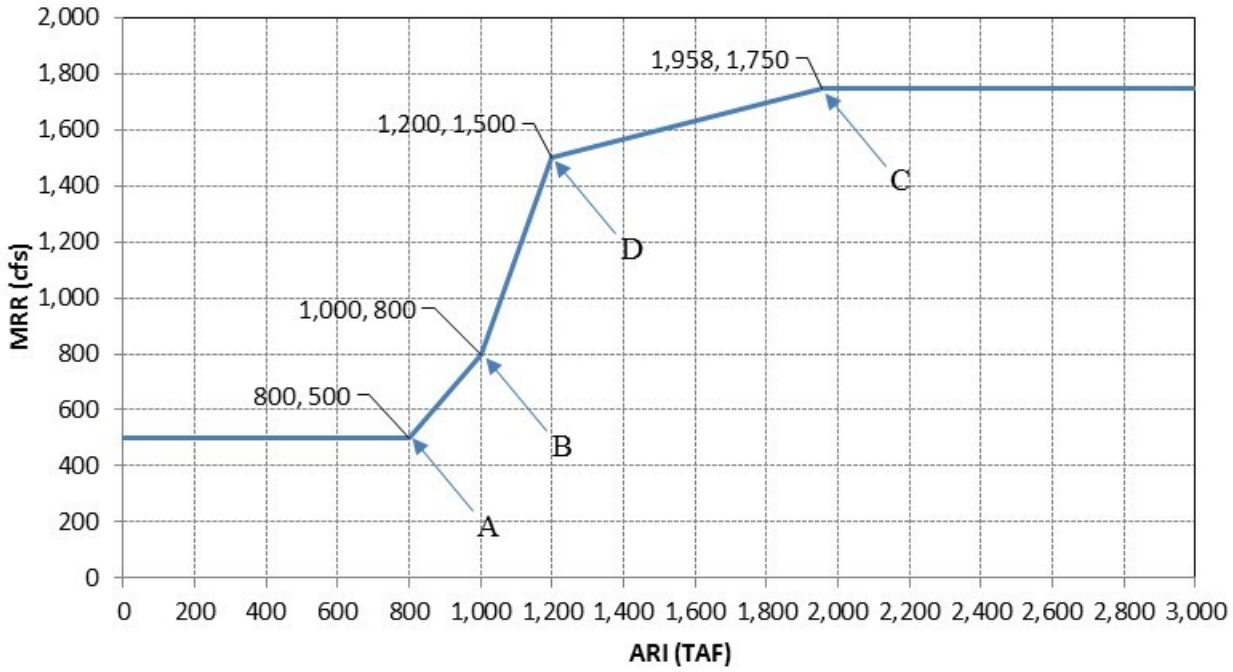


Figure 8. Relationship between the American River Index and monthly Minimum Release Requirements for July through September.

For July through September, the following equations can be used to determine the MRR for a given ARI:

- If ARI <= 800 TAF, then MRR = 500 cfs
- If 800 TAF < ARI <= 1,000 TAF, then MRR = 1.500 * ARI -700 cfs
- If 1,000 TAF < ARI <= 1,200 TAF, then MRR = 3.500 * ARI -2,700 cfs
- If 1,200 TAF < ARI <= 1,958 TAF, then MRR = 0.330 * ARI + 1,104 cfs
- If ARI > 1,958 TAF, then MRR = 1,750 cfs

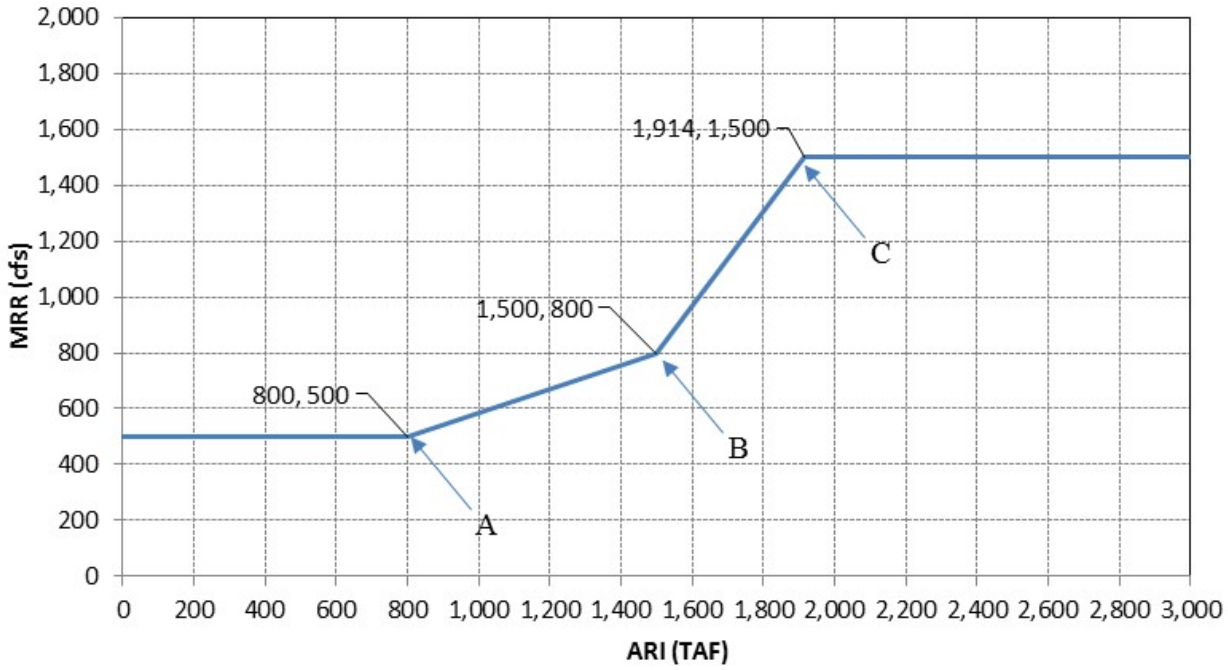


Figure 9. Relationship between the American River Index and monthly Minimum Release Requirements for October.

