Operations Model

Consultation Workshop No. 5

May 30, 2013

Doody, Andrew

From: Staples, Rose
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Subject: Don Pedro - AGENDA - ADVANCE MATERIAL for May 30 Operations Model Consultation Workshop No. 5
Attachments: Don Pedro May 30 Ops Model Workshop AGENDA_130520.pdf; WAR-02 User Guide Addendum 1 (5-20-13).pdf; Base Case Description (5_20_2013).pdf

Please find attached the AGENDA for the upcoming May 30 ***Operations Modeling Consultation Workshop No. 5***, to be held at the MID offices in Modesto from 9:00 a.m. to 4:00 p.m. Also attached for your reference are the *BASE CASE DESCRIPTION* and the *User Guide Addendum 1*. ***As these materials build upon the Initial Study Report for W&AR-02 (with the hydrology and model description—and the user's guide), it is recommended that you bring the W&AR-02 Initial Study Report with you to the workshop.*** The Districts will have DVDs of the Base Case Model available at the Workshop.

A copy of this material is also being uploaded to the www.donpedro-relicensing.com website (in the CALENDAR under May 30—and also in the ANNOUCEMENTS). If you have any difficulty accessing and/or opening these documents, please let me know. Thank you.

ROSE STAPLES
CAP-OM

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Operations Modeling Consultation Workshop No. 5
Don Pedro Relicensing Study W&AR-02
May 30, 2013 – 9:00 a.m. to 4:00 p.m. - MID Offices

AGENDA

9:00 a.m. to 9:15 a.m.	Introductions
9:15 a.m. to 9:30 a.m.	Meeting Purpose
9:30 a.m. to 10:15 a.m.	Background • Study Plan • FERC Dec 2011 Determination • Review Prior Workshops • Hydrology Update in March 2013
10:15 a.m. to 11:30 a.m.	Base Case Description • Role of Base Case • Incorporation into Operations Model • Summary of Results Provided in Base Case Report
11:30 a.m. to 1:00 p.m.	Lunch (on your own)
1:00 p.m. to 2:00 p.m.	Further Presentation and Discussion of Results of Operations Model Runs Under Base Case
2:00 p.m. to 3:00 p.m.	Run Alternative Scenarios (Districts will run the model using examples for two alternatives to assist Relicensing Participants in furthering their use of the model)
3:00 p.m. to 3:30 p.m.	Presentation of Form for Requesting Model Runs by the Districts
3:30 p.m. to 4:00 p.m.	Action Items and Closure

Don Pedro Project
Project Operations/Water Balance Model
Attachment B – Model Description and User's Guide, Addendum 1
Base Case Description
5-20-2013

1.0 INTRODUCTION

The Turlock Irrigation District ("TID") and Modesto Irrigation District ("MID") (collectively, the "Districts") have developed a computerized Tuolumne River Daily Operations Model ("Model") to assist in the relicensing of the Don Pedro Project ("Project") (FERC Project 2299). The Model is fully described in the User's Guide submitted to FERC as part of the Initial Study Report ("ISR"), January 2013 (Model version 1.01) and supplemented by Addendum 1, May 2013 regarding the currently used version of the Model (Version 2.0).

The Districts have proceeded to develop the "Base Case" which depicts the operation of the Don Pedro Project in accordance with the current FERC license, ACOE flood management guidelines, and the Districts' irrigation and M&I water management practices. Under FERC policy, the Base Case represents the "No Action" alternative for purposes of evaluating future operating scenarios under NEPA. Future scenarios are compared to the Base Case to assess their impacts. For purposes of representing the City and County of San Francisco ("CCSF") operations, the Base Case also includes changes that are permitted under CEQA, approved by CCSF, and authorized (funded), but not yet fully implemented. This document provides a description of the assumptions and results of the modeled simulation of the Base Case as depicted by the Tuolumne River Daily Operations Model.

2.0 BASE CASE MODEL AND ASSUMPTIONS

The Tuolumne River Daily Operations Model (Version 2.0) has been developed to depict the Base Case water management operations of CCSF facilities and the Don Pedro Project, providing a tool to simulate and compare alternative operation scenarios. The Model was constructed within the platform of a Microsoft Excel 2010 workbook, and allows alternative user-specified data and assumptions for numerous components of Don Pedro Project operations in accordance with the Districts Study Plan W&AR-02 as approved by FERC's December 2011 Study Plan Determination. A brief description of Model assumptions and data for the Base Case follows.

2.1 Reservoir Inflows

The Model requires several records of estimated unimpaired flow. These records are (1) unimpaired flow (inflow) at Hetch Hetchy Reservoir, (2) unimpaired flow (inflow) at Lake Lloyd Reservoir and Eleanor Reservoir, (3) flow which depicts the runoff entering Don Pedro Reservoir that is not affected by upstream CCSF facilities, and (4) unimpaired flow at the La Grange USGS gage.

The estimated unimpaired flow of the Tuolumne River has been computed for various locations within the basin for decades. The hydrologic data set developed by the Districts and CCSF was provided in Study Report W&AR-02: Project Operations/Water Balance Model Attachment A, January 2013. Subsequently during March 2013, the Districts and the RPs developed a consensus-based revised data set of unimpaired daily hydrology. The revised data set generally provides a "smoother" daily sequence of flows while maintaining the overall monthly volumes of runoff from the watershed contained in the January 2013 report. The revised data set for the four components of unimpaired flow described above was agreed to during the March 27, 2013 Workshop concerning unimpaired flow hydrology.

Inflow to Don Pedro Reservoir is modeled as two components: (1) a fluctuating unregulated inflow to Don Pedro Reservoir, and (2) the regulated releases (regulated Don Pedro Reservoir inflow) from the CCSF System. The unregulated component of inflow to Don Pedro Reservoir remains the same among all operation simulations. The regulated inflow to Don Pedro is based on the operation of the CCSF System. The latter component of Don Pedro Reservoir inflow may change among operation simulations due to user-controlled parameters. The Base Case operation for the CCSF System is based on current facilities, operational plans and objectives, regulatory requirements in place, and operational plans and facilities that have been approved under CEQA and authorized for funding by CCSF, but not yet fully implemented.

Projected[1] annual inflow to Don Pedro Reservoir under the Base Case is illustrated in Figure 2.1-1, representing the regulated and unregulated components of total inflow to Don Pedro Reservoir. Average annual inflow to Don Pedro Reservoir is projected to be 1,690,100 acre-feet,

[1] The terms "projected" and "modeled" are used as qualifiers of an expressed term or unit of measurement, and are meant to identify a distinction between results that have been simulated by the Model as opposed to values of the historical reported record.

with approximately 683,400 acre-feet occurring as unregulated inflow. Although not completely appropriate for comparison purposes, the historically computed annual total inflow to Don Pedro Reservoir has also been shown in the figure as confirmation that the Model's simulation of inflow is capturing the magnitude and range of historical hydrology. It is known that simulated inflow and historical inflow will differ for several reasons including historical CCSF water diversions and operations that differ from the Base Case operation represented by the Model.

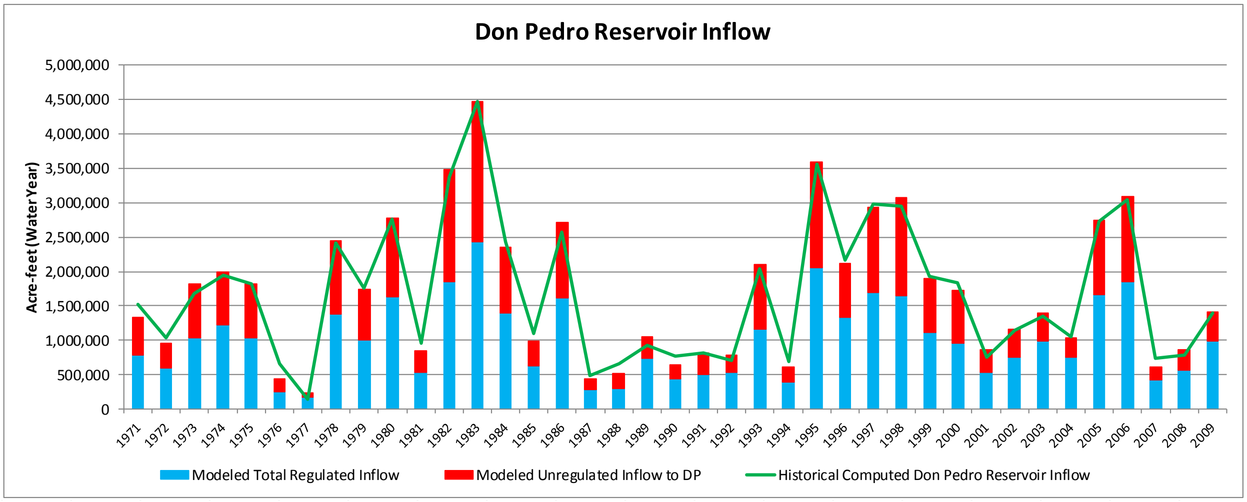


Figure 2.1-1. Projected Don Pedro Reservoir inflow – Base Case.

2.2 Don Pedro Project Minimum Flow Requirement

Table 2.2-1 illustrates the FERC minimum flow requirements for the Base Case. Values for each defined flow period by year type are consistent with the FERC order issued July 31, 1996. Seven water year types are defined based on the San Joaquin Basin 60-20-20 water supply index. The sequence year of the flow schedule begins in April and continues through the following March. The historical actual 60-20-20 index is used for computations. The volume of water interpolated between annual base flow schedules, October attraction flow and the total flow schedule is distributed daily among April (16 days) and May (15 days). The October attraction flow volume is provided equally during two days, beginning October 15. Base flow during October for year types 1, 2 and 6 has been modeled as an average value for the entire month for modeling convenience to fit within the daily parsing logic of the Model.

The daily parsing of April-May outmigration flows is illustrated in Figure 2.2-1. The 31-day pulse flow during April and May occurs beginning April 15 and ends May 15.

The simulated annual minimum flow requirement for the Base Case is illustrated in Figure 2.2-2, and ranges from a minimum of 94,000 acre-feet up to a maximum of 300,900 acre-feet. The 39-year average of the flow requirement is 212,700 acre-feet.

Table 2.2-1. FERC license flow requirements from Don Pedro Project to the lower Tuolumne River.

Year Type	1	2	3	4	5	6	7
Oct 1-15 (CFS)	100	100	150	150	180	200	300
Oct 16-31 (CFS)	150	150	150	150	180	175	300
Total Base (AF)	7,736	7,736	9,223	9,223	11,068	11,504	18,447
Attraction (AF)	0	0	0	0	1,676	1,736	5,950
Total Oct (AF)	7,736	7,736	9,223	9,223	12,744	13,240	24,397
Nov (CFS)	150	150	150	150	180	175	300
AF	8,926	8,926	8,926	8,926	10,711	10,413	17,852
Dec (CFS)	150	150	150	150	180	175	300
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447
Jan (CFS)	150	150	150	150	180	175	300
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447
Feb (CFS)	150	150	150	150	180	175	300
AF	8,331	8,331	8,331	8,331	9,997	9,719	16,661
Mar (CFS)	150	150	150	150	180	175	300
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447
Apr (CFS)	150	150	150	150	180	175	300
AF	8,926	8,926	8,926	8,926	10,711	10,413	17,852
May (CFS)	150	150	150	150	180	175	300
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447
Migration Flow							
AF	11,091	20,091	32,619	37,060	35,920	60,027	89,882
Jun (CFS)	50	50	50	75	75	75	250
AF	2,975	2,975	2,975	4,463	4,463	4,463	14,876
Jul (CFS)	50	50	50	75	75	75	250
AF	3,074	3,074	3,074	4,612	4,612	4,612	15,372
Aug (CFS)	50	50	50	75	75	75	250
AF	3,074	3,074	3,074	4,612	4,612	4,612	15,372
Sep (CFS)	50	50	50	75	75	75	250
AF	2,975	2,975	2,975	4,463	4,463	4,463	14,876
Total Annual	94,001	103,001	117,017	127,508	142,503	165,004	300,926

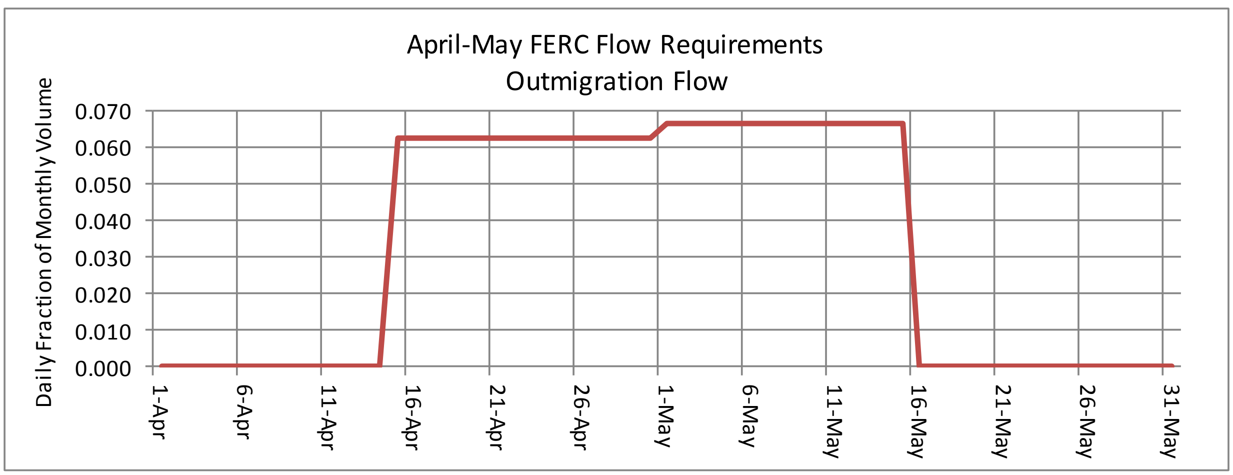


Figure 2.2-1. Daily parsing of April-May outmigration flow – Base Case.

The volumes of outmigration and attraction flows can be shaped within the current FERC requirements. The actual daily distribution of outmigration and attraction flows can in practice be different than patterned in the Base Case. At the time of simulation of any alternative operation and subsequent comparison to the Base Case, it must be recognized that the Base Case daily distribution of these flows is not absolute. For comparison purposes it may be necessary to rerun the Base Case releases with a distribution for the outmigration and attraction flows in the same pattern as provided for the alternative. If required, the Districts would perform and provide such additional versions of the Base Case.

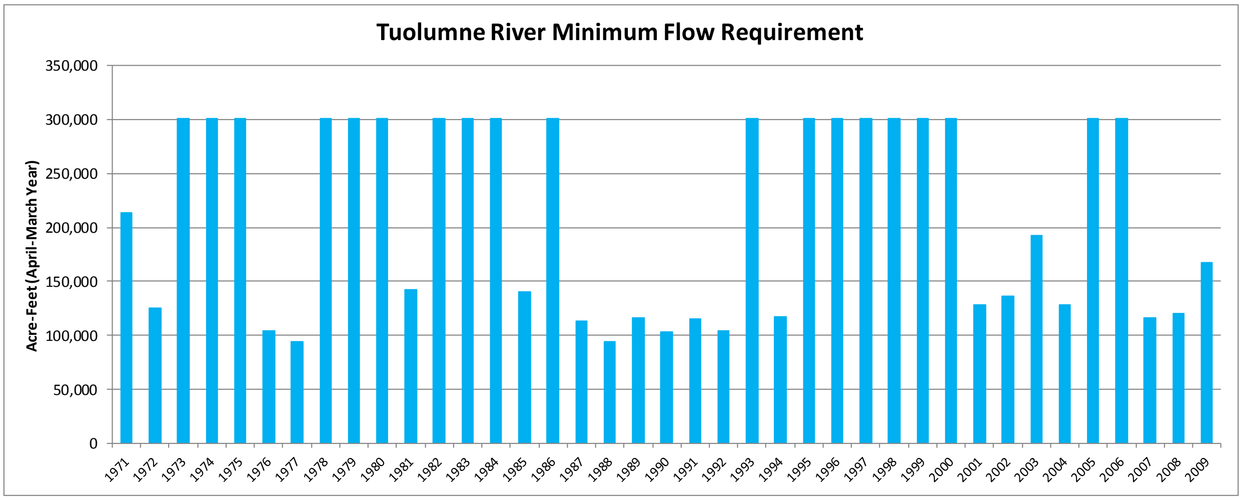


Figure 2.2-2. Minimum annual FERC flow requirement – Base Case.

The annual and monthly volume of the minimum flow requirement used in the Base Case is listed in Table 2.2-2.

Table 2.2-2. Minimum FERC flow requirement in the Base Case Model.

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Apr-Mar
1971	24,397	17,852	18,447	18,447	16,661	18,447	66,685	63,515	4,463	4,612	4,612	4,463	262,598	214,003
1972	13,240	10,413	10,760	10,760	9,719	10,760	30,288	29,251	2,975	3,074	3,074	2,975	137,292	125,788
1973	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	300,923
1974	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1975	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1976	24,397	17,852	18,447	18,447	16,661	18,447	20,153	19,749	2,975	3,074	3,074	2,975	166,250	104,663
1977	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
1978	7,736	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	239,336	300,923
1979	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1980	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1981	24,397	17,852	18,447	18,447	16,661	18,447	29,339	28,532	4,463	4,612	4,612	4,463	190,269	142,675
1982	12,744	10,711	11,068	11,068	9,997	11,068	64,241	61,936	14,876	15,372	15,372	14,876	253,329	300,923
1983	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1984	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1985	24,397	17,852	18,447	18,447	16,661	18,447	34,656	33,346	4,463	4,612	4,612	4,463	200,400	140,301
1986	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	300,923
1987	24,397	17,852	18,447	18,447	16,661	18,447	24,481	23,806	2,975	3,074	3,074	2,975	174,636	113,049
1988	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
1989	7,736	8,926	9,223	9,223	8,331	9,223	25,991	25,222	2,975	3,074	3,074	2,975	115,975	115,975
1990	7,736	8,926	9,223	9,223	8,331	9,223	19,362	19,008	2,975	3,074	3,074	2,975	103,131	103,131
1991	7,736	8,926	9,223	9,223	8,331	9,223	25,870	25,109	2,975	3,074	3,074	2,975	115,740	115,740
1992	7,736	8,926	9,223	9,223	8,331	9,223	19,995	19,601	2,975	3,074	3,074	2,975	104,357	104,357
1993	7,736	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	239,336	300,923
1994	24,397	17,852	18,447	18,447	16,661	18,447	25,903	25,140	2,975	3,074	3,074	2,975	177,392	117,292
1995	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	300,923
1996	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1997	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1998	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1999	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2000	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2001	24,397	17,852	18,447	18,447	16,661	18,447	28,572	27,642	4,463	4,612	4,612	4,463	188,613	128,513
2002	9,223	8,926	9,223	9,223	8,331	9,223	32,729	31,539	4,463	4,612	4,612	4,463	136,567	136,567
2003	9,223	8,926	9,223	9,223	8,331	9,223	55,641	53,161	4,463	4,612	4,612	4,463	181,101	192,606
2004	13,240	10,413	10,760	10,760	9,719	10,760	28,696	27,758	4,463	4,612	4,612	4,463	140,258	128,753
2005	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	300,923
2006	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2007	24,397	17,852	18,447	18,447	16,661	18,447	26,085	25,310	2,975	3,074	3,074	2,975	177,743	116,156
2008	7,736	8,926	9,223	9,223	8,331	9,223	27,470	26,609	2,975	3,074	3,074	2,975	118,840	120,328
2009	9,223	8,926	9,223	9,223	8,331	9,223	42,919	41,235	4,463	4,612	4,612	4,463	156,452	167,957
Average	16,957	13,625	14,079	14,079	12,717	14,079	46,531	44,910	9,078	9,381	9,381	9,078	213,897	212,651
Min	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
Max	24,397	17,852	18,447	18,447	16,661	18,447	66,685	63,515	14,876	15,372	15,372	14,876	300,923	300,923

2.3 Districts' Canal Demands

The computation of canal demands incorporates the projected demand of applied water ("PDAW") and the canal operation and maintenance practices of the Districts. Canal operation assumptions include the operation of the Districts' irrigation system reservoirs - Turlock Lake and Modesto Reservoir, seepage and losses, groundwater pumping and canal operational spills. Table 2.3-1 lists the Base Case assumptions for the Districts' canal operations. Also described in the data set are monthly turnout delivery factors, unique to each District that represent a modeling mechanism to adjust the PDAW for irrigation practices that are not included in the estimation of the consumptive use of applied water, such as irrigation that provides for groundwater recharge. Refer to the Model's Users' Guide for additional information regarding the canal demand components.

Table 2.3-1. Districts' canal demand components in the Base Case.

Modesto Irrigation District

Month	Turnout Delivery Factor (%)	Private GW Pumping (TAF)	Canal Operational Spills Critical (TAF)	Canal Operational Spills Non-crit (TAF)	System Losses below Modesto Res (TAF)	Intercepted Flows (TAF)	MID GW Pumping (TAF)	Modesto Res and Upper Canal Losses/Div (TAF)	Municipal Delivery from Modesto Res (TAF)	Modesto Res Target Storage (TAF)	Modesto Res Target Storage Change (TAF)
January	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0	2.0
February	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0	1.0
March	65.0	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0	0.0
April	70.0	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0	1.0
May	85.0	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0	1.0
June	85.0	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0	0.0
July	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0	1.0
August	70.0	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0	1.0
September	65.0	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0	-2.0
October	40.0	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0	-3.0
November	30.0	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0	-2.0
December	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0	0.0
Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5		

MID March TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	65.0
9.9	65.0
13.2	65.0
20.0	65.0
9999.0	65.0

TID March TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	65.0
19.8	65.0
27.5	65.0
40.0	65.0
9999.0	65.0

MID April TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	70.0
10.0	70.0
17.5	70.0
25.0	80.0
9999.0	80.0

TID April TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	57.5
20.0	57.5
35.0	70.0
50.0	80.0
9999.0	80.0

Turlock Irrigation District

Month	Turnout Delivery Factor (%)	Private GW Pumping (TAF)	Canal Operational Spills Critical (TAF)	Canal Operational Spills Non-crit (TAF)	System Losses below Turlock Lk (TAF)	Intercepted and Other Flows (TAF)	TID GW Pumping (TAF)	Turlock Lk and Upper Canal Losses (TAF)	Other Delivery from Turlock Lk (TAF)	Turlock Lk Target Storage (TAF)	Turlock Lk Target Storage Change (TAF)
January	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0	5.0
February	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0	7.0
March	65.0	1.2	3.0	3.0	4.5	0.5	4.1	1.0	0.0	30.0	5.0
April	57.5	2.4	5.1	6.3	4.5	1.0	8.0	6.6	0.0	30.0	0.0
May	85.0	3.6	4.6	6.7	4.5	1.3	10.3	7.7	0.0	32.0	2.0
June	92.5	5.2	4.2	6.7	4.5	1.3	12.4	8.2	0.0	32.0	0.0
July	75.0	6.4	4.2	6.7	4.5	1.5	14.6	8.7	0.0	32.0	0.0
August	65.0	6.2	4.0	7.3	4.5	1.5	13.3	9.0	0.0	30.0	-2.0
September	67.5	3.9	3.2	7.3	4.5	1.0	9.1	5.0	0.0	27.0	-3.0
October	40.0	2.4	2.3	7.3	4.5	0.5	5.3	2.0	0.0	13.0	-14.0
November	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
December	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
Total		31.3	38.6	59.3	39.2	8.5	77.1	52.2	0.0		

2.4 Don Pedro Water Supply Factor

The premise of the Don Pedro water supply factor ("WSF") factor is to simulate the Districts' historical practice of reducing the amount of water diverted to the canals during years when lack of carryover storage at Don Pedro Reservoir becomes a concern. In practice, any such reduction is managed on a real-time basis by the Districts using the best information available at the time. The modeling mechanism used to reduce canal diversions is a factor applied to the PDAW of the canal demand. This mechanism results in a reduction to the amount of water delivered or "turned out" to the customers. Table 2.4-1 illustrates the Base Case WSF components in the Model. As an illustration of the use of the WSF in the model, if the forecast of the ending-March Don Pedro Reservoir storage plus projected inflow for April through July is greater than 1,090 TAF and less than 1,700 TAF, the PDAW for the year would be reduced by a factor of 0.875. If the forecast was greater than 1,700 TAF, there would be no reduction to the projected PDAW for the year.

Table 2.4-1. Don Pedro water supply forecast factors – Base Case.

Don Pedro Water Supply Factor		
NDP Stor + Infl Index	WS Factor	*(W)ater (S)upply (F)actor is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir.*
		Forecast begins for February:
TAF	%	*EO-January storage + Feb-July UF - Feb-July US adj - Feb-Mar minimum river*
0	0.750	*March Forecast:*
1090	0.750	*EO-February storage + Mar-July UF - Mar-July US adj - Mar minimum river*
1090	0.875	*April Forecast: (final)*
1700	0.875	*EO-March storage + Apr-July UF - Apr-July US adj*
1700	1.000	
2300	1.000	*Factor Table is April Forecast based*
9999	1.000	*February and March Forecasts act as adjustments to estimate April 1 state.*

2.5 Don Pedro Reservoir Storage Guidance

The Model allows the user to establish the preferred storage target. The Base Case preferred storage target is the Army Corps of Engineers ("ACOE") rain flood reservation objective, except after July 1, when there is no required reservation space. The preferred storage target reflects a drawdown to evacuate storage during the summer in late and wet runoff years. The preferred target storage is again equal to the ACOE objective on October 7. Figure 2.5-1 illustrates the reservoir storage target used in the Model for the Base Case.

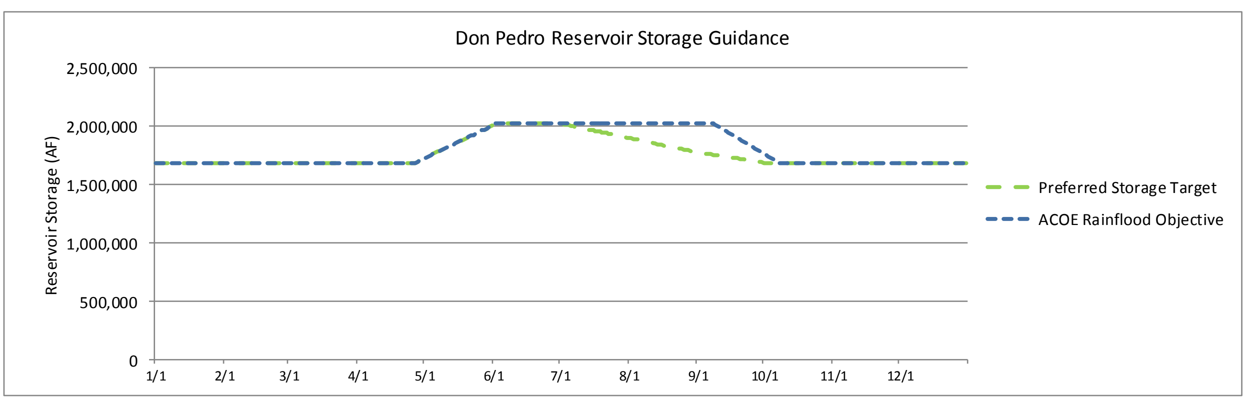


Figure 2.5-1. Don Pedro Reservoir storage guidance targets – Base Case.

2.6 CCSF Water Diversions

The Base Case operation for the CCSF system is based on the existing facilities, operational plans and objectives, and the regulatory requirements in place. The Base Case also includes facilities and operations previously approved under CEQA and authorized for funding by CCSF, but not yet fully implemented. The projected diversions of CCSF to the San Francisco Bay Area from the San Joaquin Pipeline ("SJPL") are imported to the Model from output of CCSF's Hetch Hetchy/Local Simulation Model ("HHLSM") as provided by CCSF to the Districts. Figure 2.6-1 illustrates the annual volume of diversions for the Base Case. Based on an annual average system-wide demand of 238 MGD (266,600 acre-feet), annual average diversions from the Tuolumne River are projected to be 231,200 acre-feet. These diversions integrate with other CCSF water supply resources and fully meet CCSF system-wide demands except during 1977, 1988, 1989, 1990, 1991 and 1992 when a 10 percent reduction in deliveries is needed.

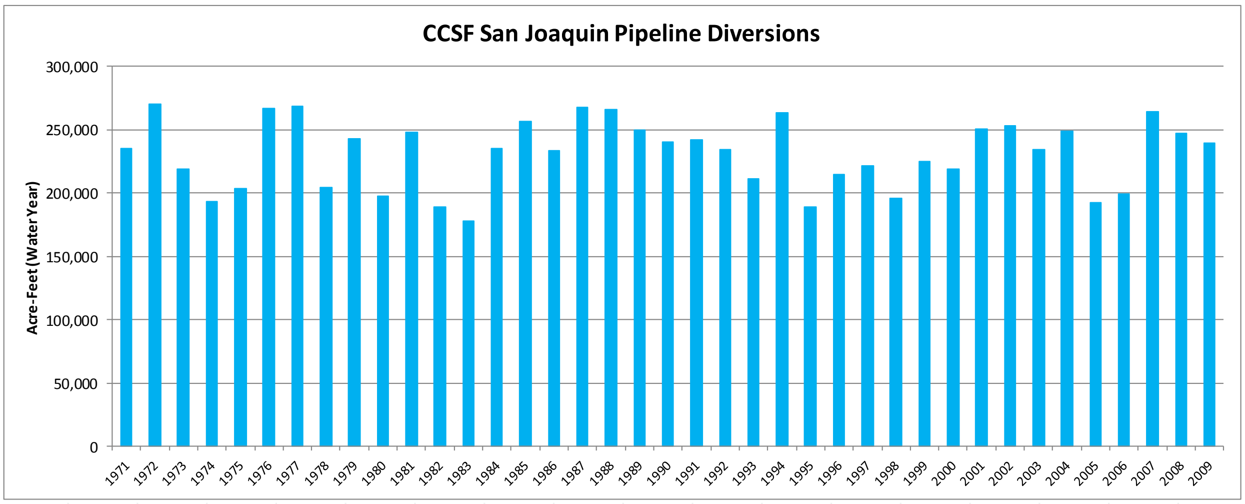


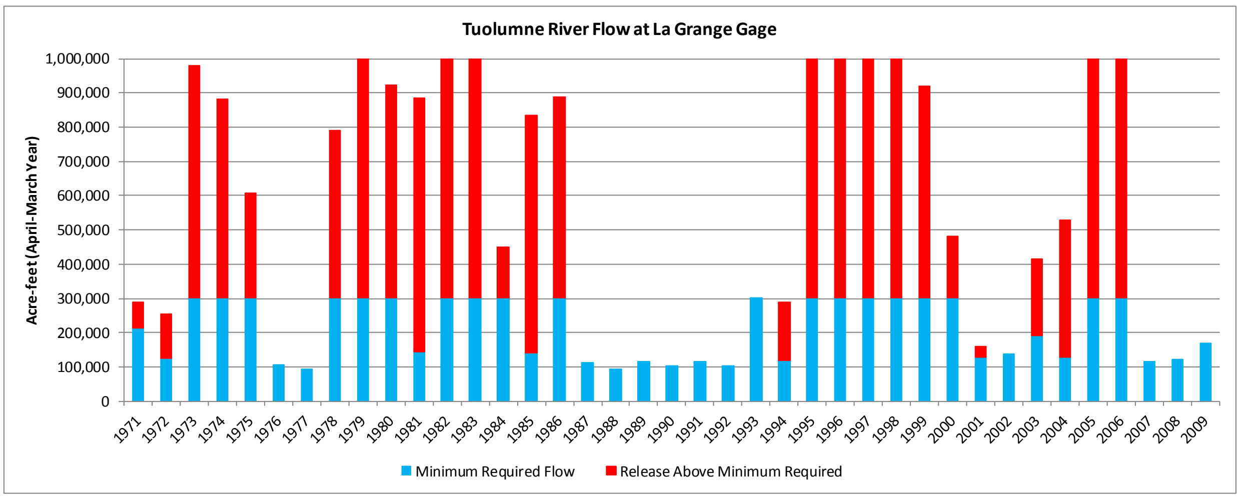
Figure 2.6-1. San Joaquin Pipeline diversions – Base Case.

3.0 REPRESENTATIVE BASE CASE RESULTS

Incorporation of the above described depictions of hydrology and demands, and the performance of operations according to operational parameters established in the Model, result in a 39-year simulation of Don Pedro Project and CCSF Tuolumne River operations under the Base Case.

3.1 Tuolumne River Flow

Flow delivered from Don Pedro to the Tuolumne River at the La Grange gage will result from meeting the FERC license minimum flow requirements and releasing flows for flood control operations and discretionary drawdown of Don Pedro Reservoir. The projected annual flow of the river at the La Grange gage under the Base Case is illustrated in Figure 3.1-1. Seasonal flow volume in the Tuolumne River is illustrated in Table 3.1-1 which provides average flow by month within a ranking of all years according to a preliminary year type classification.[2]



(Flows exceeding scale of graph: 1979 – 1,396,600 acre-feet; 1982 – 3,052,100 acre-feet; 1983 – 3,322,600 acre-feet; 1995 – 4,444,700 acre-feet; 1996 – 4,309,800 acre-feet; 1997 – 1,045,800 acre-feet; 1988 – 2,044,700 acre-feet; 2005 – 1,865,100 acre-feet; 2006 – 1,556,100 acre-feet.)

Figure 3.1-1. Projected flow at La Grange gage – Base Case.

Table 3.1-1. Projected seasonal flow at La Grange gage (acre-feet) – Base Case.

Prelim Year Type		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	1	23,912	30,156	51,946	173,266	227,151	304,806	297,533	255,305	300,263	176,799	70,473	38,242	1,949,853
AN	2	27,345	36,232	78,097	98,325	157,042	183,876	155,840	79,345	102,401	27,829	15,372	16,202	977,906
N	3	17,720	12,751	14,214	26,235	69,340	108,279	116,684	55,305	39,080	11,543	9,223	8,926	489,300
BN	4	14,069	11,901	12,298	12,327	26,022	39,636	42,413	28,173	3,613	3,733	3,733	3,613	201,530
D	5	22,274	15,620	16,141	16,141	14,579	24,563	30,035	24,497	3,347	3,459	3,459	3,347	177,461
C	6	15,723	12,586	14,370	12,917	11,663	12,913	18,786	18,467	2,975	3,074	3,074	2,975	129,523
All		20,344	20,947	33,591	69,787	102,511	137,167	134,311	97,533	101,132	53,105	23,509	15,274	809,211

[2] The preliminary relicensing year type is based on a rank-ordering of the water-year runoff for the years 1921-2011. Each water year type W, AN, N, and BN represent 20% of the years of ranking. D and C year types each represent 10% of the years.

Total average daily flow projected for the Tuolumne River at La Grange gage by month is listed in Table 3.1-2.

Table 3.1-2. Projected average daily flow at La Grange gage (cfs) – Base Case.

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	397	300	418	960	1,848	1,511	2,253	1,033	75	75	75	75
1972	215	175	175	175	169	291	509	476	50	50	50	50
1973	150	150	150	150	150	2,241	2,659	1,068	2,204	482	250	250
1974	397	300	849	2,210	2,535	3,140	3,720	1,088	2,192	499	250	250
1975	397	300	300	300	2,198	3,247	2,697	1,242	2,748	673	250	384
1976	504	308	419	300	290	300	339	321	50	50	50	50
1977	126	150	150	150	150	150	246	237	50	50	50	50
1978	126	150	150	150	150	150	1,080	1,515	250	250	300	1,146
1979	624	300	300	1,127	2,729	3,584	2,795	1,036	1,248	282	250	250
1980	397	300	300	4,249	6,150	6,001	3,116	2,666	2,136	3,286	996	474
1981	530	300	300	300	300	848	820	464	75	75	75	75
1982	207	180	180	963	5,178	6,633	7,137	6,151	5,979	2,915	1,075	1,155
1983	1,476	3,088	3,832	3,327	6,964	7,772	7,686	8,226	7,597	5,959	3,708	1,572
1984	739	2,303	5,672	5,450	2,962	2,972	2,044	1,007	250	250	250	250
1985	397	300	300	300	825	1,312	1,269	542	75	75	75	75
1986	150	150	150	150	2,819	8,385	5,442	3,177	3,095	661	250	250
1987	397	300	300	300	300	300	411	387	50	50	50	50
1988	126	150	150	150	145	150	246	237	50	50	50	50
1989	126	150	150	150	150	150	437	410	50	50	50	50
1990	126	150	150	150	150	150	325	309	50	50	50	50
1991	126	150	150	150	150	150	435	408	50	50	50	50
1992	126	150	150	150	145	150	336	319	50	50	50	50
1993	126	150	150	150	150	150	1,080	1,007	250	250	250	250
1994	397	300	300	300	300	300	435	409	50	50	50	50
1995	150	150	150	150	150	2,960	5,800	6,622	7,870	5,933	2,927	584
1996	470	300	300	300	4,334	5,068	3,672	2,391	3,239	653	250	250
1997	397	300	2,826	13,576	7,805	3,202	1,997	1,007	677	258	250	250
1998	397	300	300	970	6,323	4,995	5,593	3,996	7,134	5,207	1,455	478
1999	540	300	350	1,184	4,527	3,365	2,501	1,007	1,646	390	250	250
2000	397	300	300	300	3,440	4,540	3,202	1,111	845	250	250	250
2001	397	300	300	300	300	497	984	487	75	75	75	75
2002	150	150	150	150	150	150	550	513	75	75	75	75
2003	150	150	150	150	150	150	1,546	865	75	75	75	75
2004	215	175	175	178	1,477	1,962	894	451	75	75	75	75
2005	150	150	150	150	1,907	4,672	4,340	2,600	7,818	2,100	250	268
2006	440	300	410	4,494	3,235	4,801	7,812	5,563	7,905	2,185	250	250
2007	397	300	300	300	300	300	438	412	50	50	50	50
2008	126	150	150	150	145	150	462	433	50	50	50	50
2009	150	150	150	150	150	150	721	671	75	75	75	75
Average	331	352	546	1,135	1,828	2,231	2,257	1,586	1,700	864	382	257
Min	126	150	150	150	145	150	246	237	50	50	50	50
Max	1,476	3,088	5,672	13,576	7,805	8,385	7,812	8,226	7,905	5,959	3,708	1,572

3.2 Districts' Canal Diversions

Projected Base Case combined diversions of the Districts are illustrated in Figure 3.2-1. The average annual Base Case diversion is 848,600 acre-feet, ranging from a maximum of 966,900 acre-feet to a minimum of 648,300 acre-feet which includes a reduction to deliveries due to a limited water supply from Don Pedro Reservoir. Also shown in Figure 3.2-1 is the full combined diversion demand of the Districts. Reductions from full diversion demand are projected to occur when the projected combined diversions are less than the full diversion demand, during 1977, and 1988 through 1992.

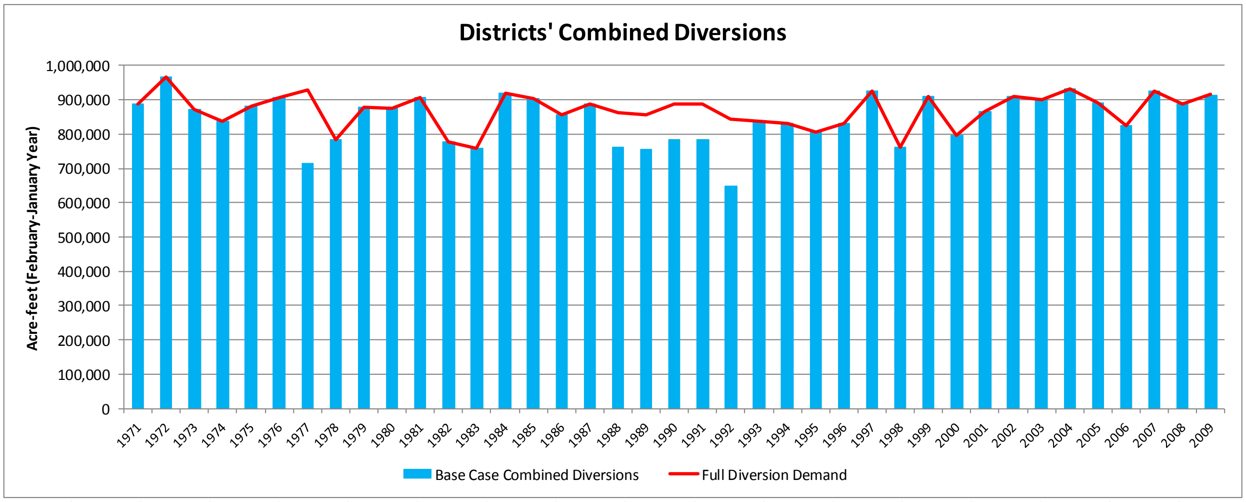


Figure 3.2-1. Districts' combined diversions and demand – Base Case.

3.3 Don Pedro Reservoir

Don Pedro Reservoir storage will fluctuate throughout the year and will result in carryover storage that varies from year to year. Figure 3.3-1 illustrates projected end-of-September storage for the Base Case.

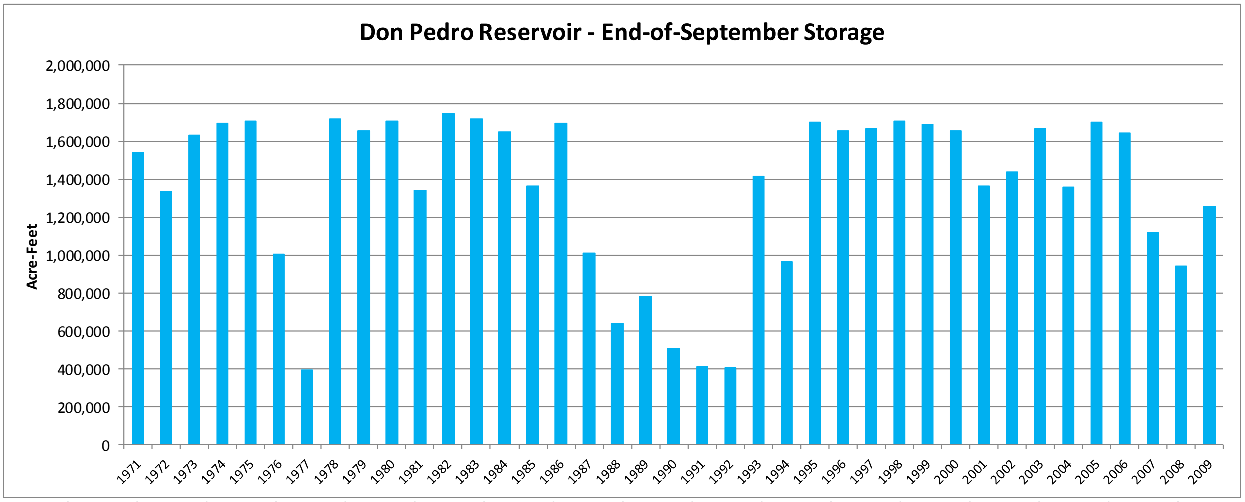
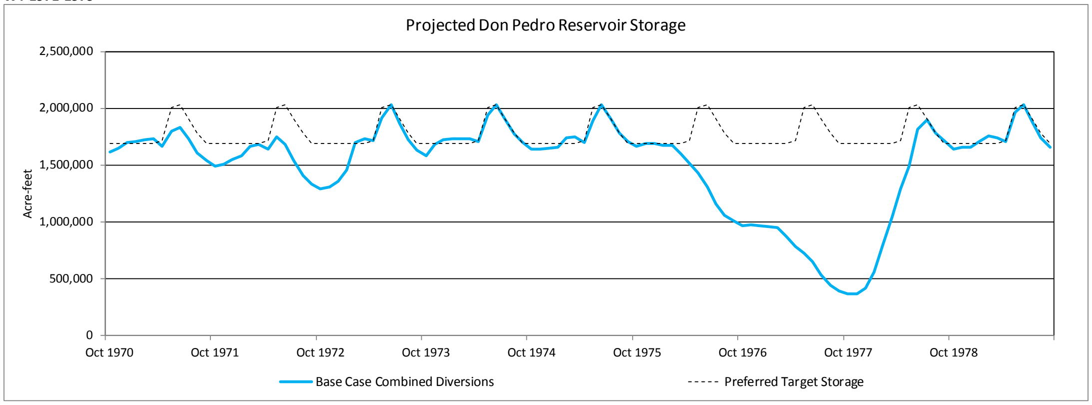


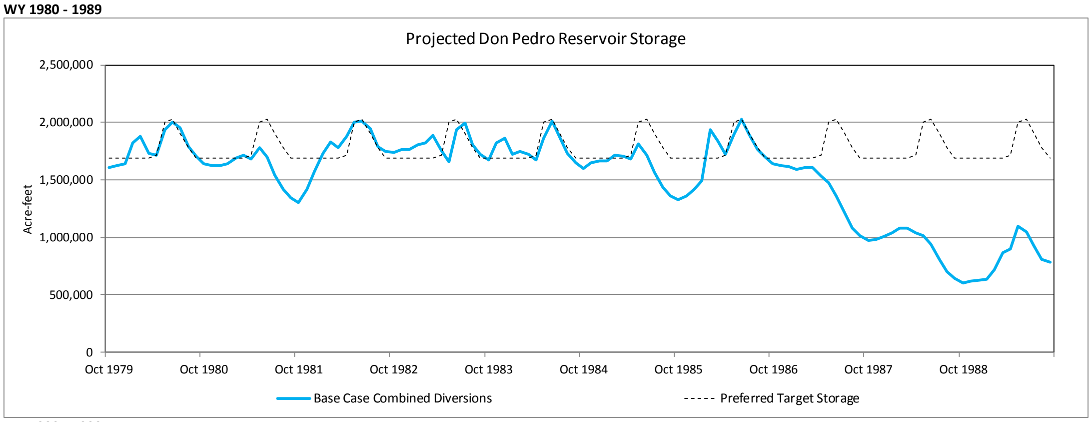
Figure 3.3-1. Don Pedro Reservoir end-of-September storage – Base Case.

The monthly variation of Don Pedro Reservoir storage is cyclic throughout the year in response to inflow, water release demands and preferred storage objectives. Figure 3.3-2 illustrates the projected end-of-month storage of Don Pedro Reservoir of the 39-year simulation period. Severe or prolonged droughts and their effect on storage are noteable during 1976-1977 and 1987-1992.

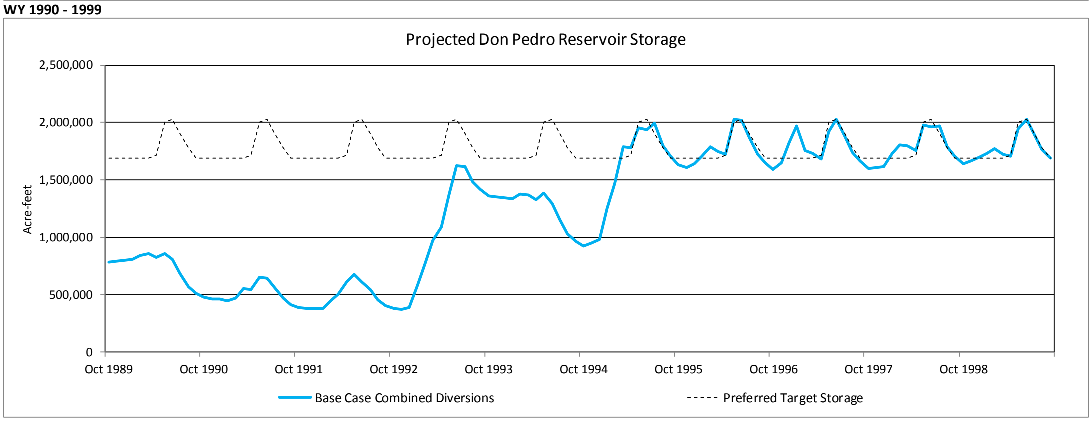
WY 1971-1979



WY 1980 - 1989



WY 1990 - 1999



WY 2000 - 2009

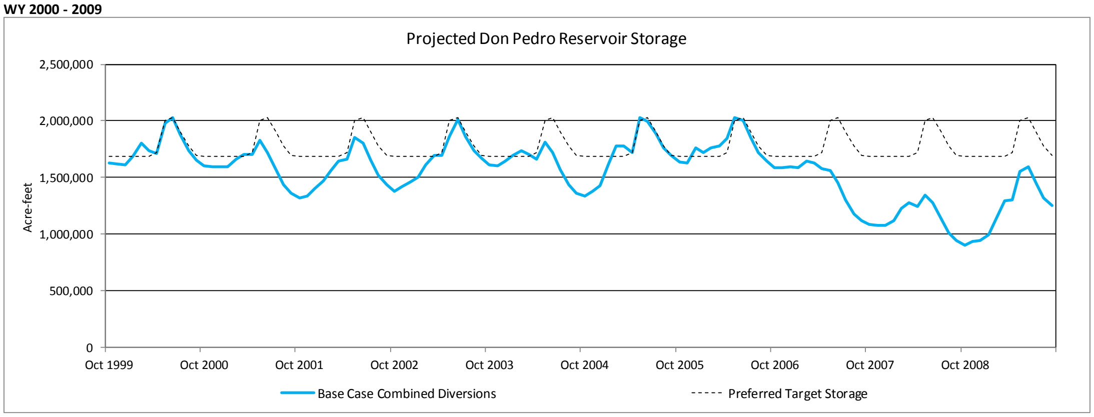


Figure 3.3-2. Don Pedro Reservoir storage – Base Case.

3.4 Don Pedro Project Generation

Hydroelectric generation is incidental to water operations, and will vary from day to day, month to month and year to year as Don Pedro Project reservoir and release operations react to hydrology and water demands. Figure 3.4-1 illustrates the projected annual power generation of the Don Pedro Project for the Base Case. Annual generation is projected to vary from 1,393,900 MWh to 197,500 MWh, with an average of 607,000 MWh.

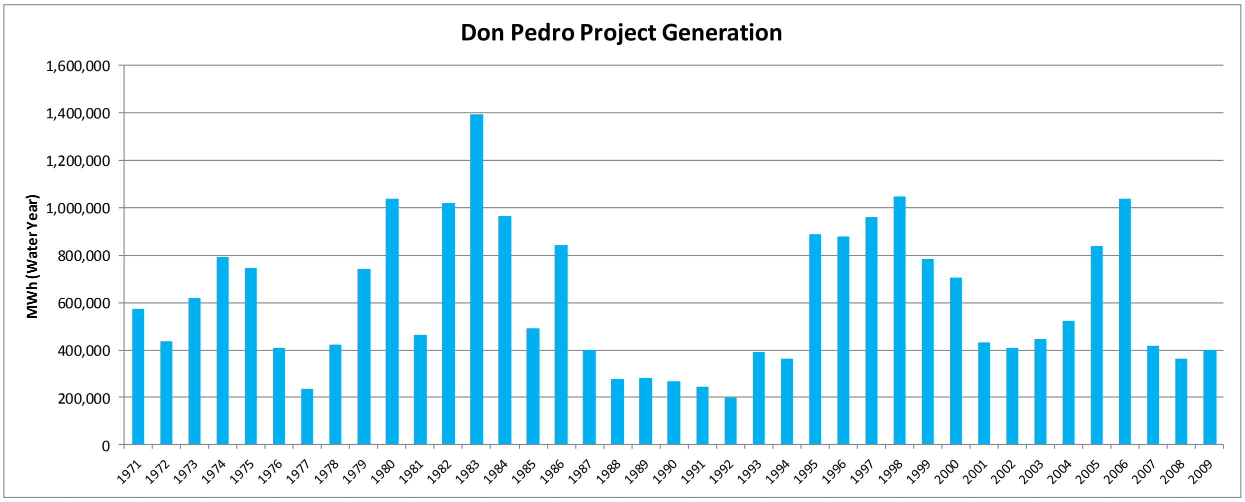


Figure 3.4-2. Don Pedro Project generation – Base Case.

Seasonal Don Pedro Project generation is illustrated in Table 3.4-1 which provides average generation by month within a ranking of all years according to the preliminary year type classification.

Table 3.4-1. Don Pedro Project generation (MWh) – Base Case.

Prelim Year Type		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	1	23,510	13,142	22,421	50,518	80,511	122,925	123,739	129,550	128,771	121,263	88,723	42,293	947,367
AN	2	25,294	15,271	29,800	38,956	69,357	101,667	101,180	85,371	103,097	84,287	65,379	37,104	756,762
N	3	22,292	5,933	5,711	12,638	31,376	67,364	86,974	74,381	75,932	76,468	62,650	33,241	554,960
BN	4	18,144	6,427	4,812	6,869	13,551	37,260	55,858	60,801	52,053	62,810	51,153	24,200	393,939
D	5	22,587	7,767	6,195	8,298	9,379	33,428	49,786	51,231	52,237	61,674	49,999	23,948	376,530
C	6	17,735	7,136	5,405	6,885	8,129	26,344	37,790	45,604	41,573	49,402	38,154	18,276	302,435
All		21,768	9,649	13,551	24,182	41,382	72,745	82,882	81,716	82,538	81,718	63,254	31,662	607,047

3.5 CCSF Tuolumne River Storage and Water Supply

The Base Case CCSF water supply of the Tuolumne River can be expressed by the amount of diversions from the basin through the San Joaquin Pipeline (illustrated in Section 2 above), water in CCSF Tuolumne River reservoirs and the credit balance of the CCSF Don Pedro Water Bank Account. Annual CCSF water delivery decisions are guided by the projection of total CCSF system storage for July 1 of a year. Included in the metric is CCSF Tuolumne River reservoir storage and Water Bank Account balance. Figure 3.5-1 illustrates the projected July 1 metric of CCSF Tuolumne River reservoir storage and Water Bank Account balance.

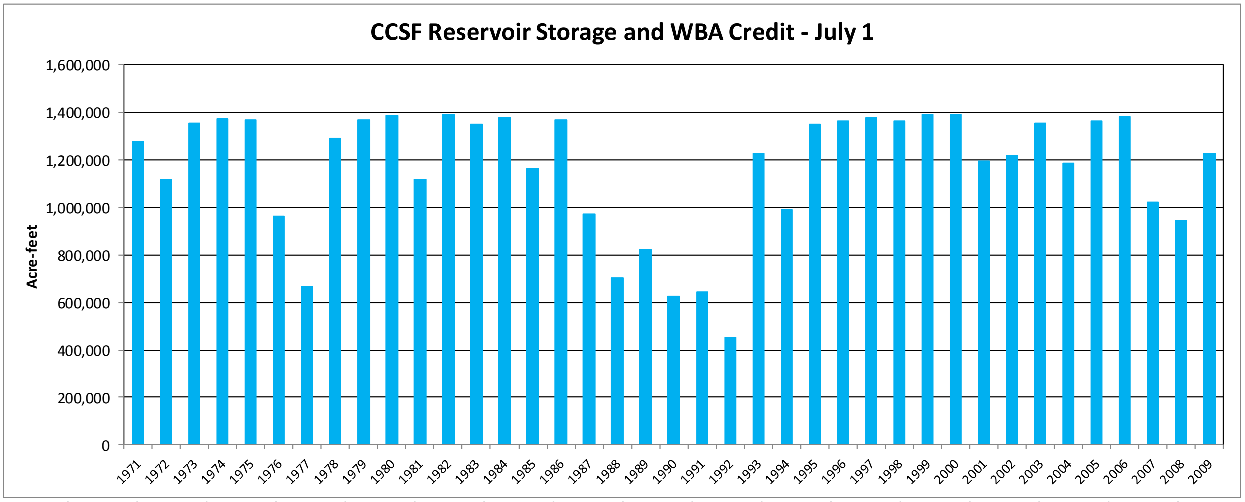


Figure 3.5-1. CCSF Tuolumne River storage and Water Bank Account credit – Base Case.

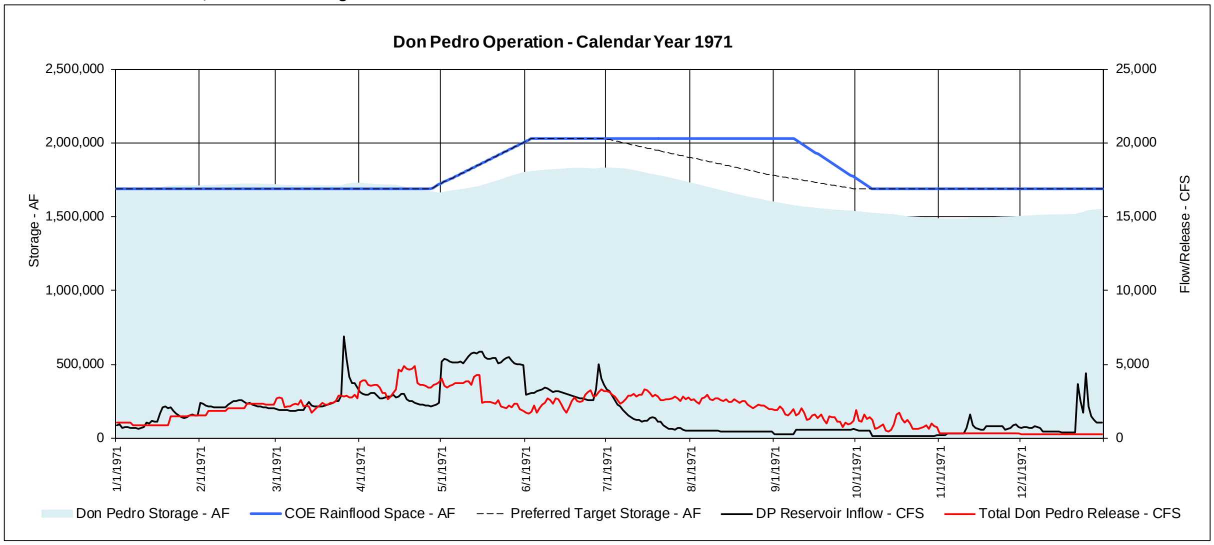
4.0 ANNUAL DON PEDRO PROJECT OPERATIONS

Annual hydrographs for the projected operation of Don Pedro Reservoir and the lower Tuolumne River for the Base Case follow. Three hydrographs are presented for each year of the 39-year simulation. The upper hydrograph illustrates the simulated daily storage of Don Pedro Reservoir (light blue area graph) for an entire calendar year. Plotted for reference is the modeled reservoir target storage during the year (solid blue and black dashed lines). These two components are plotted to the left axis scale (acre-feet), and are also shown in the other two hydrographs. Also illustrated in the upper hydrograph are the inflow to Don Pedro Reservoir (solid black line) and total Don Pedro release (solid red line). Flow values are plotted to the right axis scale (CFS).