For October, the following equations can be used to determine the MRR for a given ARI:

- If ARI <= 800 TAF, then MRR = 500 cfs
- If 800 TAF < ARI <= 1,500 TAF, then MRR = 0.429 * ARI +157 cfs
- If 1,500 TAF < ARI <= 1,914 TAF, then MRR = 1.690 * ARI - 1,736cfs
- If ARI > 1,706 TAF, then MRR = 1,500 cfs

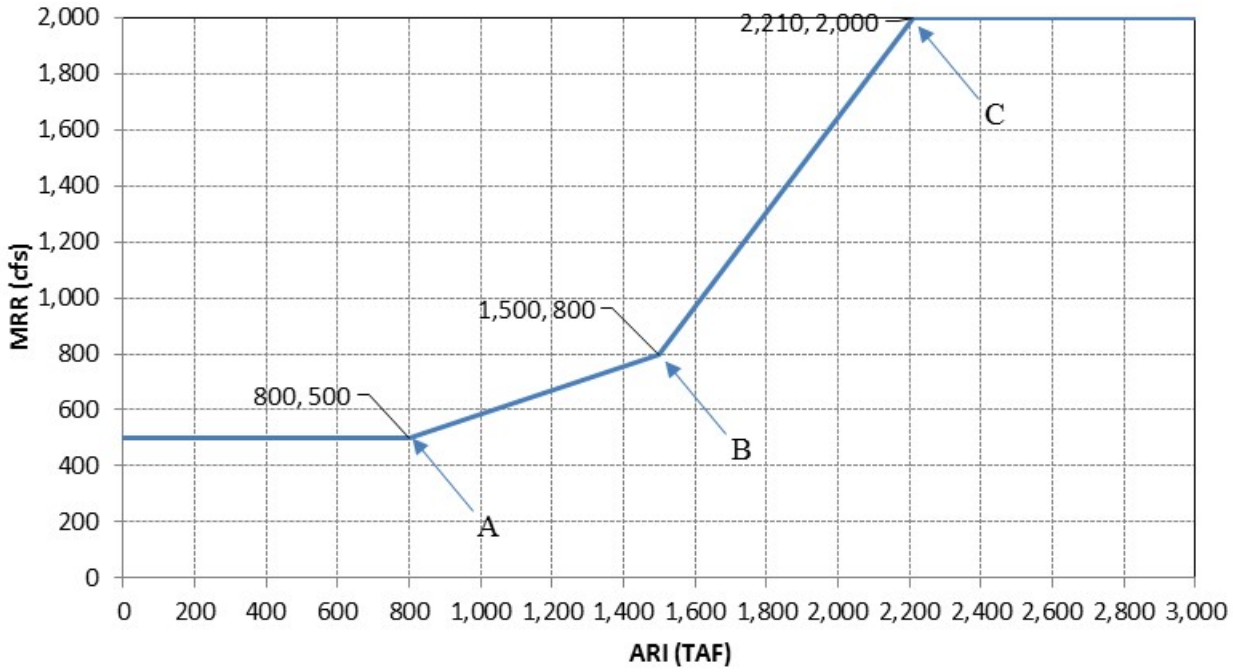


Figure 10. Relationship between the American River Index and monthly Minimum Release Requirements for November and December.

For November and December, the following equations can be used to determine the MRR for a given ARI:

- If ARI <= 800 TAF, then MRR = 500 cfs
- If 800 TAF < ARI <= 1,500 TAF, then MRR = 0.429 * ARI + 157 cfs
- If 1,500 TAF < ARI <= 2,210 TAF, then MRR = 1.690 * ARI -1,736 cfs
- If ARI > 2,210 TAF, then MRR = 2,000 cfs

4 RESERVOIR STORAGE REQUIREMENTS

The Modified FMS includes both an End-of-May (EOM) storage requirement and an End-of-December (EOD) storage requirement for Folsom Reservoir. The Folsom Reservoir EOM and EOD storage requirements are described below.

4.1 DETERMINATION OF END-OF-MAY STORAGE REQUIREMENT

With the publication of the February B120 and the subsequent determination of the ARI, an initial Folsom Reservoir EOM storage requirement is computed. The Folsom Reservoir EOM storage requirement will be updated with subsequent B120 publications and ARI calculations, using the March, April, and May forecasts and subsequent updates. **Figure 11** shows the relationship between ARI and the Folsom Reservoir EOM storage requirement.

The EOM storage requirement will be linearly interpolated from a 0 TAF storage requirement for an ARI of 0 TAF, to a 900 TAF storage requirement corresponding to an ARI of 2,200 TAF. An ARI greater than 2,200 TAF also would result in an EOM Folsom Reservoir storage requirement of 900 TAF.