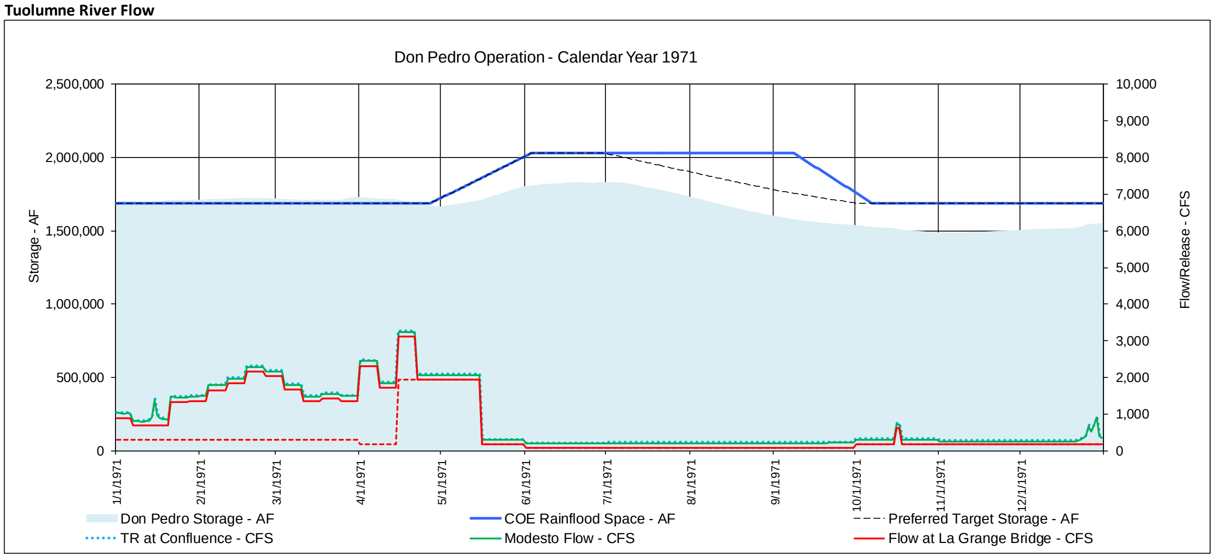
The middle hydrograph illustrates the simulated daily flows at three locations in the lower Tuolumne River: (1) flow at the La Grange Bridge gage (solid red line), (2) flow at the Modesto gage (solid green line), and (3) flow at the Tuolumne River confluence with the San Joaquin River (dotted light blue line). Flow projected to occur at the La Grange Bridge gage is the result of flow being released from Don Pedro Reservoir and depletion by diversions to the Districts' canals. Flow projected to occur at the Modesto gage is the result of adding those flows to lower Tuolumne River accretions occurring above the Modesto gage location and flows from Dry Creek. The accretions and Dry Creek flow data sets are synthesized, and are described in the ISR, January 2013. Flows projected for the Tuolumne River confluence are the sum of flows occurring at the Modesto gage plus an estimated accretion between the Modesto gage and the confluence. This accretion is estimated to be a constant 32 cfs. Also shown in the hydrograph is the Base Case Tuolumne River -daily flow requirement, modeled at the La Grange Bridge gage location.

The lower hydrograph illustrates the simulated daily diversions of the Districts to their respective canals. The projected Modesto Irrigation District diversion is shown by the solid red line and the projected Turlock Irrigation District diversion is shown by the solid blue line.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

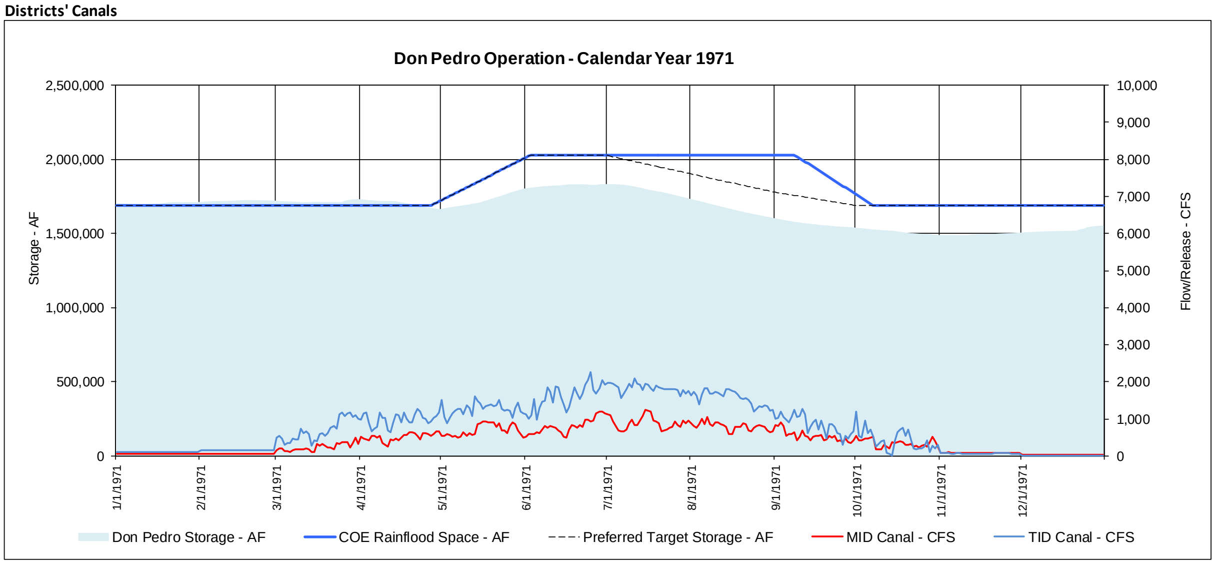


Figure 4-1. Don Pedro operations 1971 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage

Tuolumne River Flow

Districts' Canals

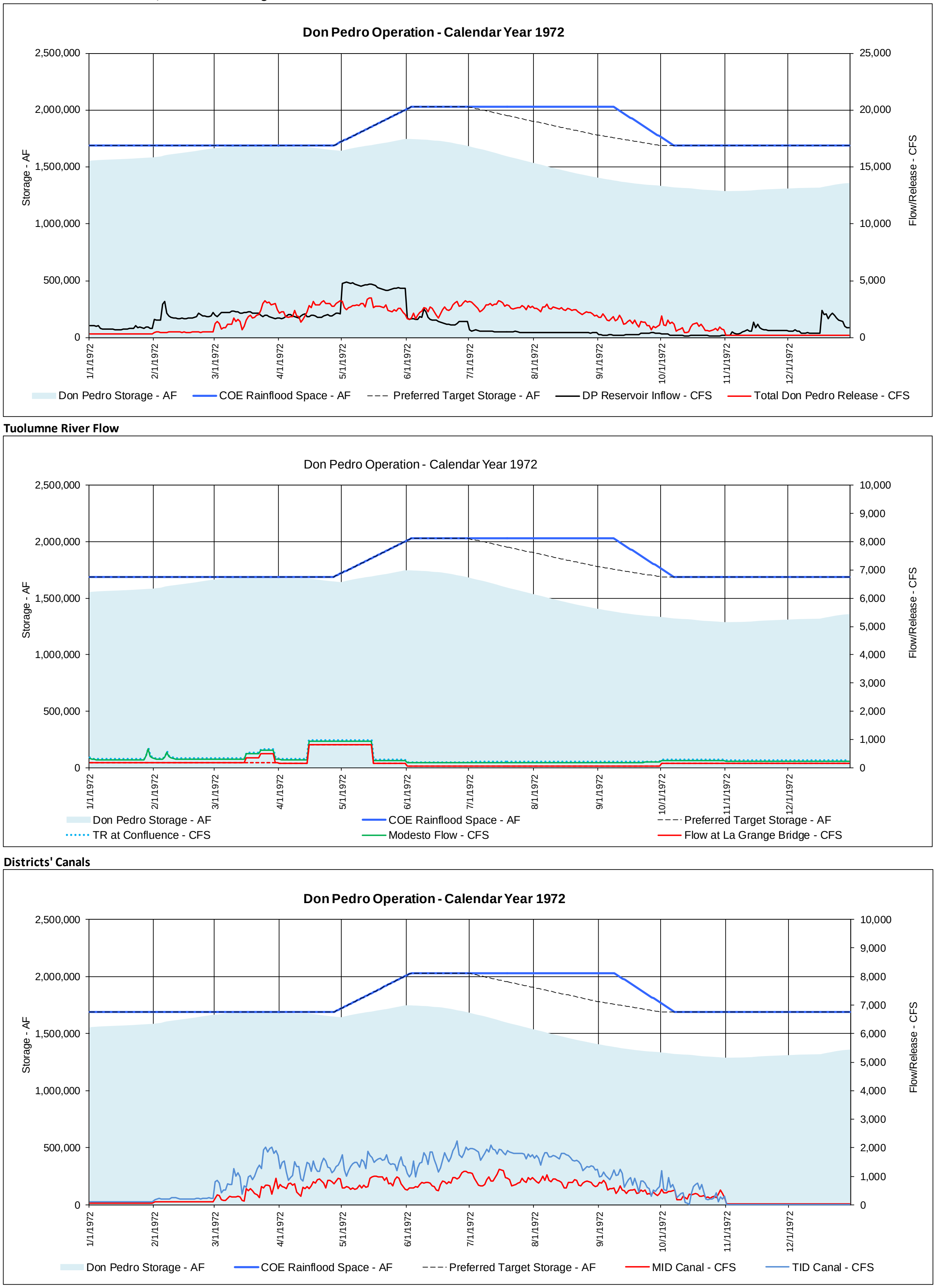
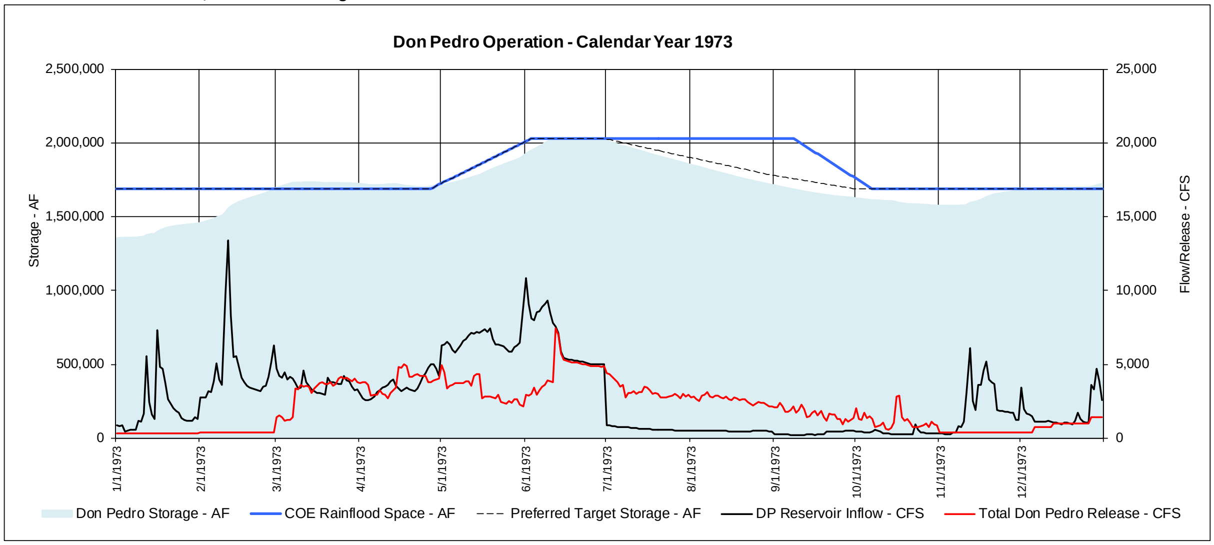
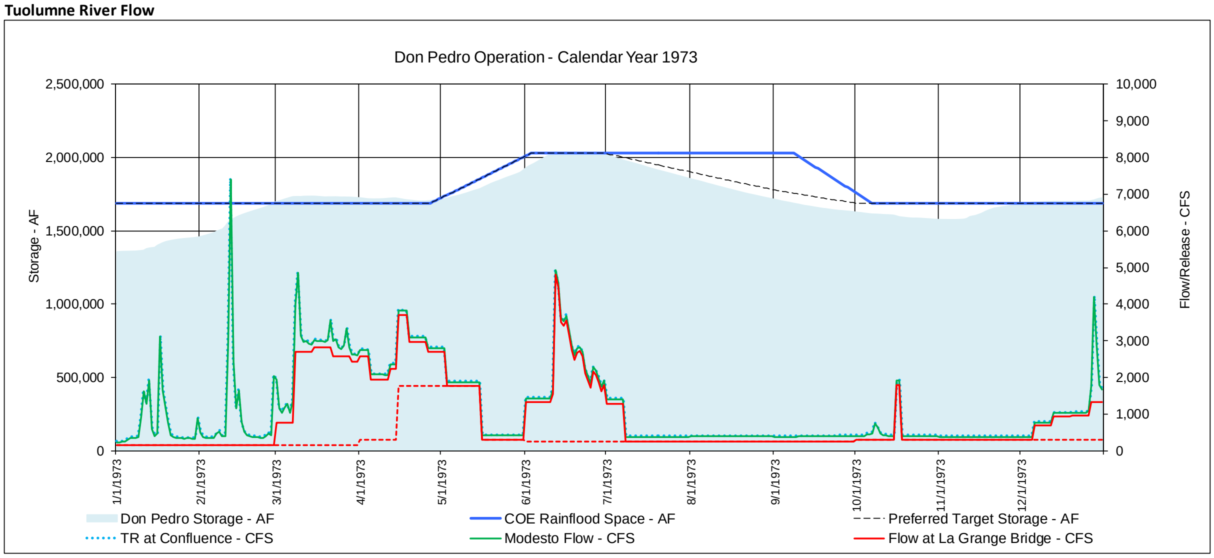


Figure 4-2. Don Pedro operations 1972 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

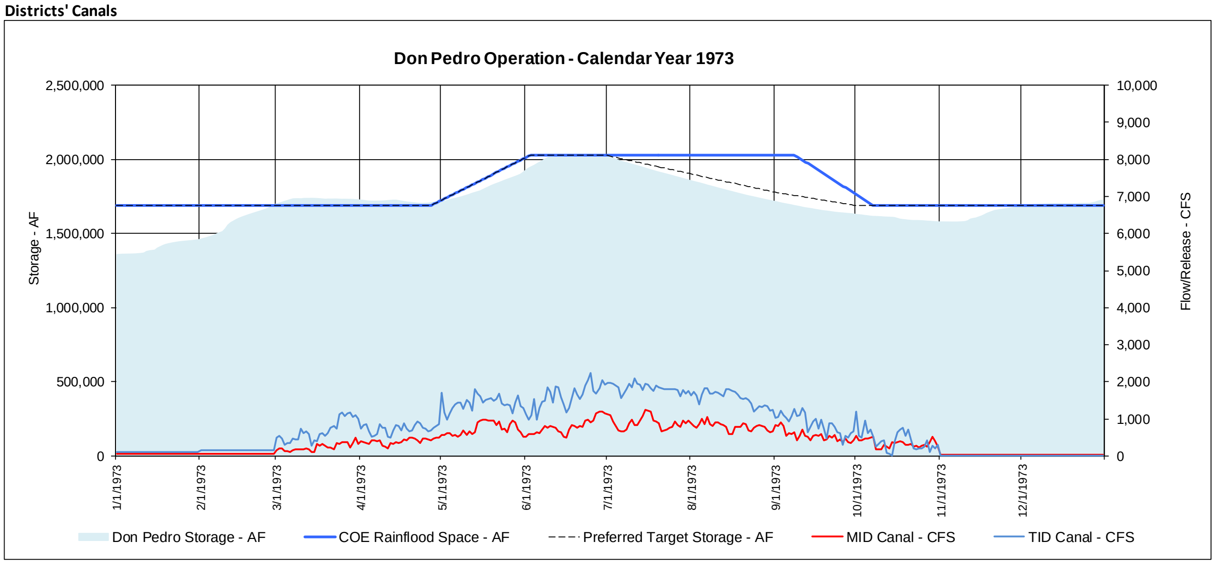
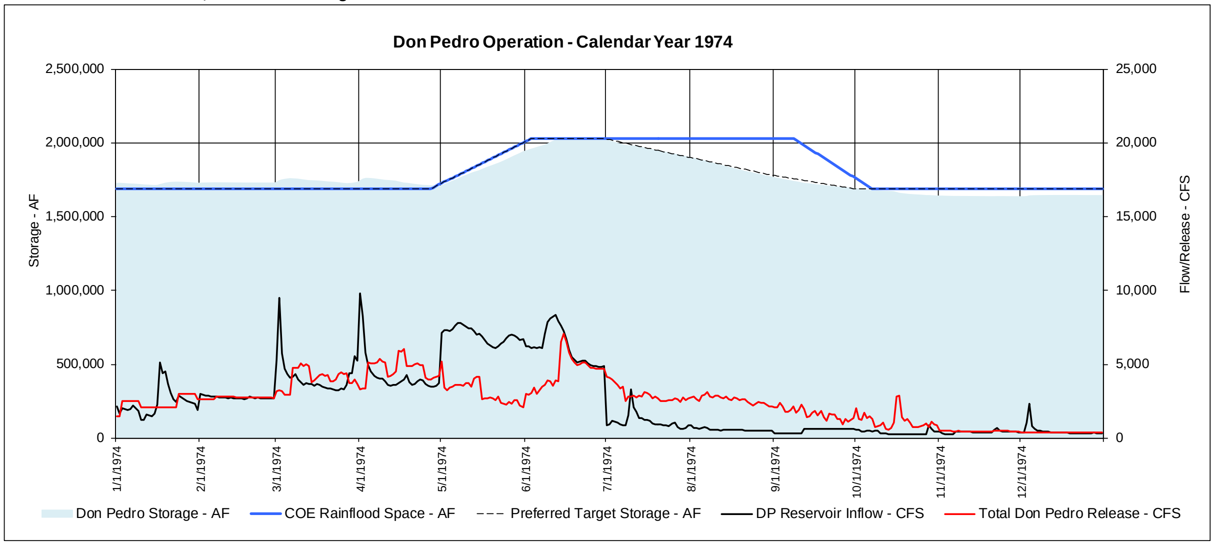
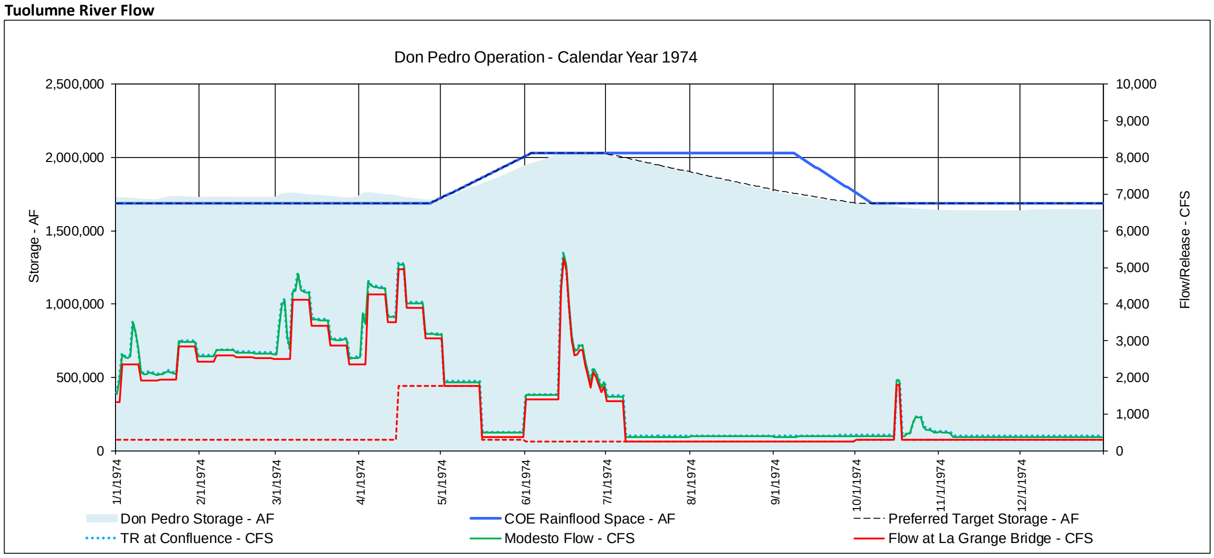


Figure 4-3. Don Pedro operations 1973 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

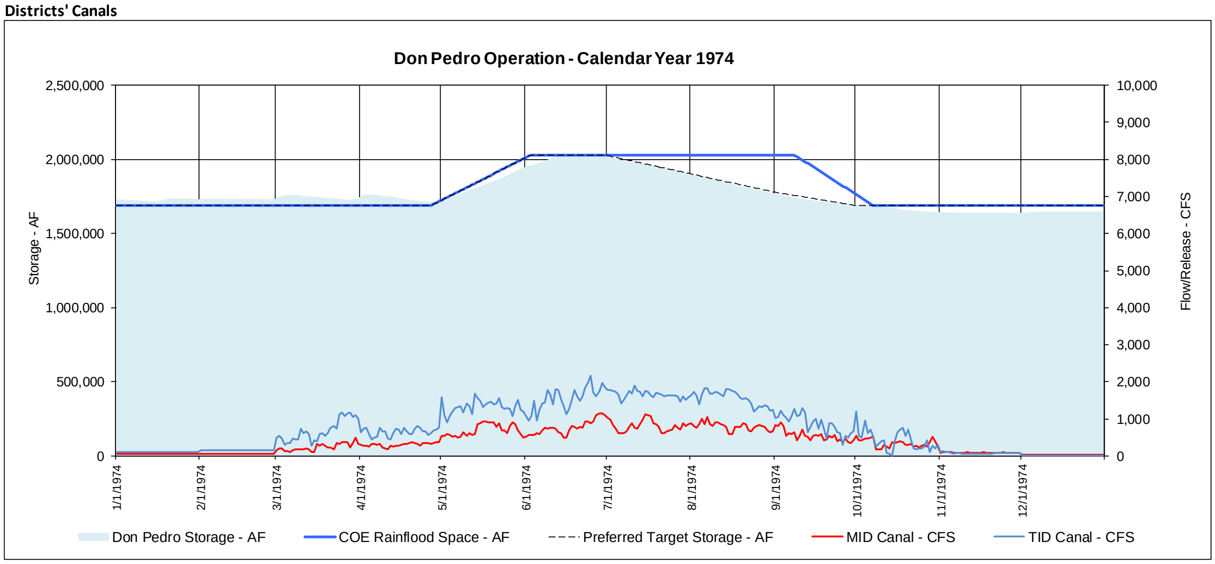
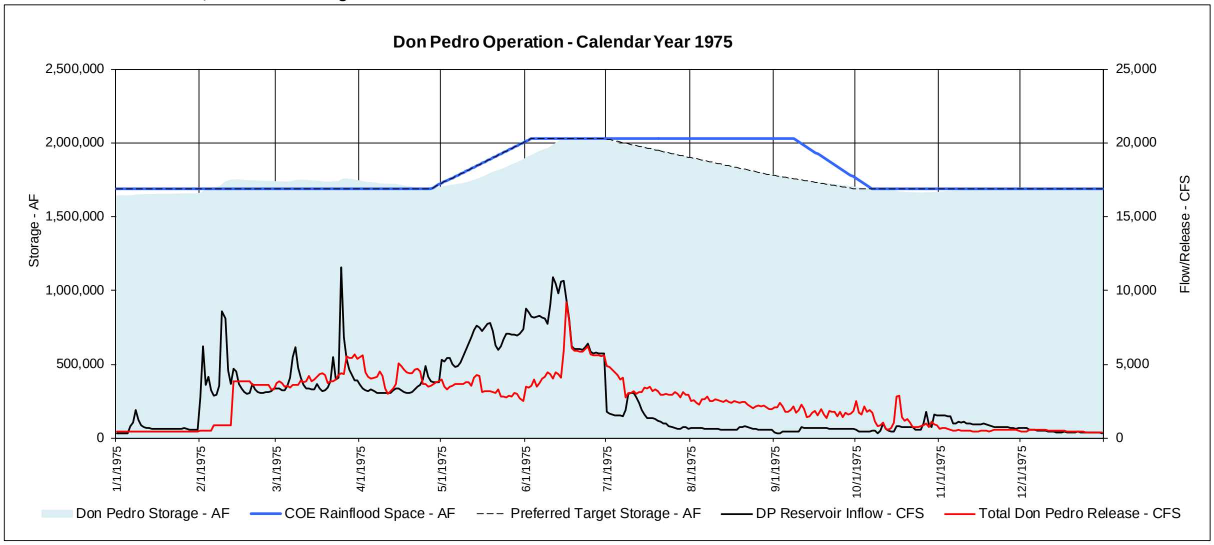
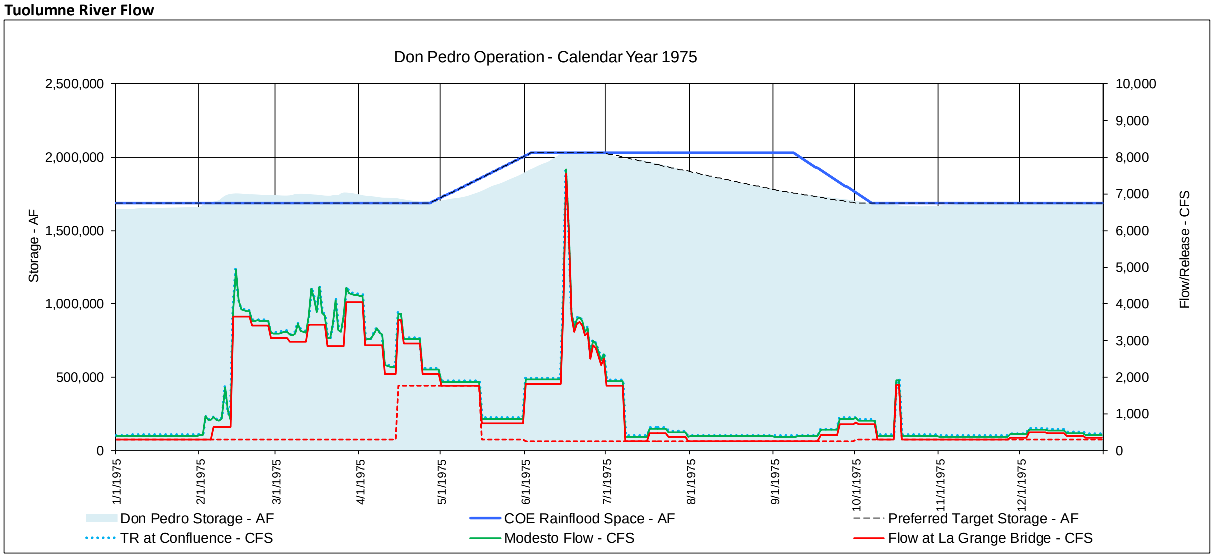


Figure 4-4. Don Pedro operations 1974 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

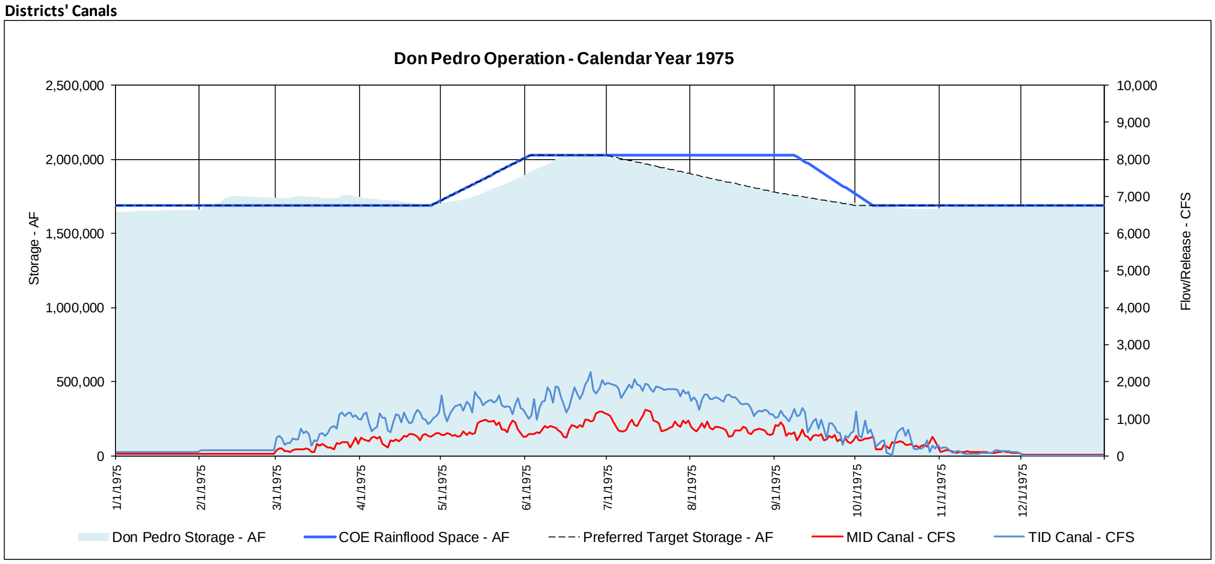
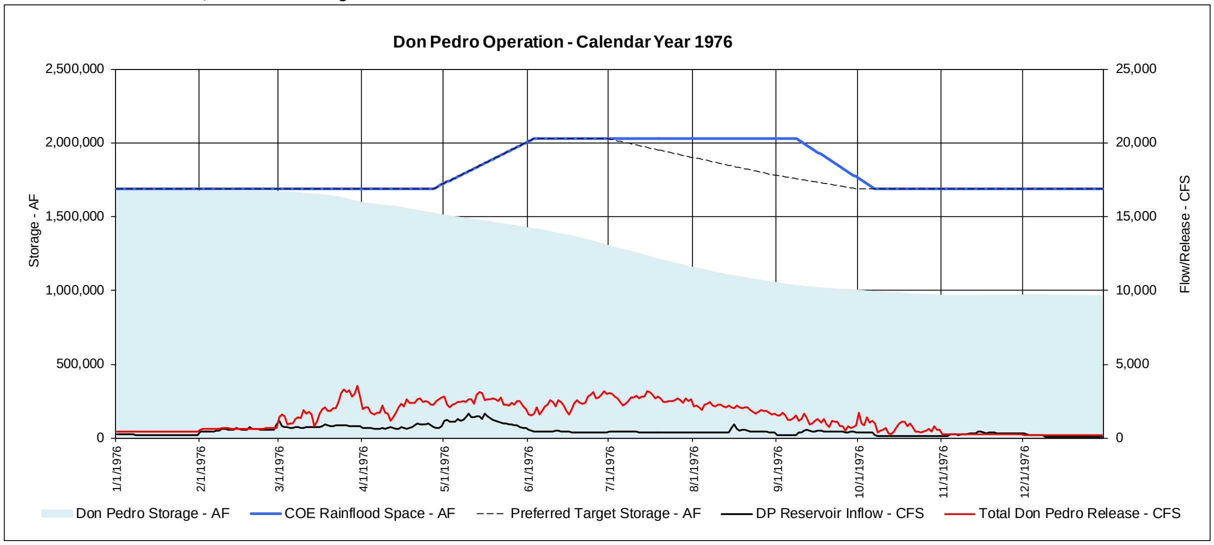
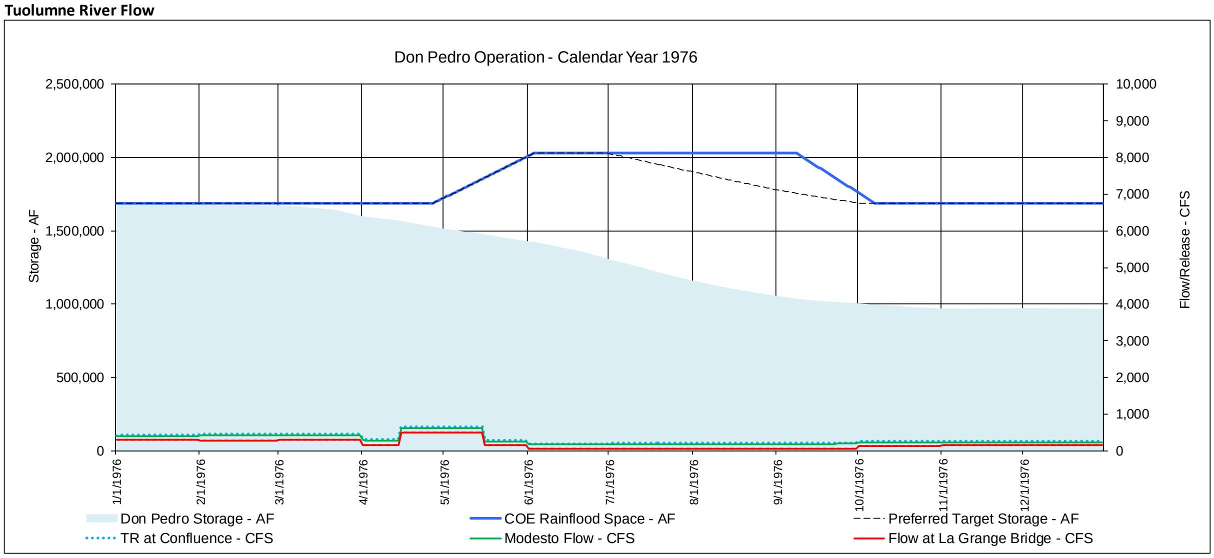


Figure 4-5. Don Pedro operations 1975 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

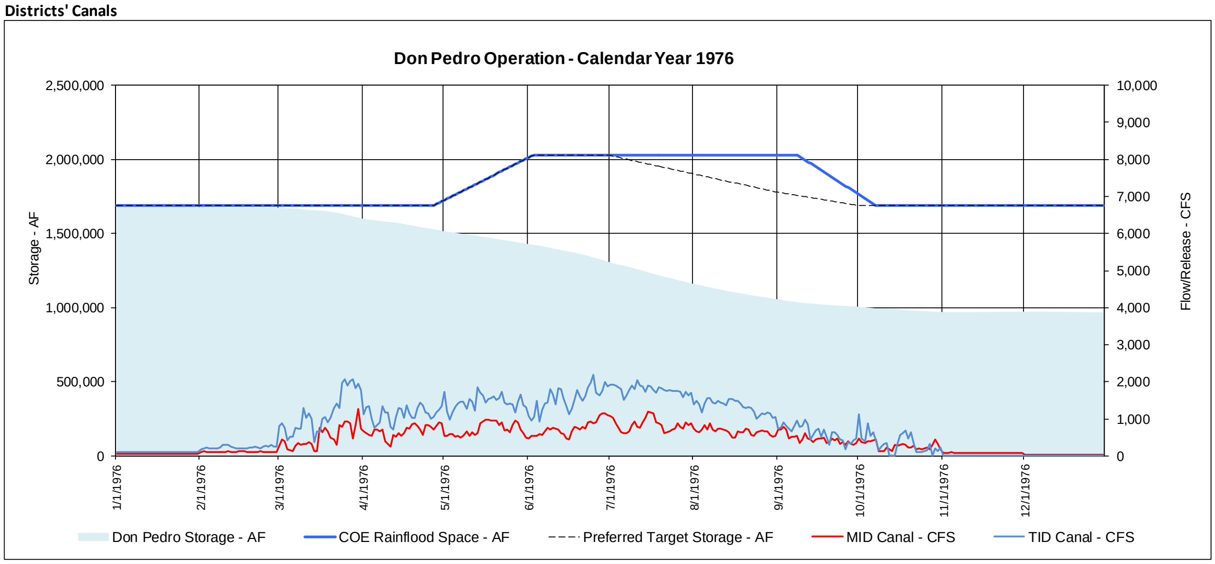
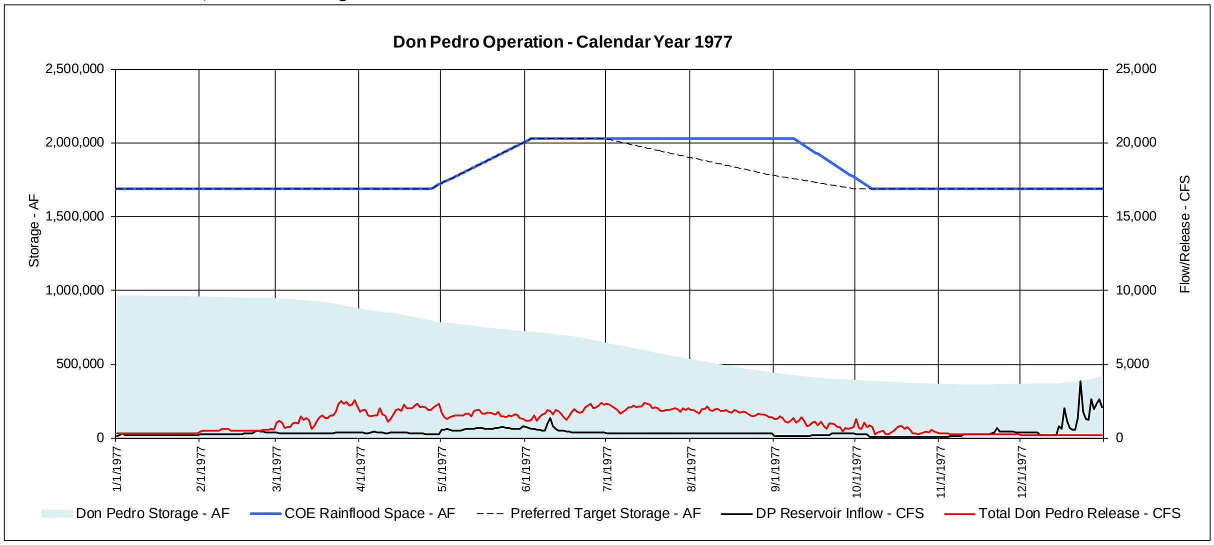
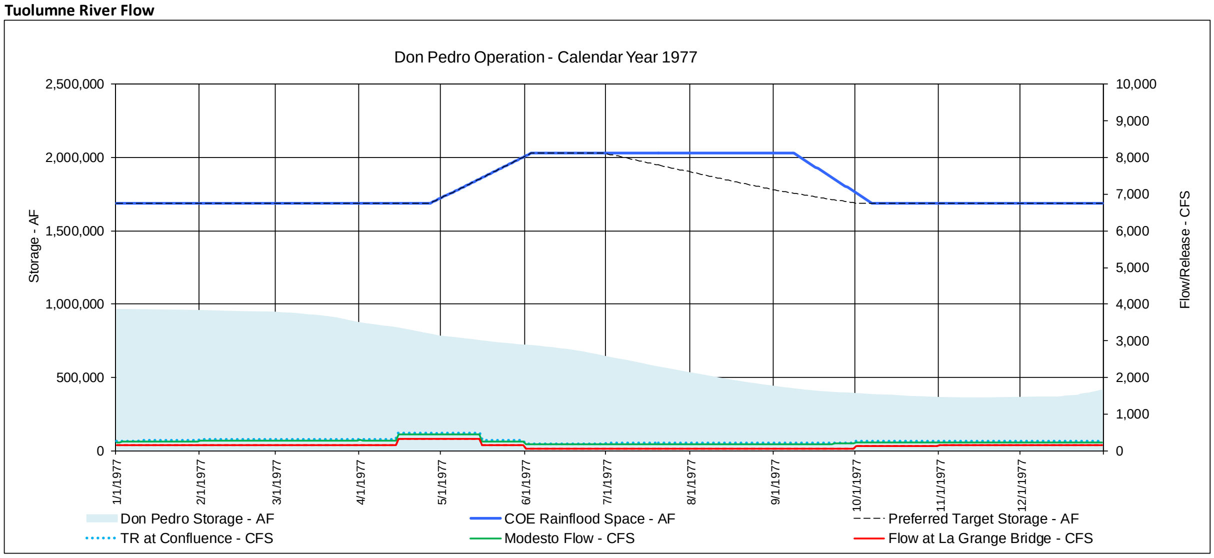


Figure 4-6. Don Pedro operations 1976 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

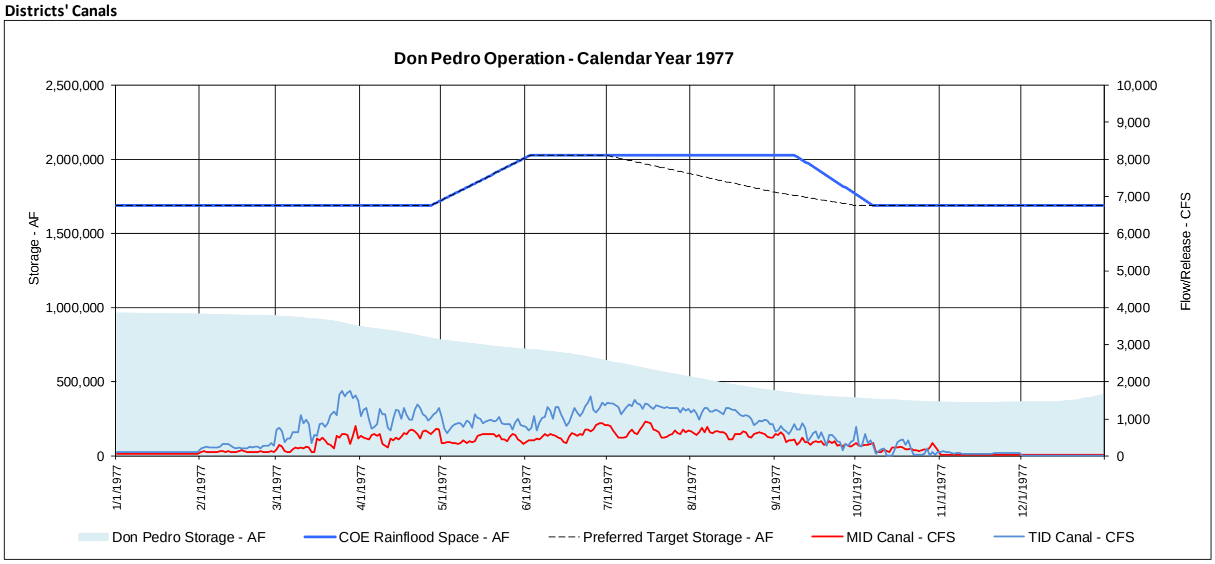
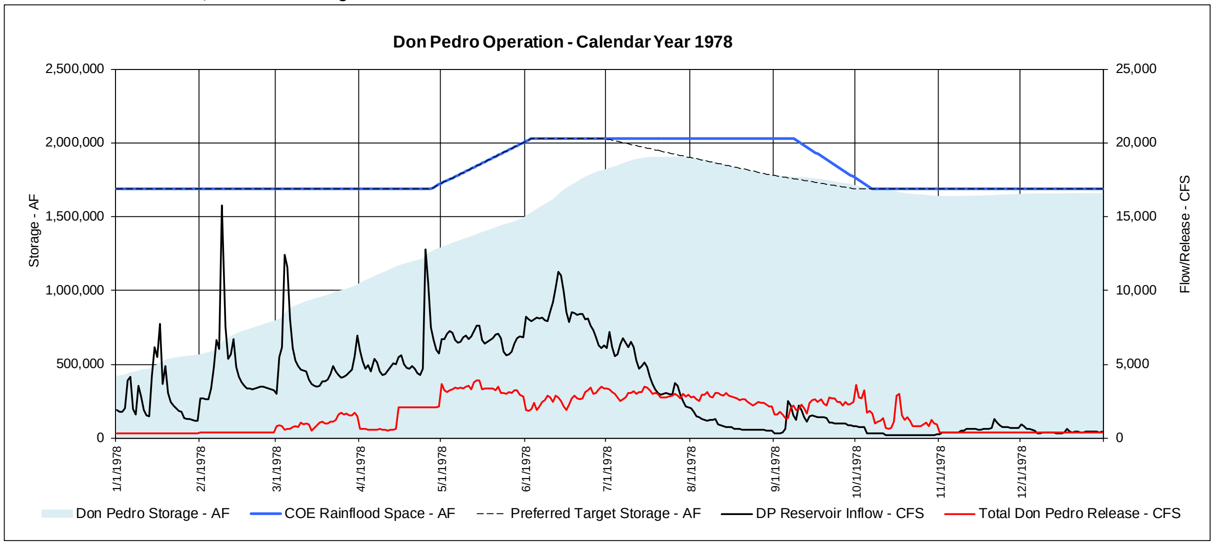
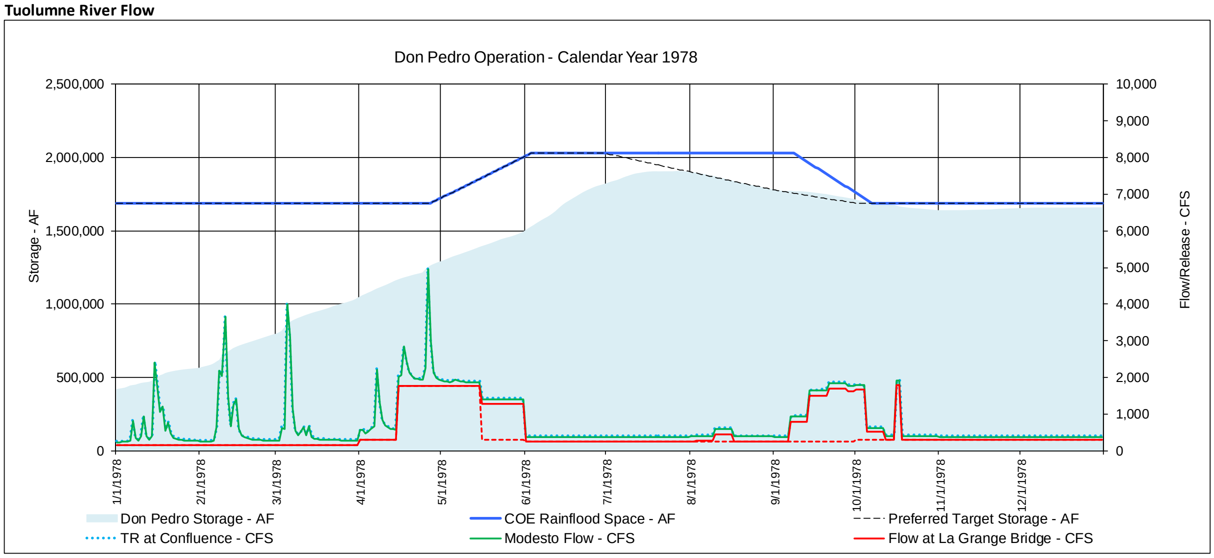


Figure 4-7. Don Pedro operations 1977 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

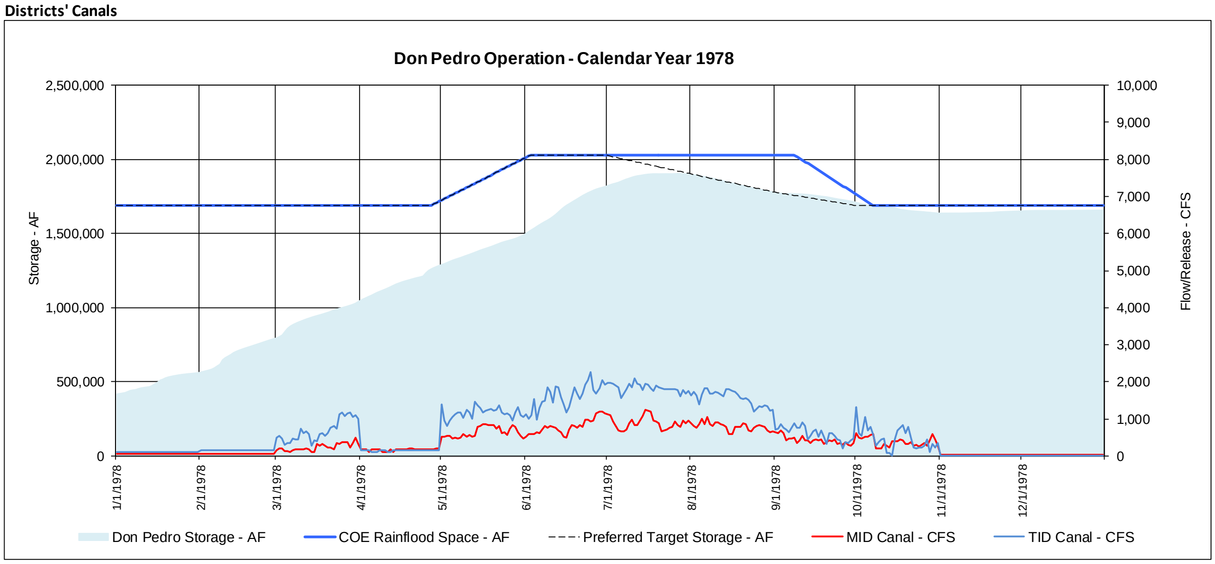
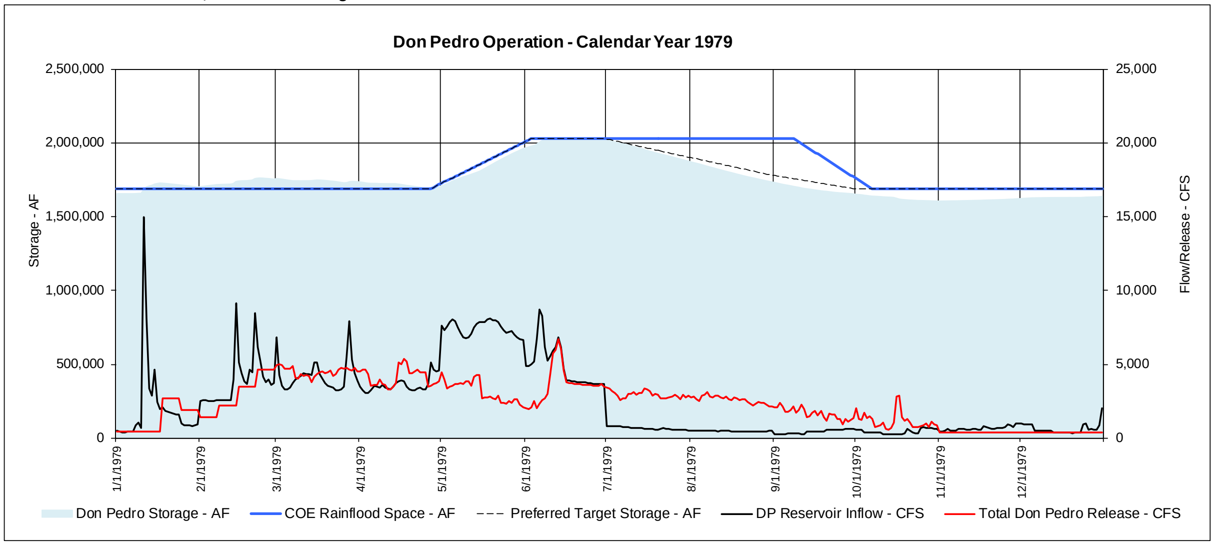
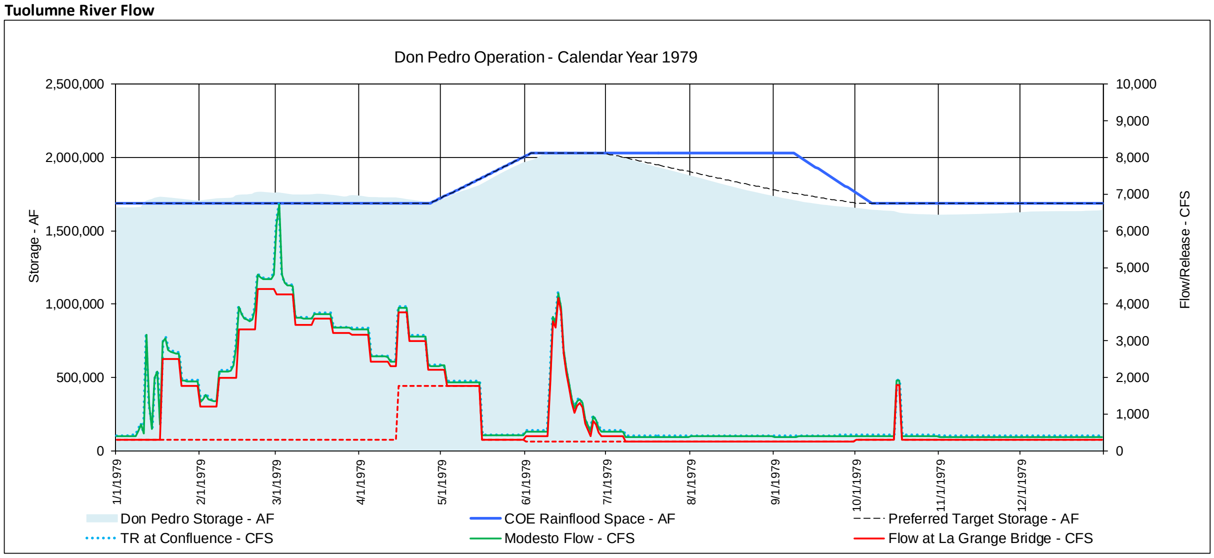


Figure 4-8. Don Pedro operations 1978 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

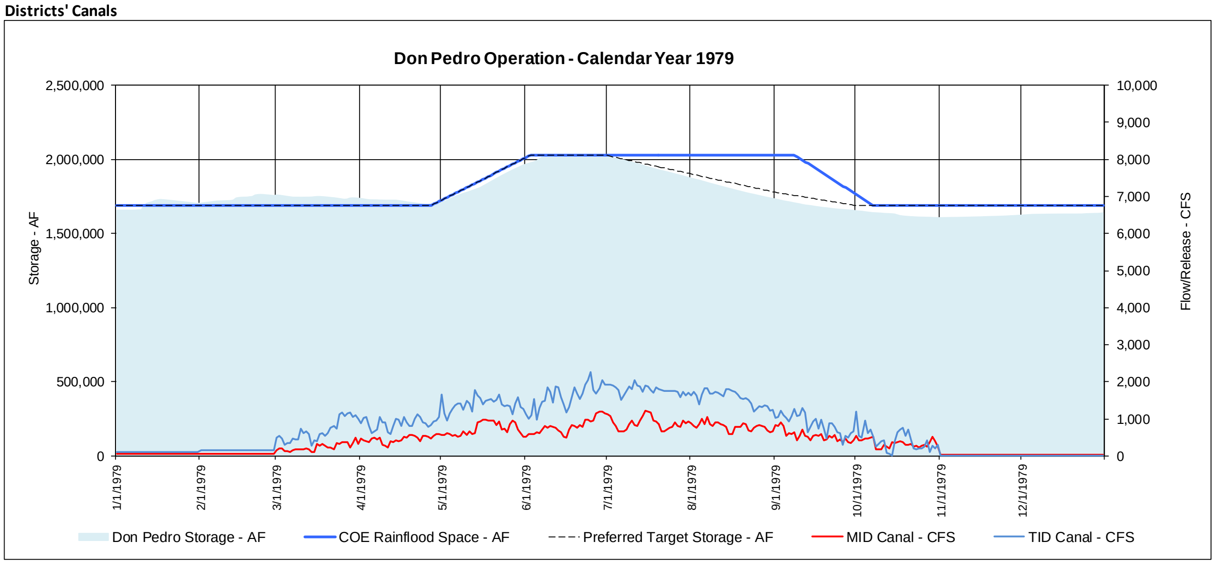
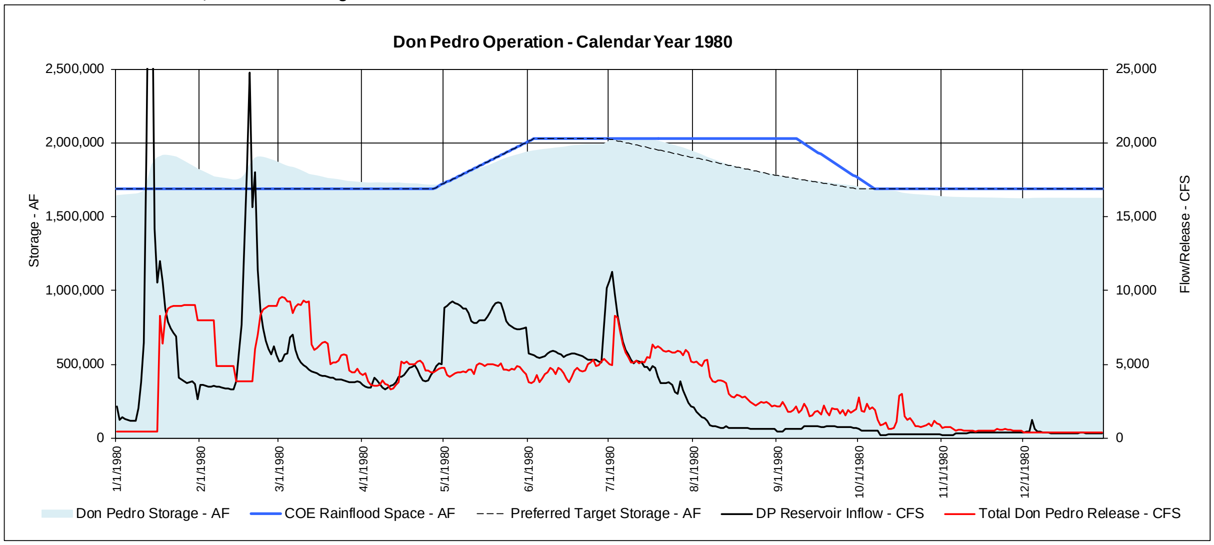
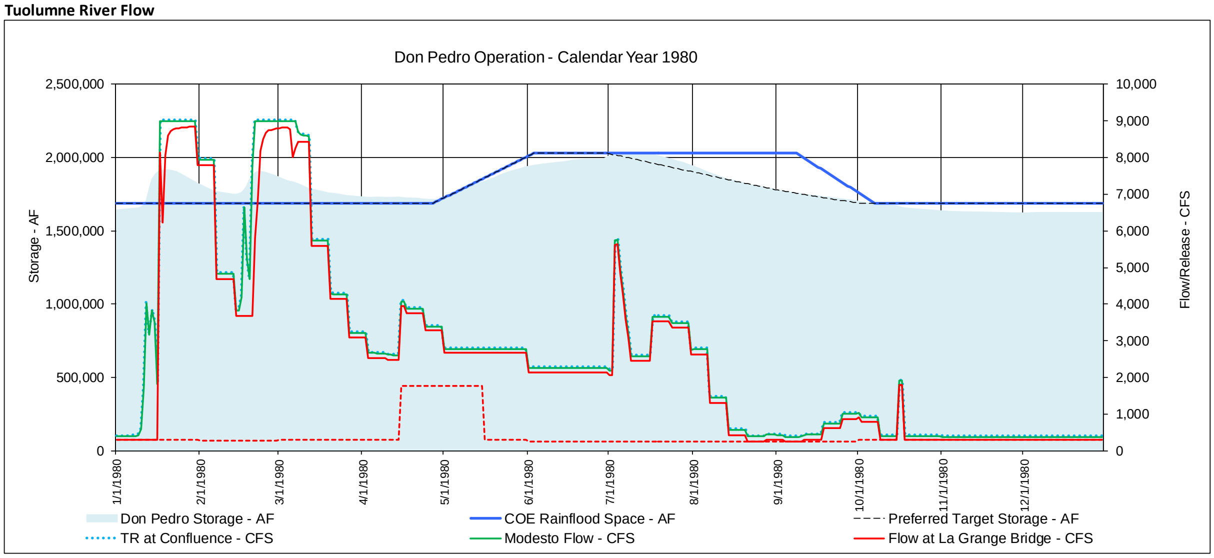


Figure 4-9. Don Pedro operations 1979 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

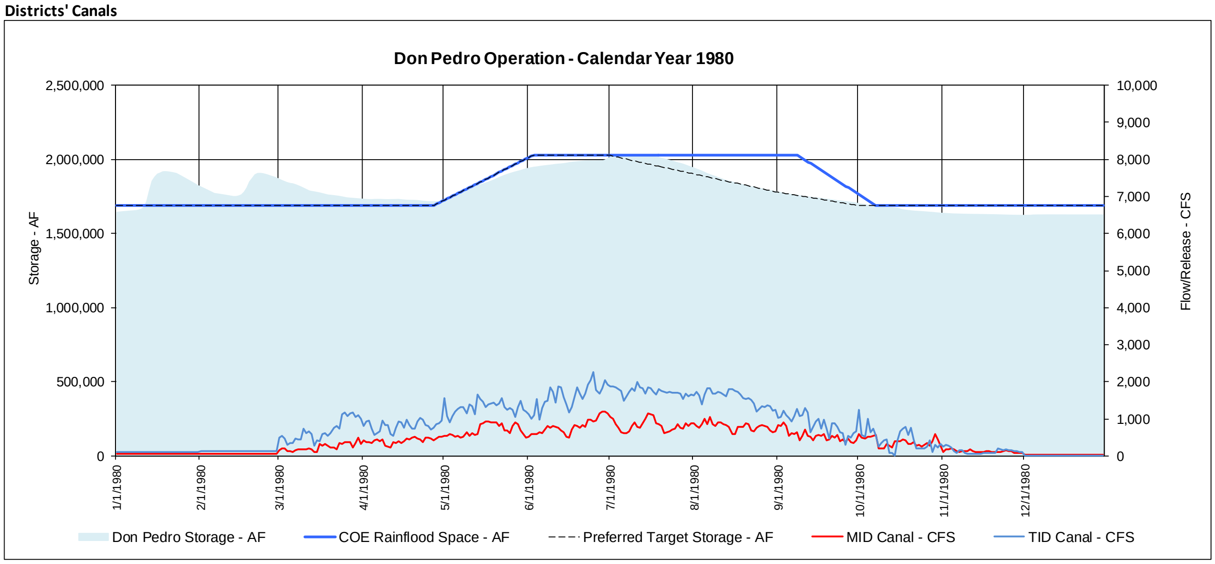
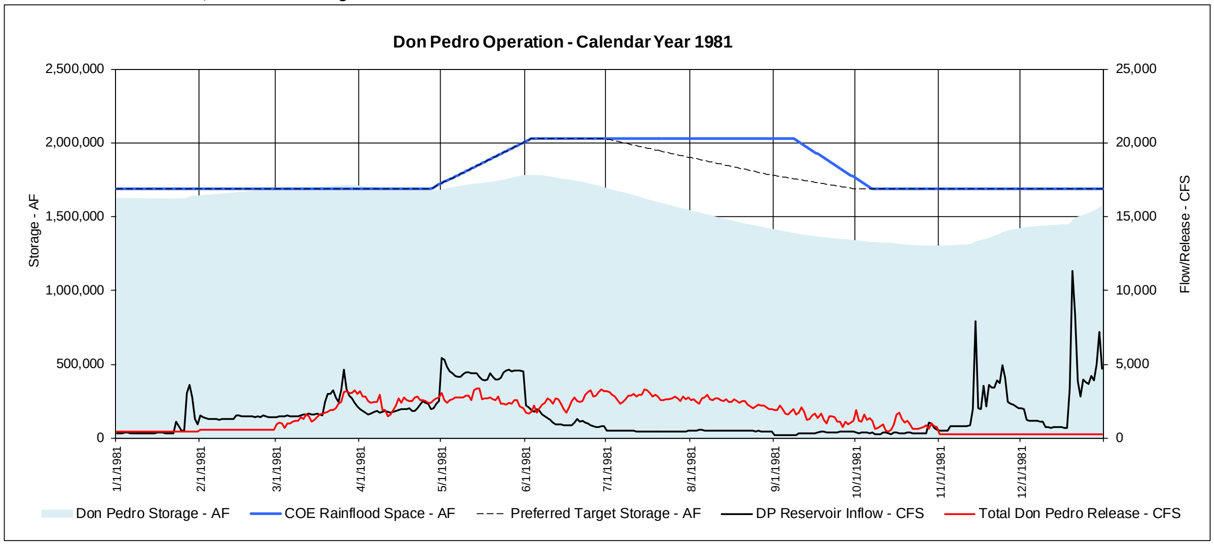
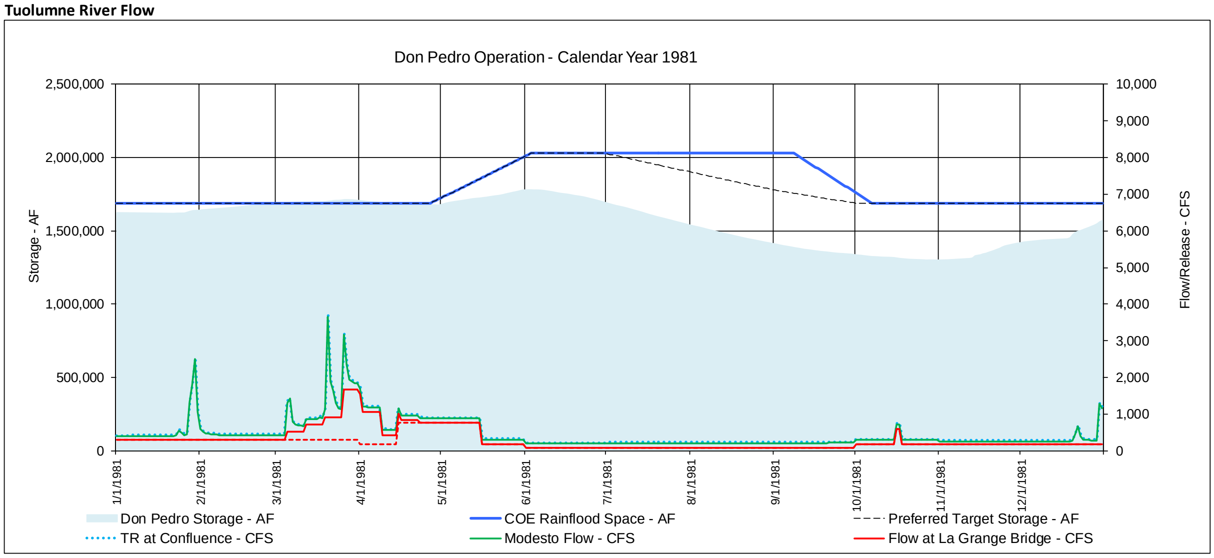


Figure 4-10. Don Pedro operations 1980 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

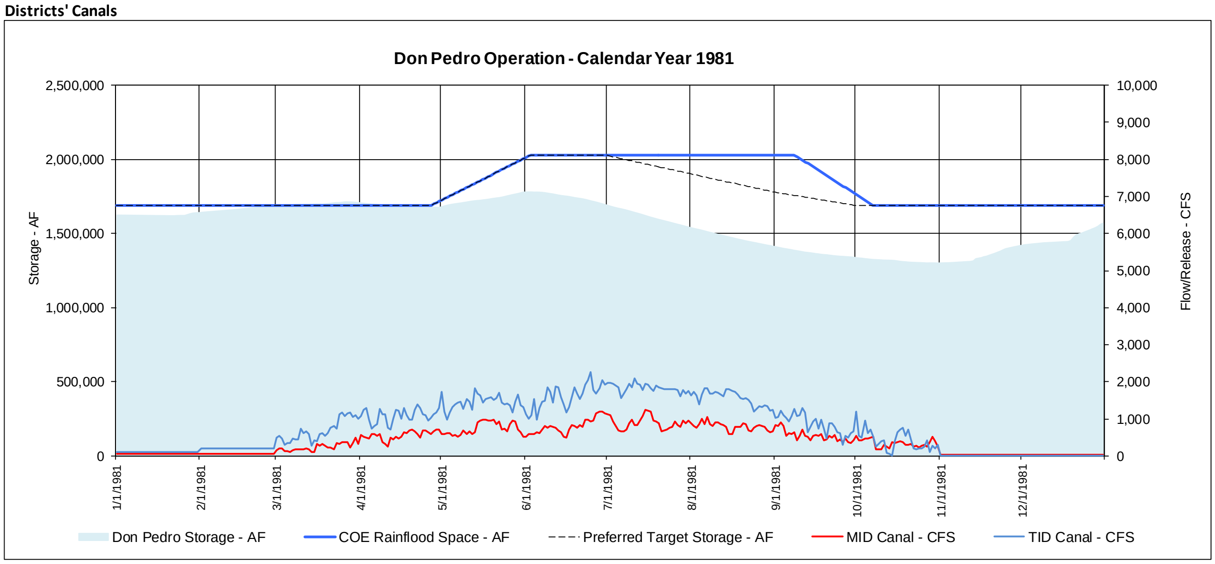
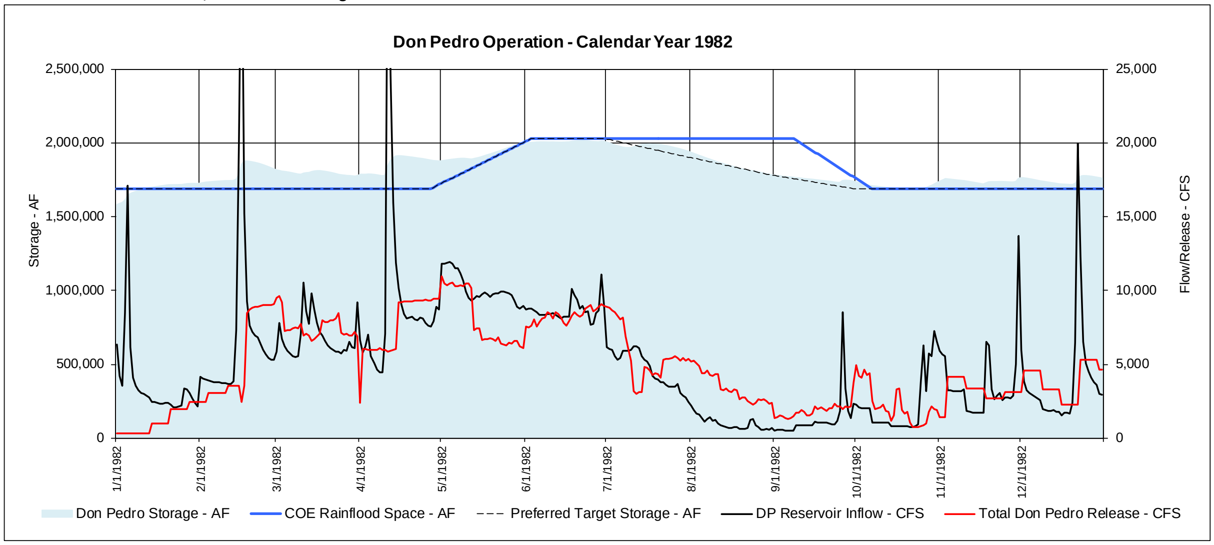
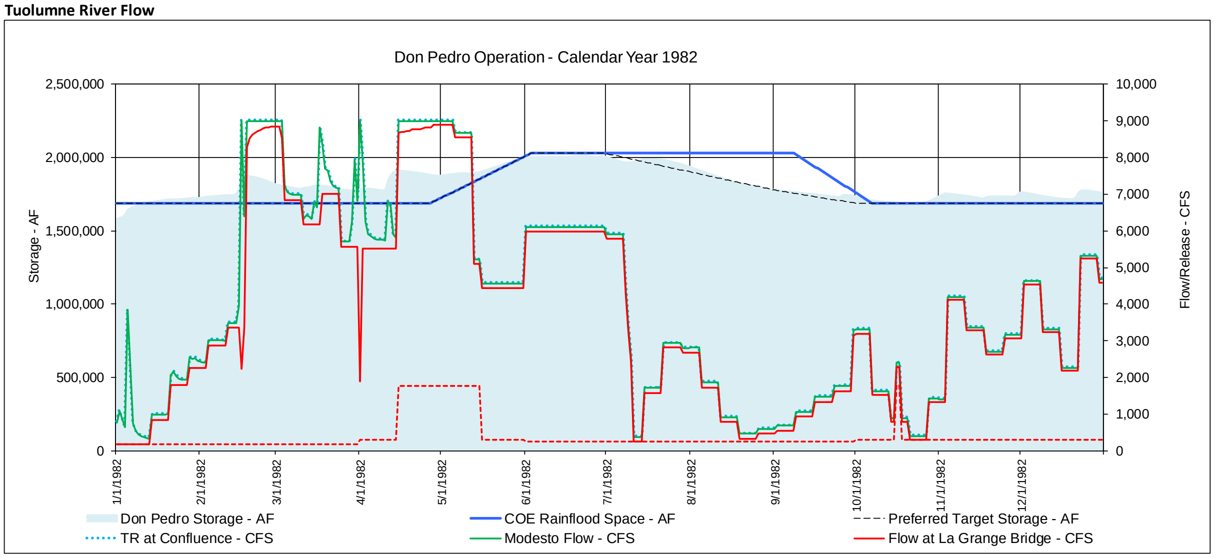


Figure 4-11. Don Pedro operations 1981 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

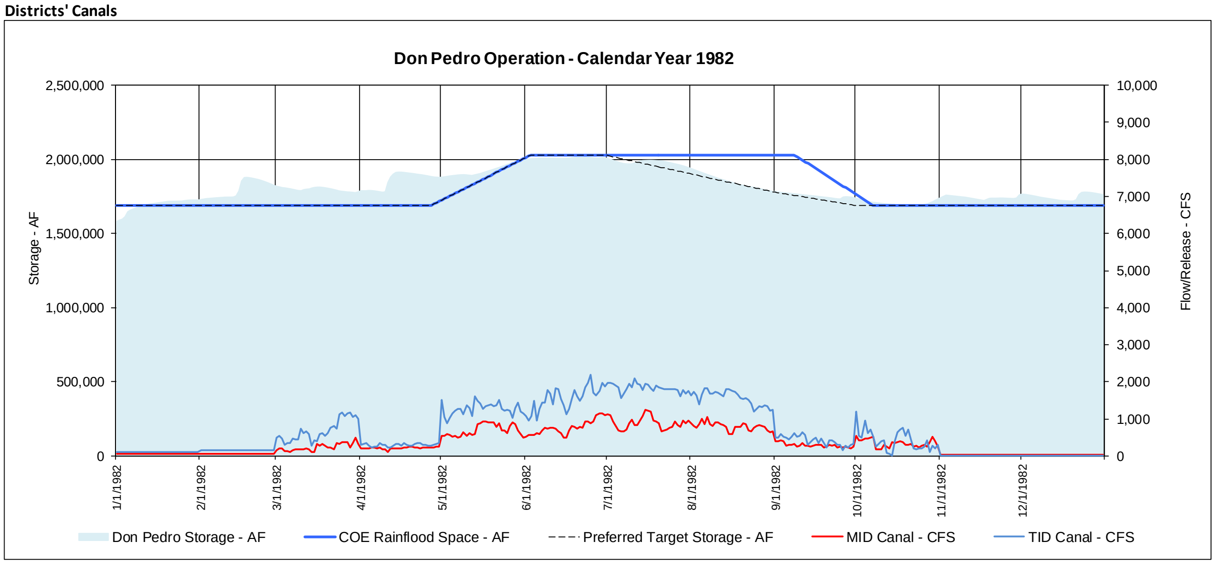
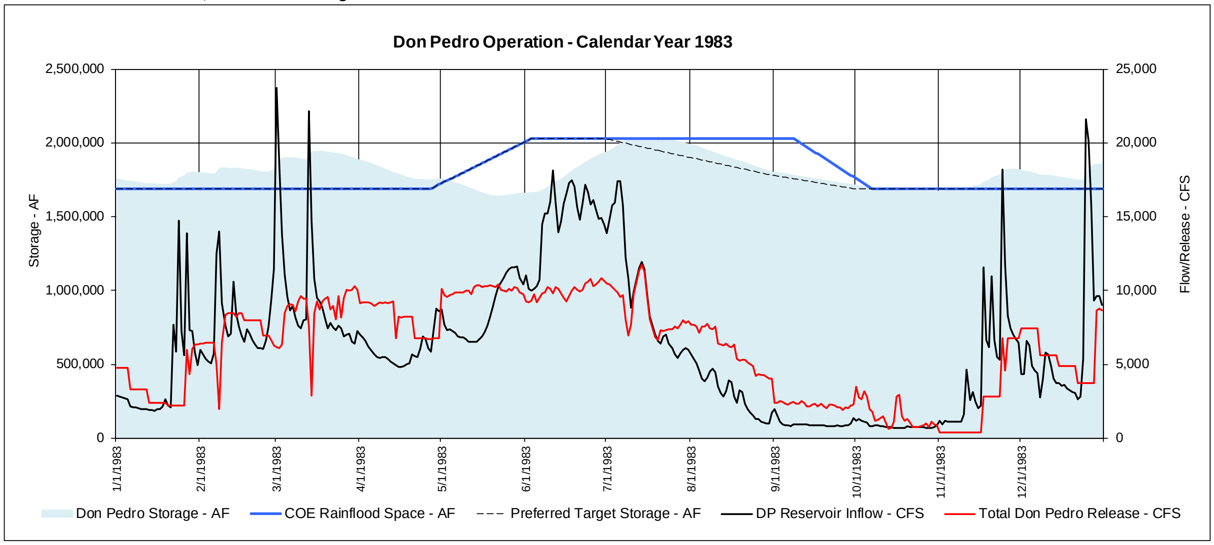
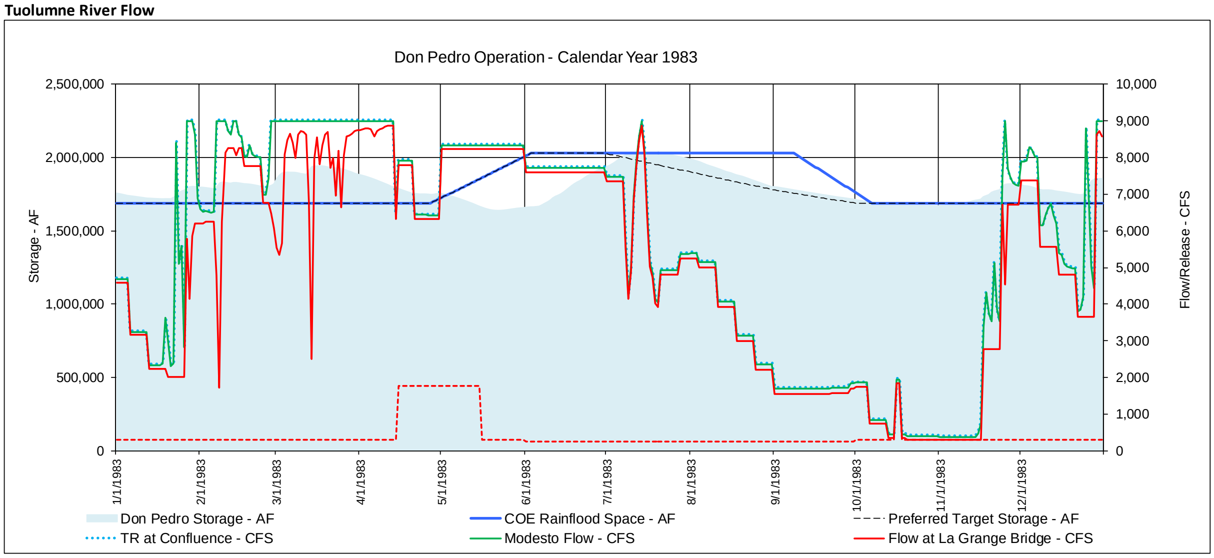


Figure 4-12. Don Pedro operations 1982 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

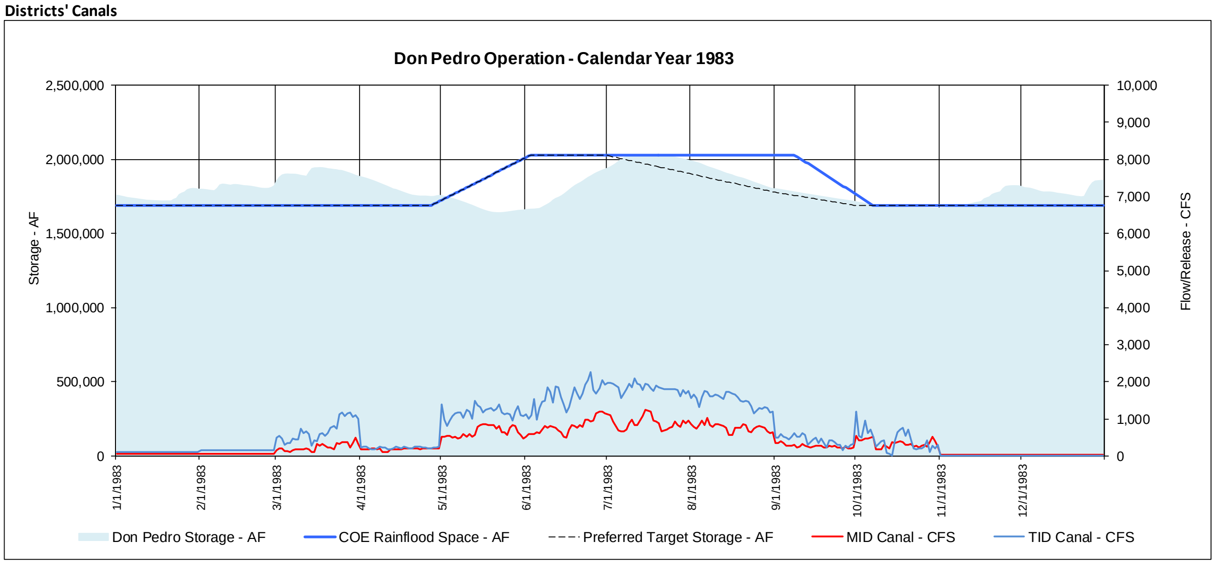
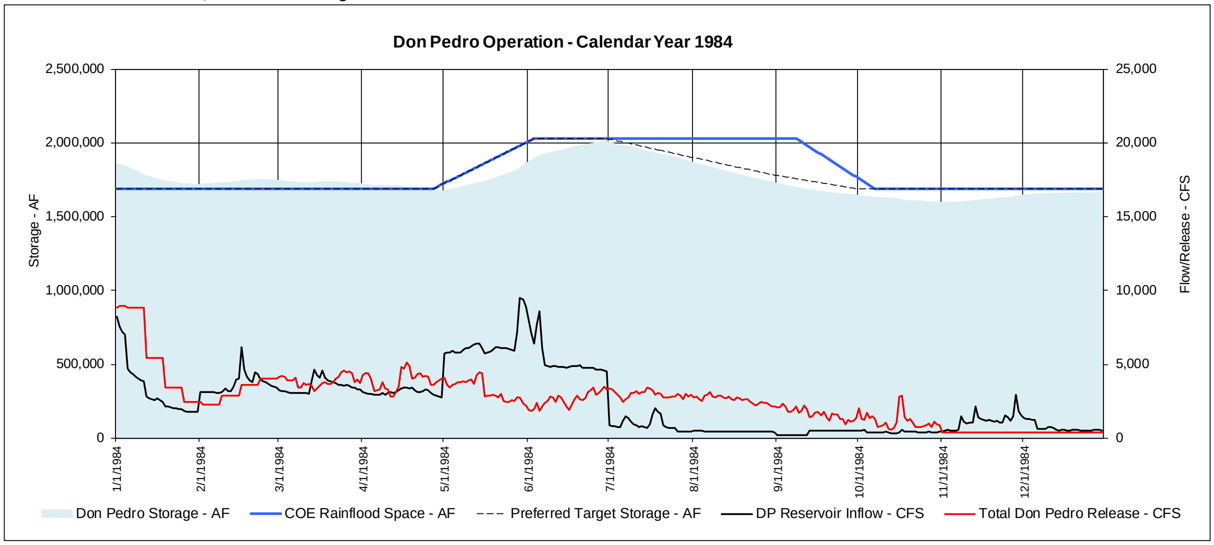
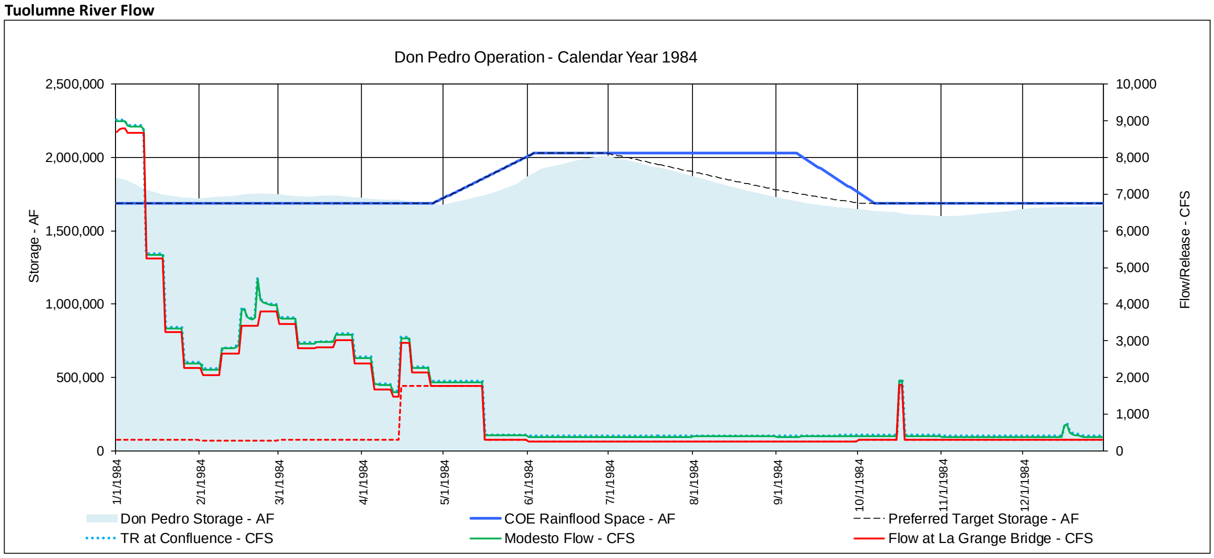


Figure 4-13. Don Pedro operations 1983 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

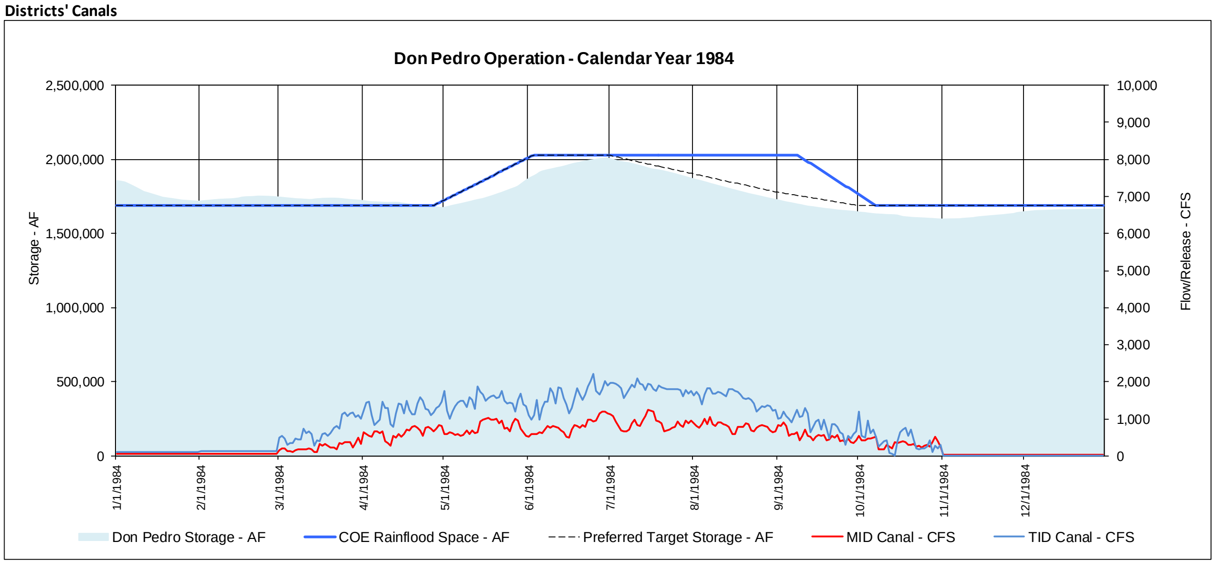
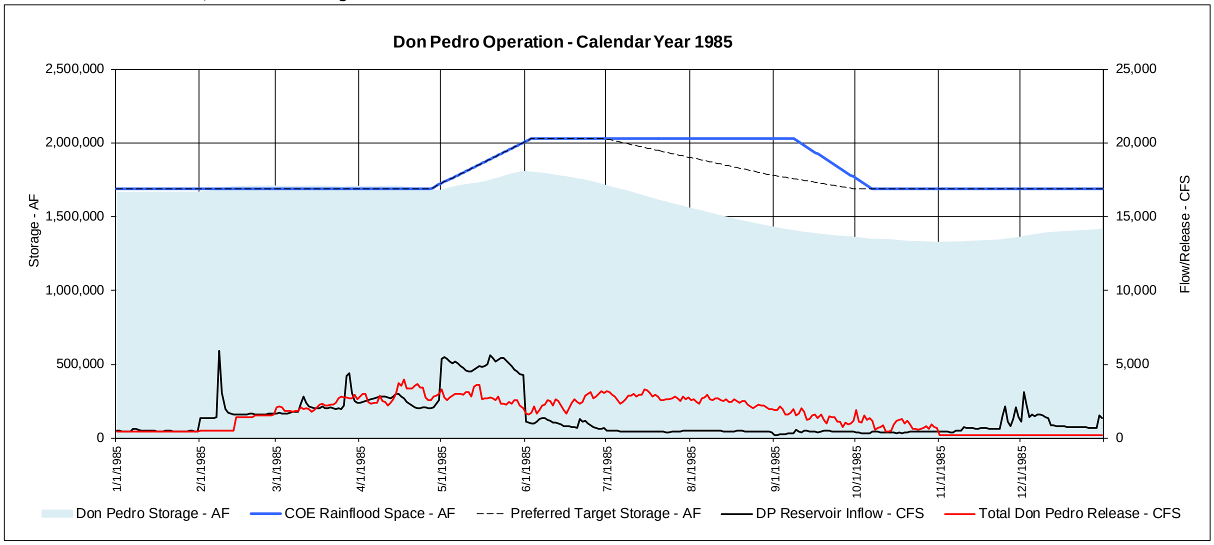
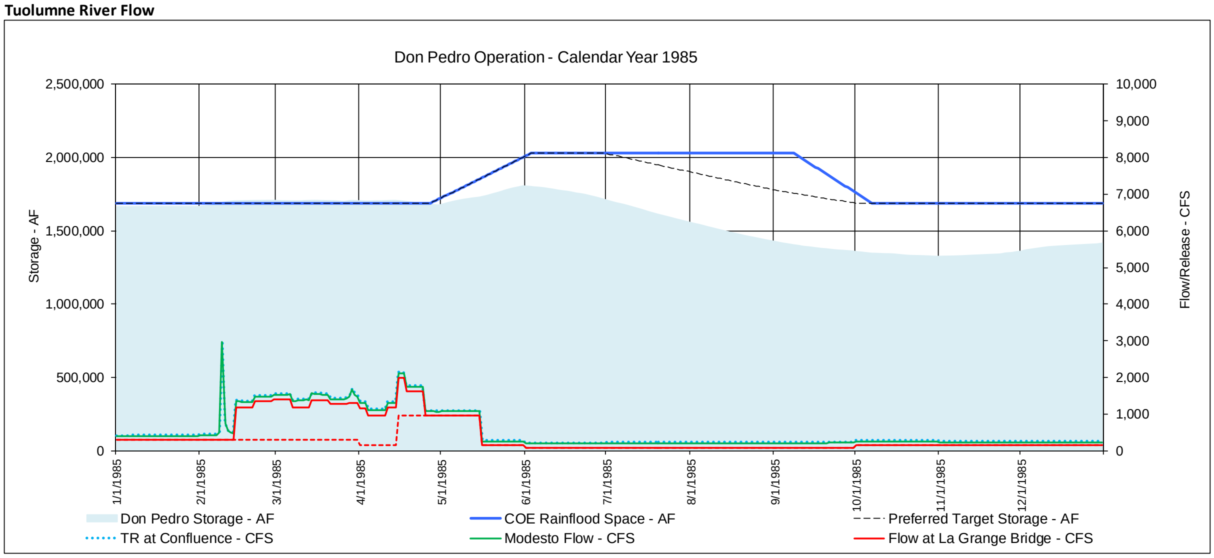


Figure 4-14. Don Pedro operations 1984 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

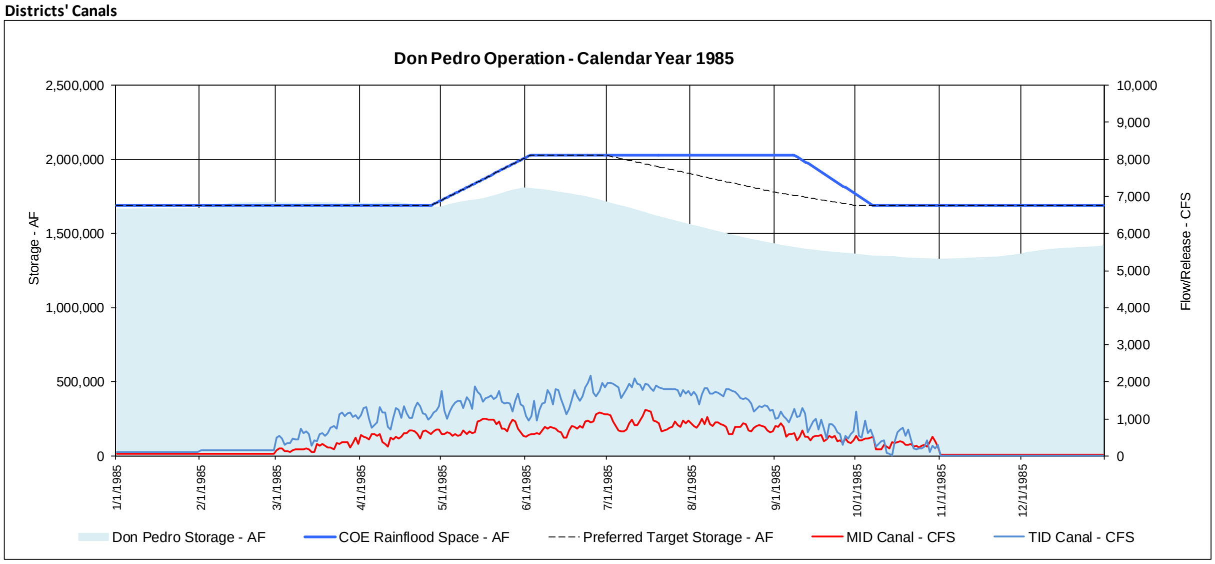
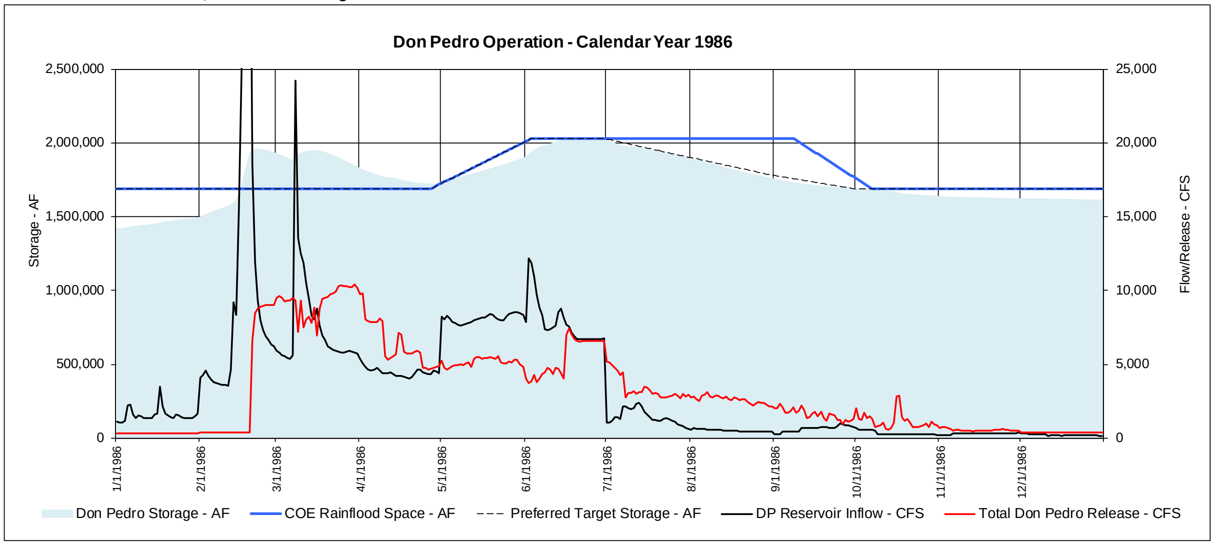
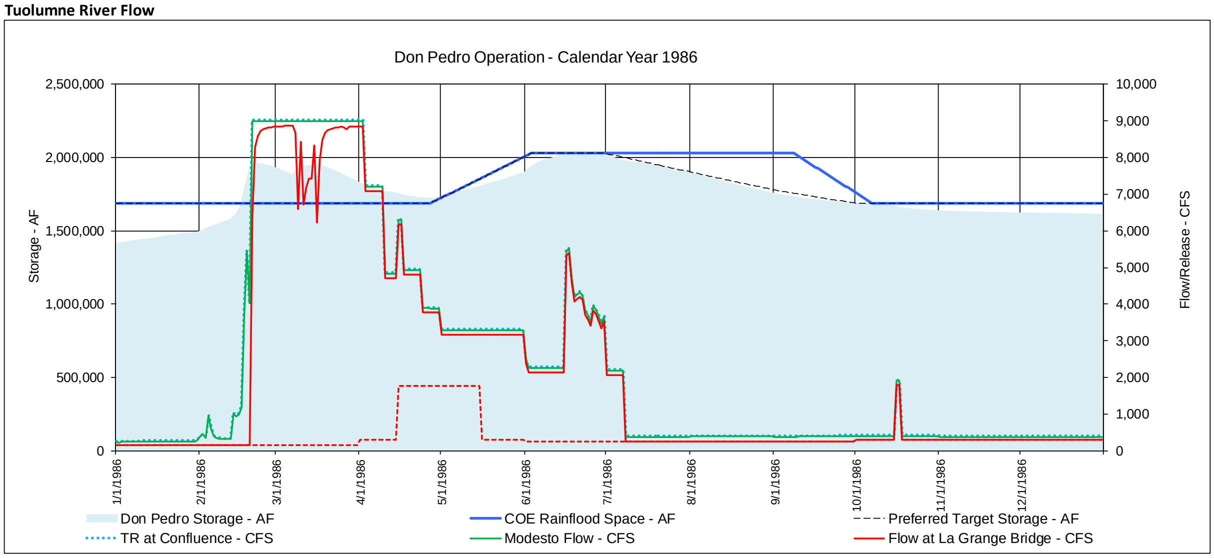


Figure 4-15. Don Pedro operations 1985 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

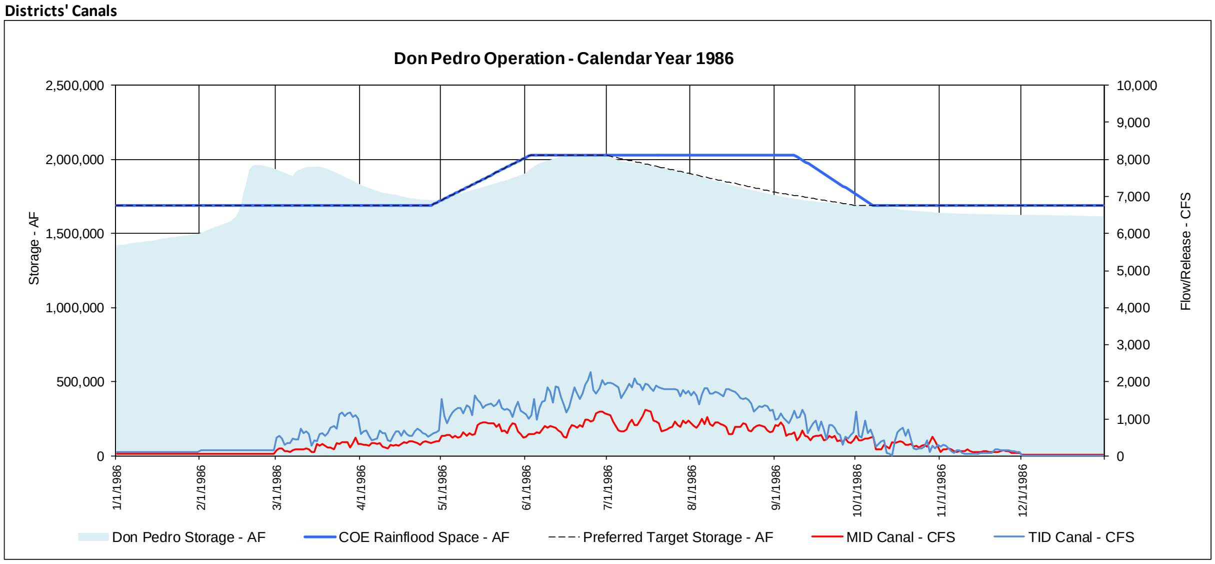
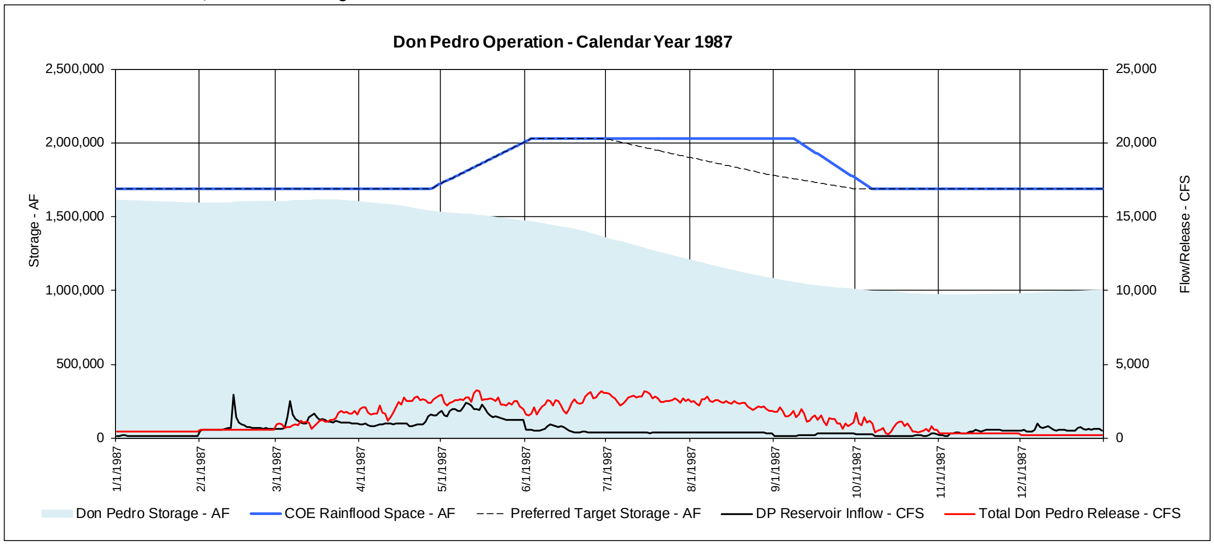
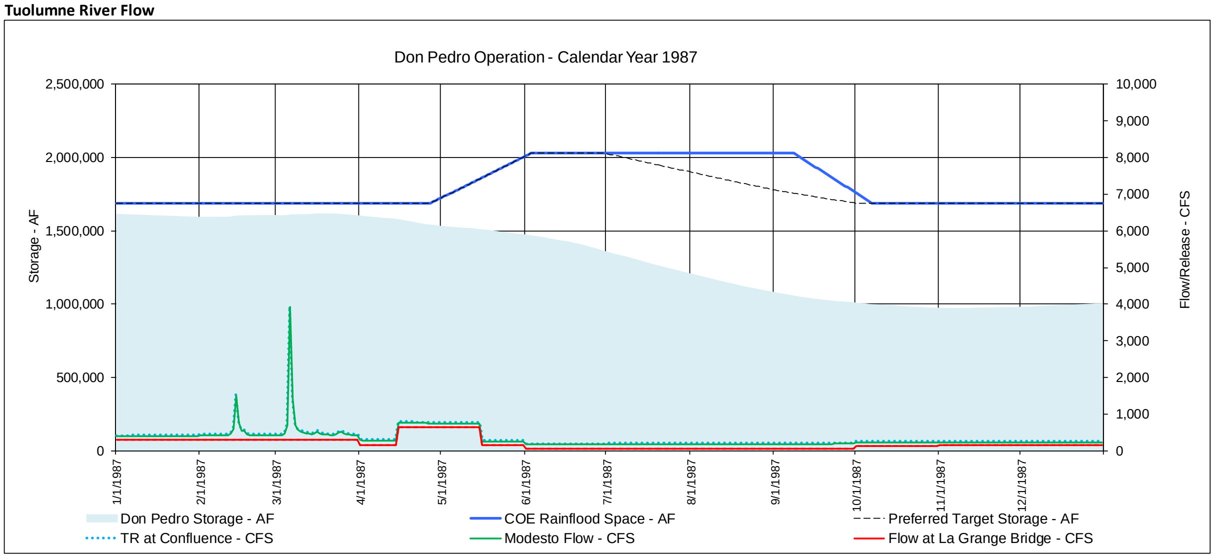


Figure 4-16. Don Pedro operations 1986 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

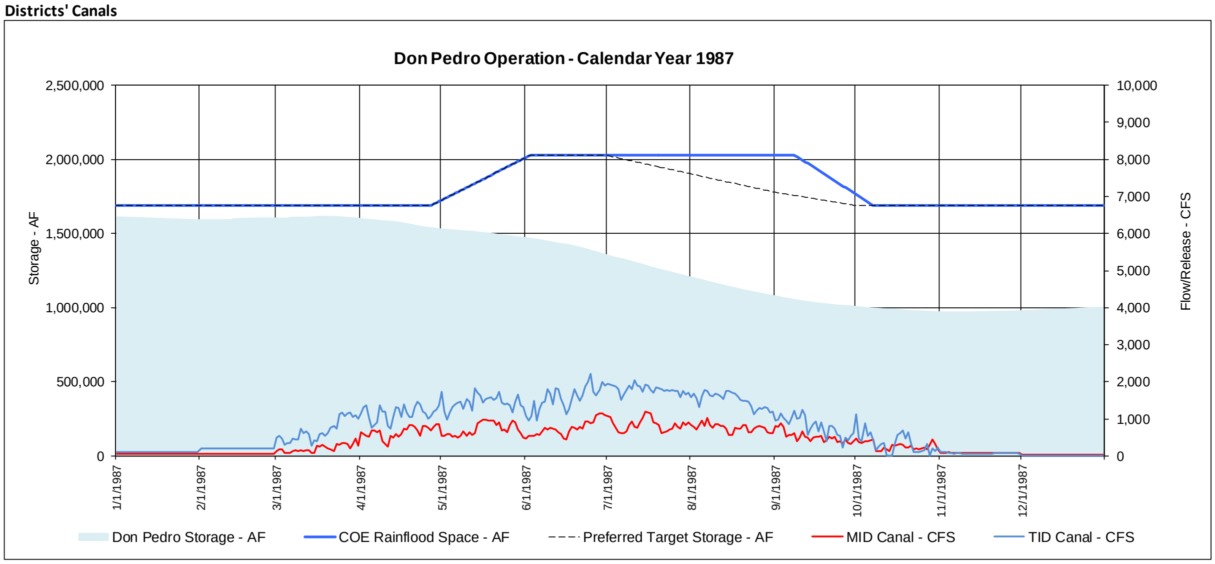
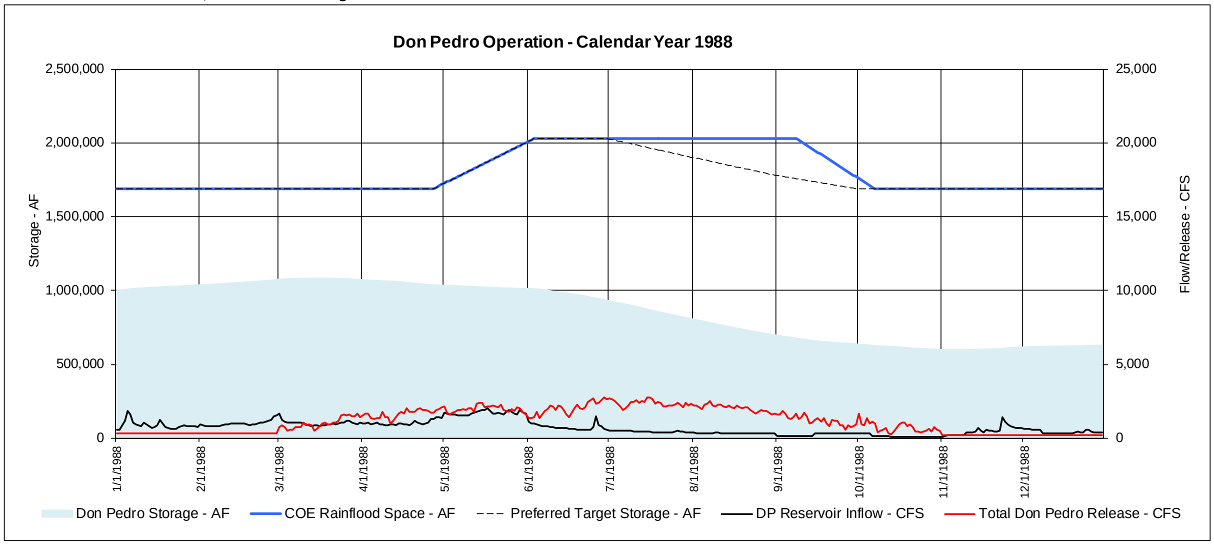
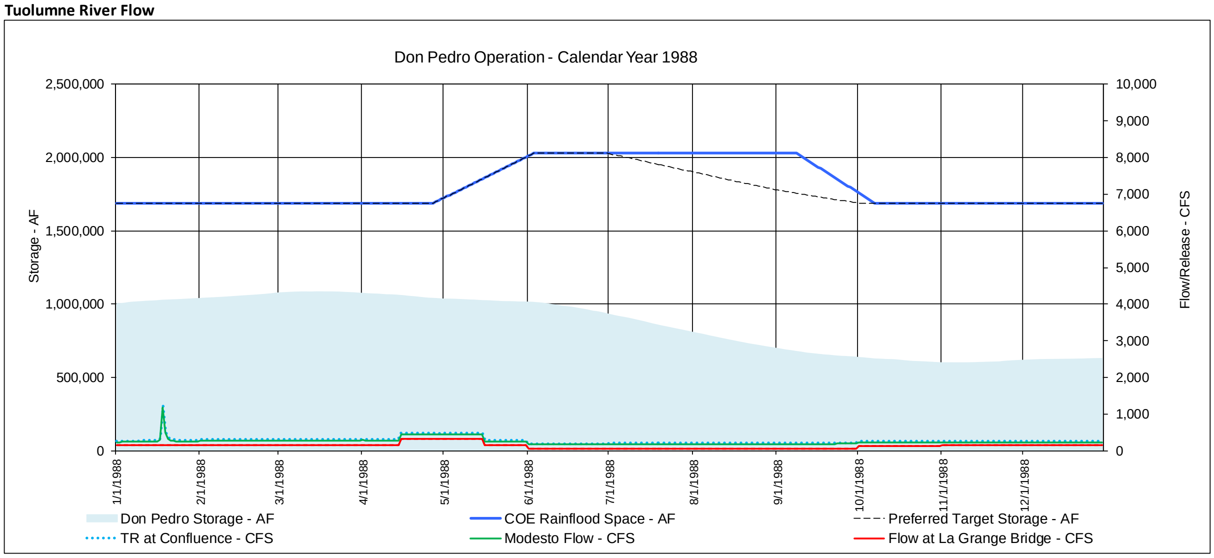


Figure 4-17. Don Pedro operations 1987 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

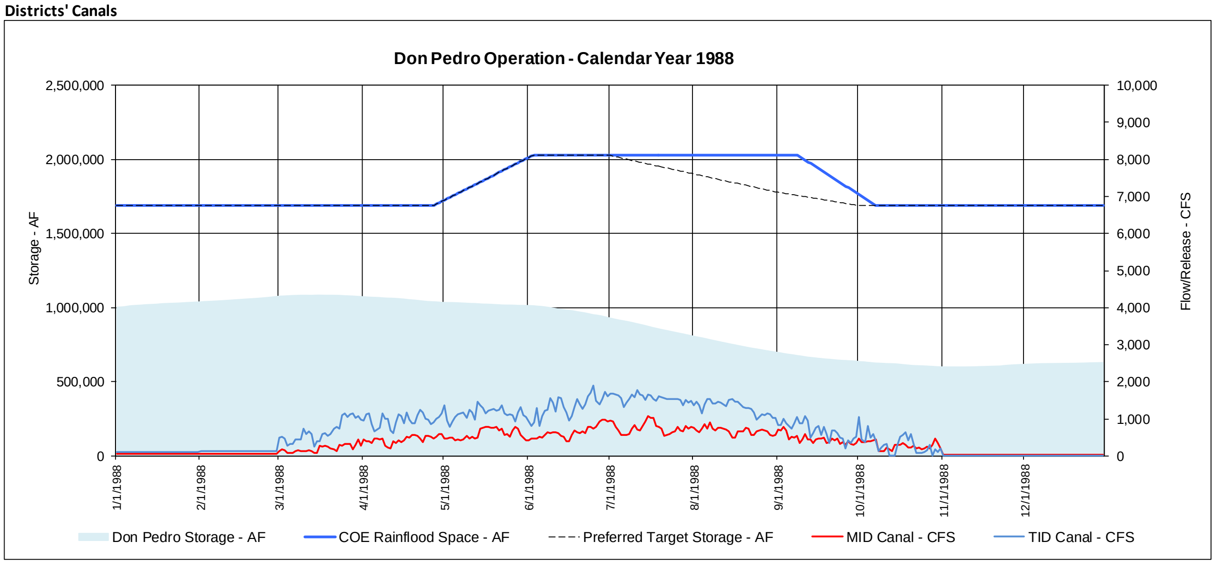
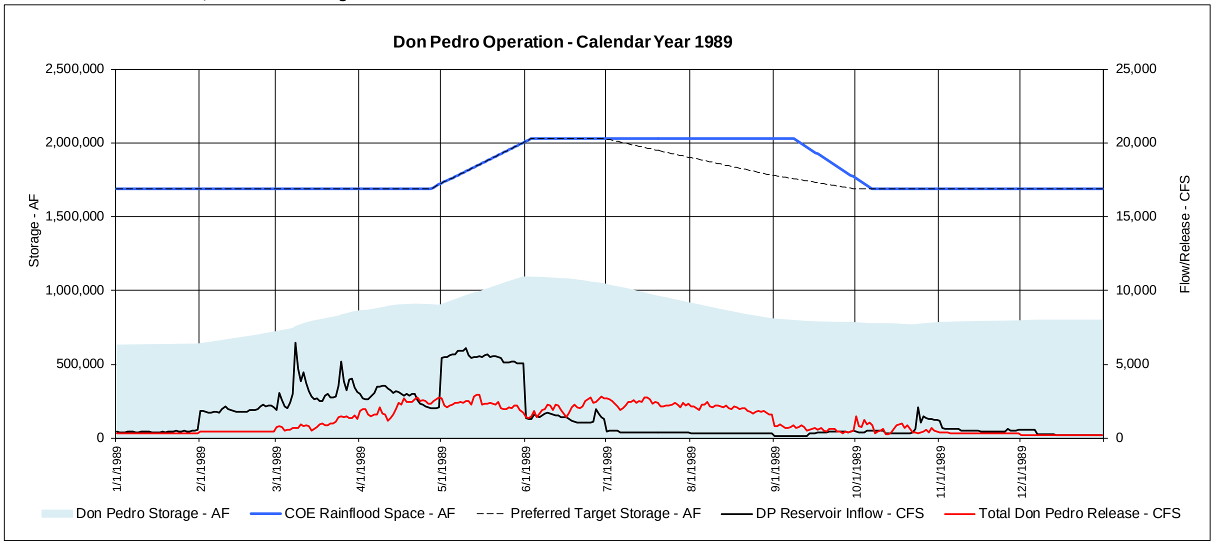
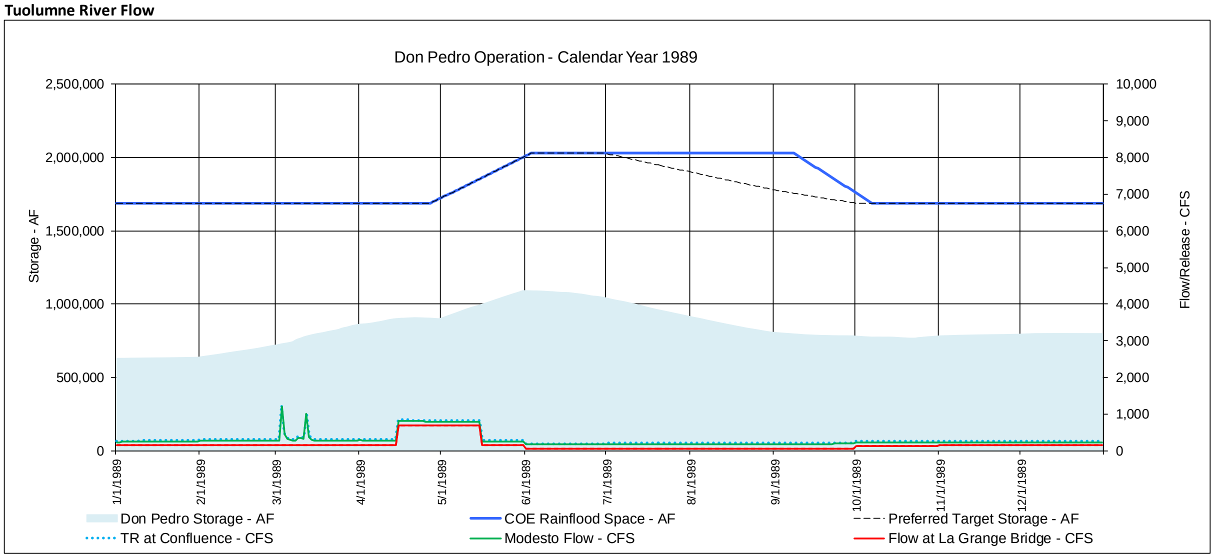