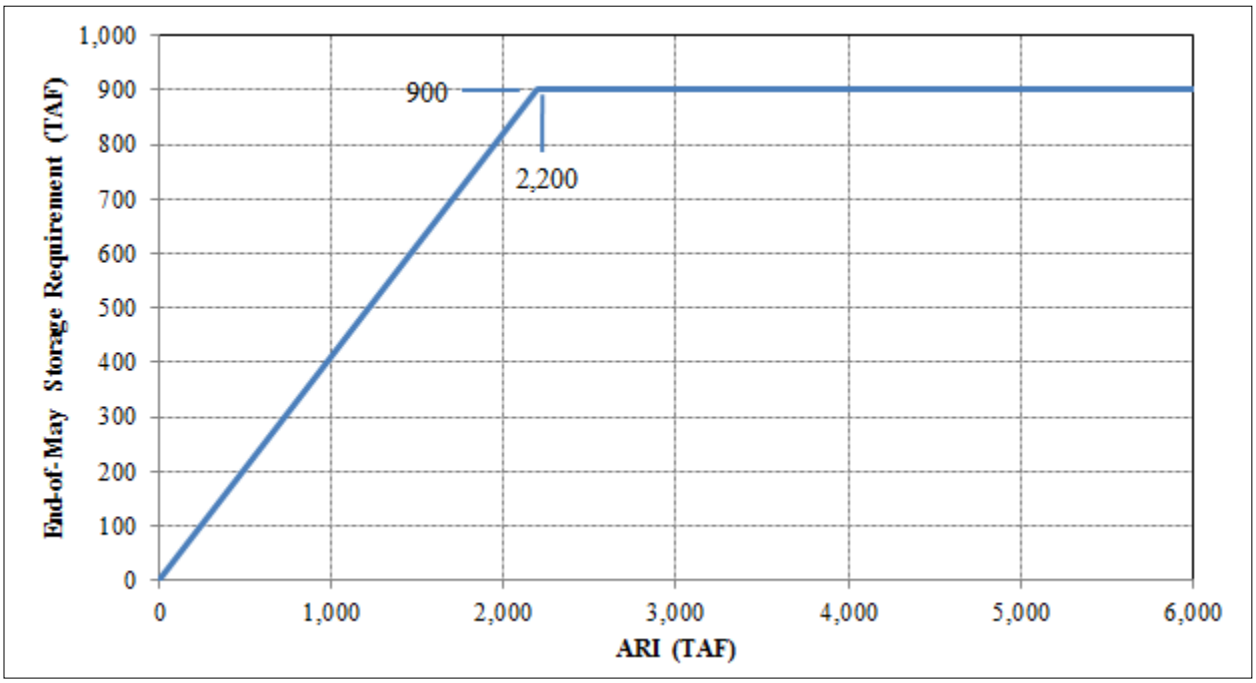


Figure 11. Relationship between ARI and End-of-May Folsom Reservoir storage requirement.

The following equations can be used to determine the EOM storage requirement for a given ARI:

- If ARI < 2,200, then EOM = 0.41 * ARI
- If ARI >= 2,200, then EOM = 900 TAF

Using the CE-QUAL-W2 model described in TM 5, it is clear that EOM storage in Folsom Reservoir is highly correlated to summer LAR water temperatures; the EOM storage requirement for Folsom Reservoir is intended to balance the following objectives:

- Providing a spring refill requirement providing protection against opportunistic releases from storage for out-of-basin purposes to the detriment of American River beneficial uses later in the year;
- Provide Reclamation similar operational flexibility to historical operations.

4.2 DETERMINATION OF END-OF-DECEMBER STORAGE REQUIREMENT

The integration of Folsom Reservoir operations with other CVP operations requires releases from Folsom Reservoir above the MRR during certain times of the year. The EOD storage requirement for Folsom Reservoir was selected to balance four potentially conflicting objectives:

1) Providing adequate reservoir storage for sufficient diversions through the Folsom Dam M&I intake to meet demands throughout the year during hydrologic conditions similar to the driest year of record (1977).

2) Maintaining adequate reservoir storage and cold water pool in consideration of thermal habitat suitability for salmonids in the lower American River during hydrologic conditions similar to the driest year of record (1977).

3) Allowing Reclamation the operational flexibility to avoid re-directing impacts to the Sacramento River downstream from Keswick Dam.

4) Preserving Reclamation's operational flexibility for integrated CVP/State Water Project (SWP) operations.

The Water Forum performed numerous sensitivity evaluations, as described in the Water and Power Rationale, Biological Rationale and associated technical memoranda 2-10 to evaluate the effects, or lack of effects, of the Modified FMS on the American and Sacramento rivers and their fish. An EOD storage requirement of 300 TAF in Folsom Reservoir was determined to represent the value at which American River Basin benefits were maximized without redirecting impacts to the Sacramento River. The Water Forum also included several exceptions for meeting the 300 TAF EOD requirement, as described below, to limit impacts to the rest of the CVP.

The first exception to the 300 TAF EOD requirement would be triggered when (1) Nimbus Dam releases to the American River would be made only to ensure adequate flow to meet the MRR, American River water supply diversions (subject to applicable shortage terms that apply to certain American River water supplies, such as those under CVP water-service contracts), and any other applicable regulatory requirement on the American River between June and December; and (2) as a result, Folsom Reservoir storage could end up below 300 TAF. Even if reductions in MRR would make it possible to meet the 300 TAF EOD requirement, such MRR reductions would not be required.

The second exemption to the 300 TAF EOD requirement would use the predicted March through November unimpaired inflow to Folsom Reservoir (UIFR), computed using the median forecast for March through September unimpaired inflow to Folsom Reservoir plus 60 TAF, to define an exemption to account for persistent dry conditions for one-, two-, three- and four-year droughts. All four drought exceptions use the cumulative UIFR volume to determine if the EOD storage for a year is required to be 300 TAF or a lower requirement of 230 TAF. The cumulative UIFR volume is the sum of the prior one, two, or three years' March through November UIFR and the current year's forecasted UIFR. **Table 3** specifies the UIFR amount required for an EOD exception for each duration. An exception to the 300 TAF EOD requirement would occur whenever at least one of the four volumes is less than the applicable amount.

Table 3. Cumulative March through November unimpaired inflow (TAF) to Folsom Reservoir for 300 TAF EOD exceptions for one-, two-, three and four-year drought persistence scenarios.

	Cumulative March – November UIFR (TAF)
1-Year Dry-Year Volume	400
2-Year Dry-Year Volume	1,200

3-Year Dry-Year Volume	2,700
4-Year Dry-Year Volume	4,400

These volumes were determined based on a review of historical UIFR volumes for 1901 through 2015. The two-, three-, and four-year definitions were selected to ensure the driest two-, three-, and four- year periods on record would be categorized as EOD exception years.