Figure 4-18. Don Pedro operations 1988 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

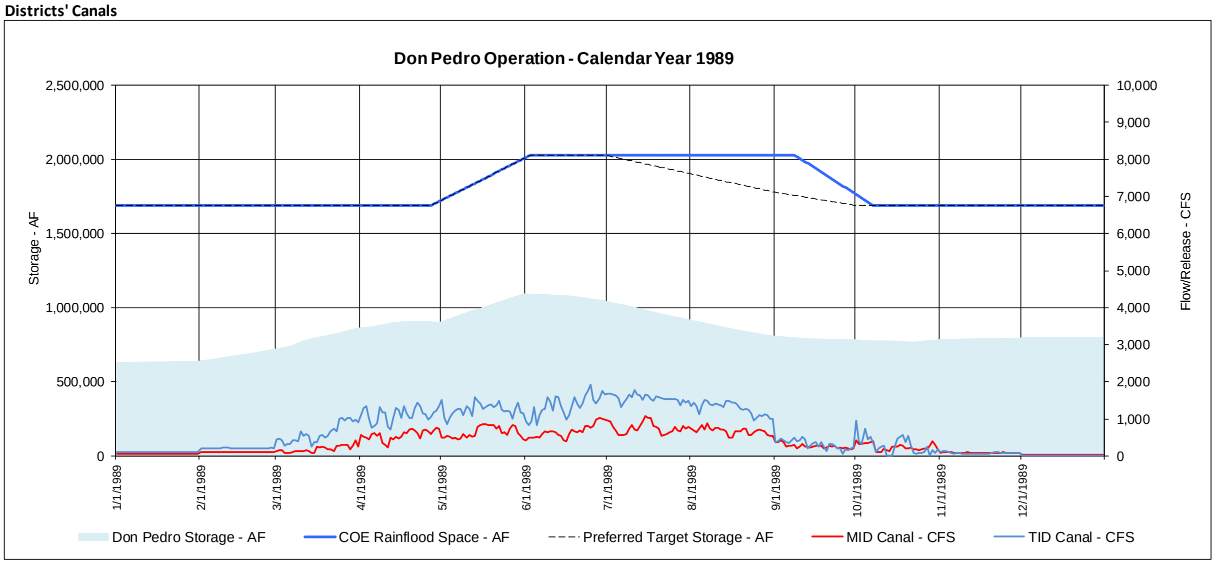
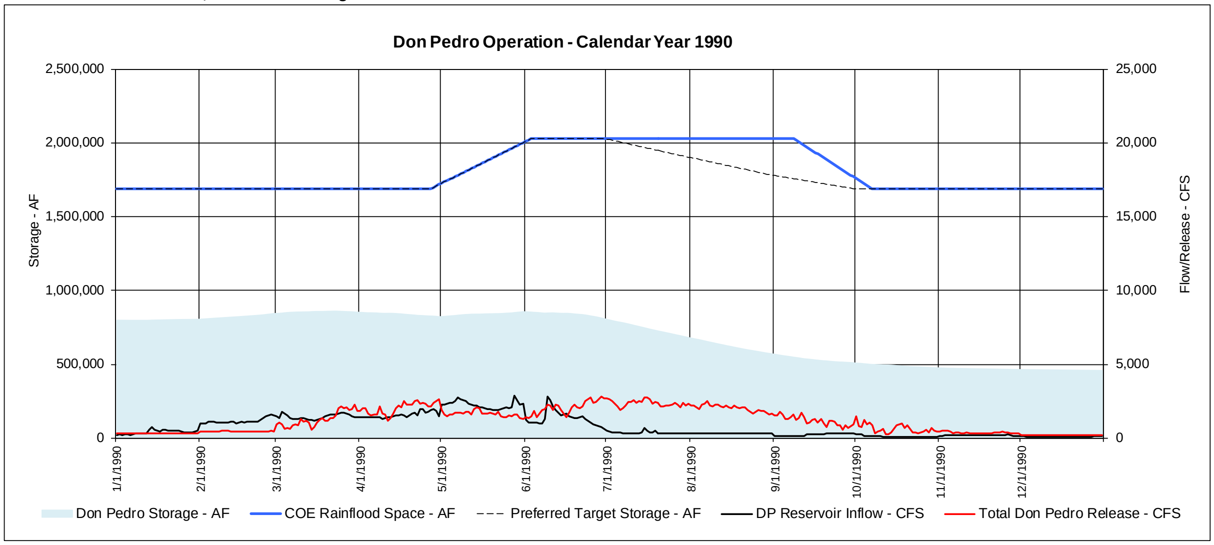
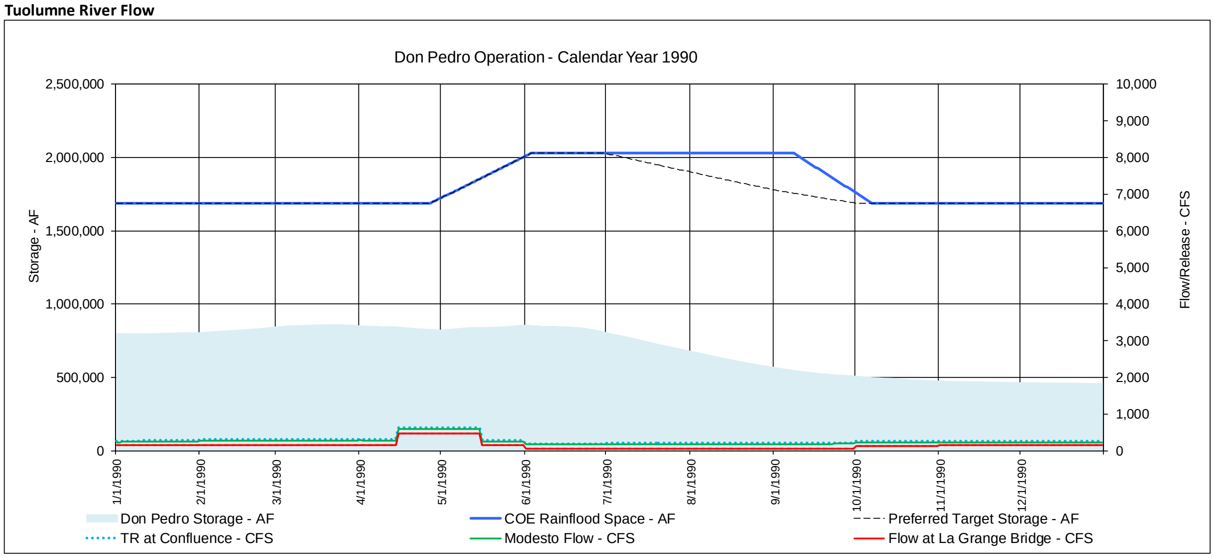


Figure 4-19. Don Pedro operations 1989 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

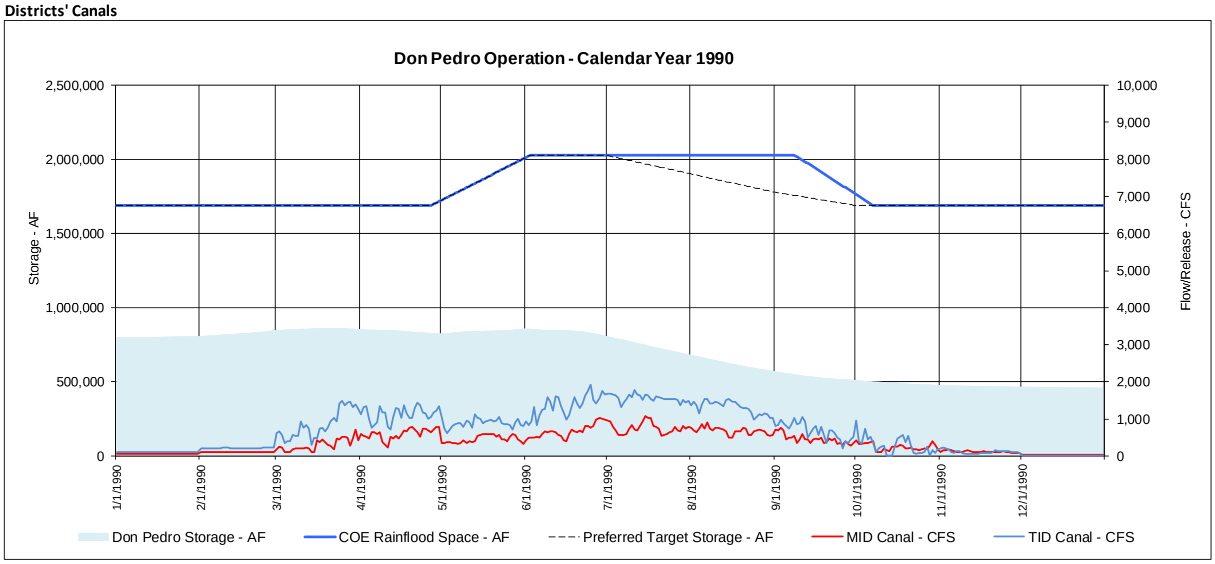
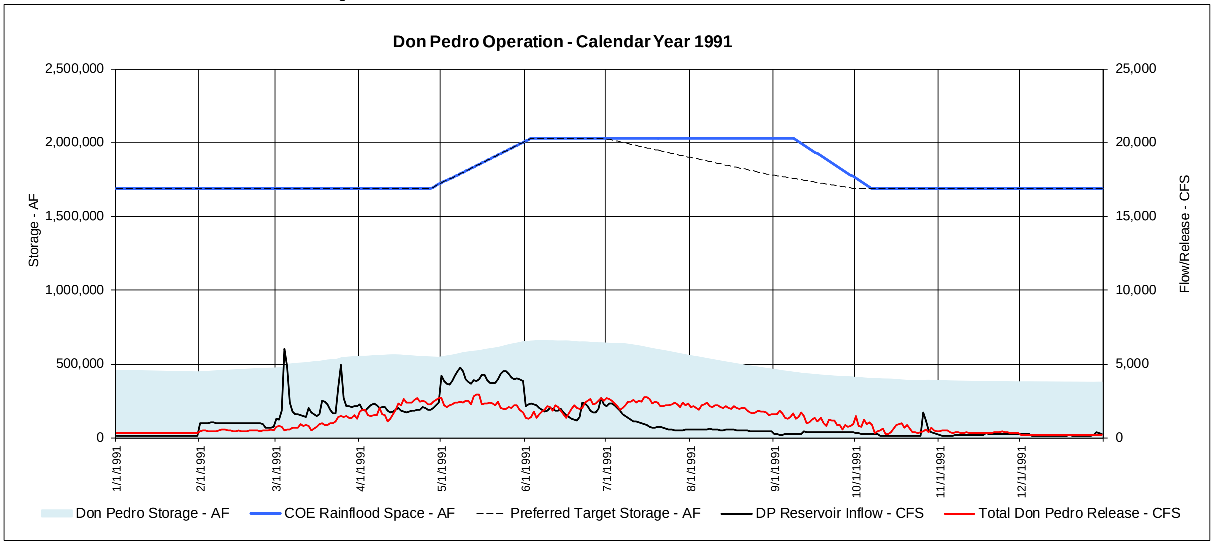
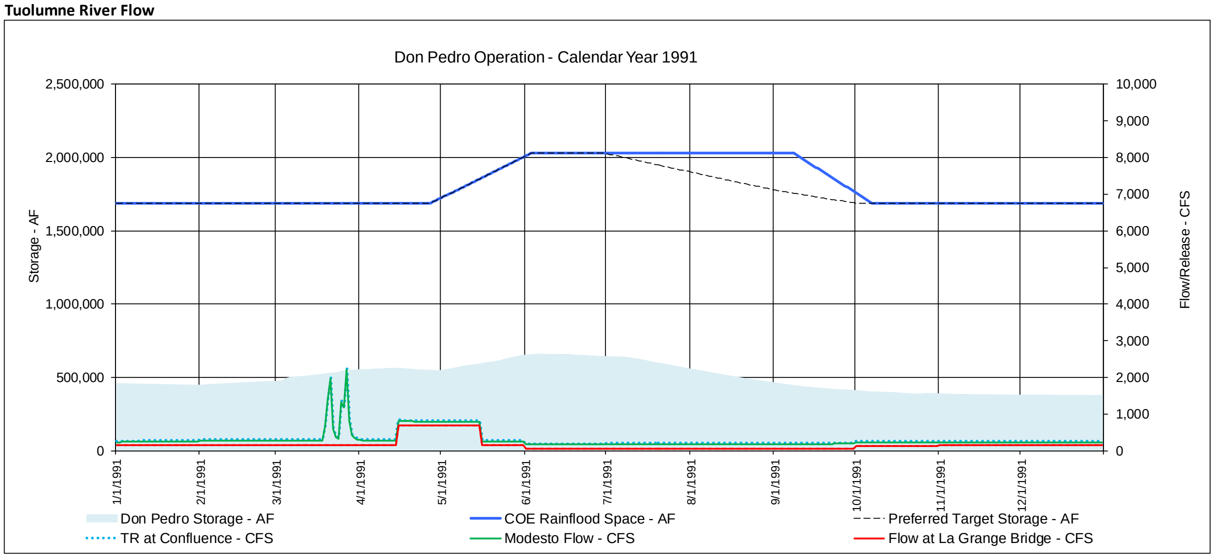


Figure 4-20. Don Pedro operations 1990 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

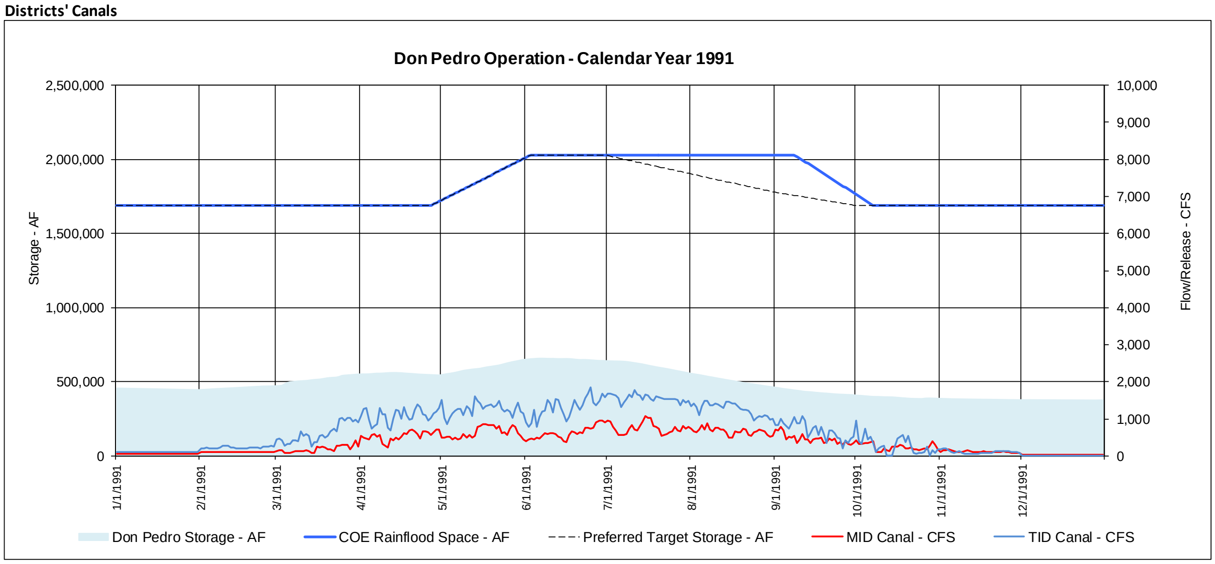
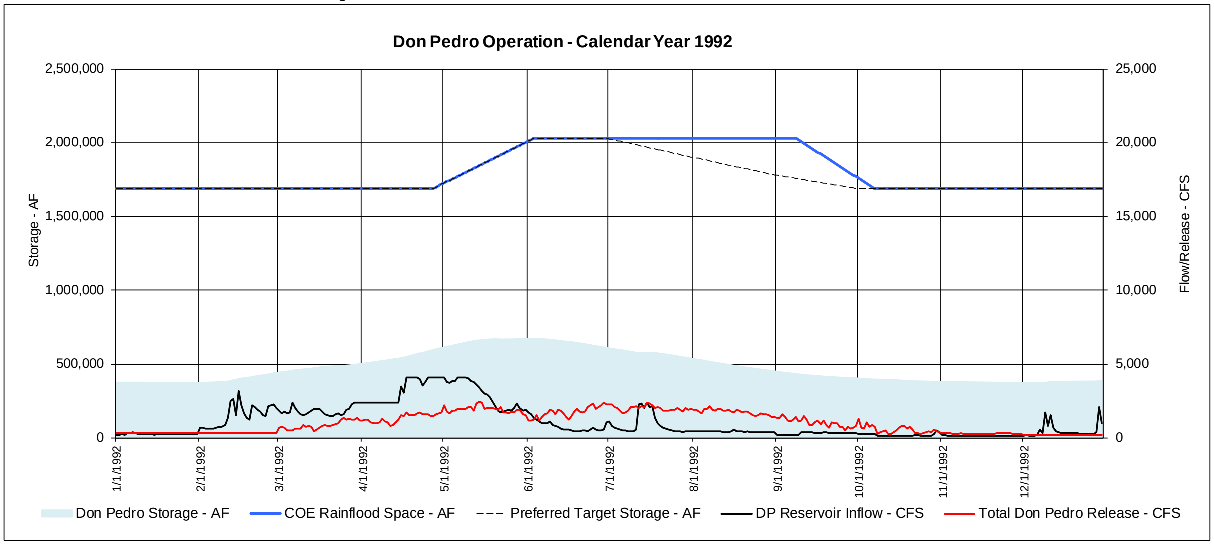
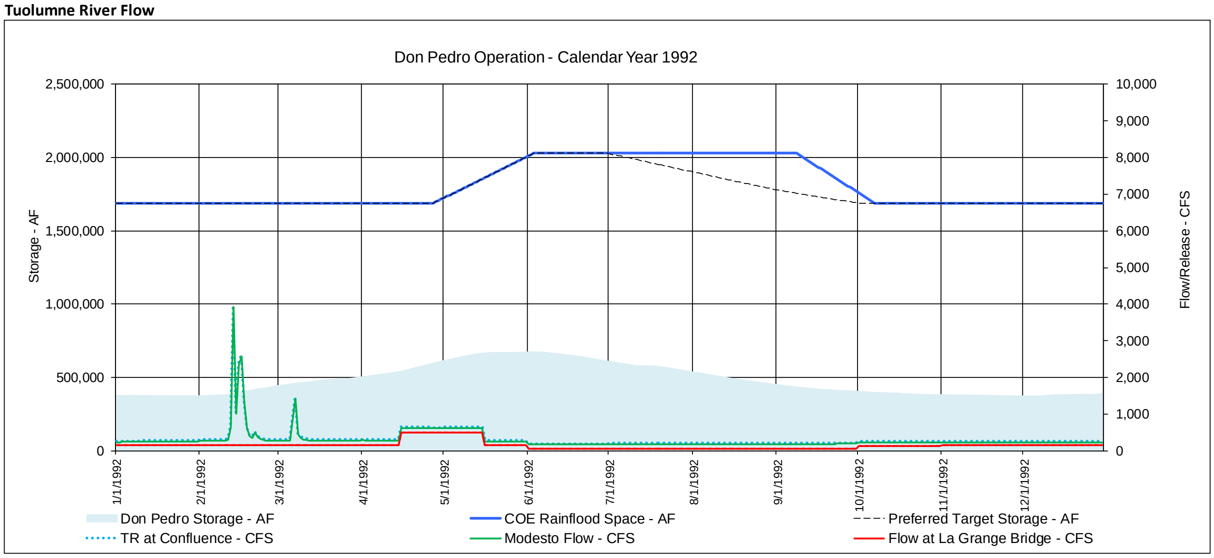


Figure 4-21. Don Pedro operations 1991 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

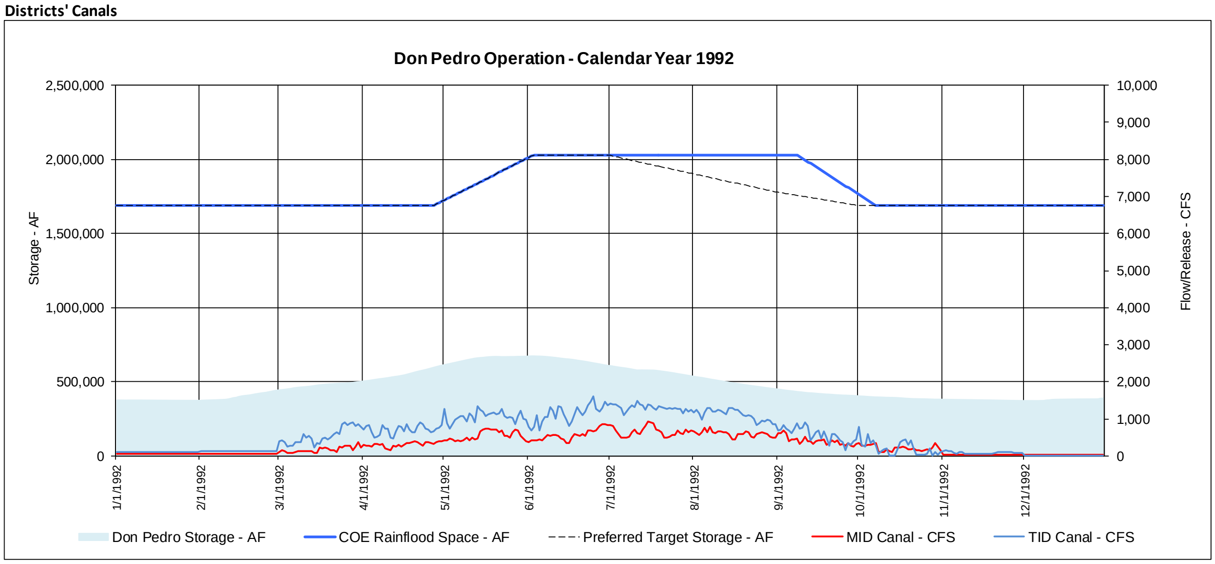
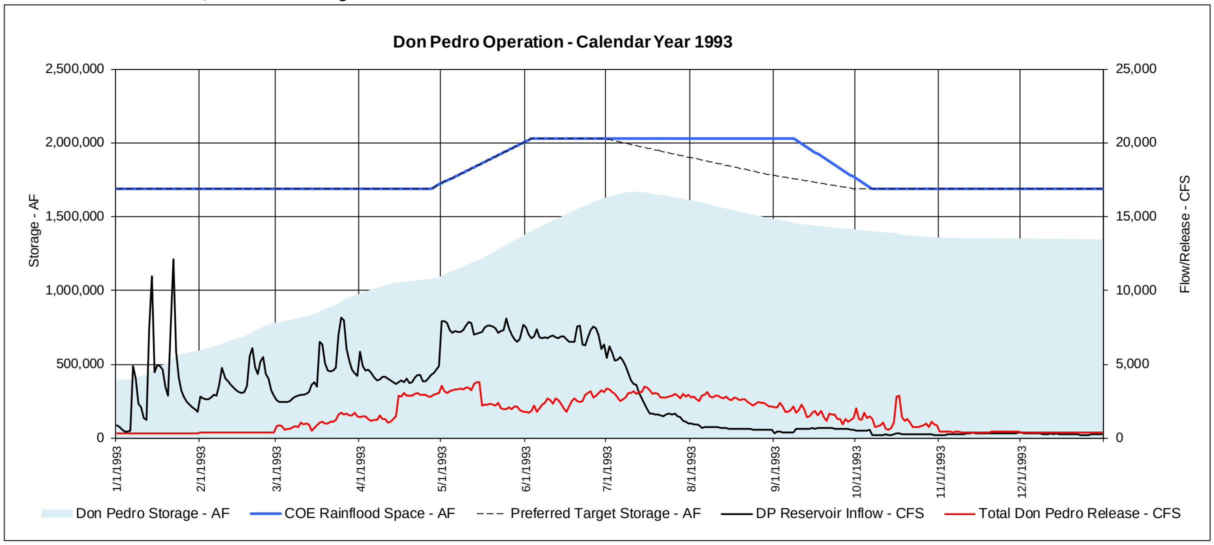
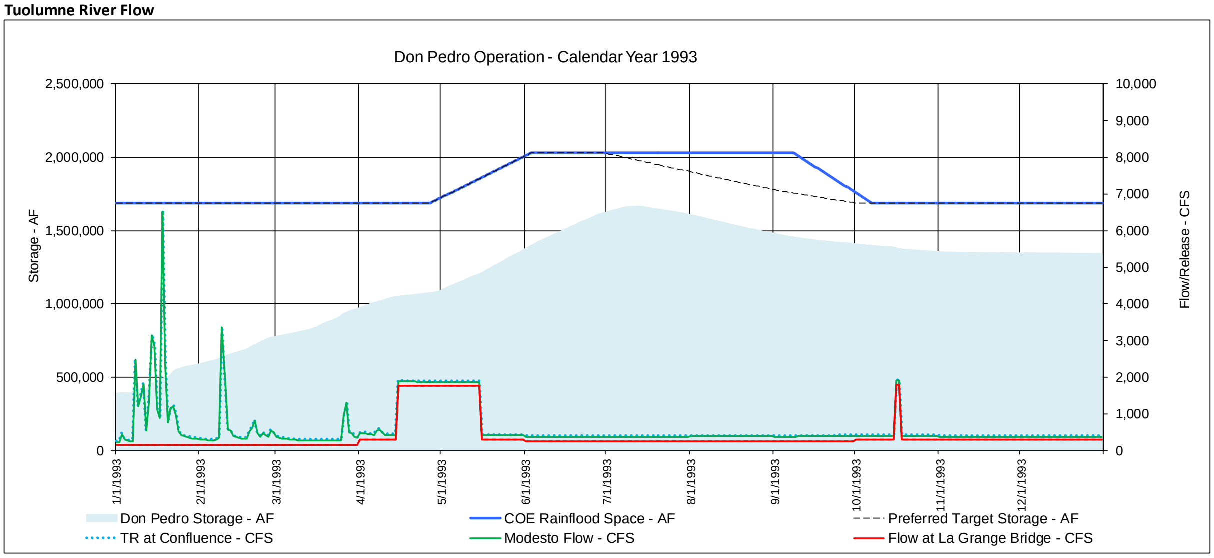


Figure 4-22 Don Pedro operations 1992 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

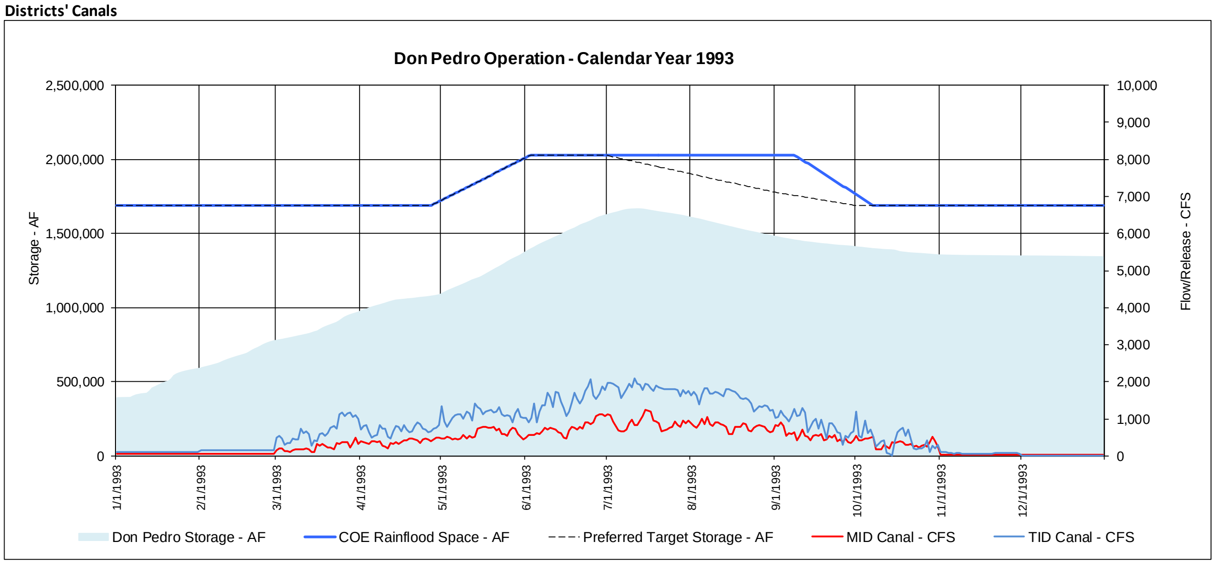


Figure 4-23. Don Pedro operations 1993 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage

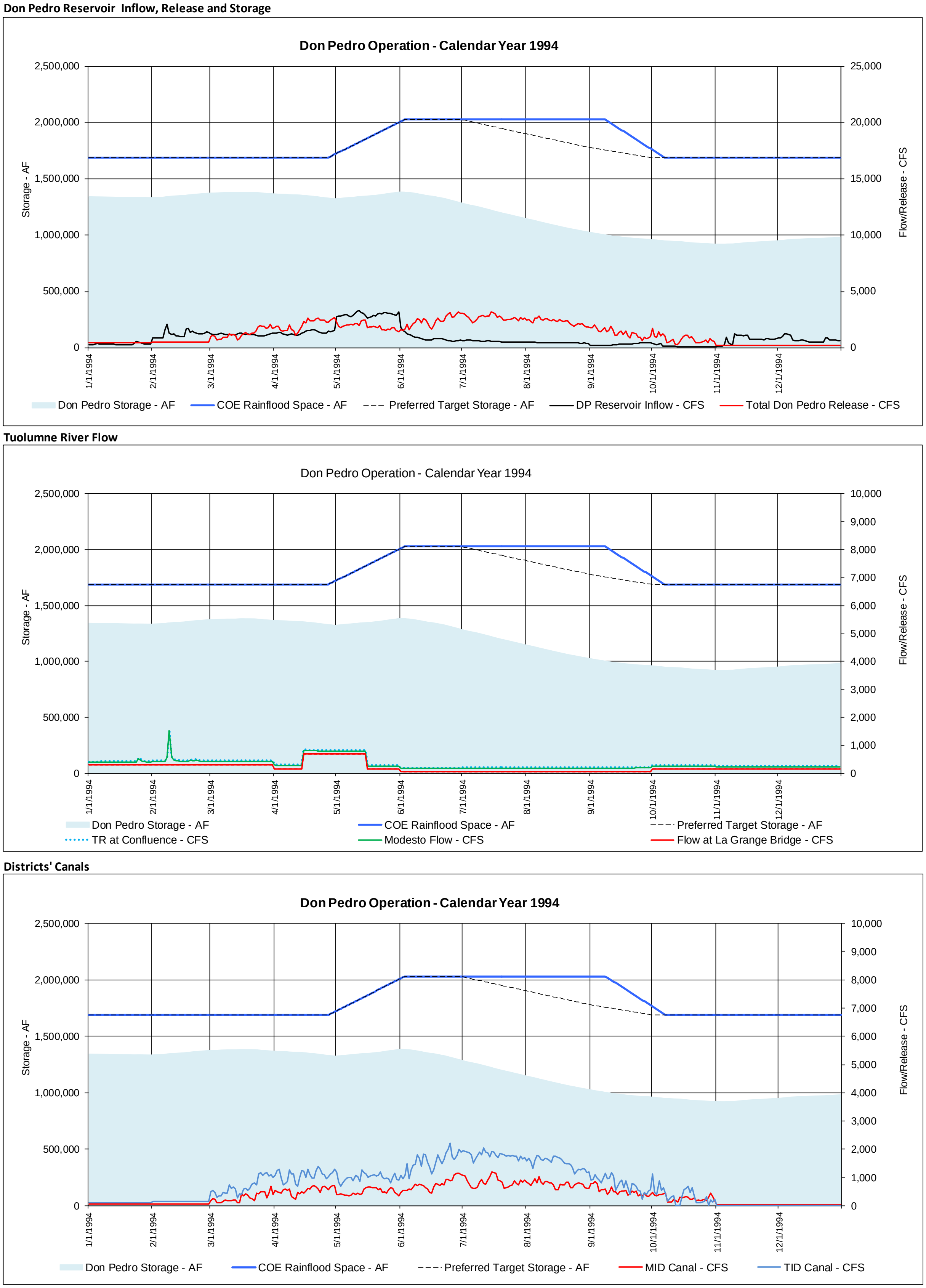
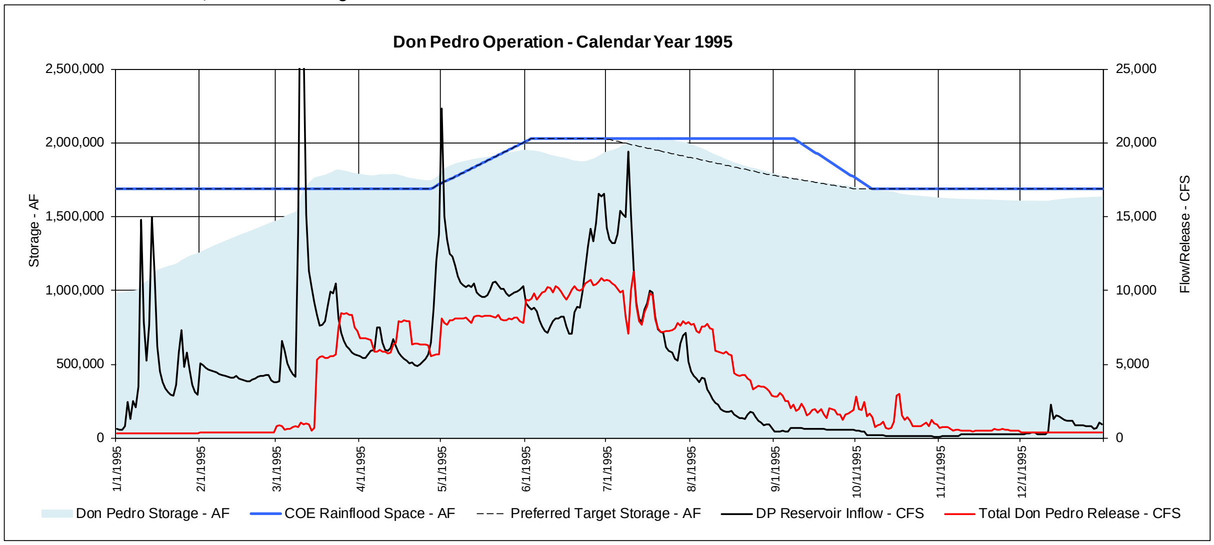
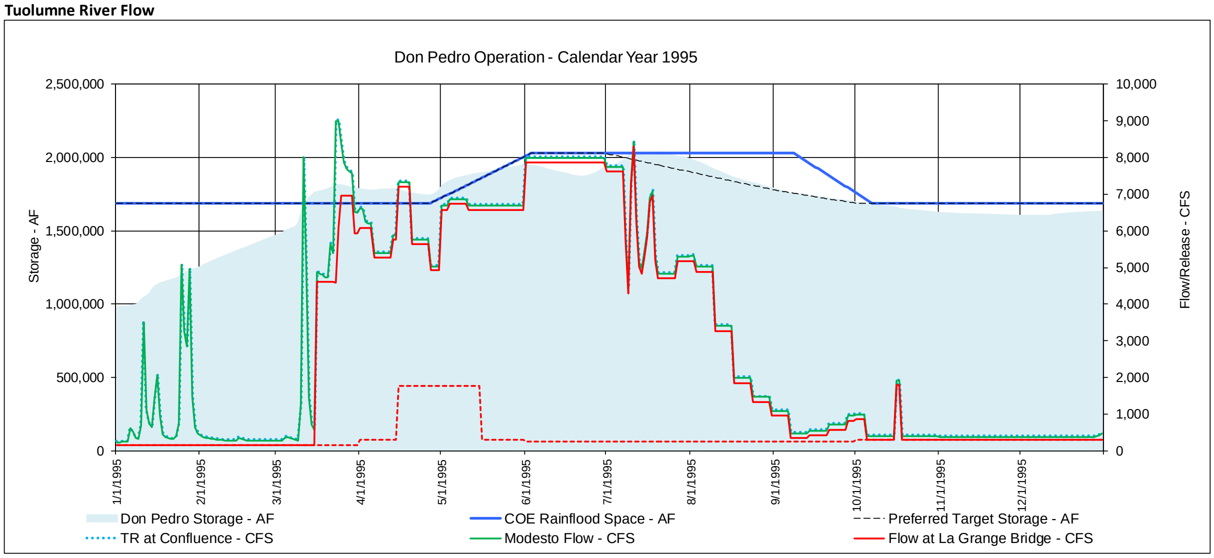


Figure 4-24. Don Pedro operations 1994 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

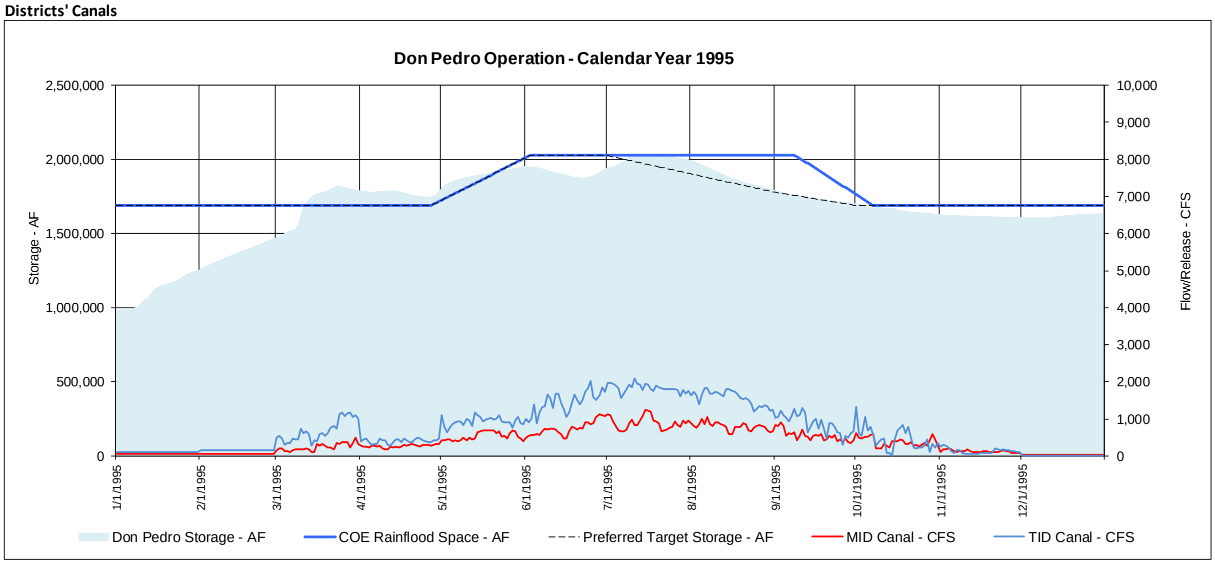
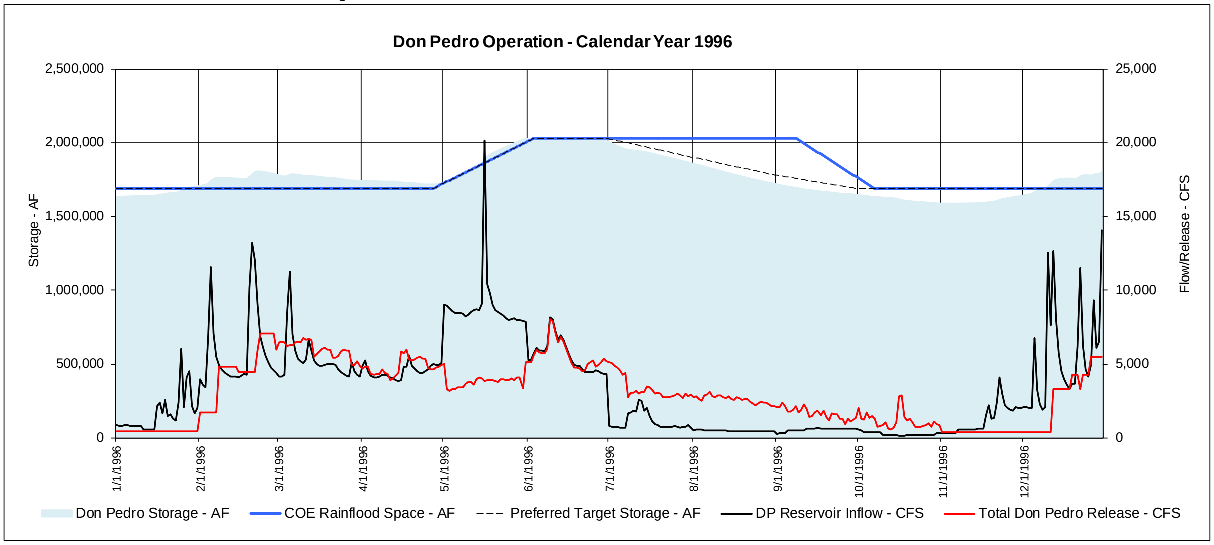
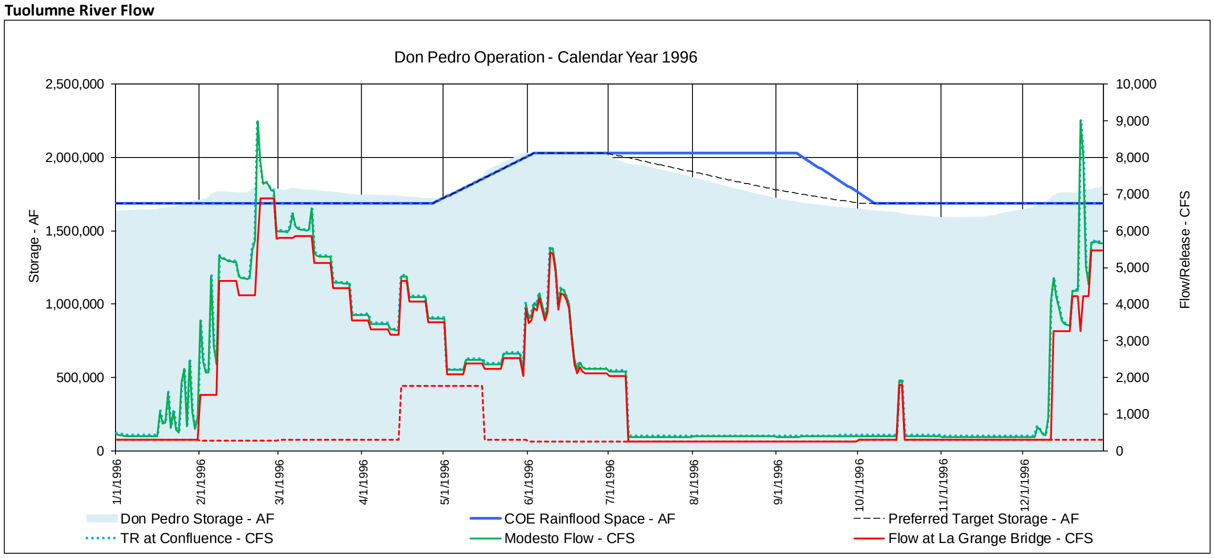


Figure 4-25. Don Pedro operations 1995 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

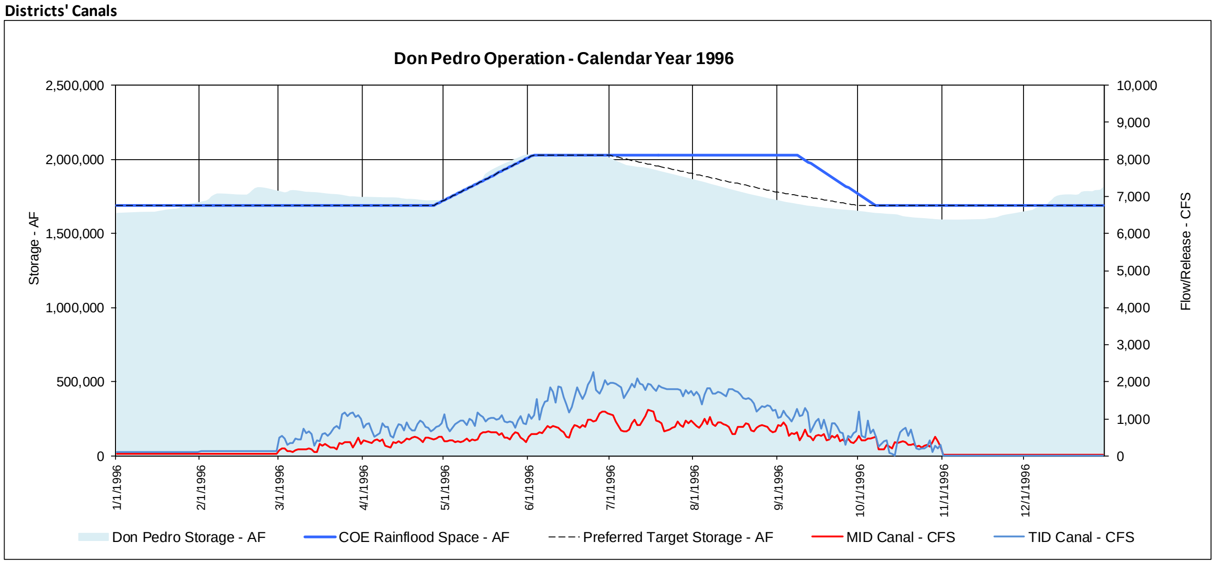
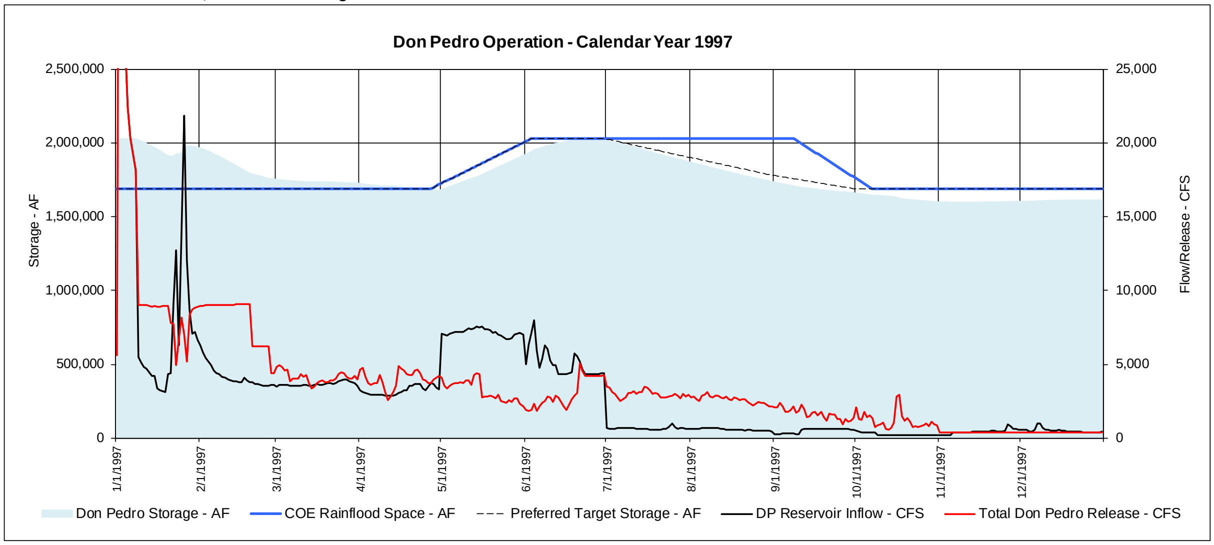
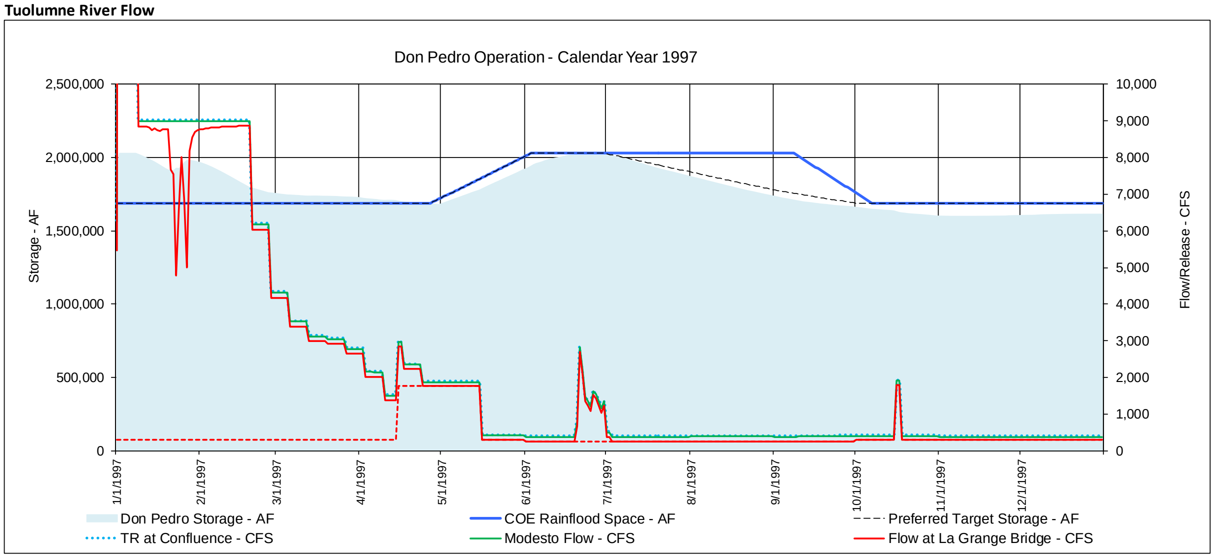


Figure 4-26. Don Pedro operations 1996 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

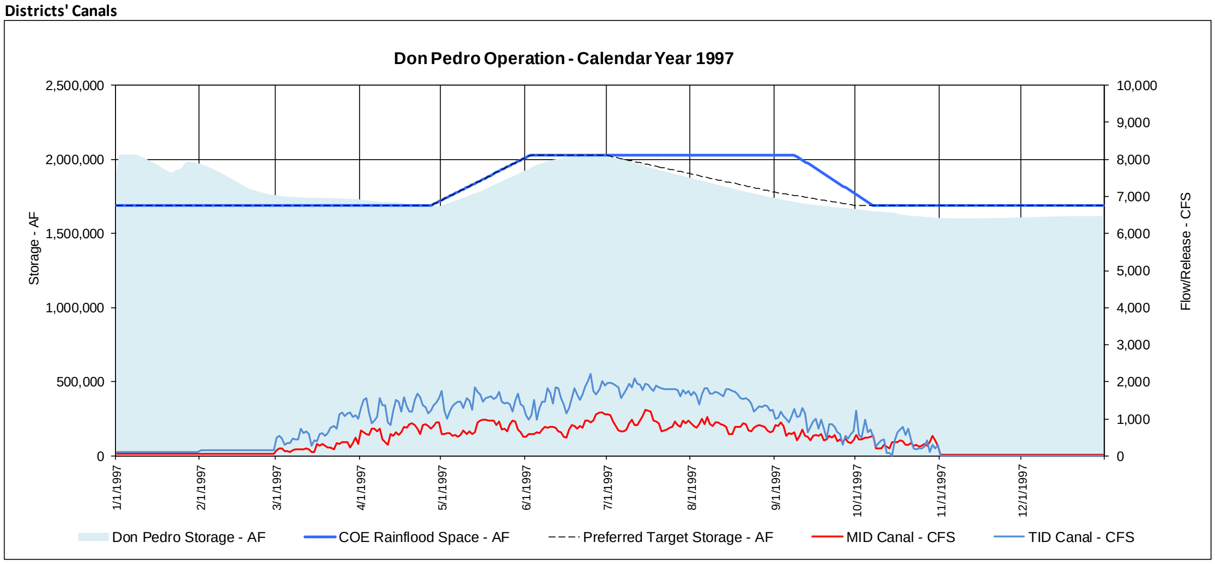
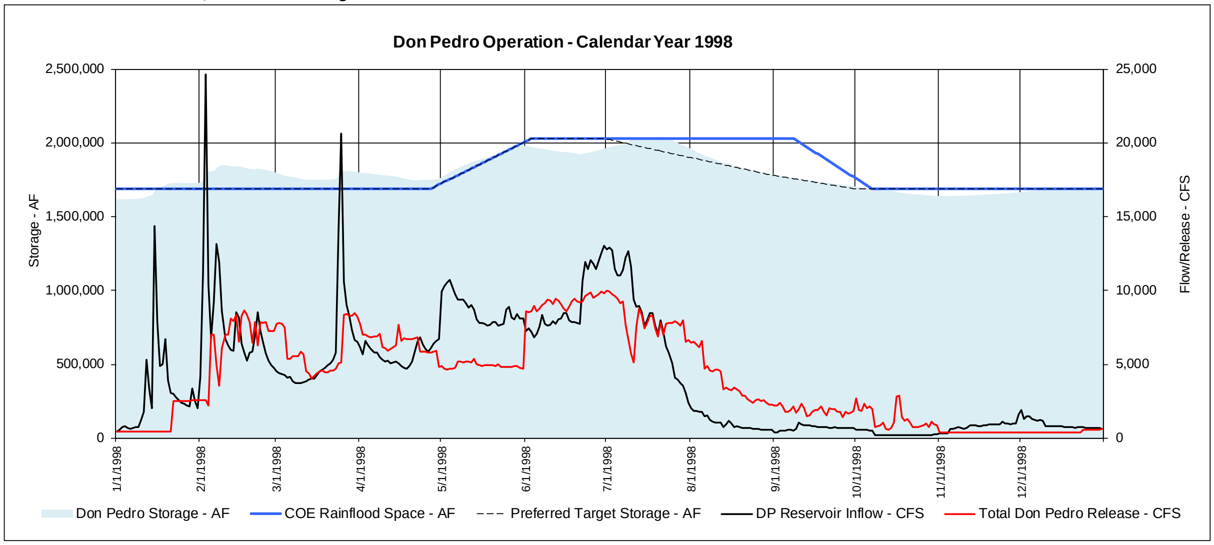
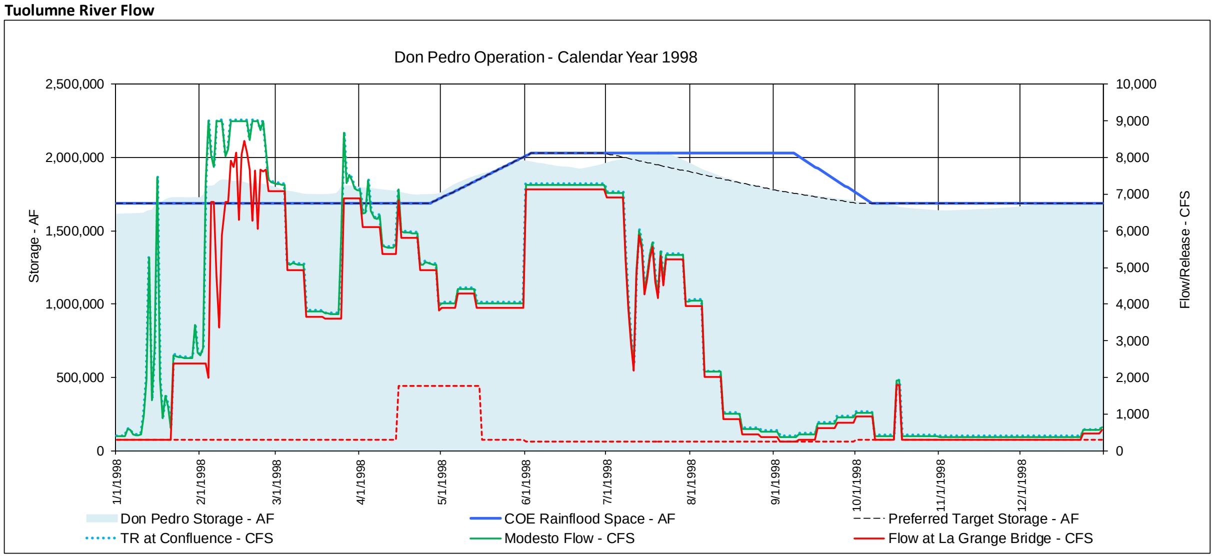


Figure 4-27. Don Pedro operations 1997 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

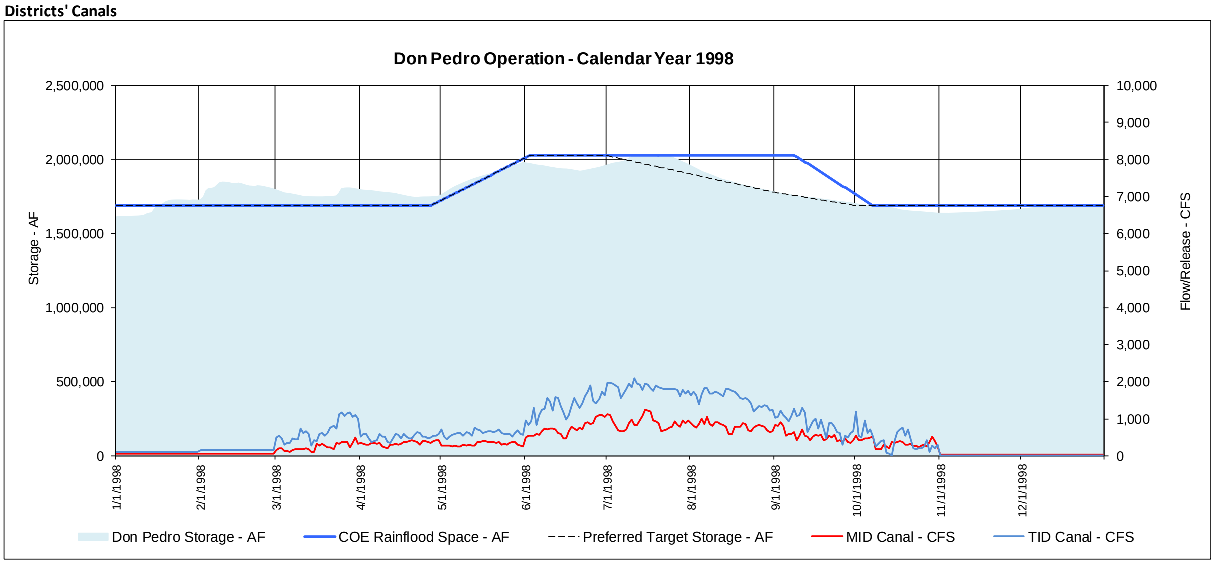
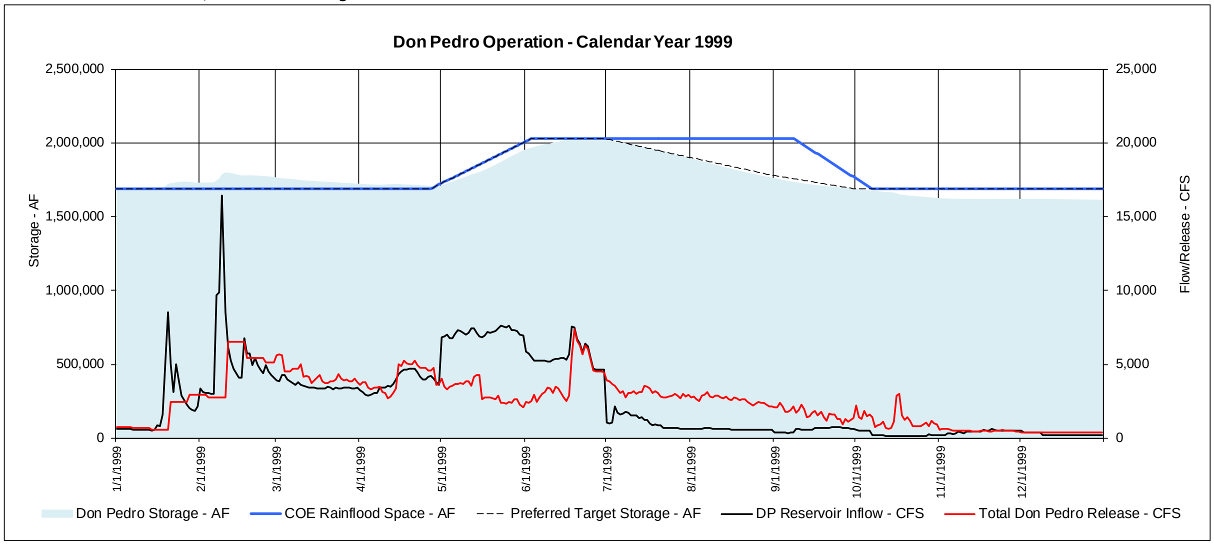
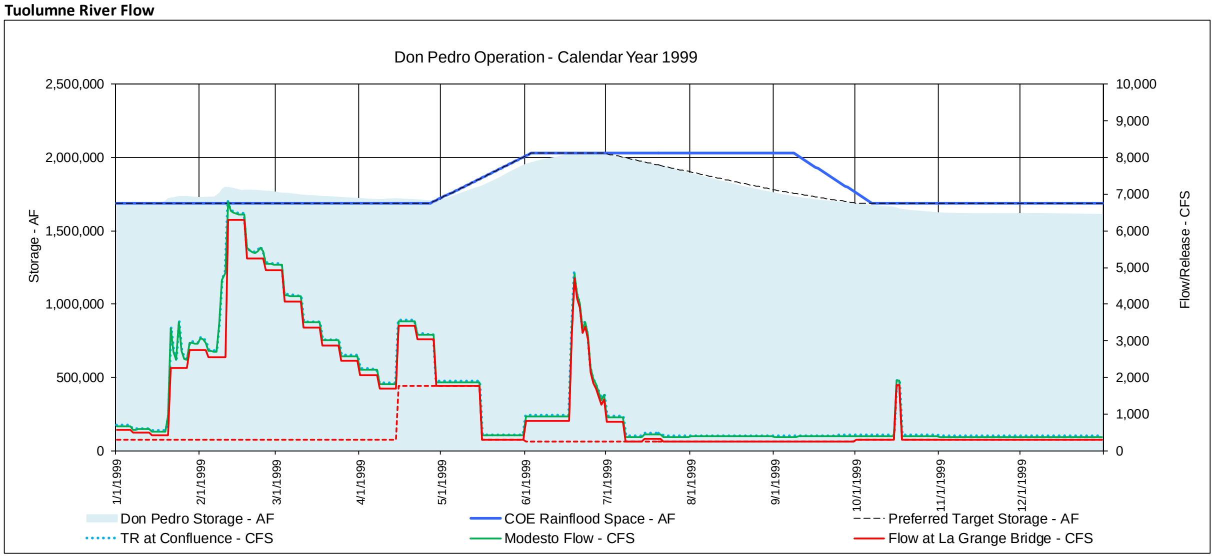


Figure 4-28. Don Pedro operations 1998 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

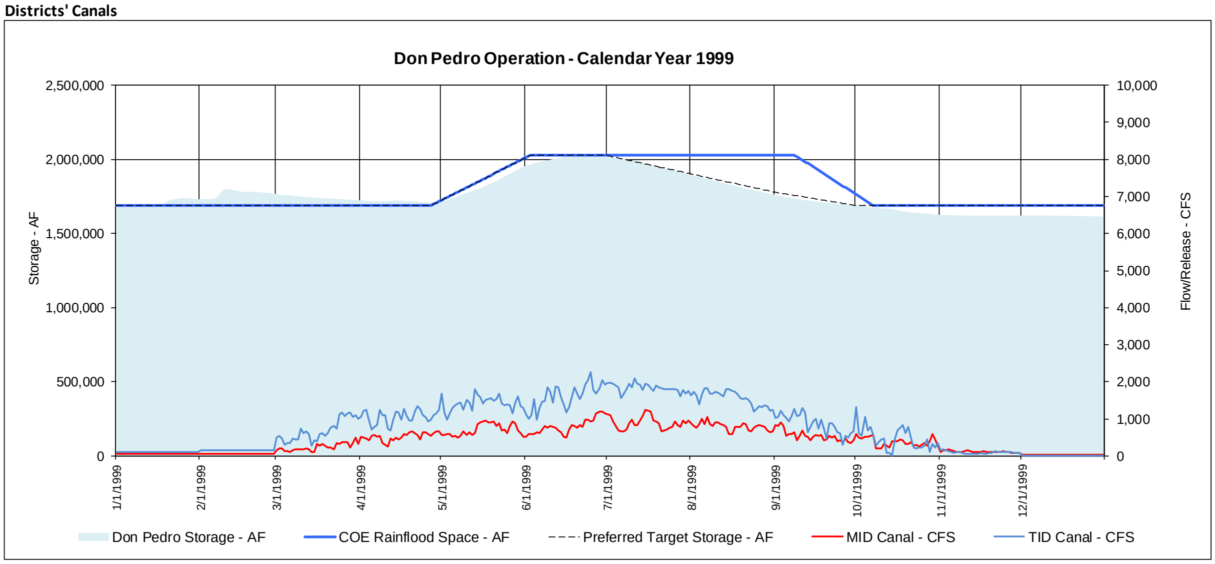
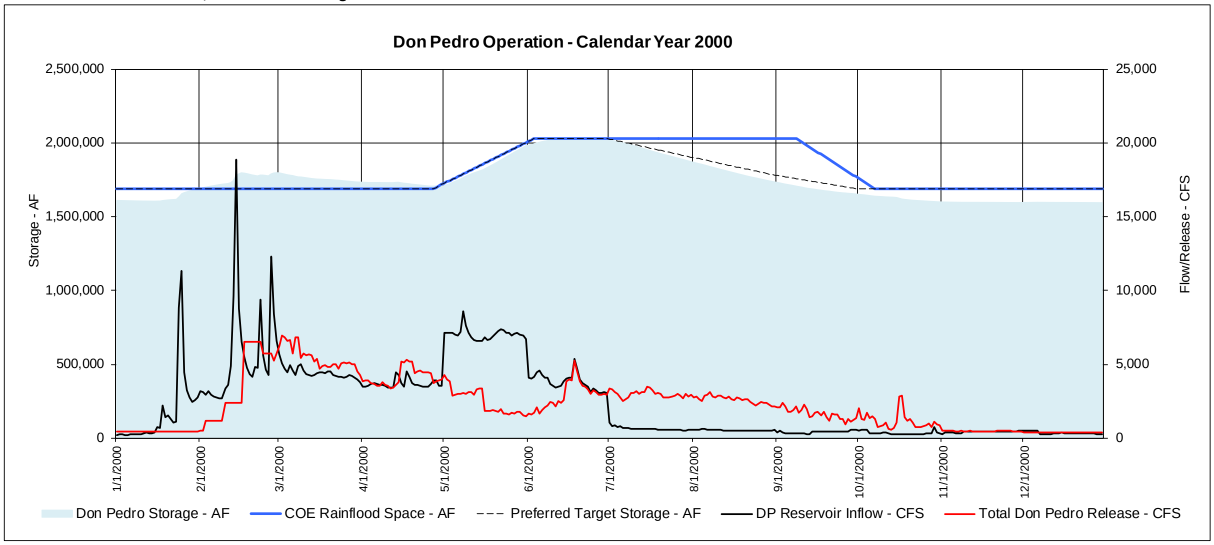
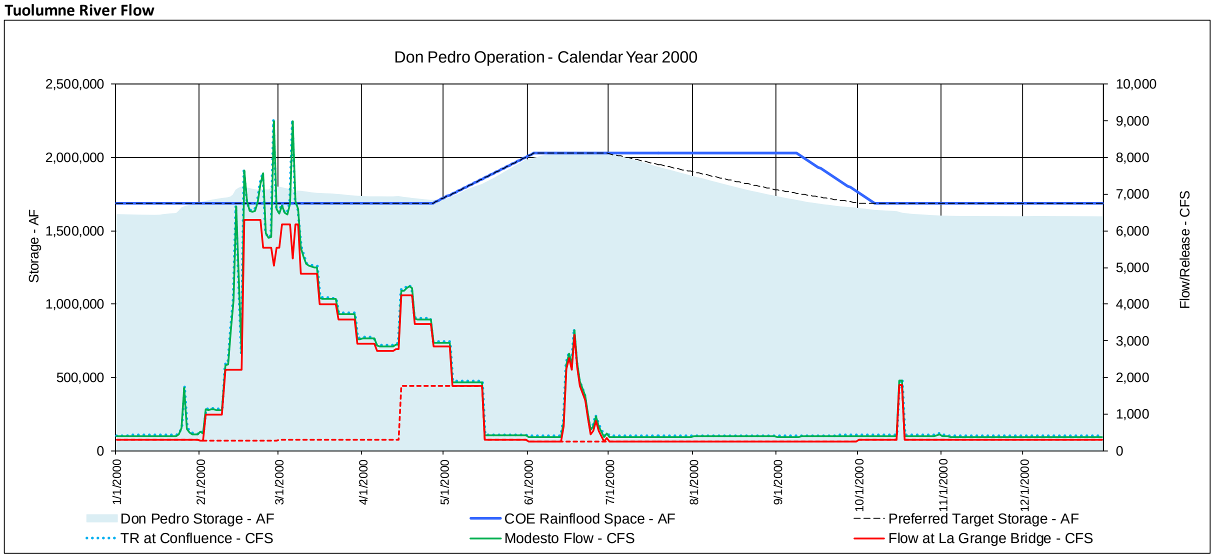


Figure 4-29. Don Pedro operations 1999 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

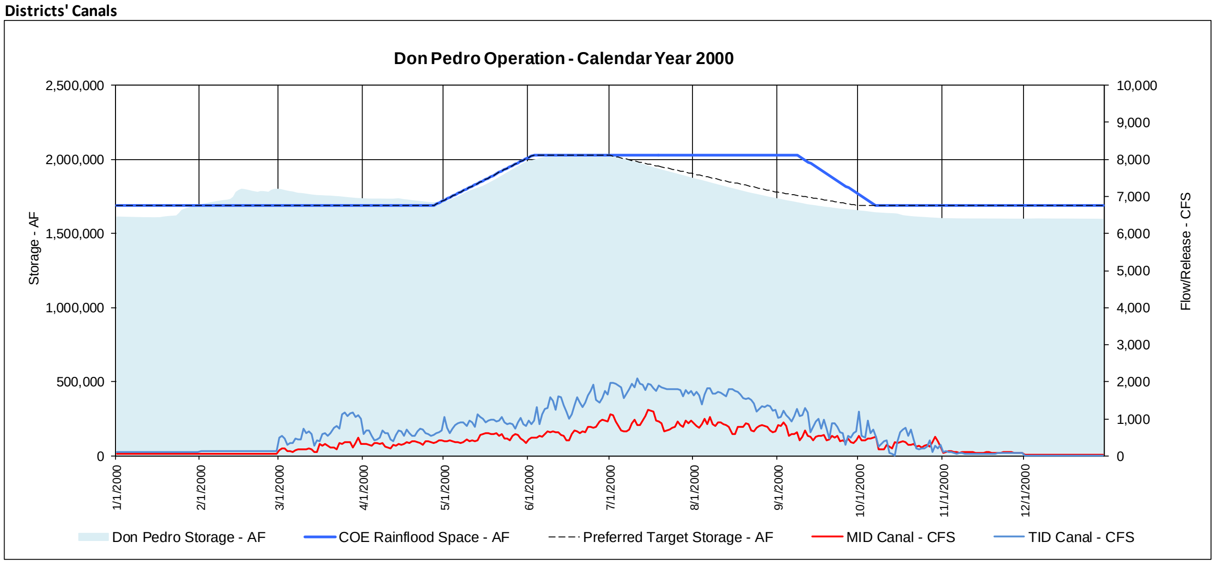
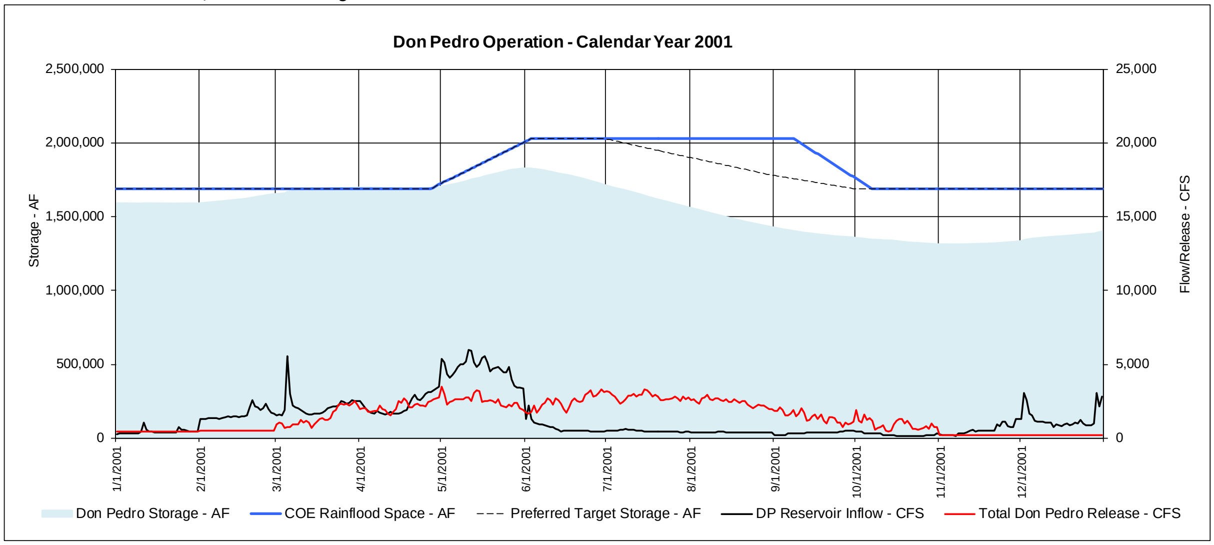
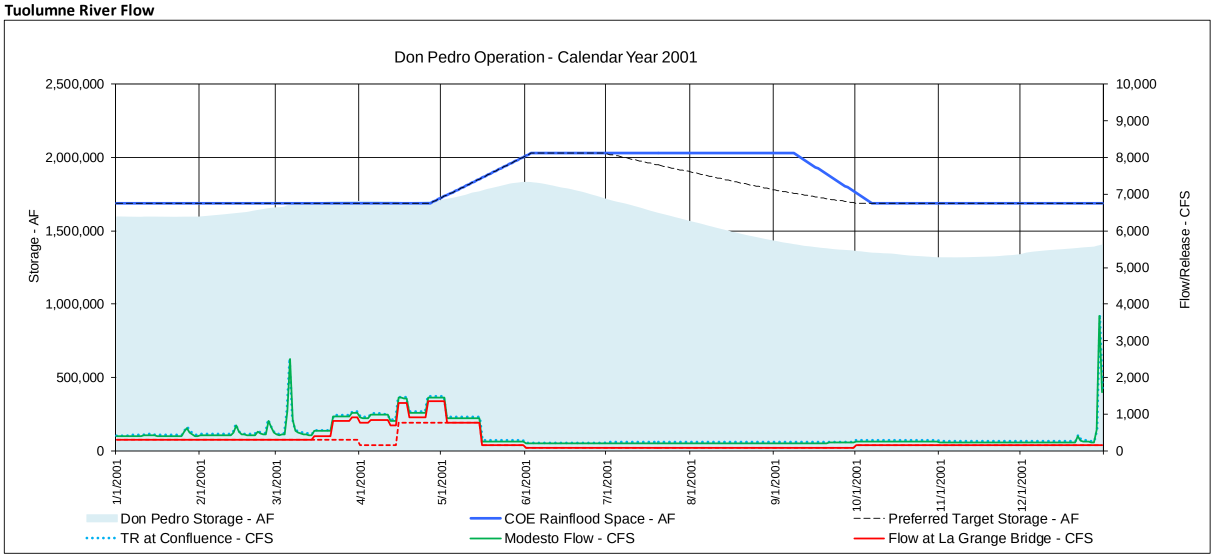


Figure 4-30. Don Pedro operations 2000 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

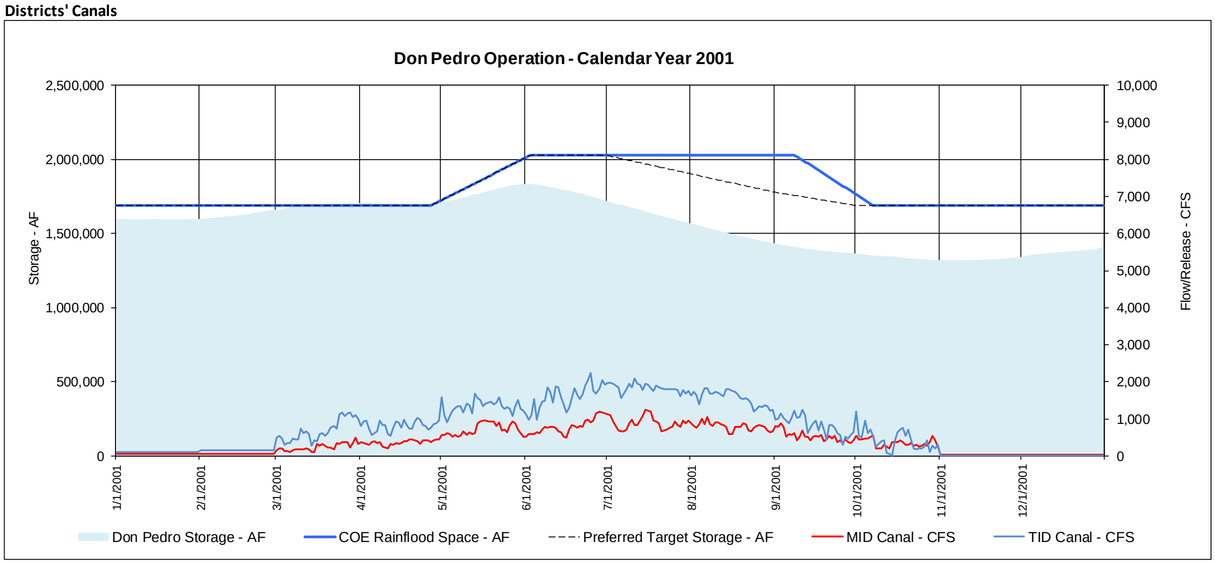
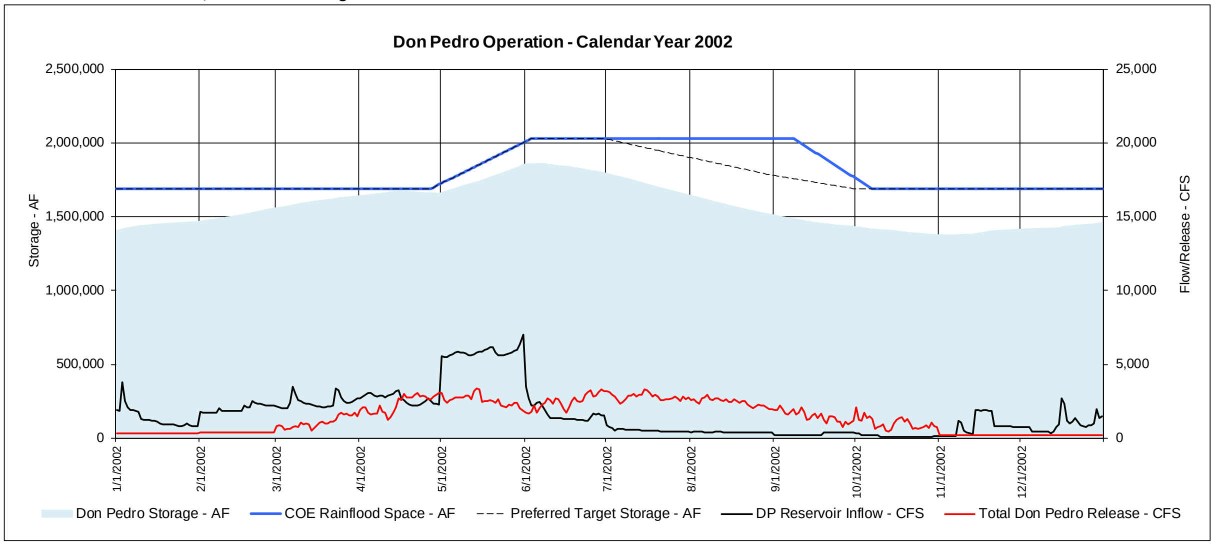
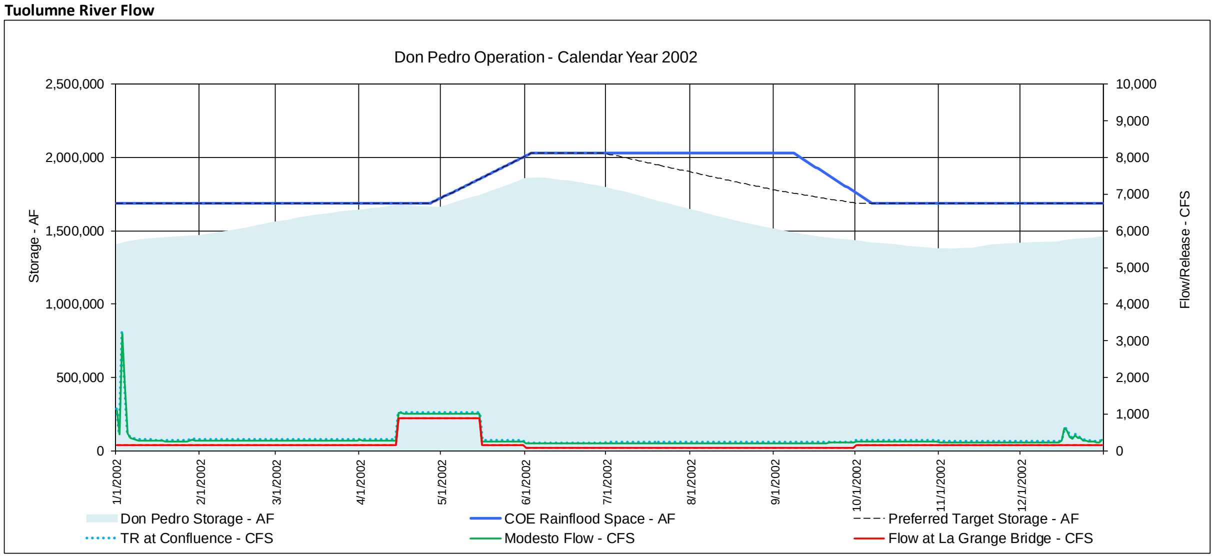


Figure 4-31. Don Pedro operations 2001 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

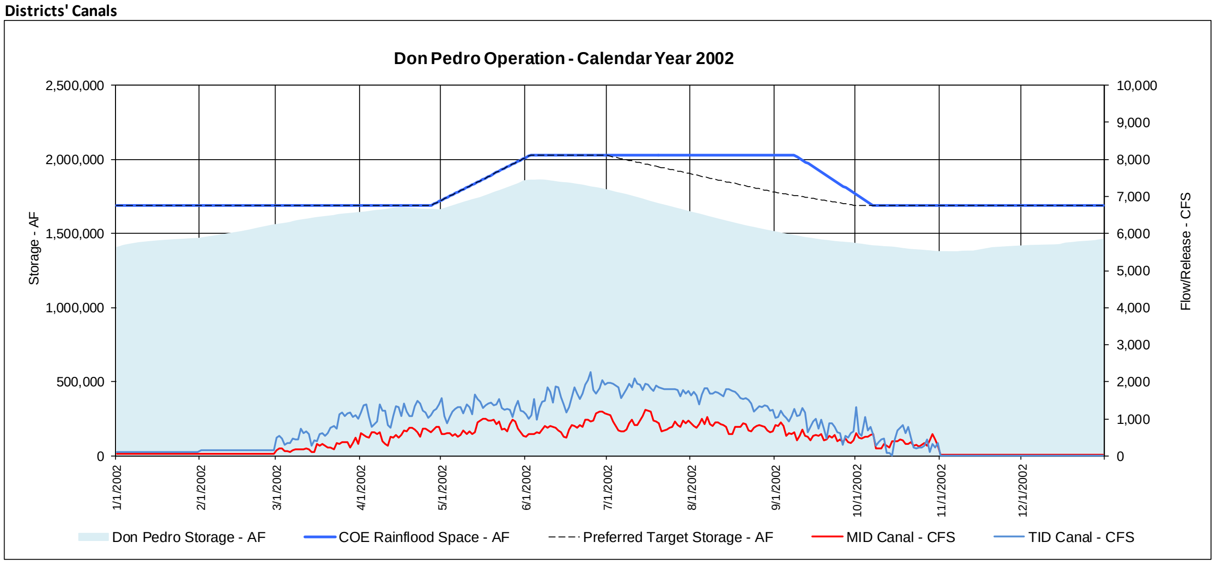
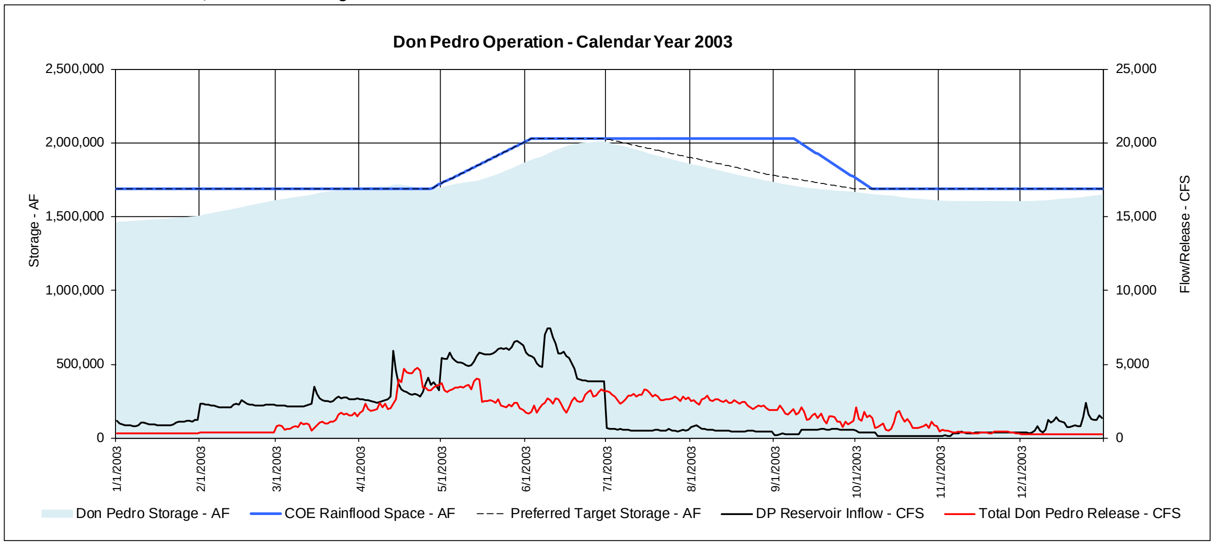
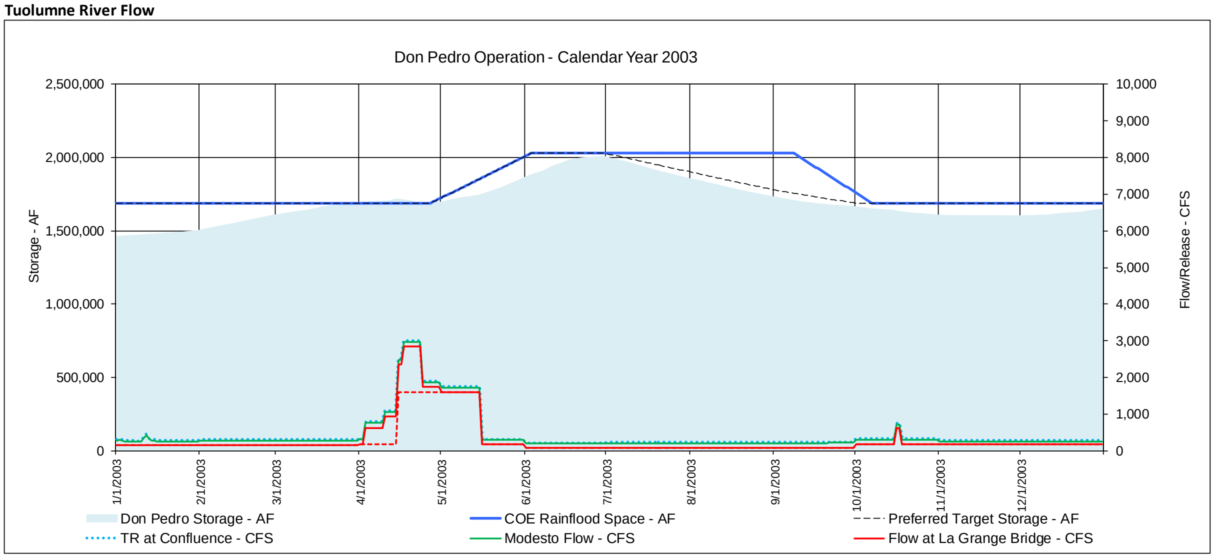


Figure 4-32. Don Pedro operations 2002 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

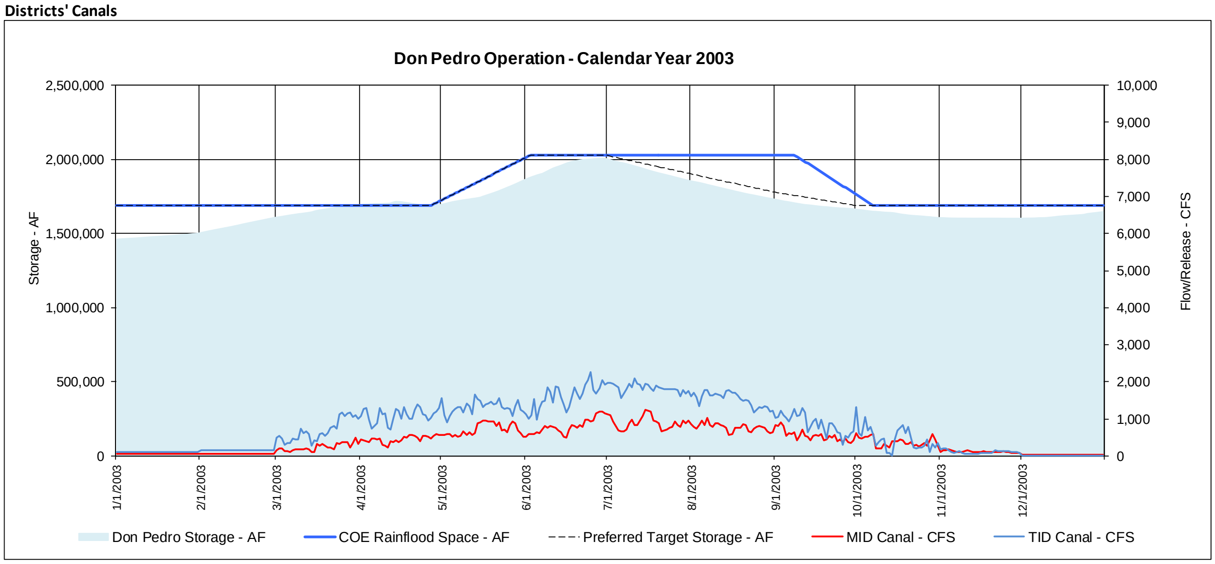
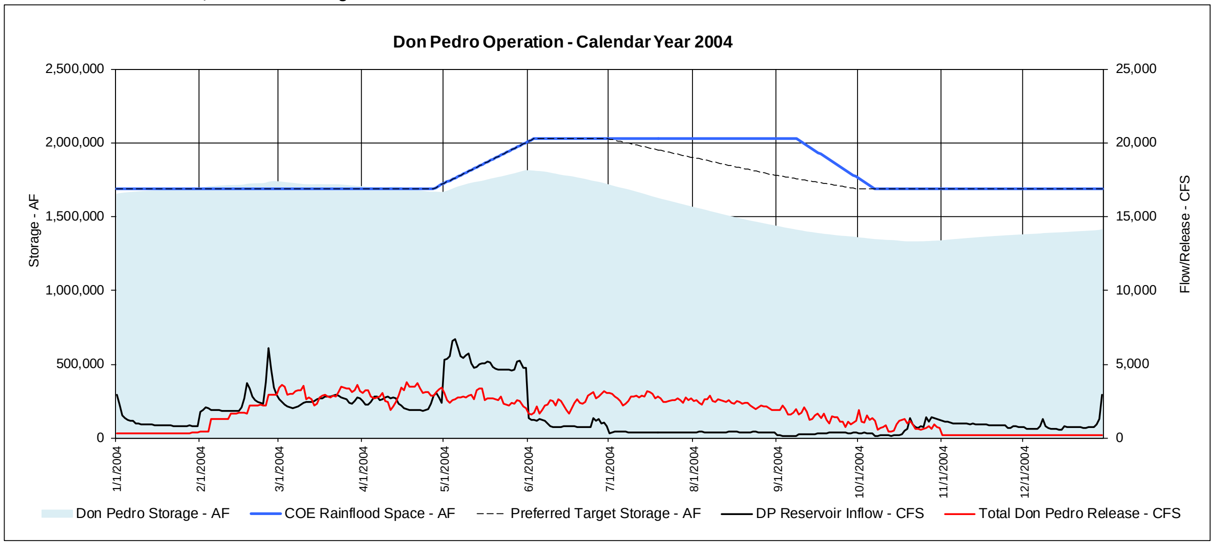
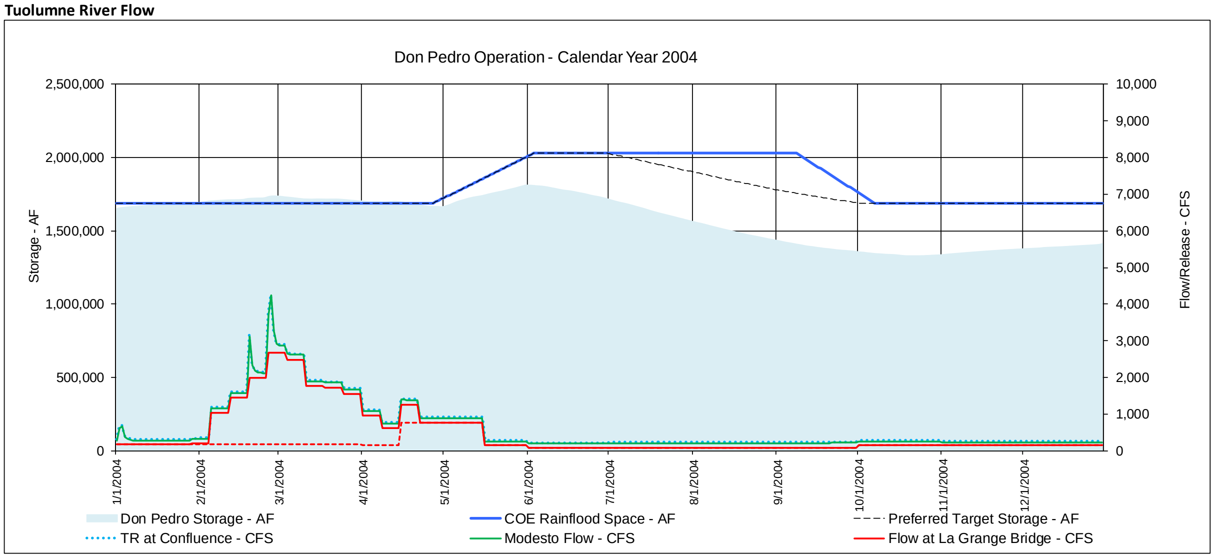


Figure 4-33. Don Pedro operations 2003 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

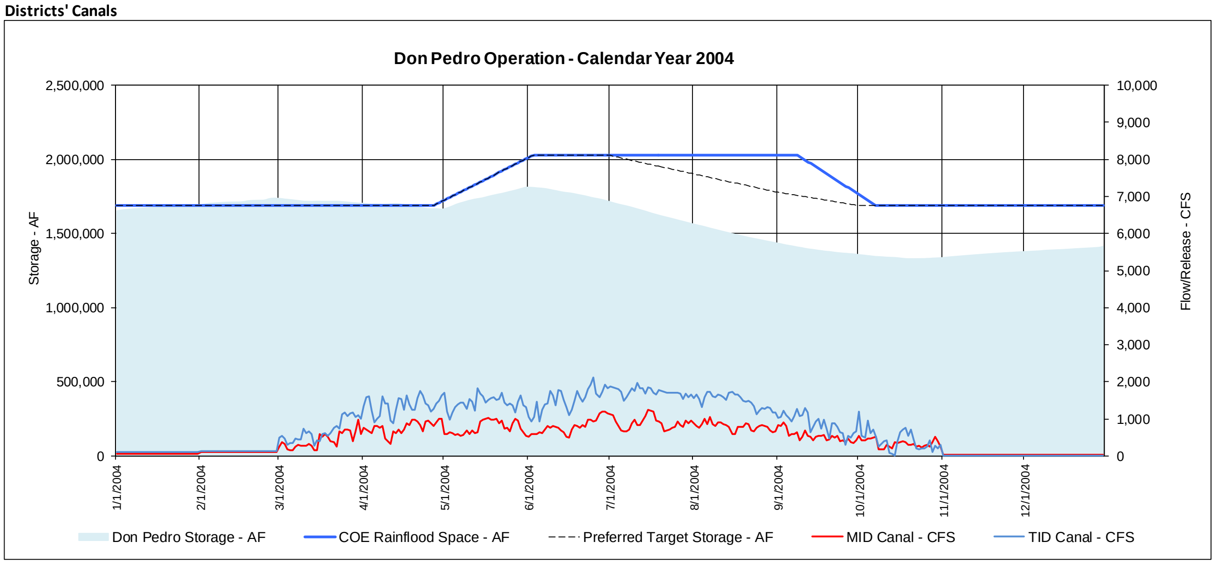
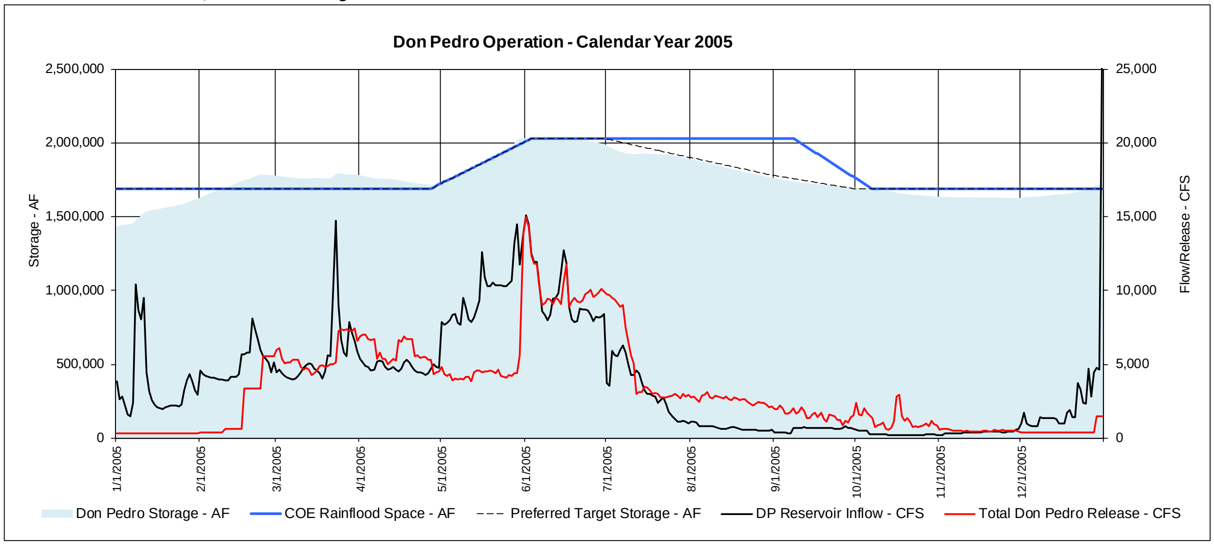
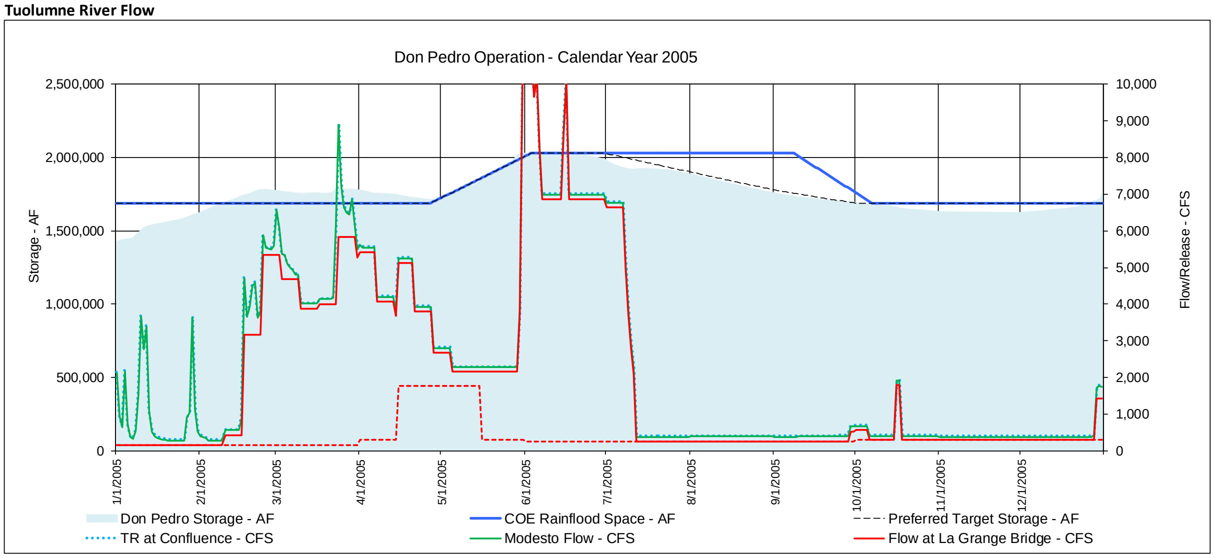


Figure 4-34. Don Pedro operations 2004 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

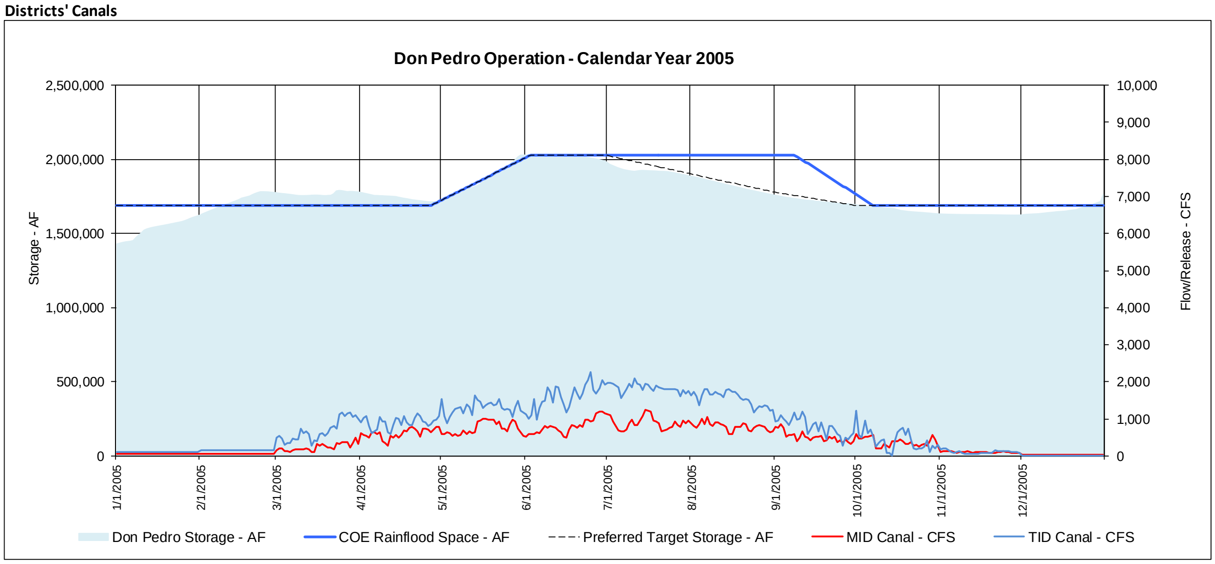
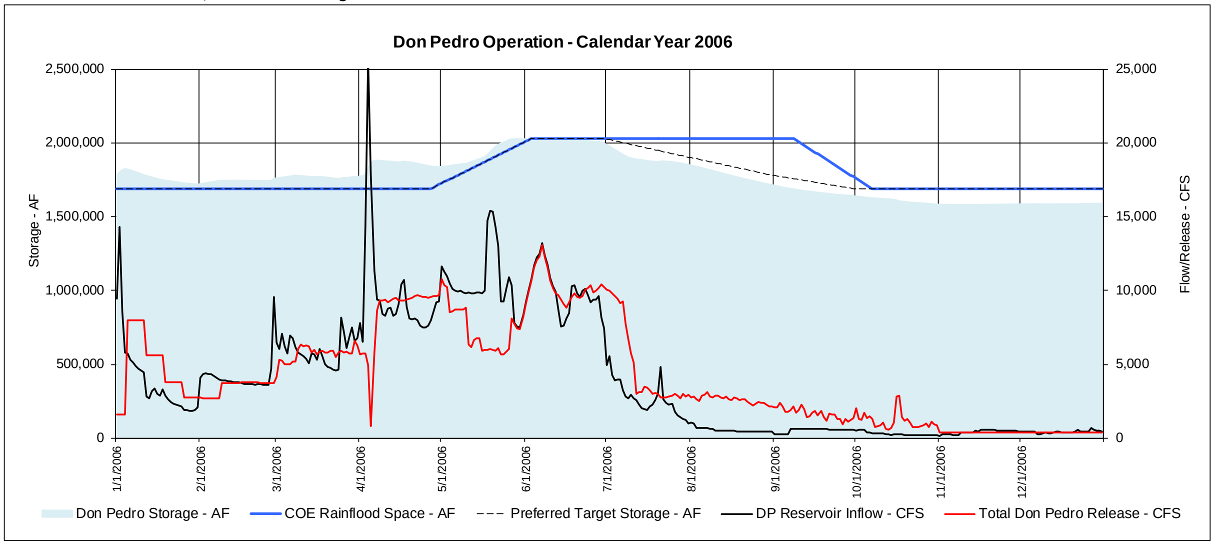
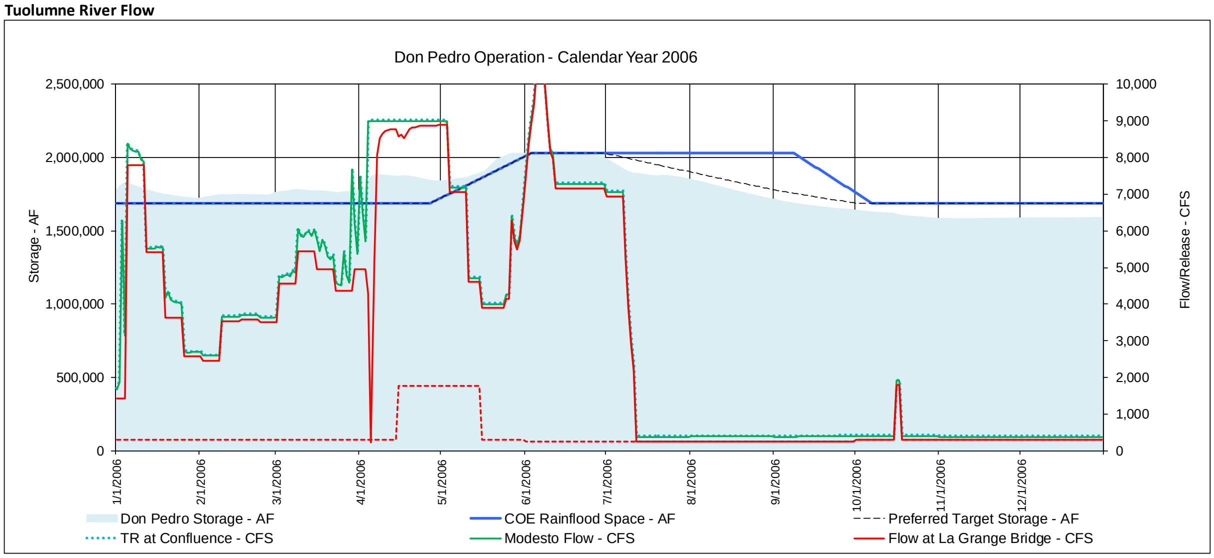


Figure 4-35. Don Pedro operations 2005 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

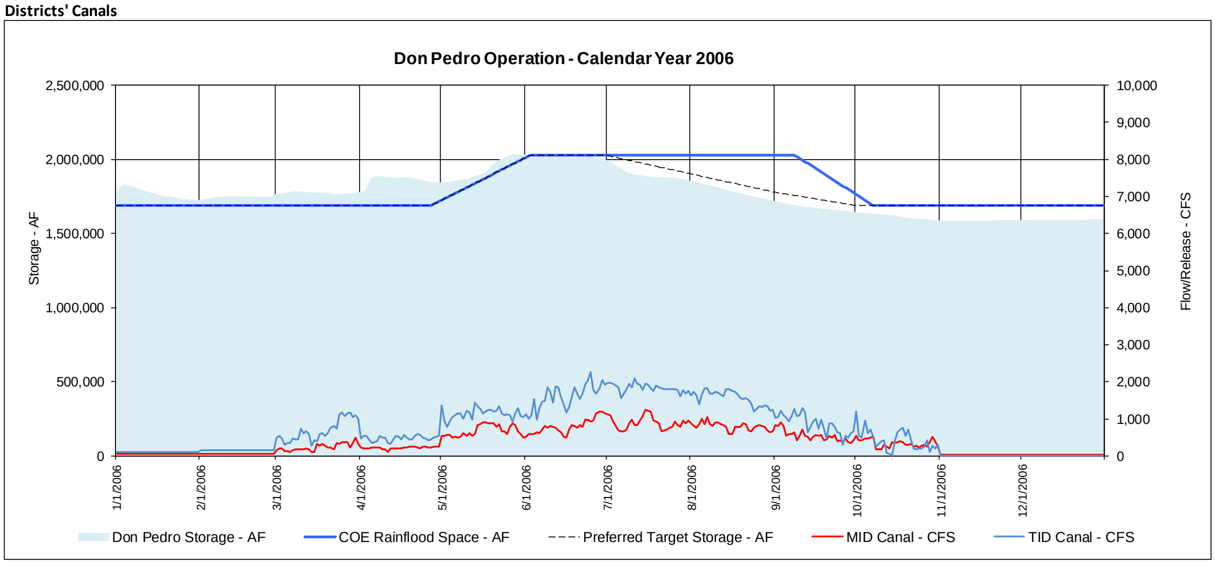
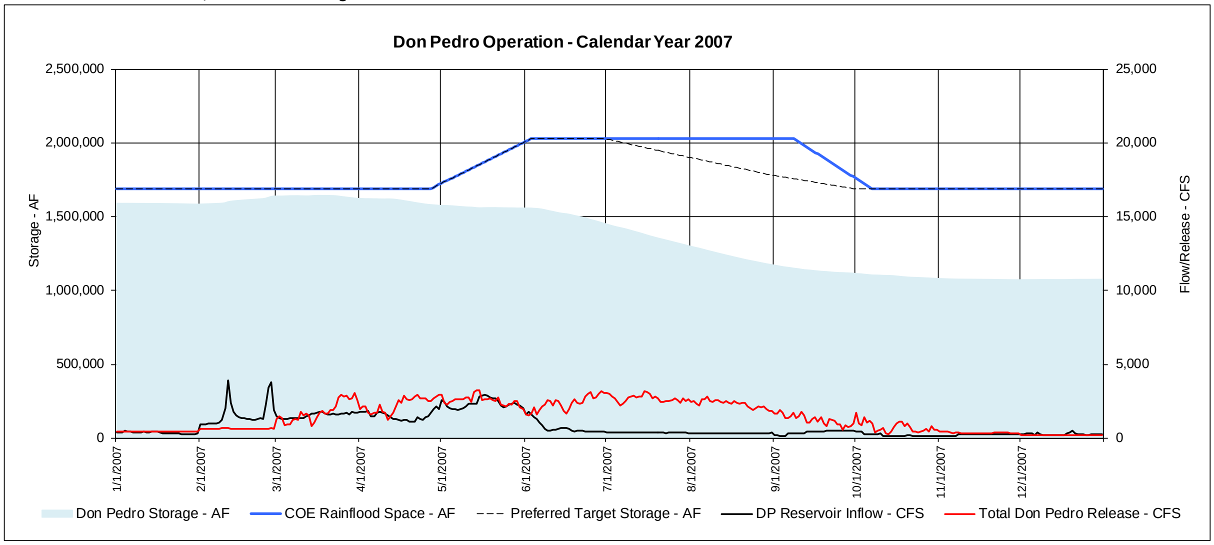
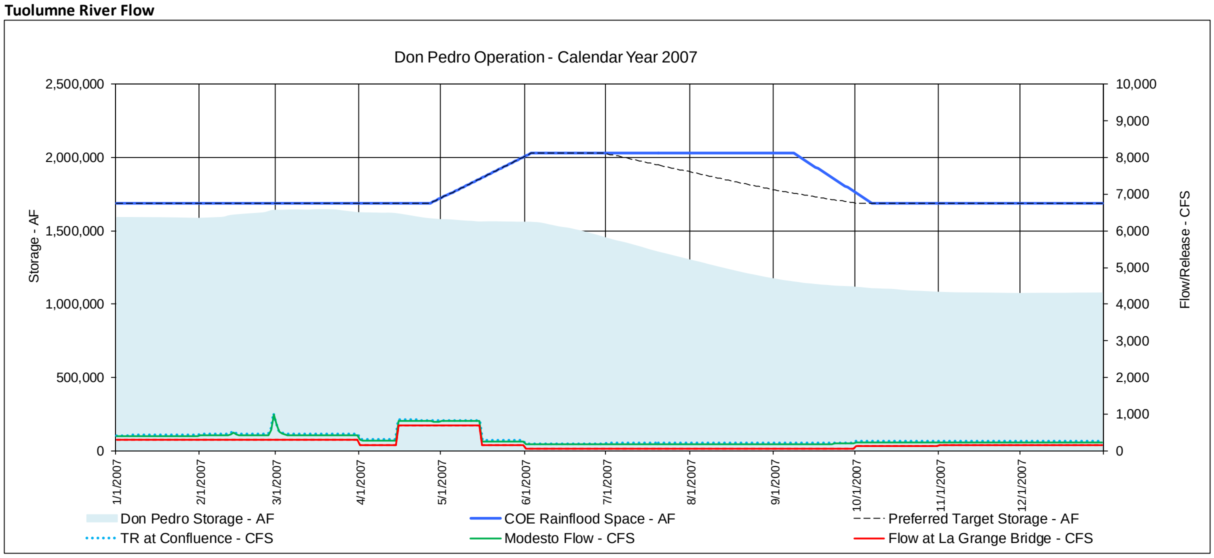


Figure 4-36. Don Pedro operations 2006 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