The EOD exception would be reassessed each month, but would continue in effect until the predicted March through November UIFR (or, in the case of persistent drought, the previous one or two years' March through November UIFR) exceeds the cumulative UIFR threshold.

The MRRs described in Section 3 remain in effect during EOD exception years. However, during EOD exception years, the Folsom Reservoir EOD storage requirement should be reduced from 300 TAF to 230 TAF to provide a storage reserve during the driest of years and to allow Reclamation the operational flexibility to avoid re-directing impacts to the Sacramento River downstream from Keswick Dam.

5 REDD DEWATERING PROTECTIVE ADJUSTMENTS

Redd dewatering protective adjustments (RDPAs) were imposed on the MRR to limit potential redd dewatering due to reductions in the MRR during the January through May period. The RDPAs should limit the amount the MRR can be reduced during this period. Two RDPAs were included: (1) the Chinook salmon RDPA in January and February; and (2) the steelhead RDPA in February through May. After calculation of the index-based MRR (as determined by the appropriate hydrologic index, SRI or ARI) the RDPA-based MRR would be calculated. The MRR with the higher value, the index-based MRR or the RDPA-based MRR, would determine the final MRR. RDPAs should limit the amount of dewatering due to a reduction of the MRR, not the actual river release (which often would be higher than the MRR) and, as such, would not always minimize dewatering impacts to the same extent. The prohibition on the January MRR being above the December MRR is also intended to avoid dewatering of redds due to uncertainty with the hydrologic forecast in January.

5.1 CHINOOK SALMON REDD DEWATERING PROTECTIVE ADJUSTMENT

The Chinook salmon RDPA should affect January and February, limiting the potential dewatering of fall-run Chinook salmon redds due to a reduction of the MRR from December to January or February.

The fall-run Chinook salmon RDPA-based MRR is computed by multiplying the December ARI-based MRR by 0.70, representing a maximum 30 percent reduction in MRR from December to both January and February. If the Chinook salmon RDPA-based MRR for January is less than the SRI-based MRR for January, or the ARI-based MRR for February, then the SRI-based MRR for January or ARI-based MRR for February would be used. Otherwise, the Chinook salmon RDPA-based MRR would be used.

5.2 STEELHEAD REDD DEWATERING PROTECTIVE ADJUSTMENT

The steelhead RDPA should use the MRR from January and February to control MRR reductions in February through May to limit the potential dewatering of steelhead redds due to a reduction in the MRR. The steelhead RDPA-based MRR should limit the potential dewatering due to a reduction in the MRR of steelhead redds constructed in January and February[1] to 0 percent due to the status of steelhead as a species listed under the Federal and State Endangered Species Acts.

First the January MRR would be used to set the minimum allowable MRR in February through May based upon **Table 4**. In some instances the MRR may increase from January to February. If the February MRR is higher than the January MRR, then the February MRR would be used to set the minimum MRR for March through May based upon **Table 4**. If the steelhead RDPA-based MRR is less than the index-based MRR, then the index-based MRR would be used. If the January or February MRR are in between the values provided in **Table 4** the steelhead RDPA-based MRR would be interpolated between the nearest values.

Table 4. Steelhead RDPA-based MRR for February through May.

MRR_{Jan} or MRR_{Feb} (cfs)	Steelhead RDPA-Based MRR for February-May (cfs)
≤700	500
800	520
900	580
1,000	640
1,100	710
1,200	780
1,300	840
1,400	950
1,500	1,030
1,600	1,100
1,700	1,180
1,800	1,250

6 SPRING PULSE FLOWS

The purpose of providing pulse flows in the lower American River would be to provide a juvenile salmonid (fall-run Chinook salmon and steelhead) emigration cue before relatively low flow conditions and associated unsuitable thermal conditions later in the spring in the river, and downstream in the lower Sacramento River.

The Modified FMS should provide a pulse flow event at some time during the period extending from March 15 to April 15 by supplementing normal operational releases from Folsom Dam

[1] Approximately 87 percent of the steelhead redds in the lower American River are constructed in January and February.

under certain conditions when no such flow event has occurred between the preceding February 1 and March 1 time frame.

The pulse flow event should be provided only when the MRR from March 1 through March 31 ranged from 1,000 cfs to 1,500 cfs. This range of MRRs during this time period generally corresponds to dry and below normal water year types.

The peak magnitude of the pulse flow should be three times the MRR base flows (pre-pulse flows), not to exceed a peak magnitude of 4,000 cfs.

The pulse flow event should range in duration from 6 to 7.5 days, depending upon the initial MRR base flows (pre-pulse flows). There are no assumed restrictions on the rate of ramp-up from base flows to the peak of the pulse flow, which should last for 2 days. Pursuant to the ramp-down restrictions provided in the NMFS (2009) Operations Criteria and Plan (OCAP) Biological Opinion (BO), flow reductions after the 2-day peak pulse flow should not exceed more than 500 cfs per day and not more than 100 cfs per hour. Consequently, if the peak pulse flow was 3,000 cfs then the pulse flow event should extend 6 days, and if the peak pulse flow was 4,000 cfs then the pulse flow event could extend 7.5 days. The pulse flow should not occur if Nimbus Dam releases between February 1 and March 15 did not meet or exceed the maximum pulse flow rate for at least two days.

If a pulse flow were to occur, the MRR (or RDPA-based MRR) for April, May, and June would be reduced by the volume of the pulse over the March MRR, distributed evenly across all three months so that the implementation of the pulse flow should not result in any net reduction in Folsom Reservoir storage by the end of June.