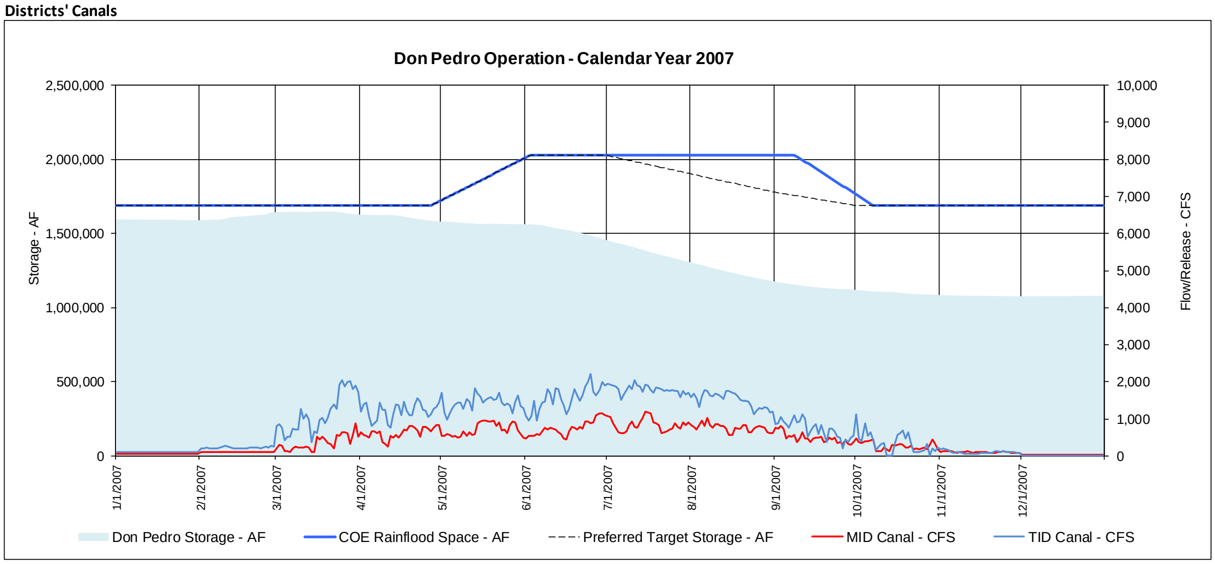
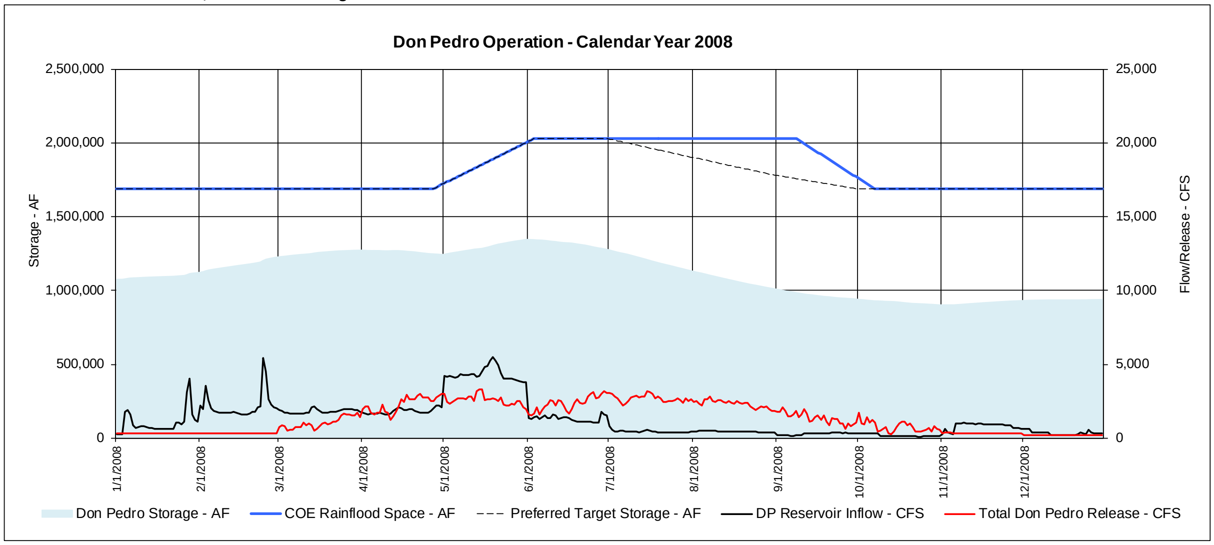
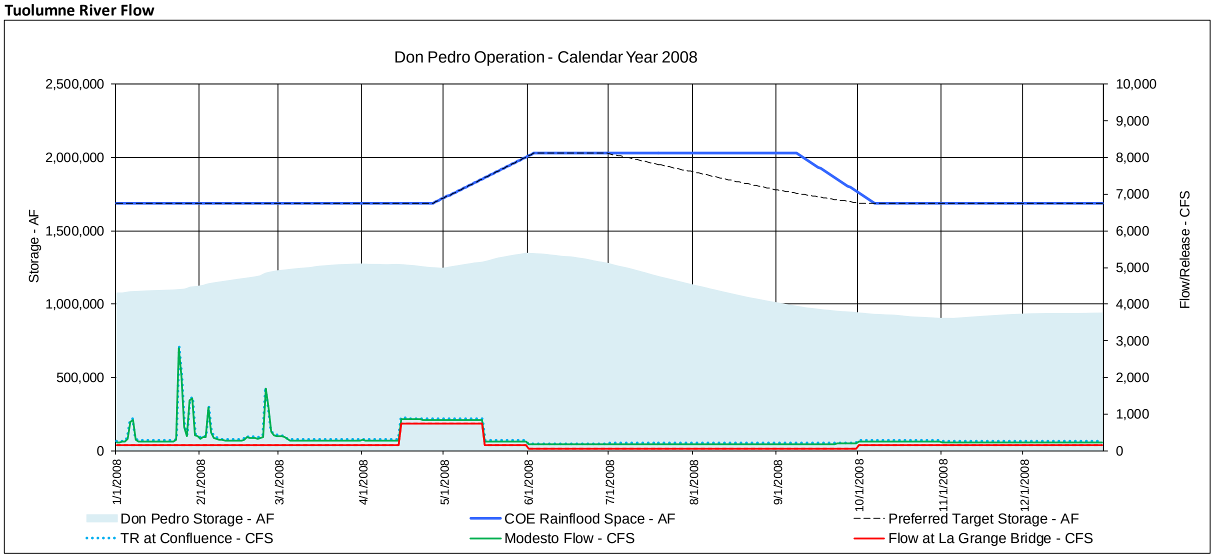


Figure 4-37. Don Pedro operations 2007 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

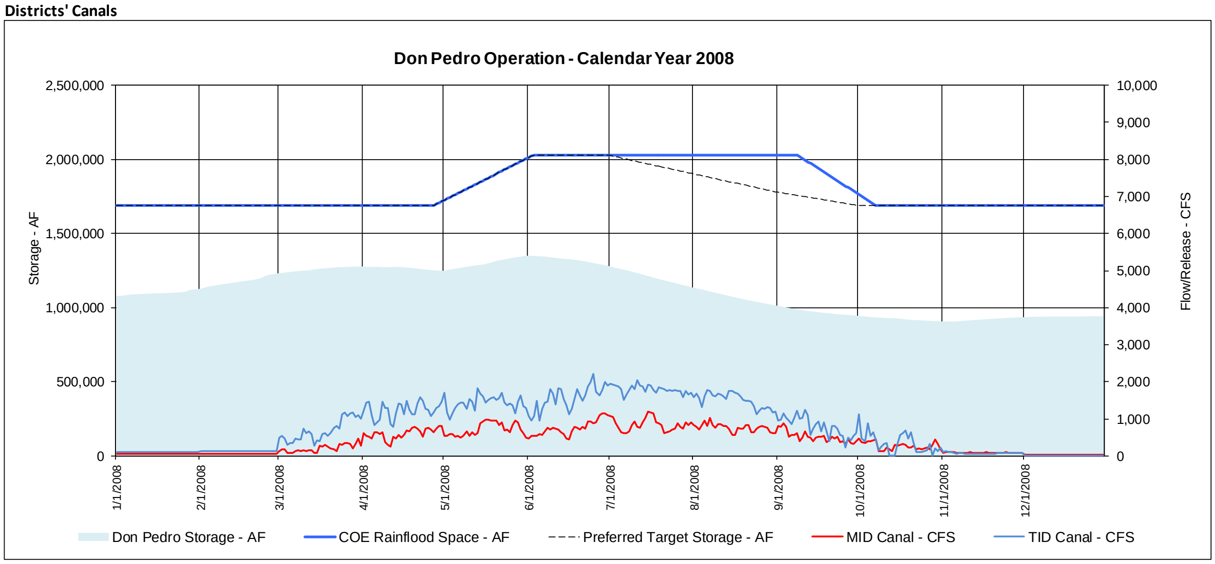
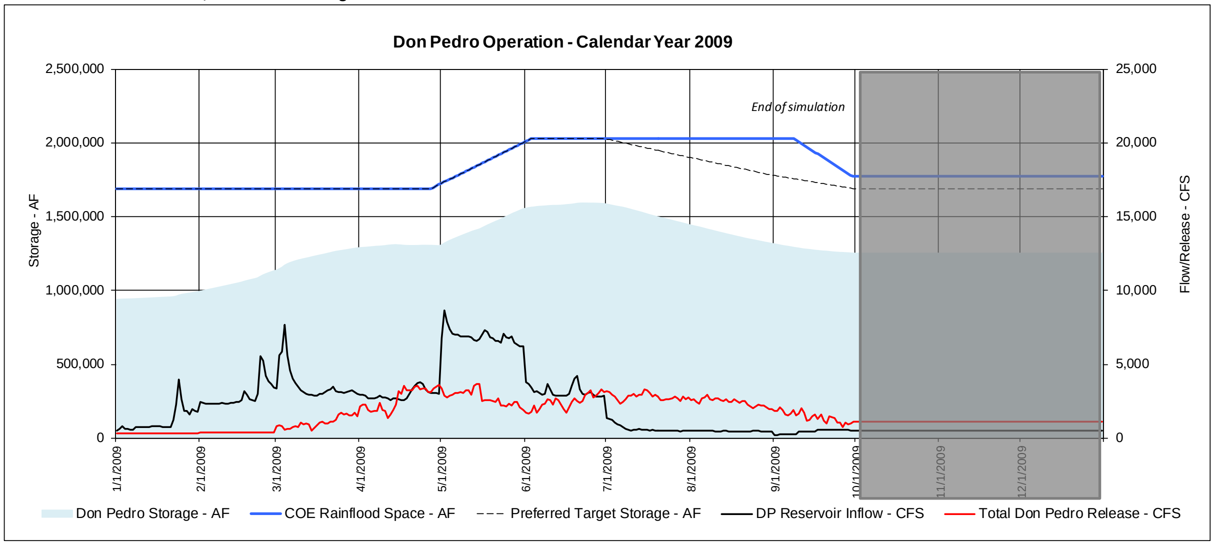
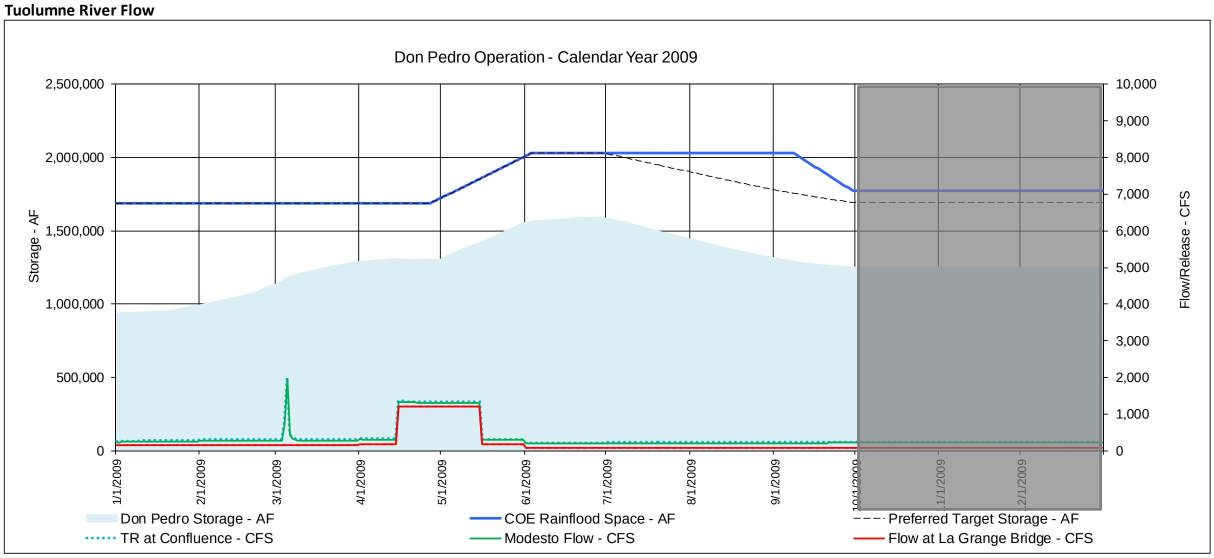


Figure 4-38. Don Pedro operations 2008 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

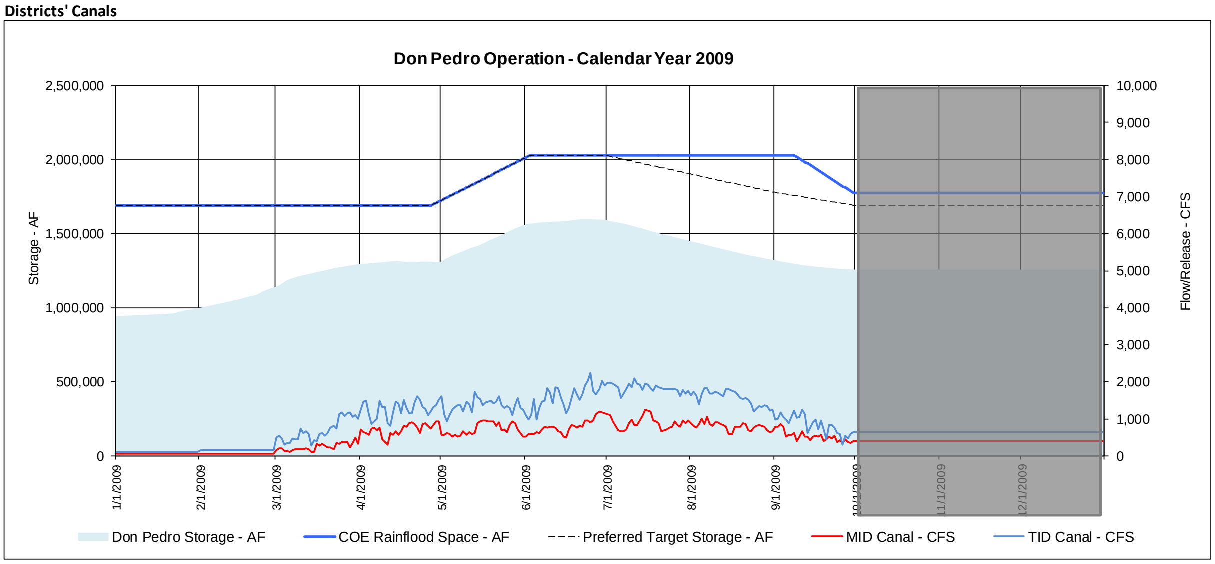


Figure 4-39. Don Pedro operations 2009 – Base Case.

Don Pedro Project
Project Operations/Water Balance Model Study Report
Attachment B – Model Description and User's Guide, Addendum 1
Revised 5-20-2013

1.0 INTRODUCTION

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) have developed a computerized Tuolumne River Daily Operations Model (Model) to assist in the relicensing of the Don Pedro Project (Project) (FERC Project 2299). The Model is fully described in the User's Guide submitted to FERC as part of the Initial Study Report (ISR), January 2013 (Model version 1.01). The purpose of the User's Guide is to describe the structure of the Model, the interfaces available for operation of the Model, and methods available for reviewing Model results. Procedures for development of input files for running scenarios for alternative future Project operations are also described and illustrated. The data presented in the ISR document referenced a "Test Case" simulation of operations for illustrative purposes. The test case was presented at a Workshop held with relicensing participants on December 7, 2012 for the purpose of training interested relicensing participants in the use of the Model.

Subsequent to the ISR submittal, the Districts proceeded to develop the "Base Case" which depicts the operation of the Don Pedro Project in accordance with the current FERC license, ACOE flood control management guidelines, and the Districts' irrigation and M&I water management practices. Under FERC policy, the Base Case represents the "No Action" alternative for purposes of evaluating future operation scenarios under NEPA. Future scenarios are compared to the Base Case to assess their impacts. As a result of the effort, including a collaborative refinement of the underlying hydrology of the Model completed at a Workshop held on March 27, 2013, several refinements and modifications to the Model have been implemented. The purpose of this Addendum 1 is to describe the refinements and modifications that have been made to the revised Model (Model Version 2.0) since the ISR submittal.

The Tuolumne River Daily Operations Model provides a depiction of the Don Pedro Project and City and County of San Francisco water operations consistent with the FERC-approved W&AR-02 study plan. The Model portrays operations that can be described systematically by various equations and algorithms. Actual project operations may vary from those depicted by the Model due to circumstantial and real-time conditions of hydrology and weather, facility operation, and human intervention. The FERC-approved study plan has identified a number of user-controlled variables. The fact that the Model provides these user-controlled inputs is not an indication that either the Districts or CCSF endorse or support any specific operational alternative developed by manipulating these inputs.

2.0 MODEL LOGIC AND EXECUTION MODIFICATIONS

Several Model logic routines were modified to provide a better or more adaptable depiction of Project operations. The specific areas of Project operations that were modified included the depiction of the current minimum flow requirements of the Don Pedro Project for the lower Tuolumne River and the reservoir operation logic during June and early July when Don Pedro Reservoir is filling. The simulation of power generation from the Project has also been revised as mentioned in the December 7, 2012 Workshop.

2.1 Don Pedro Reservoir Snow-melt Management

User's Guide reference: Section 5.12: "DonPedro" Worksheet, Section 5.12.3 Snow-melt Management

The Model computes a daily operation of Don Pedro Reservoir. Each day Don Pedro Reservoir inflow is computed from upstream CCSF System operations and unregulated inflow. The minimum stream flow requirements and the MID and TID canal diversions are assumed as the release from Don Pedro Reservoir. The prior day's reservoir evaporation is included in the calculation. If the computation produces a Don Pedro Reservoir storage value in excess of a preferred storage target, an "encroachment" is computed. If an encroachment occurs, a "check" release is computed. It is assumed that a constant supplemental "check" release (in excess of minimum releases) will be initiated. This protocol repeats itself periodically, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic "hard" releases of water to exactly conform to the target reservoir level.

A second check release is made during the April through June period for management of anticipated snow-melt runoff. Model Version 1.01 provided logic that on the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir from the date of forecast through the end of June (the assumed target date of reservoir filling). These forecasts determine the snow-melt "check" release volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. The snow-melt check release is evenly distributed across the days of the month. The release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir (2,030,000 acre-feet, elevation 830 ft) allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the Model to not exceed this storage capacity.

Through testing of alternative Model scenarios it was discovered that Version 1.01 logic could produce erratic reservoir release results during early July, whereby a relatively constant release through the end of June could be followed by an erratic large release during the first part of July. The cause of the circumstance was the result of requiring the "filling" date of the reservoir to be the end of June. The assumption could lead to a full reservoir at the end of June while substantial inflow could subsequently occur. With no empty reservoir space remaining the Model would essentially pass inflow without modulation and in some circumstances large releases in excess of downstream flood control objectives. To remedy this outcome the Model was modified to extend

the June snow-melt release check logic through July 7. All computational procedures for June remained the same except the time period upon which hydrologic information was known or assumed extends through July 7. Figure 2.1-1 illustrates the location of the revised logic within the DonPedro Worksheet, within the June computation section and designated by notes concerning the June through July 7 computational period.

Also newly incorporated into the snow-melt logic routine for the entire April through July 7 period is release change "smoothing" logic which can lessen the occurrence of modeled erratic release reductions that would otherwise sometimes occur during the transition from one month's computed release to the next month's computed release. During periods when the snow-melt release computation is controlling reservoir releases, user-defined values can be specified for a threshold and a rate of change that can occur from one day to the next. The threshold (C 1.13, "Control" Worksheet) defines the level of flow of the previous day for which a constraint to a next-day release reduction will occur, and the fraction (C 1.14, "Control" Worksheet) defines the reduced flow rate that can occur the next day. By illustration, if a previous day's flow is 2,500 cfs or greater, the next day's flow cannot be less than 0.75 of the previous day's flow. This logic does not represent any known "ramping" constraints, but the protocol provides additional guidance to Model release decisions and produces reasonable results.

	A	B	C	D	AS	AT	AU	AV	AW	AX	AY	BA	BB	BC	BD	BE	BF	BG	BI	BK	BL	BM	BN	BO
1			1																					
2	Unit Title		2																CFS	CFS	CFS	CFS	CFS	CFS
3	Parameter Title		3																Target SM Re	Dry Creek	LTR Accr	Tot Unreg	Trg Max L(	Modesto F
4																								
5	Acre-foot to CFS conversion																							
6	divide by :	1.983471			Lookup of	Est of	Uses	Compute	Compute	Compute	Amount	Lookup of	Est of	Uses	Compute	Compute	Compute	Amount						
7					1-May	May-Jun	Current Yr	Upstream	Availble	Total	to be	Actual	Actual	Current Yr	Upstream	Availble	Total	to be						
8					90% Exc	Portion	Canal +	Adjust	DP Stor	Excess	Released	Jun-Jul 7	Jun-Jul 7	Canal +	Adjust	DP Stor	Excess	Released	0	Original equation w/o release ramping constraint				
9					Apr-Jul	of	Min River	to	through	May-Jun	during	Runoff	Runoff	Min River	to	through	Jun-Jul 7	during	2,500	Prior day ramping threshold (C 1.13)				
10					Runoff	Apr-Jul	+Typ Evap	UF	June	Release	May			+Typ Evap	UF	7-Jul	Release	Period	0.75	Fraction of prior day flow for ramping (C 1.14)				
11																								
12																								
13		39-year Ave or Max			49	% May/May MJ					(C 1.20)							(C 1.30)					(C 1.00)	
14		Min			38	% Jun/May MJ		% of May-Jun excess rel in May			50						% of June excess rel in June-Jul 7	100				Enter Modesto FC Target:	9,000	CFS
15					May Snow-melt Release Routine							June - July 7 Snow-melt Release Routine								Modesto Flood Control Flow Objective				
16					May							June - July 7							Target	Report	Est	Total	Target	Calc
17	Month				1-May	1-May	M-Jun	M-Jun	M-Jun	M-Jun	May	June -	June -	Period	Period	Period	Period	Period	SM	Dry Creek	LTR Acc	Unreg	Max	Modesto
18	Index	Date	Day	Days	A-Jul Fcst	MJune Fcst	Can+Riv+E	USAdj	DP Avail	Excess	SM Rel	July 7 UF	July 7 UF	Can+Riv+E	USAdj	DP Avail	Excess	SM Rel	Release	Flow	Flow	Blw LG	LaGrange	Flow
19					TAF	TAF	AF	AF	AF	AF	CFS	TAF	TAF	AF	AF	AF	AF	CFS	CFS	CFS	CFS	CFS	CFS	CFS
20	1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
21	1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
22	1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
23	1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
24	1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
25	1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
26	1970.10	10/7/1970	W	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
27	1970.10	10/8/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
28	1970.10	10/9/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
29	1970.10	10/10/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410

Figure 2.1-1. Snow-melt management section.

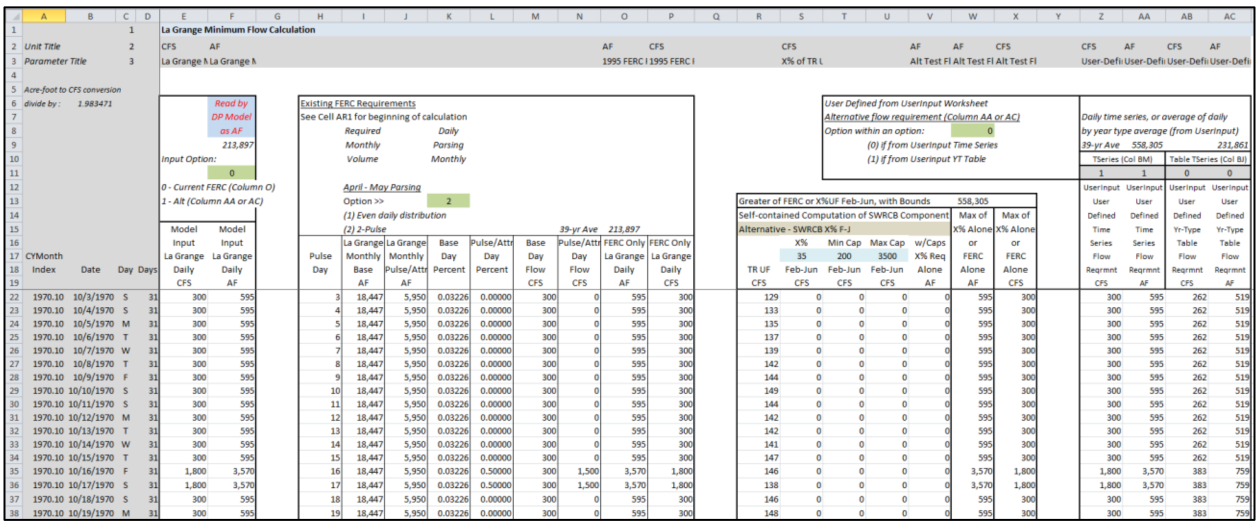
2.2 Don Pedro Current Minimum Flow Requirement

User's Guide reference: Section 5.17: "LaGrangeSchedule" Worksheet, Section 5.17.1 Minimum Flow Requirement Options, Section 5.17.2 April-May Daily Parsing of Flow Requirements, and Section 5.17.3 Computation of 1995 FERC Minimum Flow Requirement

The FERC license for the Don Pedro Project requires flow releases from Don Pedro Reservoir to the lower Tuolumne River. These flows are measured at the USGS gage downstream of the La Grange diversion dam. To keep the Don Pedro Reservoir required flow releases distinct from Don Pedro Reservoir releases in general the model designates "LaGrangeSchedule" Worksheet for assemblage of the minimum flow requirement for the lower Tuolumne River. By user specification (UI 1.10) either the current 1995 FERC schedule is selected (UI 1.10 = 0) or the

user defined minimum flow requirement is selected (UI 1.10 = 1). If the current 1995 FERC schedule is selected the computation of the schedule is computed in this worksheet.

When using current 1995 FERC minimum flow requirements, Version 1.01 (Switch C 1.60, “Control” Worksheet) allowed the user to direct the daily shape of release for pulse flows during April and May. Version 2.0 continues to allow the shaping of April-May migration flows to the lower Tuolumne River and also allows a shaping of October attraction flows. Figure 2.2-1 illustrates the parsing of the monthly flow requirements into daily flow requirements. The structure of this section of the worksheet is mostly the same as before, except the monthly/daily flow requirements have now been defined by “base” and “pulse” components. Also, a computational procedure has been added for October to prescribe current FERC-defined attraction flows.


La Grange Minimum Flow Calculation
Unit Title 2 | CFS | AF | AF | CFS | CFS | AF | AF | CFS | CFS | AF | CFS | AF
Parameter Title 3 | La Grange M | La Grange M | 1995 FERC I | 1995 FERC I | X% of TR U | Alt Test Fl | Alt Test Fl | Alt Test Fl | User-Defi | User-Defi | User-Defi | User-Defi
Acre-foot to CFS conversion
divide by : 1.983471
Read by DP Model as AF
213,897
Input Option: 0
0 - Current FERC (Column O)
1 - Alt (Column AA or AC)
Existing FERC Requirements
See Cell AR1 for beginning of calculation
Required Monthly Volume | Daily Parsing Monthly
April - May Parsing
Option >> 2
(1) Even daily distribution
(2) 2-Pulse
39-yr Ave 213,897
User Defined from UserInput Worksheet
Alternative flow requirement (Column AA or AC)
Option within an option: 0
(0) if from UserInput Time Series
(1) if from UserInput YT Table
Daily time series, or average of daily by year type average (from UserInput)
39-yr Ave 558,305 231,861
TSeries (Col BM) 1 1 | Table TSeries (Col BJ) 0 0
Greater of FERC or X%UF Feb-Jun, with Bounds 558,305
Self-contained Computation of SWRCB Component
Alternative - SWRCB X% F-J

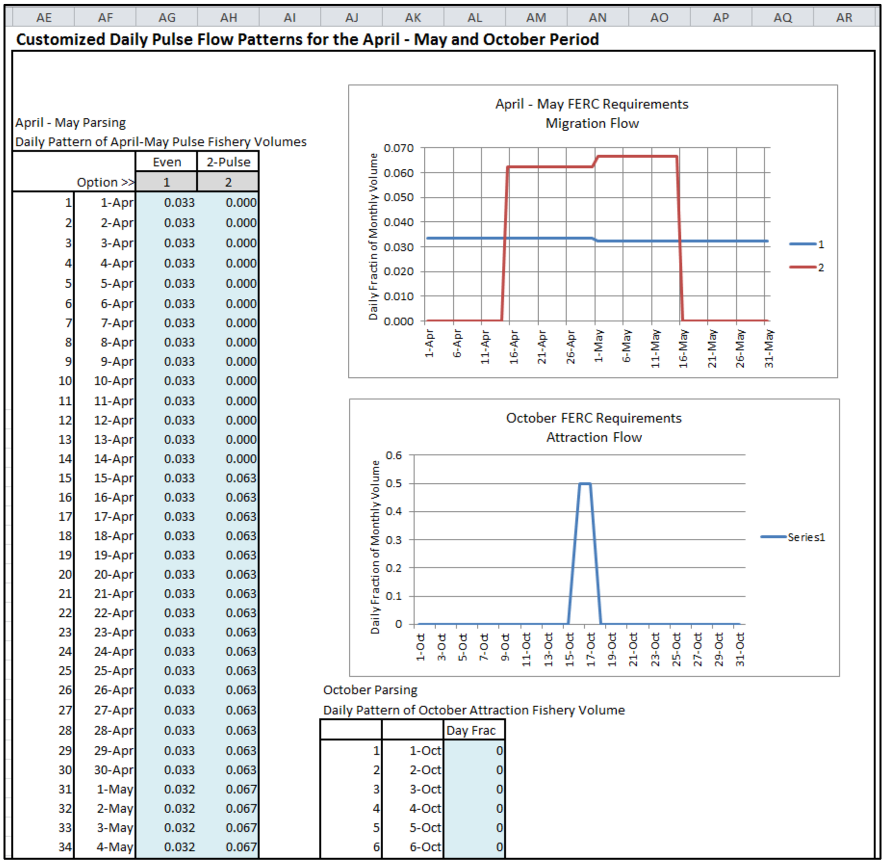
Row	CYMonth Index	Date	Day	Days	Model Input La Grange Daily CFS	Model Input La Grange Daily AF	Pulse Day	La Grange Monthly Base AF	La Grange Monthly Pulse/Attr AF	Base Day Percent	Pulse/Attr Day Percent	Base Day Flow CFS	Pulse/Attr Day Flow CFS	FERC Only La Grange Daily AF	FERC Only La Grange Daily CFS	TR UF CFS	X% 35 Feb-Jun CFS	Min Cap 200 Feb-Jun CFS	Max Cap 3500 Feb-Jun CFS	w/Caps X% Req Alone AF	Max of X% Alone or FERC Alone AF	Max of X% Alone or FERC Alone CFS	UserInput User Defined Time Series Flow Reqrmnt CFS	UserInput User Defined Time Series Flow Reqrmnt AF	UserInput User Defined Yr-Type Table Flow Reqrmnt CFS	UserInput User Defined Yr-Type Table Flow Reqrmnt AF
22	1970.10	10/3/1970	S	31	300	595	3	18,447	5,950	0.03226	0.00000	300	0	595	300	129	0	0	0	0	595	300	300	595	262	519
23	1970.10	10/4/1970	S	31	300	595	4	18,447	5,950	0.03226	0.00000	300	0	595	300	133	0	0	0	0	595	300	300	595	262	519
24	1970.10	10/5/1970	M	31	300	595	5	18,447	5,950	0.03226	0.00000	300	0	595	300	135	0	0	0	0	595	300	300	595	262	519
25	1970.10	10/6/1970	T	31	300	595	6	18,447	5,950	0.03226	0.00000	300	0	595	300	137	0	0	0	0	595	300	300	595	262	519
26	1970.10	10/7/1970	W	31	300	595	7	18,447	5,950	0.03226	0.00000	300	0	595	300	139	0	0	0	0	595	300	300	595	262	519
27	1970.10	10/8/1970	T	31	300	595	8	18,447	5,950	0.03226	0.00000	300	0	595	300	142	0	0	0	0	595	300	300	595	262	519
28	1970.10	10/9/1970	F	31	300	595	9	18,447	5,950	0.03226	0.00000	300	0	595	300	144	0	0	0	0	595	300	300	595	262	519
29	1970.10	10/10/1970	S	31	300	595	10	18,447	5,950	0.03226	0.00000	300	0	595	300	149	0	0	0	0	595	300	300	595	262	519
30	1970.10	10/11/1970	S	31	300	595	11	18,447	5,950	0.03226	0.00000	300	0	595	300	144	0	0	0	0	595	300	300	595	262	519
31	1970.10	10/12/1970	M	31	300	595	12	18,447	5,950	0.03226	0.00000	300	0	595	300	142	0	0	0	0	595	300	300	595	262	519
32	1970.10	10/13/1970	T	31	300	595	13	18,447	5,950	0.03226	0.00000	300	0	595	300	142	0	0	0	0	595	300	300	595	262	519
33	1970.10	10/14/1970	W	31	300	595	14	18,447	5,950	0.03226	0.00000	300	0	595	300	141	0	0	0	0	595	300	300	595	262	519
34	1970.10	10/15/1970	T	31	300	595	15	18,447	5,950	0.03226	0.00000	300	0	595	300	147	0	0	0	0	595	300	300	595	262	519
35	1970.10	10/16/1970	F	31	1,800	3,570	16	18,447	5,950	0.03226	0.50000	300	1,500	3,570	1,800	146	0	0	0	0	3,570	1,800	1,800	3,570	383	759
36	1970.10	10/17/1970	S	31	1,800	3,570	17	18,447	5,950	0.03226	0.50000	300	1,500	3,570	1,800	138	0	0	0	0	3,570	1,800	1,800	3,570	383	759
37	1970.10	10/18/1970	S	31	300	595	18	18,447	5,950	0.03226	0.00000	300	0	595	300	146	0	0	0	0	595	300	300	595	383	759
38	1970.10	10/19/1970	M	31	300	595	19	18,447	5,950	0.03226	0.00000	300	0	595	300	148	0	0	0	0	595	300	300	595	383	759

Figure 2.2-1. Daily parsing of FERC flow requirement from Don Pedro Reservoir.

Figure 2.2-2 illustrates the area for entry of data to parse monthly-designated migration and attraction flow requirements into daily patterns during April, May and October. The “Control” Worksheet designates which parsing pattern is to be used for April and May. The examples illustrate the entry for an evenly distributed pattern of migration flow volume during the April-May 61-day period, and a pattern for which the migration flow volume (by daily fraction of the volume) has been divided between April (16 days) and May (15 days). The migration flow volume for each month has been evenly distributed during each day of the partial month period. These daily migration flows are added to the base flow component of each month. The parsing of the attraction flow volume during the month of October is similarly defined. In this example the attraction flow volume (by daily fraction of the volume) for October is distributed evenly over a two-day period beginning October 15.

Figure 2.2-3 illustrates the section of the worksheet that defines the current 1995 FERC flow requirement from Don Pedro Reservoir. Several elements of information provided in this worksheet and from the “Control” Worksheet provide the computation of flow requirement based on 1995 FERC Settlement procedures and flow rates. The basis of the year type flow requirements is the SWRCB San Joaquin River Basin 60-20-20 index. The annual flow

schedules are assumed to be on an April through March year, with the interpolation water of the schedules applied to April and May pulse flows. For modeling convenience the explicit FERC requirements for October base and attraction flows have been slightly modified to adapt into the evenly daily distributed base flow component of the Model.



		Even	2-Pulse
	Option >>	1	2
1	1-Apr	0.033	0.000
2	2-Apr	0.033	0.000
3	3-Apr	0.033	0.000
4	4-Apr	0.033	0.000
5	5-Apr	0.033	0.000
6	6-Apr	0.033	0.000
7	7-Apr	0.033	0.000
8	8-Apr	0.033	0.000
9	9-Apr	0.033	0.000
10	10-Apr	0.033	0.000
11	11-Apr	0.033	0.000
12	12-Apr	0.033	0.000
13	13-Apr	0.033	0.000
14	14-Apr	0.033	0.000
15	15-Apr	0.033	0.063
16	16-Apr	0.033	0.063
17	17-Apr	0.033	0.063
18	18-Apr	0.033	0.063
19	19-Apr	0.033	0.063
20	20-Apr	0.033	0.063
21	21-Apr	0.033	0.063
22	22-Apr	0.033	0.063
23	23-Apr	0.033	0.063
24	24-Apr	0.033	0.063
25	25-Apr	0.033	0.063
26	26-Apr	0.033	0.063
27	27-Apr	0.033	0.063
28	28-Apr	0.033	0.063
29	29-Apr	0.033	0.063
30	30-Apr	0.033	0.063
31	1-May	0.032	0.067
32	2-May	0.032	0.067
33	3-May	0.032	0.067
34	4-May	0.032	0.067

		Day Frac
1	1-Oct	0
2	2-Oct	0
3	3-Oct	0
4	4-Oct	0
5	5-Oct	0
6	6-Oct	0

Figure 2.2-2. Daily parsing of FERC migration and attraction flow.

FERC Flow Schedules

Year Type	1	2	3	4	5	6	7	Adapted October 6	
Oct 1-15 (CFS)	100	100	150	150	180	200	300	188	*October has been modified from*
Oct 16-31 (CFS)	150	150	150	150	180	175	300	188	*explicit FERC Schedule for modeling*
Total Base (AF)	7,736	7,736	9,223	9,223	11,068	11,504	18,447	11,560	*simplicity. Split-month base flow has*
Attraction (AF)	0	0	0	0	1,676	1,736	5,950	1,680	*been levelized.*
Total Oct (AF)	7,736	7,736	9,223	9,223	12,744	13,240	24,397	13,240	
Nov (CFS)	150	150	150	150	180	175	300		
AF	8,926	8,926	8,926	8,926	10,711	10,413	17,852		
Dec (CFS)	150	150	150	150	180	175	300		
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447		
Jan (CFS)	150	150	150	150	180	175	300		
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447		
Feb (CFS)	150	150	150	150	180	175	300		
AF	8,331	8,331	8,331	8,331	9,997	9,719	16,661		
Mar (CFS)	150	150	150	150	180	175	300		
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447		
Apr (CFS)	150	150	150	150	180	175	300		
AF	8,926	8,926	8,926	8,926	10,711	10,413	17,852		
May (CFS)	150	150	150	150	180	175	300		
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447		
Migration Flow									
AF	11,091	20,091	32,619	37,060	35,920	60,027	89,882		
Jun (CFS)	50	50	50	75	75	75	250		
AF	2,975	2,975	2,975	4,463	4,463	4,463	14,876		
Jul (CFS)	50	50	50	75	75	75	250		
AF	3,074	3,074	3,074	4,612	4,612	4,612	15,372		
Aug (CFS)	50	50	50	75	75	75	250		
AF	3,074	3,074	3,074	4,612	4,612	4,612	15,372		
Sep (CFS)	50	50	50	75	75	75	250		
AF	2,975	2,975	2,975	4,463	4,463	4,463	14,876		
Total Annual	94,001	103,001	117,017	127,508	142,503	165,004	300,926		

Figure 2.2-3. 1995 FERC minimum flow requirement schedule.

Figure 2.2-4 illustrates the revised computational section of the "LaGrangeSchedule" Worksheet that computes the components of base and total required schedule annual volumes, October attraction flow volume, and April-May migration flow volume. Other sections of the worksheet have been revised to define the monthly distribution of annual volumes for incorporation into the daily parsing routines shown above.

AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI
Current FERC Requirements														
	Tuolumne River Flow Interpolation - Year 2011 Revised Distribution													
	Flow Year Type			SJR Basin Index				Flow Requirement						October
													Base	Attraction
	1		<	1510								94000	82,910	0
	2			1510	- <	2000		0.0286	x (Index -	1510	) +	103000	82,910	0
	3			2000	- <	2190		0.0552	x (Index -	2000	) +	117016	84,398	0
	4			2190	- <	2440		0.0600	x (Index -	2190	) +	127507	90,448	0
	5			2440	- <	2720		0.0804	x (Index -	2440	) +	142502	104,907	1,676
	6			2720	- <	3180		0.2955	x (Index -	2720	) +	165002	103,297	1,680
	7			3180	and Greater							300923	205,094	5,950
									Option >>	1	2	3	4	5
	1	<<Option			Ave	219,421	146,114	70,146		Actual	90% Exc.	75% Exc.	Med.	10% Exc.
	SJR				TR	Tuolumne	Tuolumne	Pulse	Base	SJR	Apr SJR	Apr SJR	Apr SJR	Apr SJR
	Index	Year			October	River	River	Flow	Year	Index	Index	Index	Index	Index
	602020	Class		Year	Attraction	Require	Base	Calc	Type	602020	Fcast	Fcast	Fcast	Fcast
	4,543,729	Wet		1922	5,950	300,923	205,094	89,879	7	4,543,729	2,424,373	2,561,322	2,674,495	2,921,846
	3,549,358	Above		1923	5,950	300,923	205,094	89,879	7	3,549,358	1,765,568	1,897,976	2,007,411	2,246,643
	1,419,746	Critical		1924	0	94,000	82,910	11,090	1	1,419,746	799,642	853,197	957,737	1,186,335
	2,929,617	Below		1925	1,680	226,944	103,297	121,967	6	2,929,617	2,042,878	2,179,628	2,292,637	2,539,632
	2,300,567	Dry		1926	0	134,141	90,448	43,693	4	2,300,567	1,256,470	1,387,014	1,494,917	1,730,818
	3,558,955	Above		1927	5,950	300,923	205,094	89,879	7	3,558,955	2,147,110	2,284,156	2,397,408	2,644,932
	2,632,407	Below		1928	1,676	157,972	104,907	51,388	5	2,632,407	1,934,163	2,068,826	2,180,117	2,423,380
	2,004,815	Critical		1929	0	117,282	84,398	32,884	3	2,004,815	1,140,712	1,270,277	1,377,372	1,611,521

Figure 2.2-4. 1995 FERC flow requirements from Don Pedro Reservoir.

2.3 Don Pedro Project Generation

User's Guide reference: Section 5.12: "DonPedro" Worksheet, Section 5.12.5 Don Pedro Project Generation and River Flows

The hydroelectric generation characteristics of any modeled Project operation scenario are modeled incidental to Project hydrologic operations. The power generation of the Project is computed from the simulation of daily time step operations and is incoporated into the "DonPedro" Worksheet. Input to the power component includes daily average flow past Don Pedro Dam (flow through the dam and through the spillway, if any) and Don Pedro Reservoir storage. The power component computes gross and net head, flow through turbines, efficiency and power output based on a group of reservoir rating, tailwater rating and manufacturer's performance characteristic curves, and generalized equations for head losses.

Figure 2.3-1 illustrates the components of computational procedure that derives power output of the Project. The power characteristics of the turbine generators are defined for a range of head and flow combinations. "Cutoff" of generation that would otherwise be indicated by the performance curves is provided through user defined switches entered in the "Control" Worksheet. Switch C 1.20 defines the minimum reservoir storage level at which generation occurs, and Switch C 1.22 defines the maximum flow through the powerplant. In this illustration generation will not occur when Don Pedro Reservoir storage is less than 308,960 acre-feet (elevation 600 ft). The performance curves indicate that generation may occur up to a flow rate of approximately 5,500 cfs. Switch C 1.22 has been set higher than this value to not impede the computation.

	A	B	C	D	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ
1			1																	
2	*Unit Title*		2			CFS														
3	*Parameter Title*		3			Total Dam Release														
4																				
5	*Acre-foot to CFS conversion*																			
6	*divide by :*	*1.983471*																		
7																				
8					*TEST*															
9					*11/21/1977*	*289*	*361,955*	*614.3*	*298.0*	*316.3*	*316.2*	*310*	*325*	*0*		*3*	*1*	*10*	*4550*	*289*
10																				
11							*308,960*	*(C 1.20) Cutoff of generation, DP Storage (sets available units to zero)*												
12						*Penstock Loss:*		*9.66E-07*	*ft/cfs²*	*Scheduled Maintenance? (1) Yes, (0) No:*				*0*					*6,000*	
13		*39-year Ave or Max*			*Max*	*67,039*		*830*	*298*	*532*	*527*	*530*	*525*			*3*	*1*	*10*	*5,655*	*5,500*
14		*Min*			*Min*	*207*		*614*	*298*	*316*	*316*	*310*	*325*			*3*	*1*	*10*	*4,550*	*207*
15					**Don Pedro Power Generation**															
16						Don	Don	Don	Approx			Net H	Net H		Unsched	Number	Number	Min	Max	Potential
17	Month					Pedro	Pedro	Pedro	Tailwater	Gross	Approx	Look-up	Look-up	Sched	Outage /	Available	Available	Plant	Plant	Plant
18	Index	Date	Day	Days		Release	Storage	Elevation	Elevation	Head	Net H	Units 1-3	Unit 4	Outage	Bypass	Units 1-3	Unit 4	Flow	Flow	Flow
19						CFS	Ave-AF	FT elev	FT elev	FT	FT	FT	FT	unit #	unit #			CFS	CFS	CFS
20	1970.10	10/1/1970	T	31		2,037	1,669,232	800.0	298.0	502.0	498.0	490	500	0		3	1	10	5500	2,037
21	1970.10	10/2/1970	F	31		1,288	1,666,644	799.7	298.0	501.7	500.1	510	500	0		3	1	10	5500	1,288
22	1970.10	10/3/1970	S	31		1,209	1,664,882	799.6	298.0	501.6	500.2	510	500	0		3	1	10	5500	1,209
23	1970.10	10/4/1970	S	31		1,718	1,662,698	799.4	298.0	501.4	498.6	490	500	0		3	1	10	5500	1,718
24	1970.10	10/5/1970	M	31		1,378	1,660,351	799.2	298.0	501.2	499.4	490	500	0		3	1	10	5500	1,378
25	1970.10	10/6/1970	T	31		1,502	1,658,222	799.0	298.0	501.0	498.8	490	500	0		3	1	10	5500	1,502
26	1970.10	10/7/1970	W	31		1,322	1,656,151	798.8	298.0	500.8	499.1	490	500	0		3	1	10	5500	1,322
27	1970.10	10/8/1970	T	31		728	1,654,638	798.7	298.0	500.7	500.2	510	500	0		3	1	10	5500	728
28	1970.10	10/9/1970	F	31		827	1,653,407	798.5	298.0	500.5	499.8	490	500	0		3	1	10	5500	827
29	1970.10	10/10/1970	S	31		898	1,652,016	798.4	298.0	500.4	499.6	490	500	0		3	1	10	5500	898

	A	B	C	D	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL
1			1													
2	*Unit Title*		2						CFS							kWh
3	*Parameter Title*		3						Total Plant Flow							Modeled D
4																
5	*Acre-foot to CFS conversion*															
6	*divide by :*	*1.983471*														
7																
8																
9					*1*	*289*	*0*	*0*	*289*	*315.9*	*60.0%*	*0.0%*	*4,648*	*0*	*4,648*	*111,544*
10																
11																
12							*39-yr Annual Ave (AF):*		*1,501,380*						*39-yr Annual Ave (MWh):*	*603,718*
13		*39-year Ave or Max*			*3*		*1*	*1,000*	*5,500*	*525*	*0.90*	*0.92*	*172,991*	*38,653*	*208,219*	*4,997,256*
14		*Min*			*1*		*0*	*0*	*207*	*316*	*0.60*	*0.00*	*3,333*	*0*	*3,333*	*80,003*
15																
16						Flow		Flow			Plant	Plant				Plant
17	Month				Operation	Through	Operation	Through	Plant	Net	Effic	Effic	Power	Power	Plant	Daily
18	Index	Date	Day	Days	Units 1-3	Units 1-3	Unit 4	Unit 4	Flow	Head	Units 1-3	Unit 4	Units 1-3	Unit 4	Power	Generation
19					Count	CFS		CFS	CFS	FT	%	%	kW	kW	kW	kWh
20	1970.10	10/1/1970	T	31	3	679	0	0	2037	495.0	77.2%	0.0%	65,942	0	65,942	1,582,609
21	1970.10	10/2/1970	F	31	3	429	0	0	1288	498.2	65.2%	0.0%	35,423	0	35,423	850,156
22	1970.10	10/3/1970	S	31	3	403	0	0	1209	498.3	63.9%	0.0%	32,602	0	32,602	782,449
23	1970.10	10/4/1970	S	31	3	573	0	0	1718	496.0	73.4%	0.0%	53,001	0	53,001	1,272,019
24	1970.10	10/5/1970	M	31	3	459	0	0	1378	497.3	67.8%	0.0%	39,381	0	39,381	945,135
25	1970.10	10/6/1970	T	31	3	501	0	0	1502	496.5	70.3%	0.0%	44,432	0	44,432	1,066,359
26	1970.10	10/7/1970	W	31	3	441	0	0	1322	497.1	67.0%	0.0%	37,296	0	37,296	895,105
27	1970.10	10/8/1970	T	31	2	364	0	0	728	499.0	60.0%	0.0%	18,467	0	18,467	443,214
28	1970.10	10/9/1970	F	31	3	276	0	0	827	498.5	60.0%	0.0%	20,971	0	20,971	503,311
29	1970.10	10/10/1970	S	31	3	299	0	0	898	498.3	60.0%	0.0%	22,759	0	22,759	546,222

Figure 2.3-1. Project power computational procedure.

A validation of the computational process was made by comparing Model-produced generation to historically reported generation. Table 2.3-1 shows a comparison between computed and reported generation for a 2002 – 2009 period of record. The results show that Project generation is well depicted with the computational procedures, with minimal annual differences. This period of record includes a dry (reduced reservoir and releases) to wet (full reservoir and large releases) range of hydrologic conditions. Figure 2.3-2 illustrates the comparison of Model-produced daily generation and historically reported generation for calendar year 2003, which had a range of reservoir storage and release conditions.

Table 2.3-1. Modeled and reported Project power.

	Reported Generation (MWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2002	5,079	4,259	38,044	61,819	54,412	54,341	66,448	52,811	28,790	18,760	6,073	7,005	397,840
2003	5,395	11,275	25,076	39,599	51,964	68,313	75,800	61,667	32,692	33,135	8,343	6,261	419,520
2004	7,509	12,122	62,985	72,157	58,301	58,788	68,904	54,145	25,452	23,118	4,565	4,402	452,449
2005	12,339	48,759	98,233	137,057	143,777	137,291	122,689	84,793	43,861	22,203	9,831	33,044	893,877
2006	111,669	72,155	125,741	110,498	131,217	124,759	97,387	80,643	46,356	26,152	11,631	8,204	946,413
2007	12,597	15,207	45,088	48,189	54,255	57,216	64,531	53,546	22,957	15,461	7,032	3,780	399,859
2008	3,184	5,562	37,289	43,158	58,312	45,852	54,811	46,690	22,417	11,467	4,647	6,114	339,501
2009	4,912	5,326	21,733	41,084	55,267	56,222	67,625	53,082	28,388	18,051	7,781	5,495	364,965
Average	20,335	21,833	56,774	69,195	75,938	75,348	77,274	60,922	31,364	21,043	7,488	9,288	526,803
Ann Dist	4%	4%	11%	13%	14%	14%	15%	12%	6%	4%	1%	2%	100%

	Modeled Generation (MWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2002	4,692	4,343	36,119	63,521	54,701	56,249	69,864	53,614	27,334	17,457	5,765	6,422	400,081
2003	5,104	10,231	23,762	39,691	51,839	67,021	80,295	64,791	31,953	31,070	7,742	5,434	418,932
2004	6,696	11,128	62,972	75,770	60,036	59,137	70,224	55,786	24,403	21,785	5,131	4,488	457,555
2005	13,839	50,180	109,404	139,619	146,930	147,343	132,278	89,284	44,552	21,561	10,306	35,026	940,321
2006	102,499	71,293	130,498	108,499	113,092	111,410	102,790	82,253	45,051	24,484	11,237	7,320	910,425
2007	11,023	13,343	43,437	47,548	54,298	59,601	67,647	56,301	22,600	14,898	6,724	4,165	401,585
2008	3,820	5,733	37,688	43,469	59,007	45,476	56,320	49,154	21,603	10,833	4,542	6,150	343,795
2009	4,985	5,740	21,720	40,985	55,636	58,102	72,166	56,015	28,577	16,255	7,465	5,421	373,066
Average	19,082	21,499	58,200	69,888	74,443	75,542	81,448	63,400	30,759	19,793	7,364	9,303	530,720
Generation	4%	4%	11%	13%	14%	14%	15%	12%	6%	4%	1%	2%	100%

	% Deviation ((Reported-Actual)/Actual)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2002	-8%	2%	-5%	3%	1%	4%	5%	2%	-5%	-7%	-5%	-8%	1%
2003	-5%	-9%	-5%	0%	0%	-2%	6%	5%	-2%	-6%	-7%	-13%	0%
2004	-11%	-8%	0%	5%	3%	1%	2%	3%	-4%	-6%	12%	2%	1%
2005	12%	3%	11%	2%	2%	7%	8%	5%	2%	-3%	5%	6%	5%
2006	-8%	-1%	4%	-2%	-14%	-11%	6%	2%	-3%	-6%	-3%	-11%	-4%
2007	-12%	-12%	-4%	-1%	0%	4%	5%	5%	-2%	-4%	-4%	10%	0%
2008	20%	3%	1%	1%	1%	-1%	3%	5%	-4%	-6%	-2%	1%	1%
2009	1%	8%	0%	0%	1%	3%	7%	6%	1%	-10%	-4%	-1%	2%
Average	-6%	-2%	3%	1%	-2%	0%	5%	4%	-2%	-6%	-2%	0%	1%

Modeled generation includes assumptions for historical outages of units.

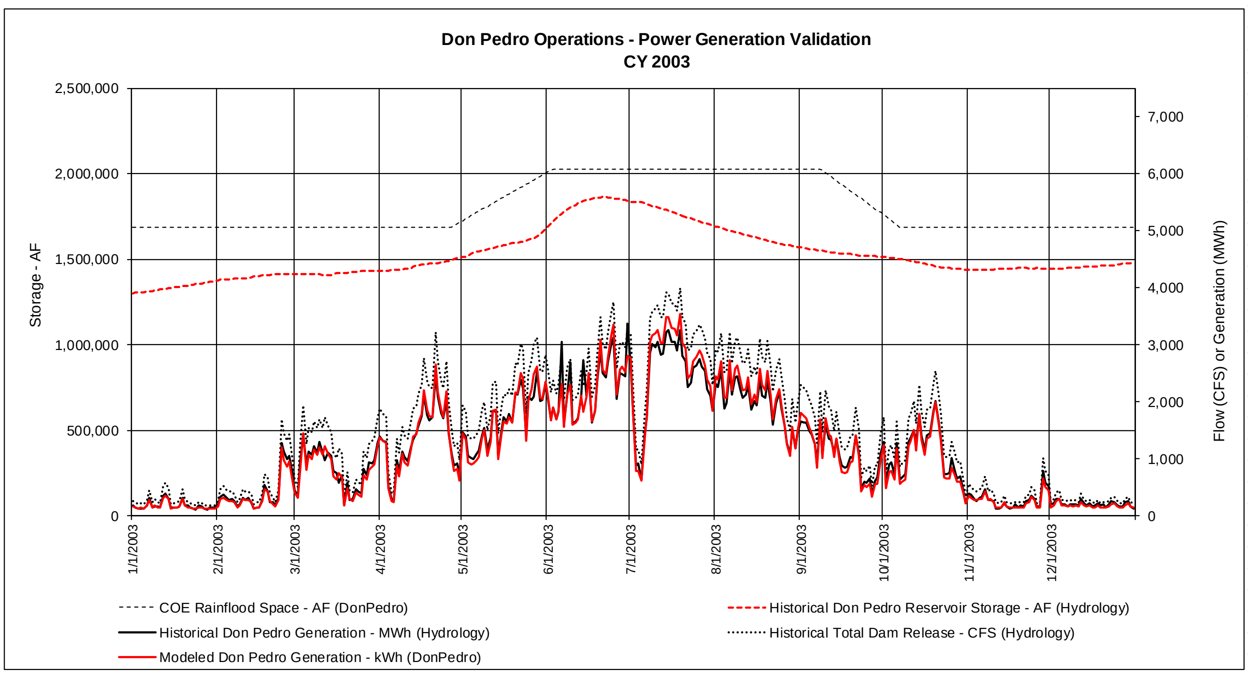


Figure 2.3-2. Project power daily generation.

3.0 INPUT AND HYDROLOGY MODIFICATIONS

Several changes to underlying hydrology and data assumptions have been implemented in the Model (Version 2.0).

3.1 Unimpaired Runoff

User's Guide reference: Section 5.22: "Hydrology" Worksheet

Concern was raised regarding the sometimes erratic daily pattern of computed unimpaired runoff for various components of the historical record, and the occassional computation of a "negative" value of flow. Although the use of the historically computed data are known to not adversely affect Model results, the Districts forwarded an approach to developing a hybrid gauge summation/gage proration hydrologic record for Tuolumne River unimpaired flow that would provide a "smoother" hydrograph. At a Workshop on March 27, 2013, RPs and the Districts worked through the approach and came to a consensus on an acceptable record of unimpaired flow for the Tuolumne River. It was clearly stated that the Districts and CCSF will not change their historical methods for calculating their respective water supplies from the Tuolumne River or the historical record of water bank operations. This modified data set will only be used to estimate unimpaired flow for the FERC relicensing.