7 OPERATIONS FORECAST

By January 15th, Reclamation will prepare an Operations Forecast that will guide operations anticipated through the following December. This forecast will be updated by the 15th of each month thereafter through December. Each Operations Forecast and update will include:

- Current calculation of applicable hydrologic indices, including:
  - Sacramento River Index
  - American River Index
  - Unimpaired Inflow to Folsom Reservoir
- Forecasted reservoir inflow through the end of December, based on available information from, but not limited to:
  - Placer County Water Agency (PCWA) forecasted releases from the Middle Fork Project (MFP)
  - Sacramento Metropolitan Utility District (SMUD) forecasted releases from the Upper American River Project (UARP)
  - El Dorado Irrigation District (EID) forecasted releases from Project 184
  - California Nevada River Forecast Center (CNRFC) ensemble forecasts of inflows to Folsom Reservoir
  - DWR B120 forecasts of unimpaired inflow to Folsom Reservoir

- Forecasted monthly average Nimbus Dam releases through the end of December, including:
  - Minimum Release Requirement
  - City of Sacramento and Carmichael diversions from the lower American River
  - Flows to meet other American River regulatory requirements
  - Flows in excess of those to meet the three preceding conditions
- Forecasted end-of-month Folsom Reservoir storages and elevations through the end of December
- Forecasted water supply diversions for PCWA, City of Folsom, City of Roseville, San Juan Water District, SMUD, and EID through the end of December
- Forecasted Folsom Reservoir evaporation through the end of December
- Controlling operations constraints (e.g., Delta water quality, flood control)

- Other information related to Folsom Dam operations, including CVP water allocations, water year classifications, and CVPIA 3406 (b)(2) accounting.
- Reclamation also will provide all equations, assumptions and methods used in calculating the MRR, Folsom releases, and other operations required to meet the EOM and EOD Storage Requirements.

8 WATER TEMPERATURE MANAGEMENT REQUIREMENTS

Required water temperature management planning depends, to a large degree, on anticipated future operations. Reclamation will prepare an Annual Water Temperature Management Plan for submission to NMFS for review by May 1 of each year. Within ten calendar days of receiving the draft Annual Water Temperature Management Plan, NMFS will provide a written review of the plan. Reclamation will produce a final plan prior to May 15, and implement the plan immediately upon finalization. The SWRCB will be provided copies of the May 15 Final Annual Water Temperature Management Plan.

8.1 ANNUAL WATER TEMPERATURE MANAGEMENT PLAN

Reclamation's Annual Water Temperature Management Plan will be prepared in accordance with the Water Temperature Objectives described below, and will be based on Reclamation's most recent monthly Operations Forecast available at the time of plan development. The Annual Water Temperature Management Plan will be designed to minimize water temperature effects on Central Valley steelhead and provide for Chinook salmon spawning in the fall.

The following Water Temperature Objectives are to be incorporated with the flow and storage provisions of the Modified FMS. In the event of conflict between meeting the flow and storage provisions of the Modified FMS and the Water Temperature Objectives, the Modified FMS flow and storage provisions will prevail.

8.1.1 Water Temperature Objectives

Modified FMS Water Temperature Objectives are to be achieved to the extent physically controllable, which includes the bypass of water in lieu of its use for power generation, and the implementation of any future water temperature-related infrastructure improvements.

Reclamation will manage the Folsom Reservoir coldwater pool, the Folsom/Nimbus Dam complex, and the water temperature control shutters at Folsom Dam in an effort to maintain a daily average water temperature (calculated using the average of the hourly readings) at Watt Avenue Bridge:

- 65°F or less from May 15 through October 14 to provide suitable conditions for juvenile steelhead rearing in the lower American River.
- 60°F or less by October 15 to provide suitable conditions for fall-run Chinook salmon holding and early spawning.
- 56°F or less by November 1 to provide suitable conditions for fall-run Chinook salmon spawning and embryo incubation.

8.1.2 Water Temperature Objectives Exceptions

When preparing the Annual Water Temperature Management Plan, Reclamation may submit to NMFS a written determination that, after taking all actions within its authorities, it is unlikely to meet the Water Temperature Objectives. This determination must be supported by specific iterative modeling techniques that vary allocations and delivery schedules as specified in the NMFS 2011 OCAP BO (or functionally equivalent document). In the event that Reclamation determines that other nondiscretionary requirements (e.g., State Water Resource Control Board Revised Decision 1641 (D-1641) or requirements of the USFWS 2008 OCAP BO) conflict with attainment of the Water Temperature Objectives, Reclamation will convene the American River Group (ARG) to obtain recommendations. If consensus cannot be achieved within the ARG, the ARG will advise NMFS, and NMFS will make a recommendation to the Water Operations Management Team (WOMT), per standard operating procedures.

8.1.3 Water Temperature Modeling and Plan Development

Reclamation will continue to be responsible for the set of data needed to model the use of Folsom Reservoir's coldwater pool. Model studies will be conducted to evaluate the ability to achieve an incrementally-adjusted series of downstream water temperature targets in the lower American River, in consideration of coldwater availability in Folsom Reservoir. Water temperature model studies will incorporate the necessary input data (e.g., Operations Forecast, reservoir temperature profile, shutter operation assumptions, and targeted lower American River water temperatures). Results of the water temperature model studies will demonstrate resultant downstream water temperatures during the late spring and summer months (May 15 through September 30), while conserving a volume of coldwater in Folsom Reservoir for use during the fall-run Chinook salmon spawning period (October 15 through December 31).

Reclamation will be responsible to perform the water temperature modeling prior to submittal of the draft Annual Water Temperature Management Plan to NMFS by May 1 each year. Modeling will be conducted using the iterative Coldwater Pool Management Model (iCPMM), CE QUAL W2, or an equivalent model in the development of the Annual Water Temperature Management Plan. The objective of the modeling will be to select the most beneficial seasonal water temperature regime for the lower American River during a given year. Selection of the seasonal water temperature regime is characterized by the rate and duration with which available cold

water will be released from Folsom Reservoir to manage water temperatures downstream in the lower American River. Water temperature modeling requires:

- Initial reservoir conditions (e.g., water temperature profiles and available storage)
- Hydrologic time series data of projected inflows to Folsom Reservoir, including the temperature of those inflows
- Reservoir evaporation and river heat gain
- Meteorological data
- Folsom Reservoir operational data (releases and diversions)

8.1.3.1 *Iterative Water Temperature Modeling Process*

The Annual Water Temperature Management Plan is to identify the most beneficial water temperature regime possible from May 15 through November, constrained by coldwater pool availability in Folsom Reservoir and the Modified FMS flow and storage provisions.