Modified sub-basin hydrology was implemented for Hetch Hetchy Reservoir inflow, Cherry/Eleanor inflow, and the unregulated inflow to Don Pedro Reservoir. With only one month of exception, the historically computed monthly volumes of total runoff above La Grange were maintained in the modified data set. However, the daily shaping of the sub-basin runoff was modified, and on occasion rebalanced between the sub-basins to rectify historically computed negative volumes. Figure 3.1-1 illustrates the location and an example of the modified hydrology implemented in the "Hydrology" Worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1			1		Hydrology								
2			2		CFS	CFS	CFS	CFS	CFS		CFS	CFS	CFS
3			3		Unimpaire	Unimpaire	Unimpaire	Revised Ur	Unregulated Inflow tc		Dry Creek	Total LTR Ac	Modesto to
4													
5													
6					Read by	Read by	Read by		Read by		Read by	Read by	Read by
7					Model	Model	Model		Model		Model	Model	Model
8													
9													
10													
11													
12											LTR Accretions		
13					March 26, 2013 Prorated Hydrology						Nov 2012	Nov 2012	
14											Dry Creek	Lower	Modesto
15					1,934,193	762,930	487,867		683,396		Flow @	Tuolumne	to
16					Unimpaired Flow			Computed Flow			Modesto	River	Confluence
17		Month				Hetch	Cherry/		Unregul		HDR est.	Acc abv	
18		Index	Date	Day	La Grange	Hetchy	Eleanor		blw SF			Modesto	
19					CFS	CFS	CFS		CFS		CFS	CFS	CFS
20	1970.10	10/1/1970	T		125	4	14		107		30	80	32
21	1970.10	10/2/1970	F		130	4	14		111		30	80	32
22	1970.10	10/3/1970	S		129	4	14		111		30	80	32
23	1970.10	10/4/1970	S		133	4	15		115		30	80	32
24	1970.10	10/5/1970	M		135	4	15		117		30	80	32
25	1970.10	10/6/1970	T		137	4	15		118		30	80	32
26	1970.10	10/7/1970	W		139	4	15		119		30	80	32
27	1970.10	10/8/1970	T		142	4	15		122		30	80	32
28	1970.10	10/9/1970	F		144	4	15		124		30	80	32
29	1970.10	10/10/1970	S		149	4	16		130		30	80	32

Figure 3.1-1. Unimpaired runoff data set.

3.2 District Canal Operation Assumptions

User's Guide reference: Section 5.18: "DailyCanalsCompute" Worksheet, Section 5.18.3 Daily Canal Operation Assumptions

The "DailyCanalsCompute" Worksheet performs the computation of the daily canal demands of the MID and TID. The computation of canal demands incorporate the PDAW and canal operations practices of the Districts. Canal operation assumptions include regulating reservoir operation, seepage and losses, nominal groundwater pumping and canal operational spills. Since the initial development of data for the Model, a recent review of the Districts' operation records associated with the Districts' preparation and filing of their 5-year Agricultural Water Management Plans has led to the refinement of certain canal operations assumptions. Model (Version 2.0) assumptions for each District are shown Figure 3.2-1.

Modesto Irrigation District

Month	Turnout Delivery Factor (%)	Nominal Private GW Pumping (TAF)	Canal Operational Spills Critical (TAF)	Canal Operational Spills Non-crit (TAF)	System Losses below Modesto Res (TAF)	Intercepted Flows (TAF)	Nominal MID GW Pumping (TAF)	Modesto Res and Upper Canal Losses/Div (TAF)	Municipal Delivery from Modesto Res (TAF)	Modesto Res Target Storage (TAF)	Modesto Res Target Storage Change (TAF)
January	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0	2.0
February	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0	1.0
March	65.0	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0	0.0
April	70.0	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0	1.0
May	85.0	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0	1.0
June	85.0	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0	0.0
July	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0	1.0
August	70.0	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0	1.0
September	65.0	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0	-2.0
October	40.0	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0	-3.0
November	30.0	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0	-2.0
December	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0	0.0
Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5		

MID March TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	65.0
9.9	65.0
13.2	65.0
20.0	65.0
9999.0	65.0

TID March TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	65.0
19.8	65.0
27.5	65.0
40.0	65.0
9999.0	65.0

MID April TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	70.0
10.0	70.0
17.5	70.0
25.0	80.0
9999.0	80.0

TID April TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	57.5
20.0	57.5
35.0	70.0
50.0	80.0
9999.0	80.0

Turlock Irrigation District

Month	Turnout Delivery Factor (%)	Nominal Private GW Pumping (TAF)	Canal Operational Spills Critical (TAF)	Canal Operational Spills Non-crit (TAF)	System Losses below Turlock Lk (TAF)	Intercepted and Other Flows (TAF)	Nominal TID GW Pumping (TAF)	Turlock Lk and Upper Canal Losses (TAF)	Other Delivery from Turlock Lk (TAF)	Turlock Lk Target Storage (TAF)	Turlock Lk Target Storage Change (TAF)
January	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0	5.0
February	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0	7.0
March	65.0	1.2	3.0	3.0	4.5	0.5	4.1	1.0	0.0	30.0	5.0
April	57.5	2.4	5.1	6.3	4.5	1.0	8.0	6.6	0.0	30.0	0.0
May	85.0	3.6	4.6	6.7	4.5	1.3	10.3	7.7	0.0	32.0	2.0
June	92.5	5.2	4.2	6.7	4.5	1.3	12.4	8.2	0.0	32.0	0.0
July	75.0	6.4	4.2	6.7	4.5	1.5	14.6	8.7	0.0	32.0	0.0
August	65.0	6.2	4.0	7.3	4.5	1.5	13.3	9.0	0.0	30.0	-2.0
September	67.5	3.9	3.2	7.3	4.5	1.0	9.1	5.0	0.0	27.0	-3.0
October	40.0	2.4	2.3	7.3	4.5	0.5	5.3	2.0	0.0	13.0	-14.0
November	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
December	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
Total		31.3	38.6	59.3	39.2	8.5	77.1	52.2	0.0		

Figure 3.2-1. Districts' canal demand components.

The change that has occurred to the data set is the estimation of "intercepted and other flows" for the TID canal system. The change reflects the addition of a component of canal water supply that was previously not recognized in the data set. Also refined in the data set and computational process for both Districts were several of the monthly turnout delivery factors. The turnout delivery factors are unique to each District and represent a modeling mechanism to adjust the PDAW for irrigation practices that are not included in the estimation of the CUAW, such as irrigation that provides for groundwater recharge. Data identified in this worksheet are entered through the Control Worksheet.

3.3 Don Pedro Water Supply Factor

User's Guide reference: Section 5.20: "DPWSF" Worksheet

The "DPSWF" Worksheet computes the Don Pedro Water Supply Factor (WSF). The premise of the WSF factor is to reduce the amount of water diverted to the canals during years when lack of carryover storage at Don Pedro Reservoir becomes a concern. The modeling mechanism used to reduce canal diversions is a factor applied to the PDAW of the canal demand. This mechanism results in a reduction to the amount of water "turned out" to the customers. Changes to estimated canal demands and underlying hydrology, in combination with the review of projected operations has led to a change in the WSF to be used for the Base Case. Figure 3.3-1 illustrates the Base Case WSF components in the Model (Version 2.0). The values are entered in the "Control" Worksheet.

Don Pedro Reservoir Inflow Forecast for Diversion of Water Supply

Reservoir Index Method - Active Matrix

	M/T NDP Stor + Infl Index	M/TID WS Factor	+1	+1
	kaf	%		
Enter	0	0.75	1090	0.75
Values	1090	0.75	1090	0.875
From	1090	0.875	1700	0.875
C1.90	1700	0.875	1700	1
	1700	1	2300	1
	2300	1	9999	1
	9999	1		

(W)ater (S)upply (F)actor is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir.

Forecast begins for February:
EO-January storage + Feb-July UF - Feb-July US adj - Feb-Mar minimum river
March Forecast:
EO-February storage + Mar-July UF - Mar-July US adj - Mar minimum river
April Forecast: (final)
EO-March storage + Apr-July UF - Apr-July US adj

Factor Table is April Forecast based
February and March Forecasts act as adjustments to estimate April 1 state.

Figure 3.3-1. Don Pedro water supply forecast factors.

3.5 Lower Tuolumne River Accretions below Modesto

The Model (Version 1.0) incorporated a synthesized data set for lower Tuolumne River accretions above the "Modesto" gage and estimated flow from Dry Creek. These data sets inform the Model of flow that could influence Don Pedro Reservoir releases during flood control operations. Recent, actual field measurements for flow in the Tuolumne River and for Dry Creek have confirmed general assumptions of the data sets. Also acquired during these field measurements has been flow data for the reach of the lower Tuolumne River below the "Modesto" gage and above the confluence with the San Joaquin River. Based on these measurements, an accretion of 32 cfs has been assumed to occur below the USGS "Modesto" gage. This data set has been added to the "Hydrology" Worksheet, Column M ("Modesto to Confluence"), incorporated into computations of river flow in the "DonPedro" Worksheet,

Column CP ("TR at Confluence"), and the projected flow at the confluence is reported in the "Output" Worksheet, Column AR ("Flow-Confluence").

3.5 Miscellaneous Reference Case Data Revisions

As the result of defining a Base Case in the Model (Version 2.0), several data sets required update or revision to facilitate automated comparisons between the Base Case results and alternative scenario results. Changes to Base Case reference values occurred in table values or time series sets for:

"UserInput" Worksheet

- Existing FERC Flow Requirements at La Grange Bridge Gage
- Base Case MID Canal Diversion
- Base Case TID Canal Diversion
- Base Case Supplemental Releases

"WaterBankRel" Worksheet

- Water Bank Supplemental Release (Column T)

"DonPedro" Worksheet

- Base Case Full Diversion Demand (Column I – Column L)

"SFWaterBankRel" Worksheet

- Water Bank Supplemental Release (Column AN)

"DailyCanalsCompute" Worksheet

- DP Water Supply Factor Base Case (Column F)

"DailyCanals" Worksheet

- Base MID Canal Diversion (Column L)
- Base TID Canal Diversion (Column N)

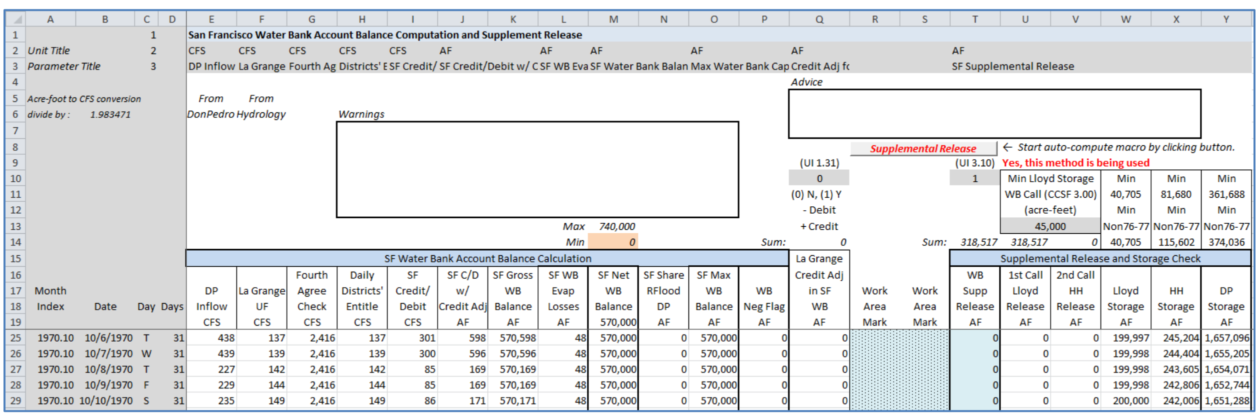
4.0 MODEL EXECUTION

To aid in the execution, completion and recording of an alternative operation scenario, several “macro” tools have been incorporated into the Model.

4.1 Water Bank Supplemental Release Macro

A variation from Base Case Don Pedro Reservoir operation assumptions will normally cause a change in results to the CCSF Water Bank Account Balance. If needing revision from Base Case conditions (e.g., revised supplemental releases to maintain a positive Water Bank Account Balance) supplemental releases can be automatically computed by use of a macro implemented for the “WaterBankRel” Worksheet. This macro will replicate the manual action of the user to provide the day-by-day supplemental release exactly needed to maintain no less than a zero Water Bank Balance.

Figure 4.1-1 illustrates the location of the macro button in the “WaterBankRel” Worksheet. To “run” the macro the user simply “clicks” on the button identified by the label “Supplemental Release”. By invoking the macro, values will be automatically placed into Column T to maintain a positive Water Bank Account Balance. The macro will iterate computations up to 24 times to complete the process. It is advised to initialize Column T with zeroes prior to invoking the macro. It is also advised to set the Excel worksheet “Options” to a manual calculation mode prior to invoking the macro.



Month Index	Date	Day	Days	DP Inflow CFS	La Grange UF CFS	Fourth Agree Check CFS	Daily Districts' Entitle CFS	SF Credit/ Debit CFS	SF C/D w/ Credit Adj AF	SF Gross WB Balance AF	SF WB Evap Losses AF	SF Net WB Balance 570,000	SF Share RFlood DP AF	SF Max WB Balance AF	WB Neg Flag AF	La Grange Credit Adj in SF WB AF	Work Area Mark	Work Area Mark	WB Supp Release AF	1st Call Lloyd Release AF	2nd Call HH Release AF	Lloyd Storage AF	HH Storage AF	DP Storage AF
1970.10	10/6/1970	T	31	438	137	2,416	137	301	598	570,598	48	570,000	0	570,000	0	0			0	0	0	199,997	245,204	1,657,096
1970.10	10/7/1970	W	31	439	139	2,416	139	300	596	570,596	48	570,000	0	570,000	0	0			0	0	0	199,998	244,404	1,655,205
1970.10	10/8/1970	T	31	227	142	2,416	142	85	169	570,169	48	570,000	0	570,000	0	0			0	0	0	199,998	243,605	1,654,071
1970.10	10/9/1970	F	31	229	144	2,416	144	85	169	570,169	48	570,000	0	570,000	0	0			0	0	0	199,998	242,806	1,652,744
1970.10	10/10/1970	S	31	235	149	2,416	149	86	171	570,171	48	570,000	0	570,000	0	0			0	0	0	200,000	242,006	1,651,288

Figure 4.1-1. Water bank supplemental release macro.

4.2 Copy Output Worksheet Macro

The “Output” Worksheet provides an interface between Model computations and summary and analysis tools. It also provides a formatted set of information usable for exchange into an HEC-DSS database file. Results provided in the worksheet are directly linked to the computational and input worksheets of the Model. As such, any change to model assumptions or data which causes a recalculation by the Model will automatically update the values in the worksheet. To preserve or store the results of a particular study a copy of the worksheet should be created with a unique tab name and its contents converted to values. The user can either use Excel keystroke or menu commands to create the worksheet copy, or can invoke a macro. Figure 4.2-1 illustrates the location of the macro button in the “Output” Worksheet. To “run” the macro the user simply “clicks” on the button identified by the label “Copy Sheet / Values”. By invoking the macro, the worksheet will be “copied” as “values” into an adjacent worksheet and given a name identified by Switch UI 1.00 in the “UserInput” Worksheet. The user must save the entire workbook to not lose the new worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	1	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE
2	2	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO
3	3	FLOW- LAGRANGE UNIMP	FLOW- HHUNIMP	FLOW- LLOYDUNI MP	FLOW- ELEANORU NIMP	FLOW- UNREGUNI MP	FLOW- TOTINFLO W	FLOW- SUP1INFLO WLL	FLOW- SUP2INFLO WHH	FLOW- INFLOWHH	FLOW- INFLOWLL	FLOW- INFLOWEL	STORAGE
4	4	2	3	4	5	6	7	8	9	10	11	12	13
5	5	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY
6	6	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case
7	*Save study results* 7	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70
8	*as unique* 8	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
9	*worksheet by* 9	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09
10	*clicking button* 10	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
11	↓ 11	CFS	CFS	CFS	CFS	CFS	CFS	AF	AF	CFS	CFS	CFS	AF
12	*Copy Sheet / Values*	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER
13	10/1/1970	125	4	10	4	107	427	0	0	90	220	10	1,667,564
14	10/2/1970	130	4	10	4	111	431	0	0	90	220	10	1,665,724
15	10/3/1970	129	4	10	4	111	431	0	0	90	220	10	1,664,041
16	10/4/1970	133	4	10	5	115	435	0	0	90	220	10	1,661,355
17	10/5/1970	135	4	10	5	117	437	0	0	90	220	10	1,659,348
18	10/6/1970	137	4	10	5	118	438	0	0	90	220	10	1,657,096
19	10/7/1970	139	4	10	5	119	439	0	0	90	220	10	1,655,205
20	10/8/1970	142	4	10	5	122	227	0	0	90	5	10	1,654,071
21	10/9/1970	144	4	10	5	124	229	0	0	90	5	10	1,652,744
22	10/10/1970	149	4	11	5	130	235	0	0	90	5	10	1,651,288

Figure 4.2-1. “Output” Worksheet copy values macro.

Doody, Andrew

From: Staples, Rose
Sent: Wednesday, June 12, 2013 7:22 PM
To: 'Alves, Jim'; 'Amerine, Bill'; 'Asay, Lynette'; 'Barnes, James'; 'Barnes, Peter'; 'Barrera, Linda'; 'Blake, Martin'; 'Bond, Jack'; Borovansky, Jenna; 'Boucher, Allison'; 'Bowes, Stephen'; 'Bowman, Art'; 'Brenneman, Beth'; 'Buckley, John'; 'Buckley, Mark'; 'Burke, Steve'; 'Burt, Charles'; 'Byrd, Tim'; 'Cadagan, Jerry'; 'Carlin, Michael'; 'Charles, Cindy'; 'Colvin, Tim'; 'Costa, Jan'; 'Cowan, Jeffrey'; 'Cox, Stanley Rob'; 'Cranston, Peggy'; 'Cremeen, Rebecca'; 'Damin Nicole'; 'Day, Kevin'; 'Day, P'; 'Denean'; 'Derwin, Maryann Moise'; Devine, John; 'Donaldson, Milford Wayne'; 'Dowd, Maggie'; 'Drake, Emerson'; 'Drekmeier, Peter'; 'Edmondson, Steve'; 'Eicher, James'; 'Fargo, James'; 'Ferranti, Annee'; 'Ferrari, Chandra'; 'Findley, Timothy'; 'Fleming, Mike'; 'Fuller, Reba'; 'Furman, Donn W'; 'Ganteinbein, Julie'; 'Giglio, Deborah'; 'Gorman, Elaine'; 'Grader, Zeke'; 'Gutierrez, Monica'; 'Hackamack, Robert'; 'Hastreiter, James'; 'Hatch, Jenny'; 'Hayat, Zahra'; 'Hayden, Ann'; 'Hellam, Anita'; 'Heyne, Tim'; 'Holley, Thomas'; 'Holm, Lisa'; 'Horn, Jeff'; 'Horn, Timi'; 'Hudelson, Bill'; 'Hughes, Noah'; 'Hughes, Robert'; 'Hume, Noah'; 'Jackson, Zac'; 'Jauregui, Julia'; 'Jennings, William'; 'Jensen, Art'; 'Jensen, Laura'; 'Johannis, Mary'; 'Johnson, Brian'; 'Jones, Christy'; 'Jsansley'; 'Justin'; 'Keating, Janice'; 'Kempton, Kathryn'; 'Kinney, Teresa'; 'Koepele, Patrick'; 'Kordella, Lesley'; Le, Bao; 'Levin, Ellen'; 'Linkard, David'; Loy, Carin; 'Lwenya, Roselynn'; 'Lyons, Bill'; 'Madden, Dan'; 'Manji, Annie'; 'Marko, Paul'; 'Marshall, Mike'; 'Martin, Michael'; 'Martin, Ramon'; 'Mathiesen, Lloyd'; 'McDaniel, Dan'; 'McDevitt, Ray'; 'McDonnell, Marty'; 'Mein Janis'; 'Mills, John'; 'Morningstar Pope, Rhonda'; 'Motola, Mary'; 'Murphey, Gretchen'; 'Murray, Shana'; 'O'Brien, Jennifer'; 'Orvis, Tom'; 'Ott, Bob'; 'Ott, Chris'; 'Paul, Duane'; 'Pavich, Steve'; 'Pool, Richard'; 'Porter, Ruth'; 'Powell, Melissa'; 'Puccini, Stephen'; 'Raeder, Jessie'; 'Ramirez, Tim'; 'Rea, Maria'; 'Reed, Rhonda'; 'Richardson, Daniel'; 'Richardson, Kevin'; 'Ridenour, Jim'; 'Riggs T'; 'Robbins, Royal'; 'Romano, David O'; 'Roos-Collins, Richard'; Rosekrans, Spreck; 'Roseman, Jesse'; 'Rothert, Steve'; 'Sandkulla, Nicole'; 'Saunders, Jenan'; 'Schutte, Allison'; 'Sears, William'; 'Shakal, Sarah'; 'Shipley, Robert'; 'Shumway, Vern'; 'Shutes, Chris'; 'Sill, Todd'; 'Slay, Ron'; 'Smith, Jim'; Staples, Rose; 'Stapley, Garth'; 'Steindorf, Dave'; 'Steiner, Dan'; 'Stender, John'; 'Stone, Vicki'; 'Stork, Ron'; 'Stratton, Susan'; 'Taylor, Mary Jane'; 'Terpstra, Thomas'; 'TeVelde, George'; 'Thompson, Larry'; 'Tmberliner'; 'Ulibarri, Nicola'; 'Ulm, Richard'; 'Vasquez, Sandy'; 'Verkuil, Colette'; 'Vierra, Chris'; 'Wantuck, Richard'; 'Welch, Steve'; 'Wenger, Jack'; 'Wesselman, Eric'; Wetzel, Jeff; 'Wheeler, Dan'; 'Wheeler, Dave'; 'Wheeler, Douglas'; 'White, David K'; 'Wilcox, Scott'; 'Williamson, Harry'; 'Willy, Allison'; 'Wilson, Bryan'; 'Winchell, Frank'; 'Wooster, John'; 'Workman, Michelle'; 'Yoshiyama, Ron'; 'Zipser, Wayne'
Subject: Don Pedro DRAFT Notes for Review from May 30 Operations Model Workshop and Training Session
Attachments: DP_WAR-02workshop_130530_DraftMtgNotes_130612.docx; Draft Scenario Request Form_ver4.docx

Please find attached the draft notes from the May 30, 2013 *Don Pedro Operations Model Workshop and Training Session*, which are being provided to relicensing participants for review and comment. In addition to the draft notes, we are also providing the *Operations Model Run Request Form* for comment. These draft notes and the request form are also being uploaded to the Don Pedro website (www.donpedro-relicensing.com) under the May 30th CALENDAR date and under ANNOUNCEMENTS. Please forward your comments to me (rose.staples@hdrinc.com) within the 30-day review period, i.e. by Friday, July 12th. Thank you.

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

970 Baxter Boulevard, Suite 301 | Portland, ME 04103
207.239.3857 | f: 207.775.1742
rose.staples@hdrinc.com | hdrinc.com

Don Pedro Project Relicensing
Operations Model Base Case Workshop and Training Session (W&AR-02)
DRAFT Meeting Notes
May 30, 2013
Modesto Irrigation District Offices

Attendees

John Devine, HDR	Donn Furman, CCSF
Patrick Koepele, Tuolumne River Trust	Bob Hughes, CDFW
Chris Shutes, CSPA	Jenna Borovansky, HDR
Lucas Sharkey, SWRCB	Dan Steiner, consultant to TID/MID
Peter Barnes, SWRCB	Rob Sherrick, HDR
Kevin Richardson, US Army Corps of Engineers (model presentation and base case only)	Christy Jones, US Army Corps of Engineers (model and base case presentation only)
Nicola Ulibarri, Stanford University	Art Godwin, counsel to TID
Ellen Levin, CCSF	Herb Smart, TID
John Mills, consultant to TID	Greg Dias, MID
Bill Paris, counsel to MID	Steve Boyd, TID

Meeting Materials

Meeting materials are:

- Agenda (*will be attached to the final notes*)
- Project Operations/Water Balance Model, Attachment B – Model Description and User's Guide, Addendum 1 (materials provided prior to the Workshop and posted on the website at: www.donpedro-relicensing.com in the CALENDAR under May 30—and also in the ANNOUCEMENTS)
  - Revised 5-20-13 Addendum to User's Guide describing updates to model Version 1.01 to create the Base Case and its supporting model
  - Base Case Description – depicts current operations and will be used as the "No Action" NEPA alternative for comparisons of alternative future operations
- Model Version 2.00 (DVD Provided at the Workshop and otherwise available by request to the Districts)
- Draft scenario sheet/Operations Model scenario request form (attached)

Meeting Summary

John Devine reviewed work completed to date on the Water Balance/Operations Model Study and previous Workshops. He indicated that the purpose of the meeting was to introduce the Base Case scenario and the revised model (Version 2.00) to relicensing participants. Development and presentation of the Base Case is the final step to completing the study plan approved by FERC December 21, 2012.

Mr. Devine described that the Base Case was developed to represent the No Action Alternative under FERC's NEPA assessment. It represents the existing FERC-ordered minimum flow schedule for the Don Pedro Project, as well as adopted and permitted operations for CCSF facilities. The Base Case will be used as the setting against which alternatives will be evaluated. The Base Case provides a depiction of current operations recast over the period of record hydrology.

Overview of Workshop Process

Mr. Devine noted there have been several prior Workshops with relicensing participants throughout the process and summarized the content of previous meetings that contributed to model development.

- The presentation of the model hydrology in April 2012 was the first Workshop. This was followed by recommendations from the Conservation Groups for an accretion/depletion workshop and update.
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- On October 23, 2012, a preliminary model was presented at Workshop No. 3, and the first training session in the use of the model was held; a follow-up training session was held on December 7, 2012 and the draft model validation was presented during this meeting. The draft Model Validation Report was issued for relicensing participant review and comment with the Initial Study Report. No subsequent comments were received on the draft Model Validation report.

A draft Model Description, Model Architecture, and User's Guide were provided prior to the October 23, 2012 Workshop and these were also provided in the Districts' January 17, 2013

Initial Study Report (ISR) filing. Review comments on Model hydrology were initially provided by CDFW to SWRCB and copied to the Districts in September 2012 indicating some concerns with the depiction of the unimpaired flow hydrology dataset in the model. Districts undertook further study in response to these concerns and provided a report to SWRCB and CDFW on December 21, 2012. Subsequently, the Districts met with CDFW and SWRCB on February 14, 2013, to discuss model hydrology. Based on that meeting, the Districts met with relicensing participants on March 27, 2013 to review a model hydrology developed by combining the gage pro-ration and mass balance approaches. Agreement was reached on a revised hydrology for the Operations Model. This approach was described in the Districts' April 9, 2013 responses to ISR comments filing with FERC. The Base Case model includes these adjustments to hydrology.

Updates to Model

Dan Steiner then walked through the specific updates to the model since Version 1.01 as described in Addendum 1 to the User's Guide.

Christy Jones and Kevin Richardson inquired on the method for depicting the flood control release. Mr. Steiner replied that throughout the year, including the rain/flood season, the model logic allows encroachment with a look-up every 7 days. Any encroachment is metered out on a 10-day schedule. He noted that there is not an explicit rate of change limit in the model, but using the method described, operations do not exceed the hourly ACOE rate of change advice. Mr. Steiner also explained other model modifications that enhanced the model's depiction of operations, including additional refinement of the current FERC minimum flow schedule and a revised characterization of Don Pedro Project power generation.

Patrick Koepele inquired how accretion above Modesto is addressed. Mr. Steiner and Mr. Devine described that accretion in the model varies daily and was based on historical records, synthesized into a consistent long-term record representing accretion flow and runoff events. For Dry Creek, a full record was also developed based on the best available information and based on watershed gages; this methodology is described in detail in an attachment to the W&AR-02 study report submitted with the ISR.

Mr. Koepele asked for clarification of the canal loss calculation source and related model parameters. Mr. Steiner explained that planning level data from the Districts' monitoring of canals is used. He also described the difference between critical versus non-critical operational spills; during years of water shortages, the Districts increase their effort to reduce operational spills. Mr. Steiner confirmed the definition of "spill" is water that spills from the canals; it was also noted the water balance of the canals include intercepted flows.

Lucas Sharkey asked for a description of the canal turnout factor. Mr. Steiner described the turnout factor as an additional adjustment between the land-use based model that describes consumptive use needs and the observation of canal deliveries. Mr. Steiner noted that these assumptions and model parameters will not change when performing a study of an alternative.

Base Case Description

Mr. Steiner reviewed the reference document with the title "Base Case Description" and responded to questions on the Base Case development.

Bob Hughes had questions regarding the results of the Base Case study and its consistency with the historical record versus recent operations. Specifically, he inquired as to why there are inflow differences in more recent years when the Base Case should mirror more closely the historical operations.

Mr. Steiner noted that more recent CCSF operations incorporate tighter management rules regarding discretionary releases. He noted that in comparing the model to actual operations, the operational trends are consistent and mimic actual conditions well across a wide range of hydrology. However, there will be differences that appear. Ellen Levin noted that the rules of operation for the CCSF system calibrate well with the model; actual recent operations include maintenance and construction-related shutdowns that have been occurring since 2005, and so as Mr. Steiner mentioned, there will be differences between the model and recent actual operations. As has been discussed in prior sessions concerning validation of the model, these differences do not equate to the model not being calibrated. The rules of operation of the TID/MID and CCSF water supply systems are accurately represented by the operations model.

Mr. Koepele inquired about the range of monthly turnout factors and the implied trends in canal use. Mr. Koepele noted that he thought there was no canal use in the winter, while the model shows some use. Mr. Steiner described the assumptions in the Department of Water Resources consumptive use model and other components of canal demands and how the model uses the information. For example, if the model is predicting consumptive use of 1,000 acre-feet for January; the model calculation for canal delivery will be 1,000 acre-feet divided by 35%. Mr. Devine and Mr. Steiner noted that the canals typically have a year-round demand for system needs, including MID municipal demand. Winter canal demand should not be assumed to be zero. Mr. Steiner also explained that the turnout factor for March and April required special logic to account for the applied water demand vagaries that occur due to variable precipitation on agricultural lands during these months. This is why there are separate references for this time frame of the year in Table 2.3-1.

Chris Shutes asked for clarification of the "projected" inflow in the model. Mr. Steiner explained that the model's logic occasionally relies on a calculation of hydrologic conditions to make operational decisions. Mr. Steiner described that while the Districts' operations use real-time information and best available information (snow surveys, forecasts, assumptions of risk, etc), the model must use a defined set of assumed hydrology. The model incorporates perfect knowledge of a set of assumed hydrologic conditions such as always assuming knowledge of a year's San Joaquin River Index when establishing the model's minimum required release for current FERC requirements, which the real-time operators do not have.

Mr. Hughes asked if CCSF demand values changed in the model recently. Mr. Steiner confirmed that the CCSF demand level applied to current conditions is the same as presented in Version 1.01 of the model and as described in the User's Manual.

Mr. Steiner reviewed figures in the Base Case depiction. Mr. Hughes expressed a desire to see the model validated to history. Mr. Steiner explained, as has been discussed in earlier workshops, how this type of planning model will not always replicate history because of the many anomalies and differences that can occur between modeled operations and historical experience. Mr. Hughes was referred to the previous Validation Report presented during the December 2012 Workshop and incorporated into the ISR. Mr. Hughes noted that this validation was for the earlier test case and not the Base Case being discussed at this Workshop. Mr. Hughes expressed an interested in seeing the base case series of rules compared to the most recent history. Mr. Steiner explained that a canal diversion re-validation was completed recently with more recent records of District operations which were described in their Agricultural Water Management plans recently submitted to the State of California.

Regarding validation, Mr. Devine indicated that, as is customary in the relicensing of hydroelectric projects, the generation predicted by the model demonstrates a strong consistency between the Base Case and recent generation history, indicating overall water flows were validated. He also noted the model's validation was provided at the December training workshop and a validation report was an appendix to the WAR-02 draft report filed with the ISR.

Mr. Steiner noted that the Base Case depicts current operations, and that the algorithms of the model are the same in the test case as well as the Base Case. Ellen Levin noted that the earlier efforts to demonstrate model operation and validation showed that the rules of operation tracked closely with actual operation, and CCSF and the Districts believe the model is fit. Mr. Steiner reviewed several examples of modeled operation with the historical record of operations, and highlighted the model's ability to depict operational activities across a variety of water years.

Model Training Alternative Development Exercise

The remainder of the workshop was used to walk through an example using the operations model. Mr. Steiner demonstrated the formulation and execution of an "alternative." The sample alternative was identified as a setting in which the minimum stream flow requirement of the Don Pedro Project is the greater of the current FERC requirements or 300 cfs.

Mr. Steiner illustrated a step-wise execution of the sample alternative:

- Create a daily flow requirement equal to the current FERC requirement or 300 cfs, whichever flow value is greater,
- Employ the new computed flow schedule into the model as the required flow,
- Discover the viability of the Don Pedro Project operation when assuming Base Case canal diversions (the model "crashed" during the 1987-1992 drought),
- Estimate the amount of reduced canal diversion needed to return Don Pedro Reservoir storage back to Base Case conditions during the drought (determine the difference between the current FERC requirement and the revised flow schedule),
- Reduce canal diversion during the drought, and employ the new diversion values in the model,
- Confirm viable Don Pedro Reservoir operation,
- Assign CCSF partial responsibility (enable model switch) for incremental FERC flow requirements, compute estimate of CCSF responsibility,
- Reduce CCSF SJPL diversions during drought to maintain CCSF system storage and Water Bank Account credit equal to Base Case,
- Adjust Supplement Water Bank Releases to maintain positive balance,
- Adjust Districts' canal diversion upward to utilize additional inflow from CCSF,
- Re-adjust Supplemental Water Bank Releases to maintain positive (or zero) balance.

The Districts presented a draft scenario request form and requested comment from relicensing participants. The intent of the form is to provide a mechanism for relicensing participants to request alternative operations scenarios to be run through the models by the Districts for consideration in the relicensing process. The draft form is posted to the Don Pedro relicensing web-site with the meeting materials, and attached to these meeting notes for comment. An additional "check-box" to indicate whether minimum flow requirements should be shared between CCSF and Districts was added to Section 1 per meeting discussion. Mr. Steiner noted that the narrative portion of the form is critical for the Districts' team to understand the drivers of the request in order to adequately incorporate the intent of an alternative in a model run.

FOR HDR USE ONLY	
Run #	

DRAFT SCENARIO SHEET
Operations Model Run Request

Originator: Date Requested:
Relicensing Participant Group: Needed By:

Instructions: Complete this entire form, including a brief narrative description of your request. The narrative description should include specific questions you think this model run will answer and/or be specific how flow requirements should be modified. Empty scenario values will be assumed to be equal to Base Case.

Decription:____
____
____
____

Section 1—Minimum Flow Requirements at La Grange Bridge	
☐ Existing 1995 FERC Requirement ☐ Alternative, provided as daily time series___________ ☐ Alternative, provided as Year Type Schedule___________ ☐ Alternative, previous Run #___________ ☐ Shared CCSF/Districts Responsibility	*Instructions: Attach alternative flow requirements or provide location of file containing alternative flow requirements*
Section 2—Canal Diversions of Modesto Irrigation District and Turlock Irrigation District	
☐ Base Case Diversions ☐ Alternative diversions, volume by month ☐ Alternative, previous Run #___________	*Instructions: Attach alternative diversions or provide location of file containing alternative diversions*
Section 3—Supplemental Releases to Water Bank from San Francisco	
☐ "WaterBankRel" Worksheet ☐ Alternative releases, volume by month, add to Base Case ☐ Alternative releases, volume by month, replace Base Case ☐ Alternative, previous Run #___________	*Instructions: Attach alternative diversion, worksheet, or provide location of file containing alternative diversions*
Section 4—San Joaquin Pipeline Diversions of San Francisco	
☐ Base Case San Joaquin Pipeline Diversions ☐ Alternative diversions, volume by month ☐ Alternative, previous Run #___________	*Instructions: Attach alternative diversions or provide location of file containing alternative diversions*
Section 5—Additional Operational Objectives	

November 5, 2013 Don Pedro Project
E-Filed FERC No. 2299-075

Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
Mail Code: DHAC, PJ-12.3
888 First Street, NE
Washington, DC 20426

RE: Turlock Irrigation District and Modesto Irrigation District
Don Pedro Project - FERC Project No. 2299
Final Meeting Notes - May 30, 2013
W&AR-02 Operations Model Consultation Workshop

Dear Secretary Bose:

In May 2013, as part of the ongoing studies under the Integrated Licensing Process ("ILP") for the Don Pedro Project ("Project"), the Turlock Irrigation District and the Modesto Irrigation District (collectively the "Districts"), co-licensees of the Project, held a relicensing participant meeting to discuss the Project Operations/Water Balance Model ("Operations Model") developed for the W&AR-02 Project Operations/Water Balance Model Study.

The Districts held Consultation Workshop No. 5 on May 30, 2013 as proposed in the Project Operations/Water Balance Model Study Plan and approved by FERC in its December 22, 2011 Study Plan Determination ("SPD"). The Workshop was held to introduce the Base Case scenario and revised model (Version 2.00). Development and presentation of the Base Case was the final step to completing the study plan. Prior to the Workshop, on May 22, 2013, the Districts released the Workshop agenda and following advance materials:

1. Operations/Water Balance Model Attachment B – Model Description and User's Guide, Addendum 1, Base Case Description, 5-20-2013, and

2. Operations/Water Balance Model Study Report Attachment B – Model Description and User's Guide, Addendum 1 Revised 5-20-2013.

On June 12, 2013, the Districts circulated draft Workshop meeting notes. Within the 30-day review period, which ended on July 12, 2013, the Districts did not receive any comments on the draft notes. On July 19, 2013, the California Department of Fish and Wildlife ("CDFW") filed a letter with FERC providing comments related to the Operations Model. The letter did not provide comments on the May 30, 2013 draft Workshop notes, but did provide comment on the model development process. On October 4, 2013, the Districts filed a response to CDFW's letter. Because the Districts did not receive any comments on the draft meeting notes, the final meeting notes are the same as the draft notes distributed to relicensing participants. In accordance with the Final Workshop Consultation Protocols filed with FERC on May 18, 2012, Attachment A of this filing provides the final May 30, 2013 Workshop meeting notes, which also include the advance materials, the Workshop agenda, and the Draft Scenario Sheet Operations Model Run Request form. Attachment B of this filing contains CDFW's July 19, 2013, letter to FERC and Attachment C contains the Districts' October 4, 2013 response letter.

Sincerely,

John Devine

John Devine, P.E.
Project Manager

Enclosures:
Attachment A – May 30, 2013 Operations Model (W&AR-02) Workshop Notes and Materials
Attachment B – CDFW's July 19, 2013 comment letter to FERC
Attachment C – The Districts' October 4, 2013 response to CDFW's letter to FERC

Attachment A

May 30, 2013 Operations Model (W&AR-02) Workshop Notes and Materials

TID WATER & POWER
Serving Central California since 1887

MID Modesto Irrigation District
The Power to Grow

Operations Modeling Consultation Workshop No. 5
Don Pedro Relicensing Study W&AR-02
May 30, 2013 – 9:00 a.m. to 4:00 p.m. - MID Offices

AGENDA

9:00 a.m. to 9:15 a.m.	Introductions
9:15 a.m. to 9:30 a.m.	Meeting Purpose
9:30 a.m. to 10:15 a.m.	Background • Study Plan • FERC Dec 2011 Determination • Review Prior Workshops • Hydrology Update in March 2013
10:15 a.m. to 11:30 a.m.	Base Case Description • Role of Base Case • Incorporation into Operations Model • Summary of Results Provided in Base Case Report
11:30 a.m. to 1:00 p.m.	Lunch (on your own)
1:00 p.m. to 2:00 p.m.	Further Presentation and Discussion of Results of Operations Model Runs Under Base Case
2:00 p.m. to 3:00 p.m.	Run Alternative Scenarios (Districts will run the model using examples for two alternatives to assist Relicensing Participants in furthering their use of the model)
3:00 p.m. to 3:30 p.m.	Presentation of Form for Requesting Model Runs by the Districts
3:30 p.m. to 4:00 p.m.	Action Items and Closure

Don Pedro Project Relicensing
Operations Model Base Case Workshop and Training Session (W&AR-02)
Final Meeting Notes
May 30, 2013
Modesto Irrigation District Offices

Attendees

John Devine, HDR	Donn Furman, CCSF
Patrick Koepele, Tuolumne River Trust	Bob Hughes, CDFW
Chris Shutes, CSPA	Jenna Borovansky, HDR
Lucas Sharkey, SWRCB	Dan Steiner, consultant to TID/MID
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Christy Jones and Kevin Richardson inquired on the method for depicting the flood control release. Mr. Steiner replied that throughout the year, including the rain/flood season, the model logic allows encroachment with a look-up every 7 days. Any encroachment is metered out on a 10-day schedule. He noted that there is not an explicit rate of change limit in the model, but using the method described, operations do not exceed the hourly ACOE rate of change advice. Mr. Steiner also explained other model modifications that enhanced the model's depiction of operations, including additional refinement of the current FERC minimum flow schedule and a revised characterization of Don Pedro Project power generation.

Patrick Koepele inquired how accretion above Modesto is addressed. Mr. Steiner and Mr. Devine described that accretion in the model varies daily and was based on historical records, synthesized into a consistent long-term record representing accretion flow and runoff events. For Dry Creek, a full record was also developed based on the best available information and based on watershed gages; this methodology is described in detail in an attachment to the W&AR-02 study report submitted with the ISR.

Mr. Koepele asked for clarification of the canal loss calculation source and related model parameters. Mr. Steiner explained that planning level data from the Districts' monitoring of canals is used. He also described the difference between critical versus non-critical operational spills; during years of water shortages, the Districts increase their effort to reduce operational spills. Mr. Steiner confirmed the definition of "spill" is water that spills from the canals; it was also noted the water balance of the canals include intercepted flows.

Lucas Sharkey asked for a description of the canal turnout factor. Mr. Steiner described the turnout factor as an additional adjustment between the land-use based model that describes consumptive use needs and the observation of canal deliveries. Mr. Steiner noted that these assumptions and model parameters will not change when performing a study of an alternative.

Base Case Description

Mr. Steiner reviewed the reference document with the title "Base Case Description" and responded to questions on the Base Case development.

Bob Hughes had questions regarding the results of the Base Case study and its consistency with the historical record versus recent operations. Specifically, he inquired as to why there are inflow differences in more recent years when the Base Case should mirror more closely the historical operations.

Mr. Steiner noted that more recent CCSF operations incorporate tighter management rules regarding discretionary releases. He noted that in comparing the model to actual operations, the operational trends are consistent and mimic actual conditions well across a wide range of hydrology. However, there will be differences that appear. Ellen Levin noted that the rules of operation for the CCSF system calibrate well with the model; actual recent operations include maintenance and construction-related shutdowns that have been occurring since 2005, and so as Mr. Steiner mentioned, there will be differences between the model and recent actual operations. As has been discussed in prior sessions concerning validation of the model, these differences do not equate to the model not being calibrated. The rules of operation of the TID/MID and CCSF water supply systems are accurately represented by the operations model.

Mr. Koepele inquired about the range of monthly turnout factors and the implied trends in canal use. Mr. Koepele noted that he thought there was no canal use in the winter, while the model shows some use. Mr. Steiner described the assumptions in the Department of Water Resources consumptive use model and other components of canal demands and how the model uses the information. For example, if the model is predicting consumptive use of 1,000 acre-feet for January; the model calculation for canal delivery will be 1,000 acre-feet divided by 35%. Mr. Devine and Mr. Steiner noted that the canals typically have a year-round demand for system needs, including MID municipal demand. Winter canal demand should not be assumed to be zero. Mr. Steiner also explained that the turnout factor for March and April required special logic to account for the applied water demand vagaries that occur due to variable precipitation on agricultural lands during these months. This is why there are separate references for this time frame of the year in Table 2.3-1.

Chris Shutes asked for clarification of the "projected" inflow in the model. Mr. Steiner explained that the model's logic occasionally relies on a calculation of hydrologic conditions to make operational decisions. Mr. Steiner described that while the Districts' operations use real-time information and best available information (snow surveys, forecasts, assumptions of risk, etc), the model must use a defined set of assumed hydrology. The model incorporates perfect knowledge of a set of assumed hydrologic conditions such as always assuming knowledge of a year's San Joaquin River Index when establishing the model's minimum required release for current FERC requirements, which the real-time operators do not have.

Mr. Hughes asked if CCSF demand values changed in the model recently. Mr. Steiner confirmed that the CCSF demand level applied to current conditions is the same as presented in Version 1.01 of the model and as described in the User's Manual.

Mr. Steiner reviewed figures in the Base Case depiction. Mr. Hughes expressed a desire to see the model validated to history. Mr. Steiner explained, as has been discussed in earlier workshops, how this type of planning model will not always replicate history because of the many anomalies and differences that can occur between modeled operations and historical experience. Mr. Hughes was referred to the previous Validation Report presented during the December 2012 Workshop and incorporated into the ISR. Mr. Hughes noted that this validation was for the earlier test case and not the Base Case being discussed at this Workshop. Mr. Hughes expressed an interested in seeing the base case series of rules compared to the most recent history. Mr. Steiner explained that a canal diversion re-validation was completed recently with more recent records of District operations which were described in their Agricultural Water Management plans recently submitted to the State of California.

Regarding validation, Mr. Devine indicated that, as is customary in the relicensing of hydroelectric projects, the generation predicted by the model demonstrates a strong consistency between the Base Case and recent generation history, indicating overall water flows were validated. He also noted the model's validation was provided at the December training workshop and a validation report was an appendix to the WAR-02 draft report filed with the ISR.

Mr. Steiner noted that the Base Case depicts current operations, and that the algorithms of the model are the same in the test case as well as the Base Case. Ellen Levin noted that the earlier efforts to demonstrate model operation and validation showed that the rules of operation tracked closely with actual operation, and CCSF and the Districts believe the model is fit. Mr. Steiner reviewed several examples of modeled operation with the historical record of operations, and highlighted the model's ability to depict operational activities across a variety of water years.

Model Training Alternative Development Exercise

The remainder of the workshop was used to walk through an example using the operations model. Mr. Steiner demonstrated the formulation and execution of an "alternative." The sample alternative was identified as a setting in which the minimum stream flow requirement of the Don Pedro Project is the greater of the current FERC requirements or 300 cfs.

Mr. Steiner illustrated a step-wise execution of the sample alternative:

- Create a daily flow requirement equal to the current FERC requirement or 300 cfs, whichever flow value is greater,
- Employ the new computed flow schedule into the model as the required flow,
- Discover the viability of the Don Pedro Project operation when assuming Base Case canal diversions (the model "crashed" during the 1987-1992 drought),
- Estimate the amount of reduced canal diversion needed to return Don Pedro Reservoir storage back to Base Case conditions during the drought (determine the difference between the current FERC requirement and the revised flow schedule),
- Reduce canal diversion during the drought, and employ the new diversion values in the model,
- Confirm viable Don Pedro Reservoir operation,
- Assign CCSF partial responsibility (enable model switch) for incremental FERC flow requirements, compute estimate of CCSF responsibility,
- Reduce CCSF SJPL diversions during drought to maintain CCSF system storage and Water Bank Account credit equal to Base Case,
- Adjust Supplement Water Bank Releases to maintain positive balance,
- Adjust Districts' canal diversion upward to utilize additional inflow from CCSF,
- Re-adjust Supplemental Water Bank Releases to maintain positive (or zero) balance.

The Districts presented a draft scenario request form and requested comment from relicensing participants. The intent of the form is to provide a mechanism for relicensing participants to request alternative operations scenarios to be run through the models by the Districts for consideration in the relicensing process. The draft form is posted to the Don Pedro relicensing web-site with the meeting materials, and attached to these meeting notes for comment. An additional "check-box" to indicate whether minimum flow requirements should be shared between CCSF and Districts was added to Section 1 per meeting discussion. Mr. Steiner noted that the narrative portion of the form is critical for the Districts' team to understand the drivers of the request in order to adequately incorporate the intent of an alternative in a model run.

Don Pedro Project
Project Operations/Water Balance Model
Attachment B – Model Description and User's Guide, Addendum 1
Base Case Description
5-20-2013

1.0 INTRODUCTION

The Turlock Irrigation District ("TID") and Modesto Irrigation District ("MID") (collectively, the "Districts") have developed a computerized Tuolumne River Daily Operations Model ("Model") to assist in the relicensing of the Don Pedro Project ("Project") (FERC Project 2299). The Model is fully described in the User's Guide submitted to FERC as part of the Initial Study Report ("ISR"), January 2013 (Model version 1.01) and supplemented by Addendum 1, May 2013 regarding the currently used version of the Model (Version 2.0).

The Districts have proceeded to develop the "Base Case" which depicts the operation of the Don Pedro Project in accordance with the current FERC license, ACOE flood management guidelines, and the Districts' irrigation and M&I water management practices. Under FERC policy, the Base Case represents the "No Action" alternative for purposes of evaluating future operating scenarios under NEPA. Future scenarios are compared to the Base Case to assess their impacts. For purposes of representing the City and County of San Francisco ("CCSF") operations, the Base Case also includes changes that are permitted under CEQA, approved by CCSF, and authorized (funded), but not yet fully implemented. This document provides a description of the assumptions and results of the modeled simulation of the Base Case as depicted by the Tuolumne River Daily Operations Model.

2.0 BASE CASE MODEL AND ASSUMPTIONS

The Tuolumne River Daily Operations Model (Version 2.0) has been developed to depict the Base Case water management operations of CCSF facilities and the Don Pedro Project, providing a tool to simulate and compare alternative operation scenarios. The Model was constructed within the platform of a Microsoft Excel 2010 workbook, and allows alternative user-specified data and assumptions for numerous components of Don Pedro Project operations in accordance with the Districts Study Plan W&AR-02 as approved by FERC's December 2011 Study Plan Determination. A brief description of Model assumptions and data for the Base Case follows.

2.1 Reservoir Inflows

The Model requires several records of estimated unimpaired flow. These records are (1) unimpaired flow (inflow) at Hetch Hetchy Reservoir, (2) unimpaired flow (inflow) at Lake Lloyd Reservoir and Eleanor Reservoir, (3) flow which depicts the runoff entering Don Pedro Reservoir that is not affected by upstream CCSF facilities, and (4) unimpaired flow at the La Grange USGS gage.

The estimated unimpaired flow of the Tuolumne River has been computed for various locations within the basin for decades. The hydrologic data set developed by the Districts and CCSF was provided in Study Report W&AR-02: Project Operations/Water Balance Model Attachment A, January 2013. Subsequently during March 2013, the Districts and the RPs developed a consensus-based revised data set of unimpaired daily hydrology. The revised data set generally provides a "smoother" daily sequence of flows while maintaining the overall monthly volumes of runoff from the watershed contained in the January 2013 report. The revised data set for the four components of unimpaired flow described above was agreed to during the March 27, 2013 Workshop concerning unimpaired flow hydrology.

Inflow to Don Pedro Reservoir is modeled as two components: (1) a fluctuating unregulated inflow to Don Pedro Reservoir, and (2) the regulated releases (regulated Don Pedro Reservoir inflow) from the CCSF System. The unregulated component of inflow to Don Pedro Reservoir remains the same among all operation simulations. The regulated inflow to Don Pedro is based on the operation of the CCSF System. The latter component of Don Pedro Reservoir inflow may change among operation simulations due to user-controlled parameters. The Base Case operation for the CCSF System is based on current facilities, operational plans and objectives, regulatory requirements in place, and operational plans and facilities that have been approved under CEQA and authorized for funding by CCSF, but not yet fully implemented.

Projected[1] annual inflow to Don Pedro Reservoir under the Base Case is illustrated in Figure 2.1-1, representing the regulated and unregulated components of total inflow to Don Pedro Reservoir. Average annual inflow to Don Pedro Reservoir is projected to be 1,690,100 acre-feet,

[1] The terms "projected" and "modeled" are used as qualifiers of an expressed term or unit of measurement, and are meant to identify a distinction between results that have been simulated by the Model as opposed to values of the historical reported record.

with approximately 683,400 acre-feet occurring as unregulated inflow. Although not completely appropriate for comparison purposes, the historically computed annual total inflow to Don Pedro Reservoir has also been shown in the figure as confirmation that the Model's simulation of inflow is capturing the magnitude and range of historical hydrology. It is known that simulated inflow and historical inflow will differ for several reasons including historical CCSF water diversions and operations that differ from the Base Case operation represented by the Model.

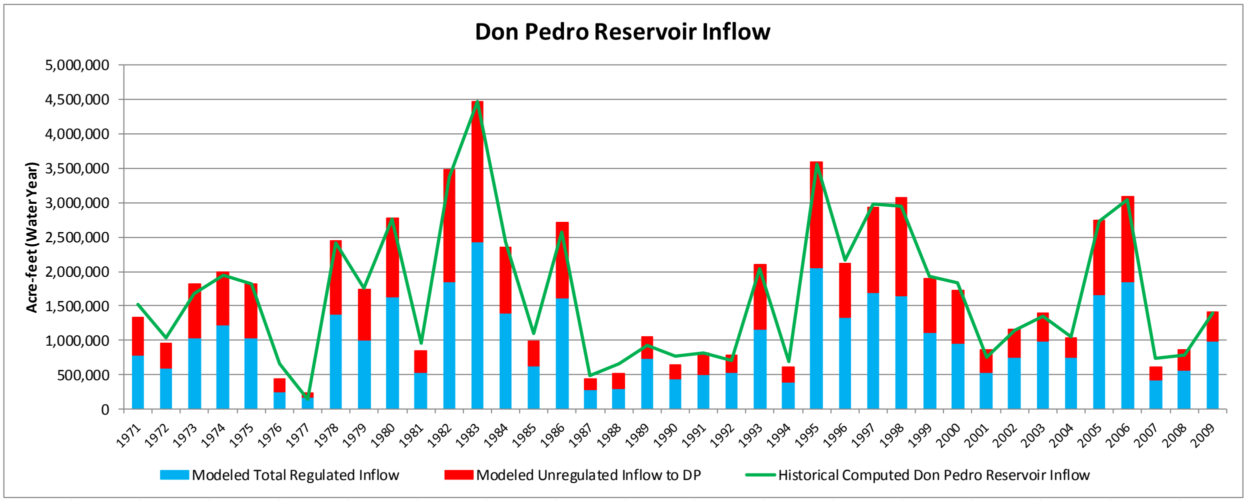


Figure 2.1-1. Projected Don Pedro Reservoir inflow – Base Case.

2.2 Don Pedro Project Minimum Flow Requirement

Table 2.2-1 illustrates the FERC minimum flow requirements for the Base Case. Values for each defined flow period by year type are consistent with the FERC order issued July 31, 1996. Seven water year types are defined based on the San Joaquin Basin 60-20-20 water supply index. The sequence year of the flow schedule begins in April and continues through the following March. The historical actual 60-20-20 index is used for computations. The volume of water interpolated between annual base flow schedules, October attraction flow and the total flow schedule is distributed daily among April (16 days) and May (15 days). The October attraction flow volume is provided equally during two days, beginning October 15. Base flow during October for year types 1, 2 and 6 has been modeled as an average value for the entire month for modeling convenience to fit within the daily parsing logic of the Model.

The daily parsing of April-May outmigration flows is illustrated in Figure 2.2-1. The 31-day pulse flow during April and May occurs beginning April 15 and ends May 15.

The simulated annual minimum flow requirement for the Base Case is illustrated in Figure 2.2-2, and ranges from a minimum of 94,000 acre-feet up to a maximum of 300,900 acre-feet. The 39-year average of the flow requirement is 212,700 acre-feet.

Table 2.2-1. FERC license flow requirements from Don Pedro Project to the lower Tuolumne River.

Year Type	1	2	3	4	5	6	7
Oct 1-15 (CFS)	100	100	150	150	180	200	300
Oct 16-31 (CFS)	150	150	150	150	180	175	300
Total Base (AF)	7,736	7,736	9,223	9,223	11,068	11,504	18,447
Attraction (AF)	0	0	0	0	1,676	1,736	5,950
Total Oct (AF)	7,736	7,736	9,223	9,223	12,744	13,240	24,397
Nov (CFS)	150	150	150	150	180	175	300
AF	8,926	8,926	8,926	8,926	10,711	10,413	17,852
Dec (CFS)	150	150	150	150	180	175	300
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447
Jan (CFS)	150	150	150	150	180	175	300
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447
Feb (CFS)	150	150	150	150	180	175	300
AF	8,331	8,331	8,331	8,331	9,997	9,719	16,661
Mar (CFS)	150	150	150	150	180	175	300
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447
Apr (CFS)	150	150	150	150	180	175	300
AF	8,926	8,926	8,926	8,926	10,711	10,413	17,852
May (CFS)	150	150	150	150	180	175	300
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447
Migration Flow							
AF	11,091	20,091	32,619	37,060	35,920	60,027	89,882
Jun (CFS)	50	50	50	75	75	75	250
AF	2,975	2,975	2,975	4,463	4,463	4,463	14,876
Jul (CFS)	50	50	50	75	75	75	250
AF	3,074	3,074	3,074	4,612	4,612	4,612	15,372
Aug (CFS)	50	50	50	75	75	75	250
AF	3,074	3,074	3,074	4,612	4,612	4,612	15,372
Sep (CFS)	50	50	50	75	75	75	250
AF	2,975	2,975	2,975	4,463	4,463	4,463	14,876
Total Annual	94,001	103,001	117,017	127,508	142,503	165,004	300,926

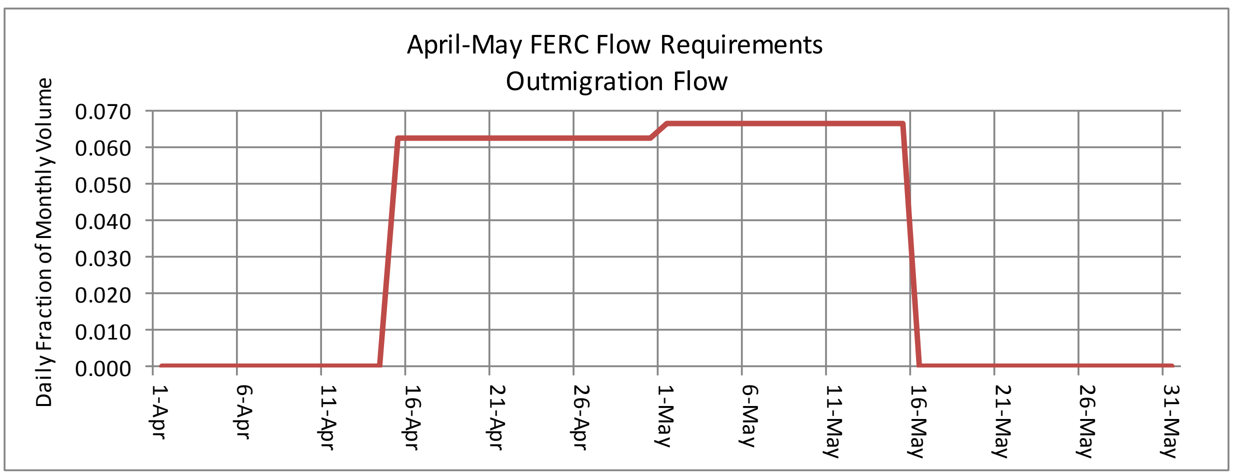


Figure 2.2-1. Daily parsing of April-May outmigration flow – Base Case.