The Folsom Reservoir and lower American River water temperature models are utilized in an iterative manner referred to as the Automated Temperature Selection Procedure (ATSP). The ATSP operates the reservoir and river water temperature models with the objective of achieving monthly target water temperatures in the lower American River at the Watt Avenue bridge.

The ATSP involves the use of multiple target water temperature schedules for the lower American River at Watt Avenue. The "schedule" approach was developed with the purpose of balancing the seasonal use of Folsom Reservoir's coldwater availability, which varies from year-to-year. The prioritization order of the target temperature schedules for the Modified FMS reflects the desire to protect juvenile steelhead over-summer rearing, while considering the needs of fall-run Chinook salmon spawning, given the constraints of coldwater pool availability in Folsom Reservoir.

A schedule of water temperatures, for May through November, is specified as the preferred schedule of monthly water temperature targets. Because Folsom Reservoir water temperatures are not isothermal during the May through November period, ATSP water temperature targets are achieved through choice of reservoir level from which releases are drawn. If the preferred schedule cannot be achieved with the available release level choices, the procedure cycles to a second, slightly less preferred schedule of water temperatures. If the second schedule cannot be met, the procedure continues stepwise through the series of schedules, arranged by declining preference, until a schedule of targets can be met for that year.

Table 6 presents the ATSP schedules, with Schedule #1 representing the most beneficial application of coldwater pool availability for Folsom Reservoir releases during the May though November period. Schedule #78 represents the least desirable condition represented by this analysis, but may be the only achievable schedule during years of extremely limited coldwater pool availability in Folsom Reservoir. In **Table 6**, the highlighted cells indicate changes in water temperature targets for a given month and schedule, as compared to the previous schedule.

Table 6. Automated Temperature Selection Procedure schedules.

Schedule	Lower American River Water Temperature Targets at Watt Avenue (°F)						
	May	Jun	Jul	Aug	Sep	Oct	Nov
1	63	63	63	63	63	56	56
2	63	63	63	63	63	57	56
3	63	63	63	63	63	58	56
4	63	63	63	63	63	59	56
5	63	63	63	63	63	60	56
6	63	63	63	63	63	60	57
7	63	63	63	63	63	60	58
8	63	63	64	63	63	60	58
9	63	63	64	64	63	60	58
10	63	63	64	64	64	60	58
11	63	64	64	64	64	60	58
12	64	64	64	64	64	60	58
13	64	64	65	64	64	60	58
14	64	64	65	65	64	60	58
15	64	64	65	65	65	60	58
16	64	65	65	65	65	60	58
17	65	65	65	65	65	60	58
18	65	65	65	65	65	61	58
19	65	65	65	65	65	62	58
20	65	65	65	65	65	63	58
21	65	65	65	65	65	64	58
22	65	65	65	65	65	65	58
23	65	65	65	65	65	65	59
24	65	65	66	65	65	65	59
25	65	65	66	66	65	65	59
26	65	65	66	66	66	65	59
27	65	66	66	66	66	65	59
28	66	66	66	66	66	65	59
29	66	66	67	66	66	65	59
30	66	66	67	67	66	65	59
31	66	66	67	67	67	65	59
32	66	67	67	67	67	65	59
33	67	67	67	67	67	65	59
34	67	67	68	67	67	65	59
35	67	67	68	68	67	65	59
36	67	67	68	68	68	65	59
37	67	68	68	68	68	65	59
38	68	68	68	68	68	65	59
39	68	68	68	68	68	66	59
40	68	68	68	68	68	67	59
41	68	68	68	68	68	68	59
42	68	68	69	68	68	68	59
43	68	68	69	69	68	68	59
44	68	68	69	69	69	68	59
45	68	69	69	69	69	68	59
46	69	69	69	69	69	68	59
47	69	69	69	69	69	69	59
48	69	69	69	69	69	69	60
49	69	69	70	69	69	69	60

50	69	69	70	70	69	69	60
51	69	69	70	70	70	69	60
52	69	70	70	70	70	69	60
53	70	70	70	70	70	69	60
54	70	70	70	70	70	70	60
55	70	70	70	70	70	70	61
56	70	70	71	70	70	70	61
57	70	70	71	71	70	70	61
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67	72	72	72	72	72	71	62
68	72	72	72	72	72	72	62
69	72	72	72	72	72	72	63
70	72	72	72	72	72	72	64
71	72	72	72	72	72	72	65
72	72	72	72	72	72	72	66
73	72	72	72	72	72	72	67
74	72	72	72	72	72	72	68
75	72	72	72	72	72	72	69
76	72	72	72	72	72	72	70
77	72	72	72	72	72	72	71
78	72	72	72	72	72	72	72

There are no water temperature targets for the months of December through April. During these months of the year, Folsom Reservoir is typically well-mixed and the water column is nearly isothermal with depth. For this reason and because ambient air temperatures are sufficient to maintain suitable water temperatures for steelhead and fall-run Chinook salmon in the lower American River, water temperature targets are not identified for the December through April period.

Once the most beneficial water temperature regime is identified, then it will be incorporated in the Annual Water Temperature Management Plan.

8.1.4 **September Water Temperature Plan Update**

Reclamation will prepare a September Water Temperature Plan Update (September Update) for submission to NMFS for review by September 15 of each year. Within ten calendar days of receiving the September Update, NMFS will provide a written review of the plan. Reclamation will produce a final plan prior to October 1, and implement the plan immediately upon finalization. The SWRCB will be provided copies of the Final September Update.

The purpose of the September Update is to reduce the uncertainty inherent in projecting specific water temperature targets during the fall (i.e., October and November). To develop the September Update, Reclamation will re-run the water temperature modeling with updated conditions (e.g., Folsom Reservoir storage and coldwater pool volume) to identify the most beneficial water temperature regime that can be achieved for fall-run Chinook salmon and incubation from October 15 through November. This update can only produce an equal or lower ATSP schedule for the fall, it does not provide the opportunity to manage for a warmer temperature regime than identified for October and November in the initial Annual Water Temperature Management Plan. This updated modeling assessment will be conducted using a weekly ATSP specifically for that time period.

8.1.5 Other Considerations

As discussed above, actual conditions can differ from the forecasted conditions as the water year progresses. If the monthly updated Annual Operations Plan demonstrates that water temperatures in the lower American River identified in the May 15 Final Annual Water Temperature Management Plan will not be able to be met, then the need for modifications or changes to the Annual Water Temperature Management Plan will be resolved through consultation with NMFS and the ARG process (see Section 9 of this Technical Memorandum).

If the monthly water temperatures specified in the Annual Water Temperature Management Plan at Watt Avenue are exceeded for three consecutive days or are exceeded by more than 3°F for a single day, Reclamation will notify NMFS in writing and convene the ARG to obtain input and recommendations regarding potential coldwater pool management alternatives to improve water temperature conditions for the fisheries.

8.1.6 Consistency

The Annual Water Temperature Management Plan requirements of the Modified FMS are based on the best available information in the literature and recent empirical evidence on the lower American River. The requirements are intended to maintain the best possible water temperatures in the lower American River for steelhead and fall-run Chinook salmon, given the limited availability of cold-water storage in Folsom Reservoir and the differential timing and needs of those two species.

9 LOWER AMERICAN RIVER GROUP

9.1 BACKGROUND

The lower American River is a significant resource of considerable interest to fishery management agencies, the public, and Reclamation. The USFWS, NMFS and CDFW are agencies with trust responsibilities for fishery resources in the lower American River. Reclamation is responsible for operating the Folsom/Nimbus Dam complex to meet local and downstream water demands, regulatory requirements, and fish habitat needs. Reclamation has a need to consider its operations as they relate to lower American River instream resources, and other concerns of fisheries agencies that have regulatory and fish management responsibilities, as well as to provide the public with a forum to provide and exchange information.

9.2 PURPOSE OF THE LOWER AMERICAN RIVER GROUP

The mission of the Lower American River Group (ARG) is to conduct open discussion and deliberation of the biological and operational status of the lower American River, and to provide useful information and formulate recommendations for protection of fisheries and other instream resources consistent with the Modified FMS, and for the operation of the Folsom/Nimbus Dam complex as a unit of the overall CVP.

9.2.1 Objectives

The objectives of the ARG are to:

- Provide information and recommendations to Reclamation for the development and implementation of management strategies and actions beneficial to aquatic resources of the lower American River, including the Annual Water Temperature Management Plan and Operations Forecast, and other special studies or events
- Review physical, biological, and ecological status of the lower American River aquatic resources
- Share information to help create common understanding
- Provide public outreach and opportunity for discussion in a public forum
- Report on actions taken

9.3 MEMBERSHIP

The ARG consists of representatives from Reclamation, USFWS, NMFS, and CDFW.

9.3.1 Sponsor

Reclamation will serve as the ARG sponsor. The sponsor will be responsible for facilitating meetings and maintaining the meeting record, with input from the ARG in accordance with ARG procedures; developing the Annual Water Temperature Management Plan and Operations Forecast and amendments thereto; maintaining and disseminating operational data (flow and water temperature), forecasting operations; providing data sources and other information used in the formulation of the Operations Forecast and the Annual Water Temperature Management Plan as needed; providing technical expertise as needed; conducting public outreach; preparing summaries of operational data; reporting relevant monitoring data and research results produced by Reclamation; and taking the lead in preparing and coordinating the compilation of annual and other reports.

9.3.2 Cooperating Agencies

The USFWS, NMFS, and CDFW will be the Cooperating Agencies. The Cooperating Agencies will be responsible for representing their respective agencies at all meetings; providing technical expertise as needed; participating in the development of operational forecasts; reviewing and commenting on the Annual Water Temperature Management Plan and Operations Forecast; assessing the biological effects of changes to proposed operations and recommending changes to

those operations; participating in public outreach; preparing summaries of biological monitoring and research activities conducted by their respective agencies; reviewing and commenting on biological sections of reports; and participating in the preparation of the annual reports by providing the assessment of biological effects associated with operations during the previous year. Each Cooperating Agency will designate an individual to represent its interests on the ARG and ensure that the responsibilities of their respective agencies are met.

9.4 PROCESS AND PROCEDURES

9.4.1 Regularly Scheduled and Other Meetings

The ARG will hold regularly scheduled meetings that will be convened no less often than every six weeks. Regularly scheduled meetings will be open to the public. Notice of these regularly scheduled meetings will be provided at least five days prior to the date of the regularly scheduled meeting to any person requesting notice. If conditions arise that warrant holding a meeting of the ARG to consider changed circumstances or proposed changes in operations other than at a regularly scheduled meeting, the ARG may meet with such notice, which may be less than five days, as may be practicable in light of the circumstances, and may meet telephonically if circumstances warrant.

9.4.2 Agenda

A typical agenda for a regularly scheduled meeting of the ARG will include, but not be limited to, review of the latest Operations Forecast, Annual Temperature Management Plan, and September Update, reviews of the current biological and hydrologic conditions, forecasted operations, and other special studies or events, followed by discussion to identify biological issues or concerns, and to formulate recommendations.

9.4.3 Public Input

Members of the public and other agencies will be encouraged to comment on matters under consideration by the ARG, and the ARG will consider all public comments when developing recommendations to Reclamation and/or the Cooperating Agencies. The public includes other agencies, individuals, or organizations with an interest in the activities of the ARG and lower American River, or whose interest may be affected by operation of the Folsom/Nimbus Dam complex. The public may attend ARG meetings as desired, provide technical input to issues relevant to project operations and biological resources, articulate special interest in or need for specific hydrologic conditions, report on their independent research activities, coordinate in-river activities, and articulate any other concerns or issues related to their organization or interest as part of the regular meeting process.

9.4.4 Regular Meeting Notes and Supporting Information

Meeting notes summarizing the issues discussed and recommendations, if any, made during each meeting will be prepared by Reclamation and reviewed by the Cooperating Agencies. The final approved meeting notes will be distributed to all meeting participants and interested public following an ARG meeting. Supporting documentation and other information used at ARG meetings also will be made available to all meeting participants and the public at the meeting at

which they are considered, or if that cannot be done, as soon as practicable following the meeting.

9.4.5 Annual Report

Reclamation will take the lead in the preparation of an annual report every February that includes the notes from ARG meetings, description and evaluation of lower American River actions taken and effects, and lessons learned during the previous calendar year. The ARG will assist Reclamation in the preparation of the annual report by preparing the section describing the evaluation of the biological effects of the operational actions taken during the previous calendar year.

9.4.6 Operational Decision Making

Reclamation maintains its authority and responsibility for operations of the Folsom/Nimbus Dam complex. The ARG has no authority to make operational decisions.

9.4.6.1 *Emergency and Time Sensitive Decisions*

Reclamation will strive to identify all foreseeable hydrologic, physical, and biological issues or conditions that have historically been, or may be expected to be of interest to the ARG during regularly scheduled meetings. If Reclamation needs to take an action, based on emergency conditions or unforeseen changes in biologic, hydrologic, or physical conditions that are so urgent that they require action before discussions with the ARG can take place, Reclamation will immediately notify Cooperating Agencies of the action and the circumstances that required the action. The public will be notified of the action taken through the normal reporting mechanisms and discussion of the action will take place at the next meeting of the ARG.

9.4.6.2 *ARG Recommendations*

All recommendations to be presented to Reclamation by the ARG will be vetted and resolved through the decision process described in this document and shown in **Figure 12**. The Cooperating Agencies will seek to reach consensus on all recommendations to be provided to Reclamation. Reclamation and the Cooperating Agencies will consider all known factors that may require additional discussion of the recommendation outside of the ARG. If ARG discussions on a proposed recommendation result in consensus, Reclamation, in coordination with the Cooperating Agencies, will review the recommendation to ensure additional discussion outside of the ARG is not needed. In the absence of a need for such further discussion, Reclamation will implement an operational decision(s) consistent with the ARG consensus. If there is no consensus, or if Reclamation and/or the Cooperating Agencies identify the need for additional discussion outside of the ARG, the matter will be referred to either the (b)(2) Interagency Team (B2IT) (or a functionally equivalent group) or to the Water Operations Management Team (WOMT) (or a functionally equivalent group), as appropriate. If there is consensus on a recommendation from the B2IT and/or WOMT (or functional equivalent), Reclamation will implement the operational decision(s) accordingly. If no consensus is reached, Reclamation will weigh the input from either the B2IT and/or WOMT (or functional equivalent) and make and implement the operational decision(s). Reclamation will inform the ARG of the

operational decision(s) through the normal reporting mechanisms and discussion of the decision(s) will take place at the next regularly scheduled meeting of the ARG.

Figure 12. American River Group decision process.

9.5 RECLAMATION AND ARG RESPONSIBILITIES

As described in Section 8.1 of this Technical Memorandum, Reclamation will prepare a draft Operations Forecast and Annual Water Temperature Management Plan for submission to NMFS by May 1, and a final plan by May 15 of each year. Reclamation will implement the final plan as soon as possible, and no later than May 15.

9.5.1 Modified FMS Monitoring and Evaluation Program

The ARG will discuss and interpret data gathered from monitoring efforts in the lower American River.

9.5.2 Other

Other special actions or studies may be brought to the ARG as needed.

10 IMPLEMENTATION CRITERIA

10.1 NIMBUS DAM FLOW MEASUREMENT

The MRRs will be measured at Nimbus Dam and are rounded to the nearest cfs. The return flow from the Nimbus Hatchery is credited towards meeting the MRRs. Folsom South Canal flows are not credited towards meeting the MRRs.

The MRRs will be maintained on a 5-day moving average of daily instream flows (in cfs), with daily average flows not less than 90 percent of the applicable MRRs. Measuring instream flows in this manner, as opposed to measuring compliance over a shorter duration, reduces the magnitude and frequency of instream flow fluctuations. On days when the MRR changes from the previous day, a new 5-day averaging period will begin.

10.2 FLOW RAMPING RATE OBJECTIVES

Flow ramping rate objectives, included in the NMFS (2009, as amended in 2011) OCAP BO, are incorporated into implementation criteria of the Modified FMS. Flow fluctuations in the lower American River have been documented to result in steelhead redd dewatering and isolation (Hannon *et al.,* 2003; Hannon and Deason 2008), fry stranding, and fry and juvenile isolation (Water Forum 2005). By limiting the rate of flow reductions, the risk of stranding and isolating steelhead is reduced.

Pursuant to NMFS (2011), the following flow fluctuation objectives will be followed:

1) From January 1 through May 30, at flow levels <5,000 cfs, flow reductions will not exceed more than 500 cfs/day and not more than 100 cfs per hour.

2) Minimize the occurrence of flows exceeding 4,000 cfs throughout the year, except as may be necessary for flood control or in response to natural high precipitation events.

11 LITERATURE CITED

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