The volumes of outmigration and attraction flows can be shaped within the current FERC requirements. The actual daily distribution of outmigration and attraction flows can in practice be different than patterned in the Base Case. At the time of simulation of any alternative operation and subsequent comparison to the Base Case, it must be recognized that the Base Case daily distribution of these flows is not absolute. For comparison purposes it may be necessary to rerun the Base Case releases with a distribution for the outmigration and attraction flows in the same pattern as provided for the alternative. If required, the Districts would perform and provide such additional versions of the Base Case.

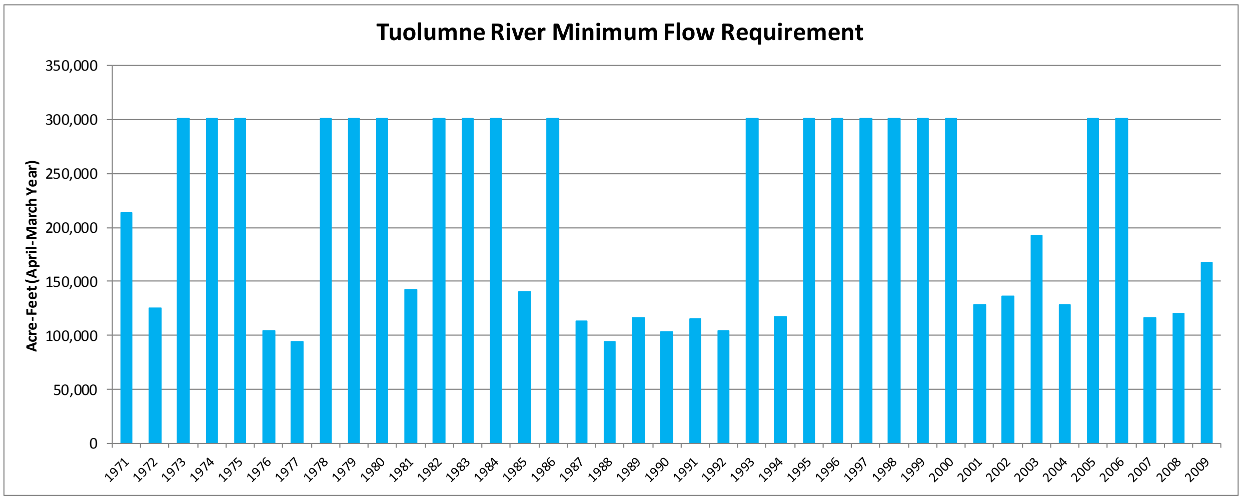


Figure 2.2-2. Minimum annual FERC flow requirement – Base Case.

The annual and monthly volume of the minimum flow requirement used in the Base Case is listed in Table 2.2-2.

Table 2.2-2. Minimum FERC flow requirement in the Base Case Model.

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Apr-Mar
1971	24,397	17,852	18,447	18,447	16,661	18,447	66,685	63,515	4,463	4,612	4,612	4,463	262,598	214,003
1972	13,240	10,413	10,760	10,760	9,719	10,760	30,288	29,251	2,975	3,074	3,074	2,975	137,292	125,788
1973	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	300,923
1974	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1975	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1976	24,397	17,852	18,447	18,447	16,661	18,447	20,153	19,749	2,975	3,074	3,074	2,975	166,250	104,663
1977	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
1978	7,736	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	239,336	300,923
1979	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1980	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1981	24,397	17,852	18,447	18,447	16,661	18,447	29,339	28,532	4,463	4,612	4,612	4,463	190,269	142,675
1982	12,744	10,711	11,068	11,068	9,997	11,068	64,241	61,936	14,876	15,372	15,372	14,876	253,329	300,923
1983	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1984	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1985	24,397	17,852	18,447	18,447	16,661	18,447	34,656	33,346	4,463	4,612	4,612	4,463	200,400	140,301
1986	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	300,923
1987	24,397	17,852	18,447	18,447	16,661	18,447	24,481	23,806	2,975	3,074	3,074	2,975	174,636	113,049
1988	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
1989	7,736	8,926	9,223	9,223	8,331	9,223	25,991	25,222	2,975	3,074	3,074	2,975	115,975	115,975
1990	7,736	8,926	9,223	9,223	8,331	9,223	19,362	19,008	2,975	3,074	3,074	2,975	103,131	103,131
1991	7,736	8,926	9,223	9,223	8,331	9,223	25,870	25,109	2,975	3,074	3,074	2,975	115,740	115,740
1992	7,736	8,926	9,223	9,223	8,331	9,223	19,995	19,601	2,975	3,074	3,074	2,975	104,357	104,357
1993	7,736	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	239,336	300,923
1994	24,397	17,852	18,447	18,447	16,661	18,447	25,903	25,140	2,975	3,074	3,074	2,975	177,392	117,292
1995	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	300,923
1996	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1997	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1998	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1999	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2000	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2001	24,397	17,852	18,447	18,447	16,661	18,447	28,572	27,642	4,463	4,612	4,612	4,463	188,613	128,513
2002	9,223	8,926	9,223	9,223	8,331	9,223	32,729	31,539	4,463	4,612	4,612	4,463	136,567	136,567
2003	9,223	8,926	9,223	9,223	8,331	9,223	55,641	53,161	4,463	4,612	4,612	4,463	181,101	192,606
2004	13,240	10,413	10,760	10,760	9,719	10,760	28,696	27,758	4,463	4,612	4,612	4,463	140,258	128,753
2005	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	300,923
2006	24,397	17,852	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2007	24,397	17,852	18,447	18,447	16,661	18,447	26,085	25,310	2,975	3,074	3,074	2,975	177,743	116,156
2008	7,736	8,926	9,223	9,223	8,331	9,223	27,470	26,609	2,975	3,074	3,074	2,975	118,840	120,328
2009	9,223	8,926	9,223	9,223	8,331	9,223	42,919	41,235	4,463	4,612	4,612	4,463	156,452	167,957
Average	16,957	13,625	14,079	14,079	12,717	14,079	46,531	44,910	9,078	9,381	9,381	9,078	213,897	212,651
Min	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
Max	24,397	17,852	18,447	18,447	16,661	18,447	66,685	63,515	14,876	15,372	15,372	14,876	300,923	300,923

2.3 Districts' Canal Demands

The computation of canal demands incorporates the projected demand of applied water ("PDAW") and the canal operation and maintenance practices of the Districts. Canal operation assumptions include the operation of the Districts' irrigation system reservoirs - Turlock Lake and Modesto Reservoir, seepage and losses, groundwater pumping and canal operational spills. Table 2.3-1 lists the Base Case assumptions for the Districts' canal operations. Also described in the data set are monthly turnout delivery factors, unique to each District that represent a modeling mechanism to adjust the PDAW for irrigation practices that are not included in the estimation of the consumptive use of applied water, such as irrigation that provides for groundwater recharge. Refer to the Model's Users' Guide for additional information regarding the canal demand components.

Table 2.3-1. Districts' canal demand components in the Base Case.

Modesto Irrigation District

Month	Turnout Delivery Factor	Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Modesto Res	Intercepted Flows	MID GW Pumping	Modesto Res and Upper Canal Losses/Div	Municipal Delivery from Modesto Res	Modesto Res Target Storage	Modesto Res Target Storage Change
	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0	2.0
February	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0	1.0
March	65.0	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0	0.0
April	70.0	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0	1.0
May	85.0	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0	1.0
June	85.0	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0	0.0
July	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0	1.0
August	70.0	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0	1.0
September	65.0	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0	-2.0
October	40.0	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0	-3.0
November	30.0	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0	-2.0
December	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0	0.0
Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5		

MID March TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	65.0
9.9	65.0
13.2	65.0
20.0	65.0
9999.0	65.0

TID March TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	65.0
19.8	65.0
27.5	65.0
40.0	65.0
9999.0	65.0

MID April TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	70.0
10.0	70.0
17.5	70.0
25.0	80.0
9999.0	80.0

TID April TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	57.5
20.0	57.5
35.0	70.0
50.0	80.0
9999.0	80.0

Turlock Irrigation District

Month	Turnout Delivery Factor	Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Turlock Lk	Intercepted and Other Flows	TID GW Pumping	Turlock Lk and Upper Canal Losses	Other Delivery from Turlock Lk	Turlock Lk Target Storage	Turlock Lk Target Storage Change
	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0	5.0
February	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0	7.0
March	65.0	1.2	3.0	3.0	4.5	0.5	4.1	1.0	0.0	30.0	5.0
April	57.5	2.4	5.1	6.3	4.5	1.0	8.0	6.6	0.0	30.0	0.0
May	85.0	3.6	4.6	6.7	4.5	1.3	10.3	7.7	0.0	32.0	2.0
June	92.5	5.2	4.2	6.7	4.5	1.3	12.4	8.2	0.0	32.0	0.0
July	75.0	6.4	4.2	6.7	4.5	1.5	14.6	8.7	0.0	32.0	0.0
August	65.0	6.2	4.0	7.3	4.5	1.5	13.3	9.0	0.0	30.0	-2.0
September	67.5	3.9	3.2	7.3	4.5	1.0	9.1	5.0	0.0	27.0	-3.0
October	40.0	2.4	2.3	7.3	4.5	0.5	5.3	2.0	0.0	13.0	-14.0
November	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
December	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
Total		31.3	38.6	59.3	39.2	8.5	77.1	52.2	0.0		

2.4 Don Pedro Water Supply Factor

The premise of the Don Pedro water supply factor ("WSF") factor is to simulate the Districts' historical practice of reducing the amount of water diverted to the canals during years when lack of carryover storage at Don Pedro Reservoir becomes a concern. In practice, any such reduction is managed on a real-time basis by the Districts using the best information available at the time. The modeling mechanism used to reduce canal diversions is a factor applied to the PDAW of the canal demand. This mechanism results in a reduction to the amount of water delivered or "turned out" to the customers. Table 2.4-1 illustrates the Base Case WSF components in the Model. As an illustration of the use of the WSF in the model, if the forecast of the ending-March Don Pedro Reservoir storage plus projected inflow for April through July is greater than 1,090 TAF and less than 1,700 TAF, the PDAW for the year would be reduced by a factor of 0.875. If the forecast was greater than 1,700 TAF, there would be no reduction to the projected PDAW for the year.

Table 2.4-1. Don Pedro water supply forecast factors – Base Case.

Don Pedro Water Supply Factor		*(W)ater (S)upply (F)actor is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir.*
NDP Stor + Infl Index	WS Factor	
TAF	%	*Forecast begins for February:*
		EO-January storage + Feb-July UF - Feb-July US adj - Feb-Mar minimum river
0	0.750	*March Forecast:*
1090	0.750	*EO-February storage + Mar-July UF - Mar-July US adj - Mar minimum river*
1090	0.875	*April Forecast: (final)*
1700	0.875	*EO-March storage + Apr-July UF - Apr-July US adj*
1700	1.000	
2300	1.000	*Factor Table is April Forecast based*
9999	1.000	*February and March Forecasts act as adjustments to estimate April 1 state.*

2.5 Don Pedro Reservoir Storage Guidance

The Model allows the user to establish the preferred storage target. The Base Case preferred storage target is the Army Corps of Engineers ("ACOE") rain flood reservation objective, except after July 1, when there is no required reservation space. The preferred storage target reflects a drawdown to evacuate storage during the summer in late and wet runoff years. The preferred target storage is again equal to the ACOE objective on October 7. Figure 2.5-1 illustrates the reservoir storage target used in the Model for the Base Case.

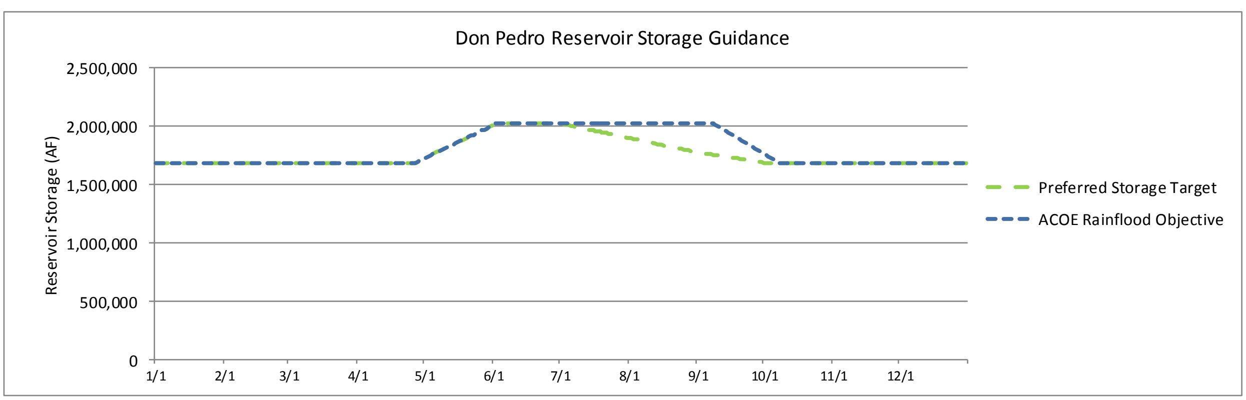


Figure 2.5-1. Don Pedro Reservoir storage guidance targets – Base Case.

2.6 CCSF Water Diversions

The Base Case operation for the CCSF system is based on the existing facilities, operational plans and objectives, and the regulatory requirements in place. The Base Case also includes facilities and operations previously approved under CEQA and authorized for funding by CCSF, but not yet fully implemented. The projected diversions of CCSF to the San Francisco Bay Area from the San Joaquin Pipeline ("SJPL") are imported to the Model from output of CCSF's Hetch Hetchy/Local Simulation Model ("HHLSM") as provided by CCSF to the Districts. Figure 2.6-1 illustrates the annual volume of diversions for the Base Case. Based on an annual average system-wide demand of 238 MGD (266,600 acre-feet), annual average diversions from the Tuolumne River are projected to be 231,200 acre-feet. These diversions integrate with other CCSF water supply resources and fully meet CCSF system-wide demands except during 1977, 1988, 1989, 1990, 1991 and 1992 when a 10 percent reduction in deliveries is needed.

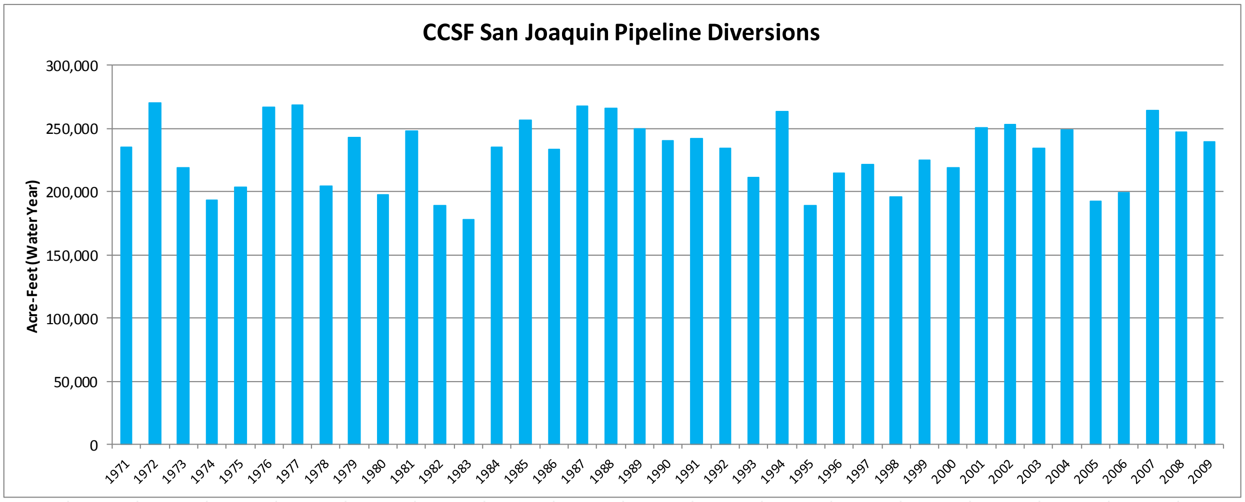


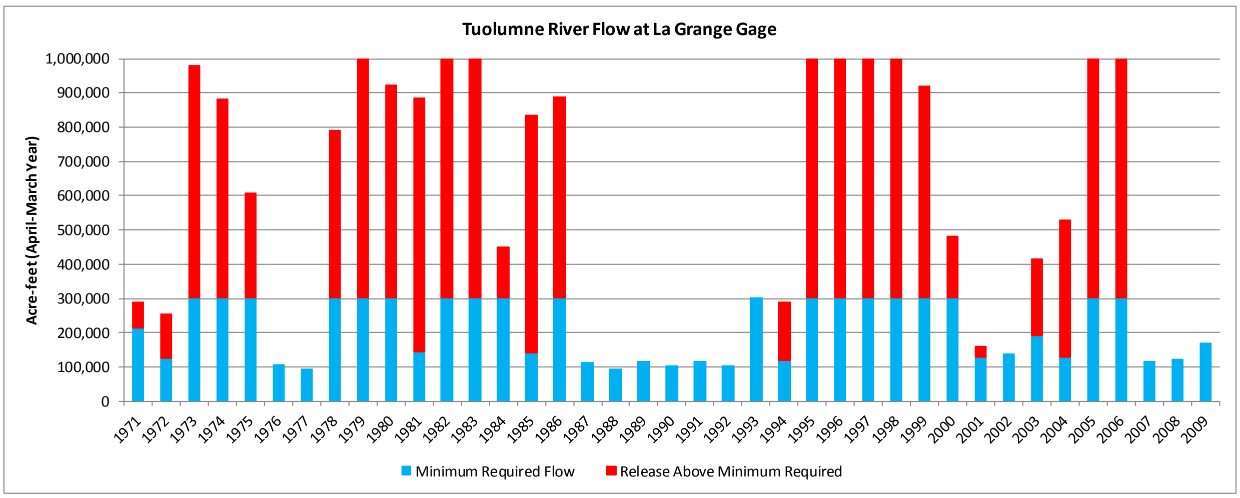
Figure 2.6-1. San Joaquin Pipeline diversions – Base Case.

3.0 REPRESENTATIVE BASE CASE RESULTS

Incorporation of the above described depictions of hydrology and demands, and the performance of operations according to operational parameters established in the Model, result in a 39-year simulation of Don Pedro Project and CCSF Tuolumne River operations under the Base Case.

3.1 Tuolumne River Flow

Flow delivered from Don Pedro to the Tuolumne River at the La Grange gage will result from meeting the FERC license minimum flow requirements and releasing flows for flood control operations and discretionary drawdown of Don Pedro Reservoir. The projected annual flow of the river at the La Grange gage under the Base Case is illustrated in Figure 3.1-1. Seasonal flow volume in the Tuolumne River is illustrated in Table 3.1-1 which provides average flow by month within a ranking of all years according to a preliminary year type classification.[2]



(Flows exceeding scale of graph: 1979 – 1,396,600 acre-feet; 1982 – 3,052,100 acre-feet; 1983 – 3,322,600 acre-feet; 1995 – 4,444,700 acre-feet; 1996 – 4,309,800 acre-feet; 1997 – 1,045,800 acre-feet; 1988 – 2,044,700 acre-feet; 2005 – 1,865,100 acre-feet; 2006 – 1,556,100 acre-feet.)

Figure 3.1-1. Projected flow at La Grange gage – Base Case.

Table 3.1-1. Projected seasonal flow at La Grange gage (acre-feet) – Base Case.

Prelim Year Type		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	1	23,912	30,156	51,946	173,266	227,151	304,806	297,533	255,305	300,263	176,799	70,473	38,242	1,949,853
AN	2	27,345	36,232	78,097	98,325	157,042	183,876	155,840	79,345	102,401	27,829	15,372	16,202	977,906
N	3	17,720	12,751	14,214	26,235	69,340	108,279	116,684	55,305	39,080	11,543	9,223	8,926	489,300
BN	4	14,069	11,901	12,298	12,327	26,022	39,636	42,413	28,173	3,613	3,733	3,733	3,613	201,530
D	5	22,274	15,620	16,141	16,141	14,579	24,563	30,035	24,497	3,347	3,459	3,459	3,347	177,461
C	6	15,723	12,586	14,370	12,917	11,663	12,913	18,786	18,467	2,975	3,074	3,074	2,975	129,523
All		20,344	20,947	33,591	69,787	102,511	137,167	134,311	97,533	101,132	53,105	23,509	15,274	809,211

[2] The preliminary relicensing year type is based on a rank-ordering of the water-year runoff for the years 1921-2011. Each water year type W, AN, N, and BN represent 20% of the years of ranking. D and C year types each represent 10% of the years.

Total average daily flow projected for the Tuolumne River at La Grange gage by month is listed in Table 3.1-2.

Table 3.1-2. Projected average daily flow at La Grange gage (cfs) – Base Case.

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	397	300	418	960	1,848	1,511	2,253	1,033	75	75	75	75
1972	215	175	175	175	169	291	509	476	50	50	50	50
1973	150	150	150	150	150	2,241	2,659	1,068	2,204	482	250	250
1974	397	300	849	2,210	2,535	3,140	3,720	1,088	2,192	499	250	250
1975	397	300	300	300	2,198	3,247	2,697	1,242	2,748	673	250	384
1976	504	308	419	300	290	300	339	321	50	50	50	50
1977	126	150	150	150	150	150	246	237	50	50	50	50
1978	126	150	150	150	150	150	1,080	1,515	250	250	300	1,146
1979	624	300	300	1,127	2,729	3,584	2,795	1,036	1,248	282	250	250
1980	397	300	300	4,249	6,150	6,001	3,116	2,666	2,136	3,286	996	474
1981	530	300	300	300	300	848	820	464	75	75	75	75
1982	207	180	180	963	5,178	6,633	7,137	6,151	5,979	2,915	1,075	1,155
1983	1,476	3,088	3,832	3,327	6,964	7,772	7,686	8,226	7,597	5,959	3,708	1,572
1984	739	2,303	5,672	5,450	2,962	2,972	2,044	1,007	250	250	250	250
1985	397	300	300	300	825	1,312	1,269	542	75	75	75	75
1986	150	150	150	150	2,819	8,385	5,442	3,177	3,095	661	250	250
1987	397	300	300	300	300	300	411	387	50	50	50	50
1988	126	150	150	150	145	150	246	237	50	50	50	50
1989	126	150	150	150	150	150	437	410	50	50	50	50
1990	126	150	150	150	150	150	325	309	50	50	50	50
1991	126	150	150	150	150	150	435	408	50	50	50	50
1992	126	150	150	150	145	150	336	319	50	50	50	50
1993	126	150	150	150	150	150	1,080	1,007	250	250	250	250
1994	397	300	300	300	300	300	435	409	50	50	50	50
1995	150	150	150	150	150	2,960	5,800	6,622	7,870	5,933	2,927	584
1996	470	300	300	300	4,334	5,068	3,672	2,391	3,239	653	250	250
1997	397	300	2,826	13,576	7,805	3,202	1,997	1,007	677	258	250	250
1998	397	300	300	970	6,323	4,995	5,593	3,996	7,134	5,207	1,455	478
1999	540	300	350	1,184	4,527	3,365	2,501	1,007	1,646	390	250	250
2000	397	300	300	300	3,440	4,540	3,202	1,111	845	250	250	250
2001	397	300	300	300	300	497	984	487	75	75	75	75
2002	150	150	150	150	150	150	550	513	75	75	75	75
2003	150	150	150	150	150	150	1,546	865	75	75	75	75
2004	215	175	175	178	1,477	1,962	894	451	75	75	75	75
2005	150	150	150	150	1,907	4,672	4,340	2,600	7,818	2,100	250	268
2006	440	300	410	4,494	3,235	4,801	7,812	5,563	7,905	2,185	250	250
2007	397	300	300	300	300	300	438	412	50	50	50	50
2008	126	150	150	150	145	150	462	433	50	50	50	50
2009	150	150	150	150	150	150	721	671	75	75	75	75
Average	331	352	546	1,135	1,828	2,231	2,257	1,586	1,700	864	382	257
Min	126	150	150	150	145	150	246	237	50	50	50	50
Max	1,476	3,088	5,672	13,576	7,805	8,385	7,812	8,226	7,905	5,959	3,708	1,572

3.2 Districts' Canal Diversions

Projected Base Case combined diversions of the Districts are illustrated in Figure 3.2-1. The average annual Base Case diversion is 848,600 acre-feet, ranging from a maximum of 966,900 acre-feet to a minimum of 648,300 acre-feet which includes a reduction to deliveries due to a limited water supply from Don Pedro Reservoir. Also shown in Figure 3.2-1 is the full combined diversion demand of the Districts. Reductions from full diversion demand are projected to occur when the projected combined diversions are less than the full diversion demand, during 1977, and 1988 through 1992.

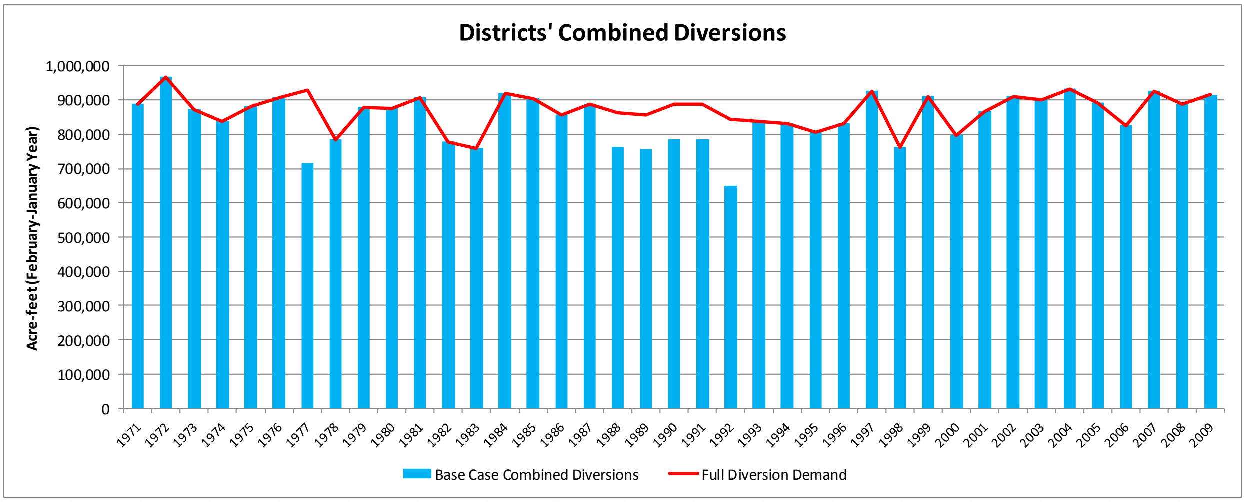


Figure 3.2-1. Districts' combined diversions and demand – Base Case.

3.3 Don Pedro Reservoir

Don Pedro Reservoir storage will fluctate throughout the year and will result in carryover storage that varies from year to year. Figure 3.3-1 illustrates projected end-of-September storage for the Base Case.

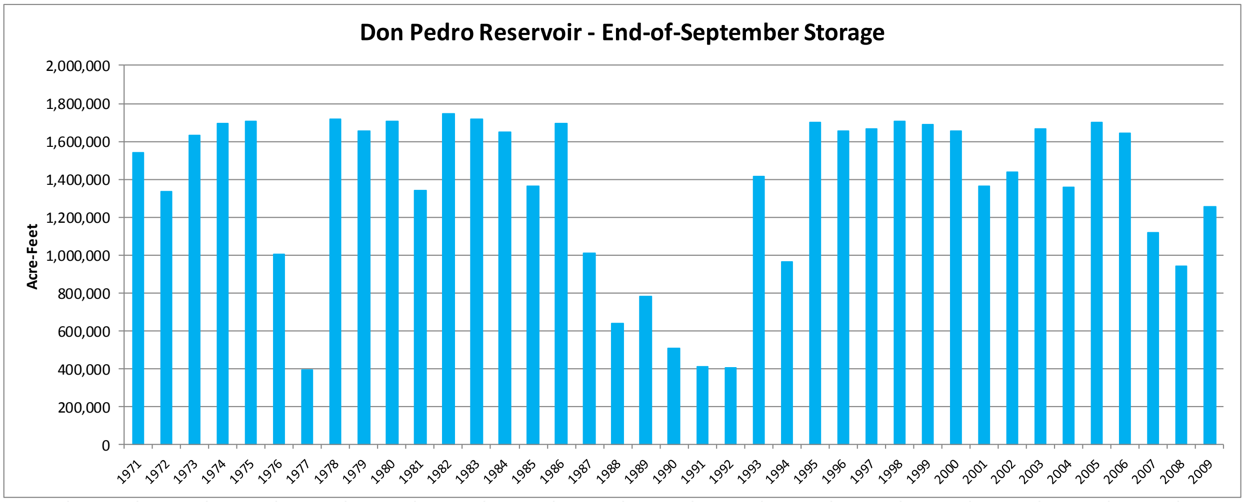
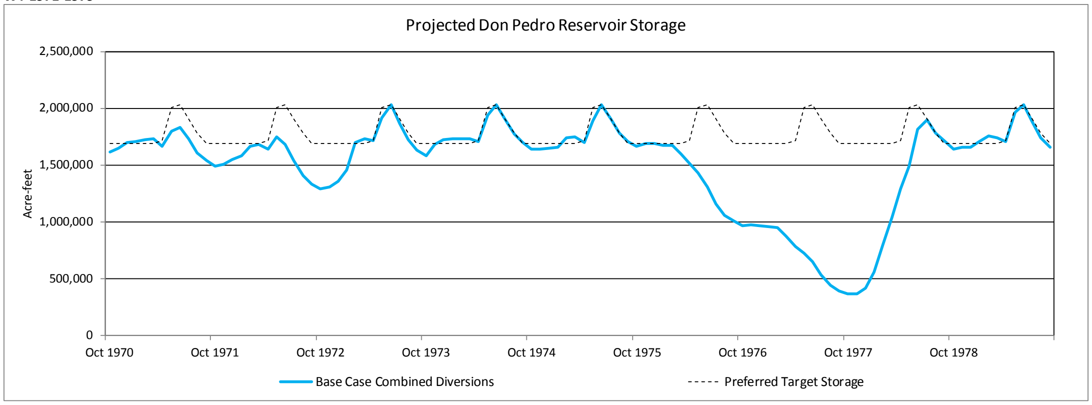


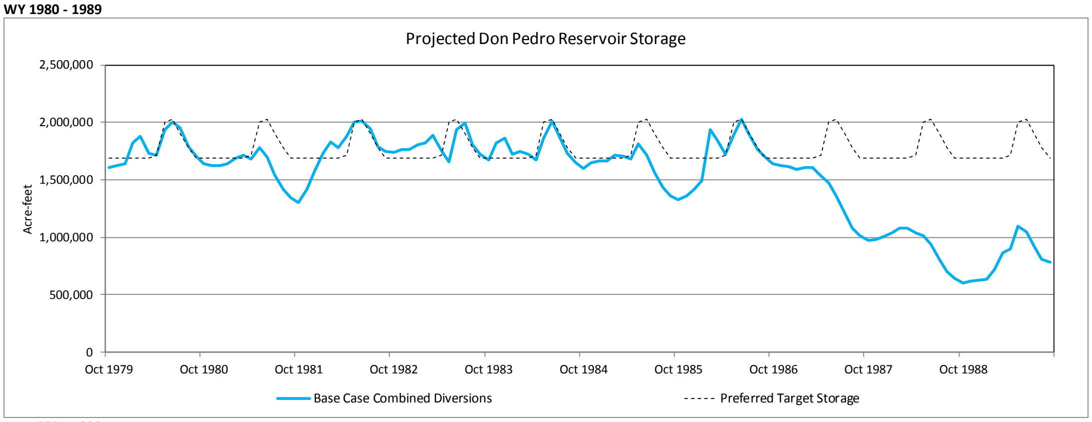
Figure 3.3-1. Don Pedro Reservoir end-of-September storage – Base Case.

The monthly variation of Don Pedro Reservoir storage is cyclic throughout the year in response to inflow, water release demands and preferred storage objectives. Figure 3.3-2 illustrates the projected end-of-month storage of Don Pedro Reservoir of the 39-year simulation period. Severe or prolonged droughts and their effect on storage are noteable during 1976-1977 and 1987-1992.

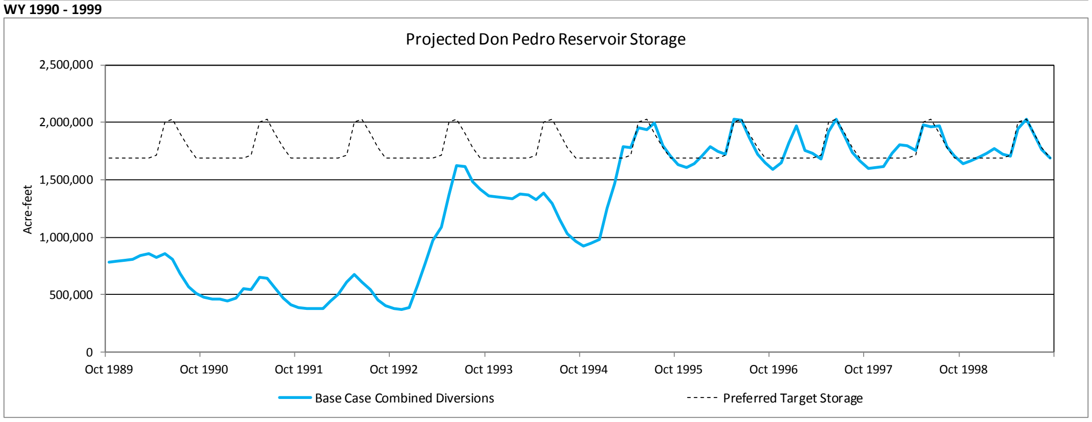
WY 1971-1979



WY 1980 - 1989



WY 1990 - 1999



WY 2000 - 2009

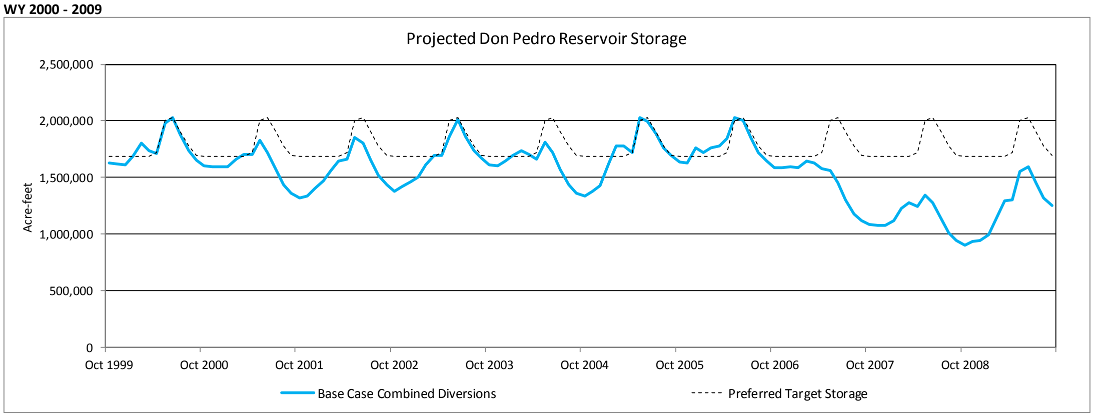


Figure 3.3-2. Don Pedro Reservoir storage – Base Case.

3.4 Don Pedro Project Generation

Hydroelectric generation is incidental to water operations, and will vary from day to day, month to month and year to year as Don Pedro Project reservoir and release operations react to hydrology and water demands. Figure 3.4-1 illustrates the projected annual power generation of the Don Pedro Project for the Base Case. Annual generation is projected to vary from 1,393,900 MWh to 197,500 MWh, with an average of 607,000 MWh.

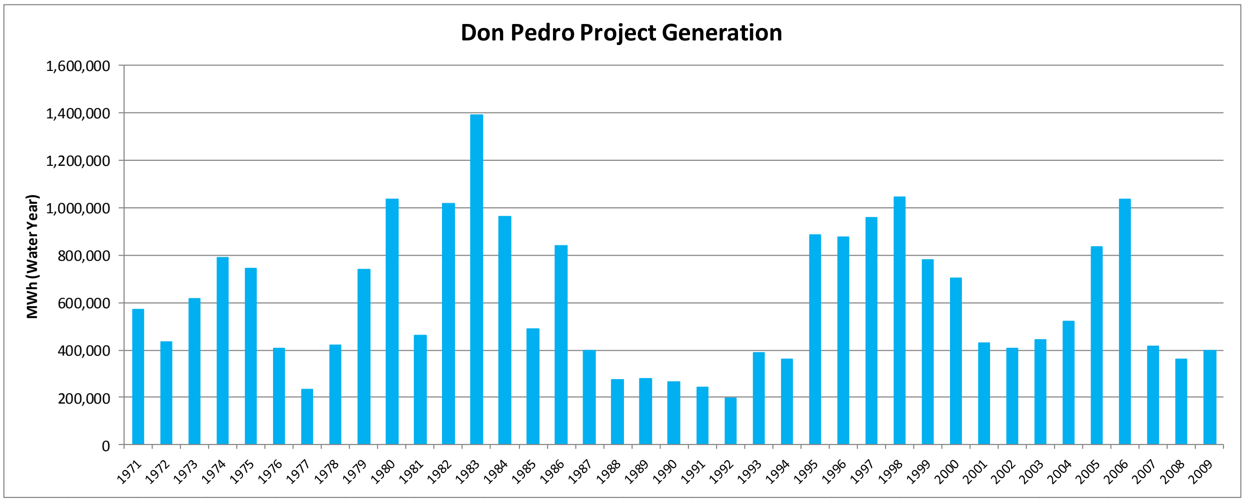


Figure 3.4-2. Don Pedro Project generation – Base Case.

Seasonal Don Pedro Project generation is illustrated in Table 3.4-1 which provides average generation by month within a ranking of all years according to the preliminary year type classification.

Table 3.4-1. Don Pedro Project generation (MWh) – Base Case.

Prelim Year Type		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
W	1	23,510	13,142	22,421	50,518	80,511	122,925	123,739	129,550	128,771	121,263	88,723	42,293	947,367
AN	2	25,294	15,271	29,800	38,956	69,357	101,667	101,180	85,371	103,097	84,287	65,379	37,104	756,762
N	3	22,292	5,933	5,711	12,638	31,376	67,364	86,974	74,381	75,932	76,468	62,650	33,241	554,960
BN	4	18,144	6,427	4,812	6,869	13,551	37,260	55,858	60,801	52,053	62,810	51,153	24,200	393,939
D	5	22,587	7,767	6,195	8,298	9,379	33,428	49,786	51,231	52,237	61,674	49,999	23,948	376,530
C	6	17,735	7,136	5,405	6,885	8,129	26,344	37,790	45,604	41,573	49,402	38,154	18,276	302,435
All		21,768	9,649	13,551	24,182	41,382	72,745	82,882	81,716	82,538	81,718	63,254	31,662	607,047

3.5 CCSF Tuolumne River Storage and Water Supply

The Base Case CCSF water supply of the Tuolumne River can be expressed by the amount of diversions from the basin through the San Joaquin Pipeline (illustrated in Section 2 above), water in CCSF Tuolumne River reservoirs and the credit balance of the CCSF Don Pedro Water Bank Account. Annual CCSF water delivery decisions are guided by the projection of total CCSF system storage for July 1 of a year. Included in the metric is CCSF Tuolumne River reservoir storage and Water Bank Account balance. Figure 3.5-1 illustrates the projected July 1 metric of CCSF Tuolumne River reservoir storage and Water Bank Account balance.

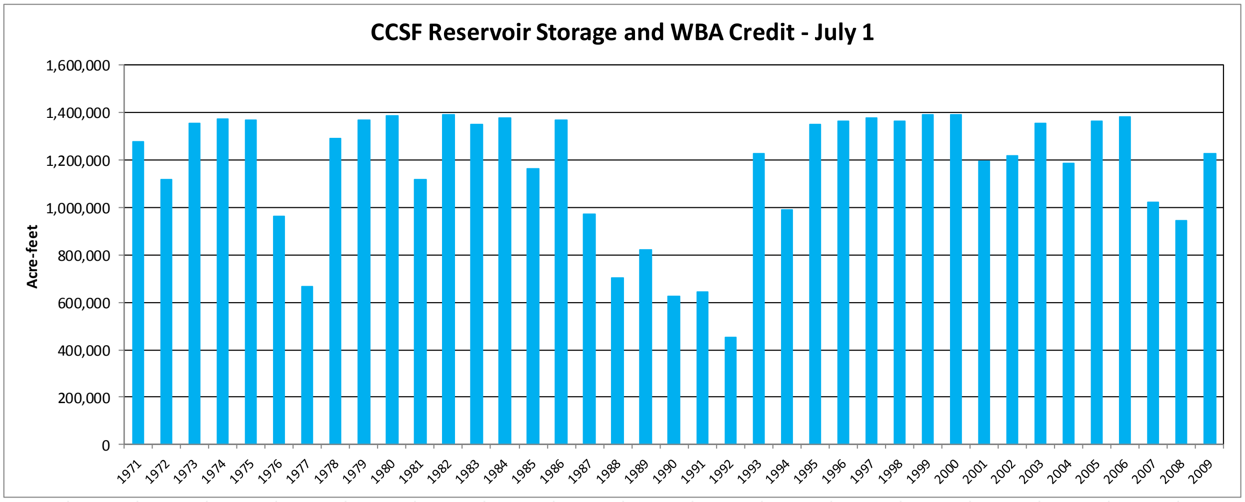


Figure 3.5-1. CCSF Tuolumne River storage and Water Bank Account credit – Base Case.

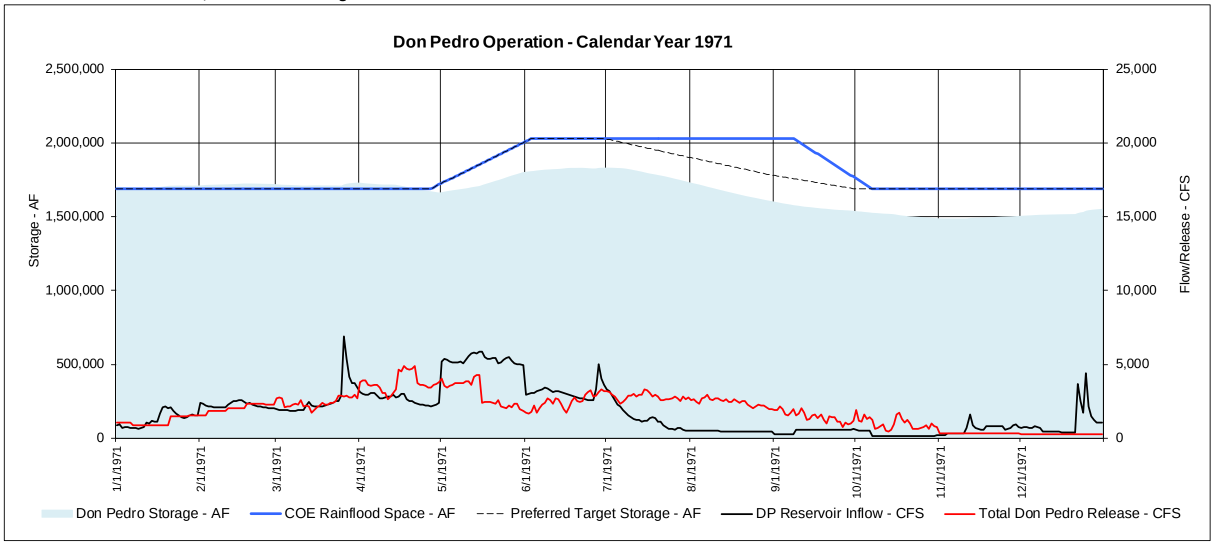
4.0 ANNUAL DON PEDRO PROJECT OPERATIONS

Annual hydrographs for the projected operation of Don Pedro Reservoir and the lower Tuolumne River for the Base Case follow. Three hydrographs are presented for each year of the 39-year simulation. The upper hydrograph illustrates the simulated daily storage of Don Pedro Reservoir (light blue area graph) for an entire calendar year. Plotted for reference is the modeled reservoir target storage during the year (solid blue and black dashed lines). These two components are plotted to the left axis scale (acre-feet), and are also shown in the other two hydrographs. Also illustrated in the upper hydrograph are the inflow to Don Pedro Reservoir (solid black line) and total Don Pedro release (solid red line). Flow values are plotted to the right axis scale (CFS).

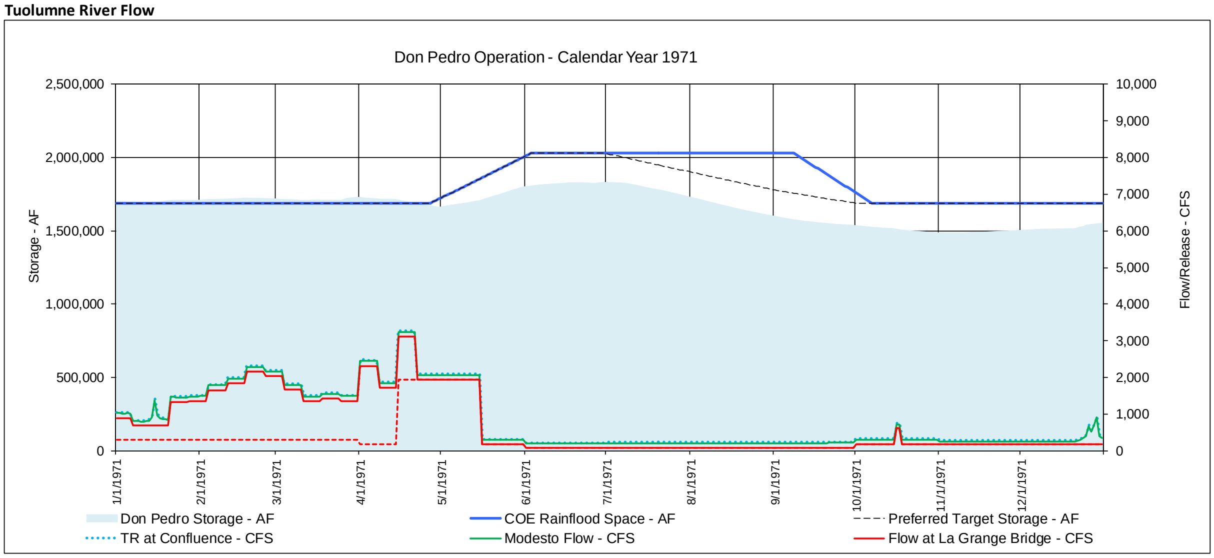
The middle hydrograph illustrates the simulated daily flows at three locations in the lower Tuolumne River: (1) flow at the La Grange Bridge gage (solid red line), (2) flow at the Modesto gage (solid green line), and (3) flow at the Tuolumne River confluence with the San Joaquin River (dotted light blue line). Flow projected to occur at the La Grange Bridge gage is the result of flow being released from Don Pedro Reservoir and depletion by diversions to the Districts' canals. Flow projected to occur at the Modesto gage is the result of adding those flows to lower Tuolumne River accretions occurring above the Modesto gage location and flows from Dry Creek. The accretions and Dry Creek flow data sets are synthesized, and are described in the ISR, January 2013. Flows projected for the Tuolumne River confluence are the sum of flows occurring at the Modesto gage plus an estimated accretion between the Modesto gage and the confluence. This accretion is estimated to be a constant 32 cfs. Also shown in the hydrograph is the Base Case Tuolumne River -daily flow requirement, modeled at the La Grange Bridge gage location.

The lower hydrograph illustrates the simulated daily diversions of the Districts to their respective canals. The projected Modesto Irrigation District diversion is shown by the solid red line and the projected Turlock Irrigation District diversion is shown by the solid blue line.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

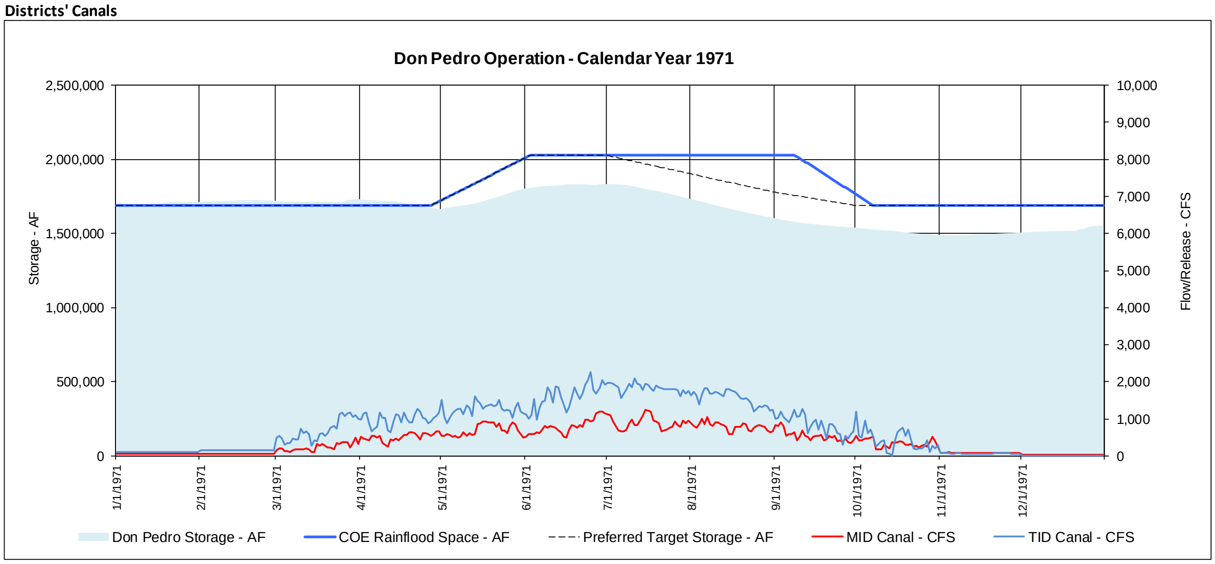
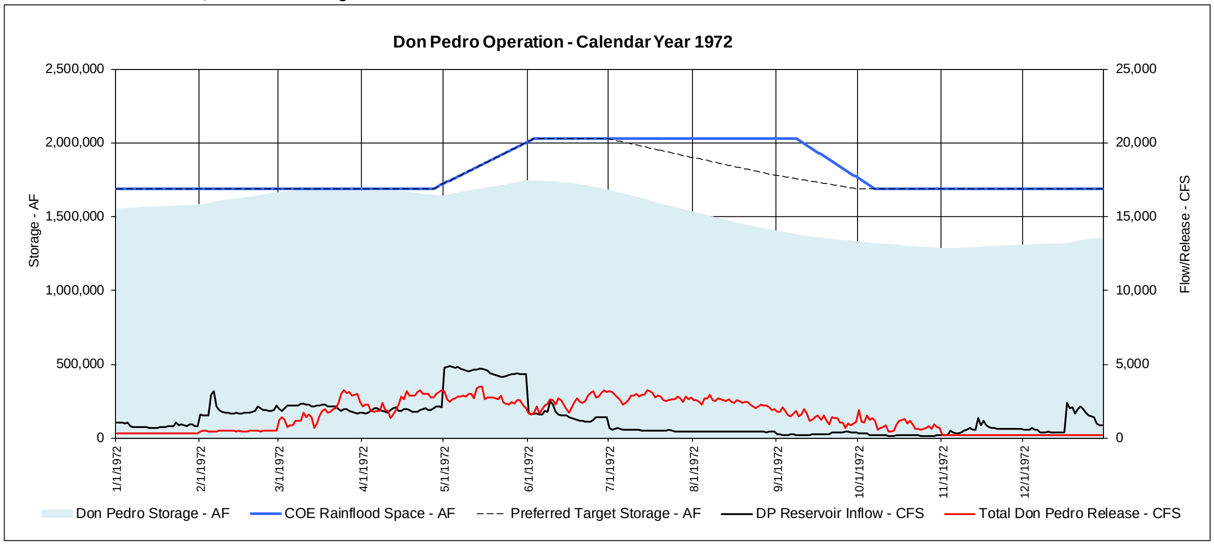
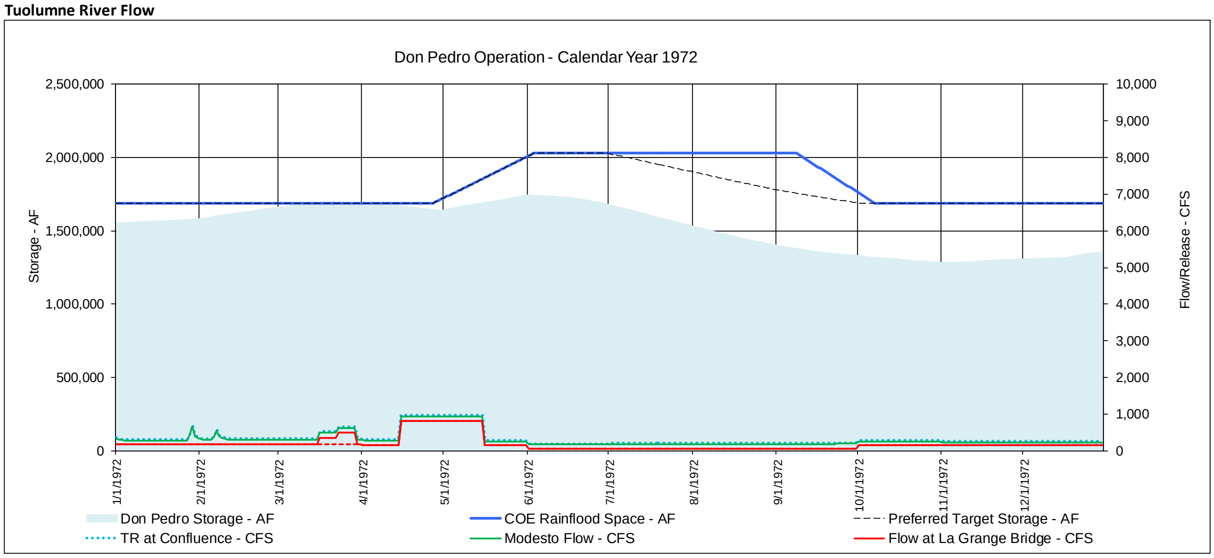


Figure 4-1. Don Pedro operations 1971 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

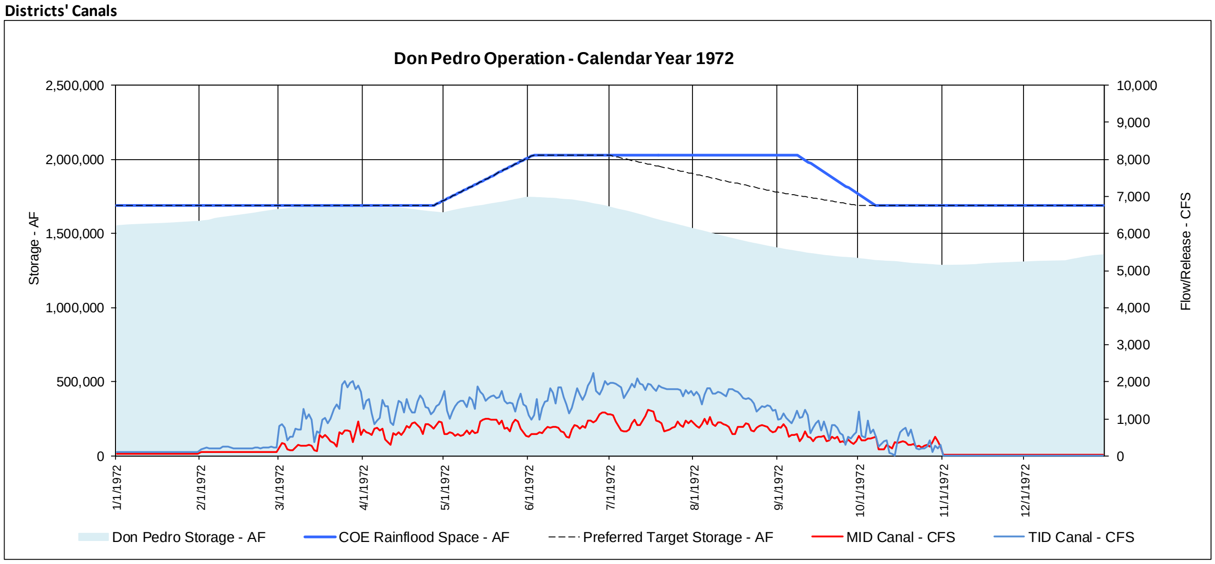
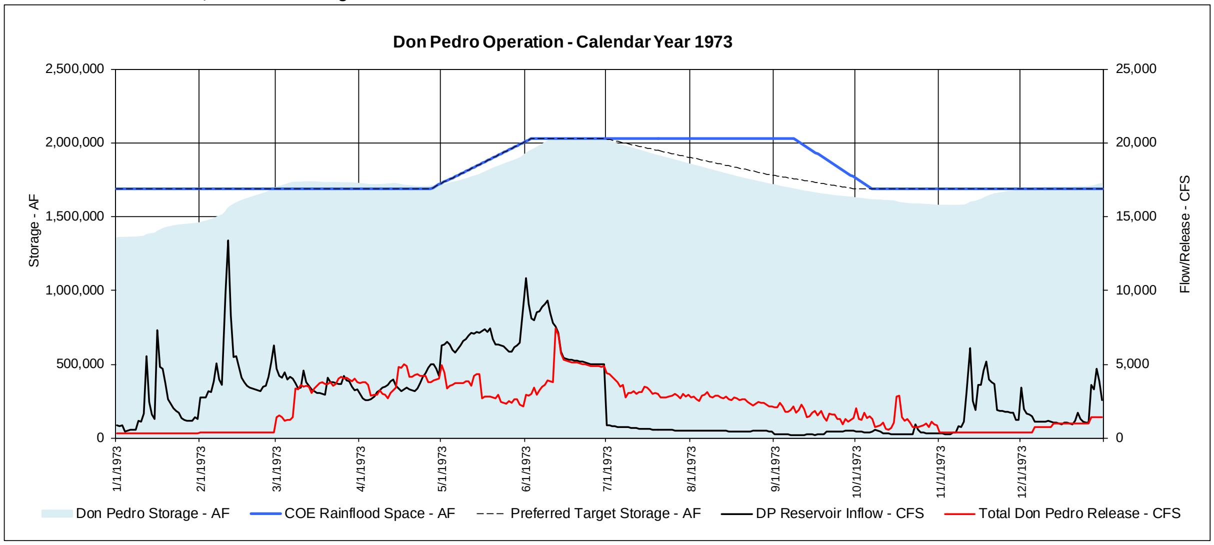
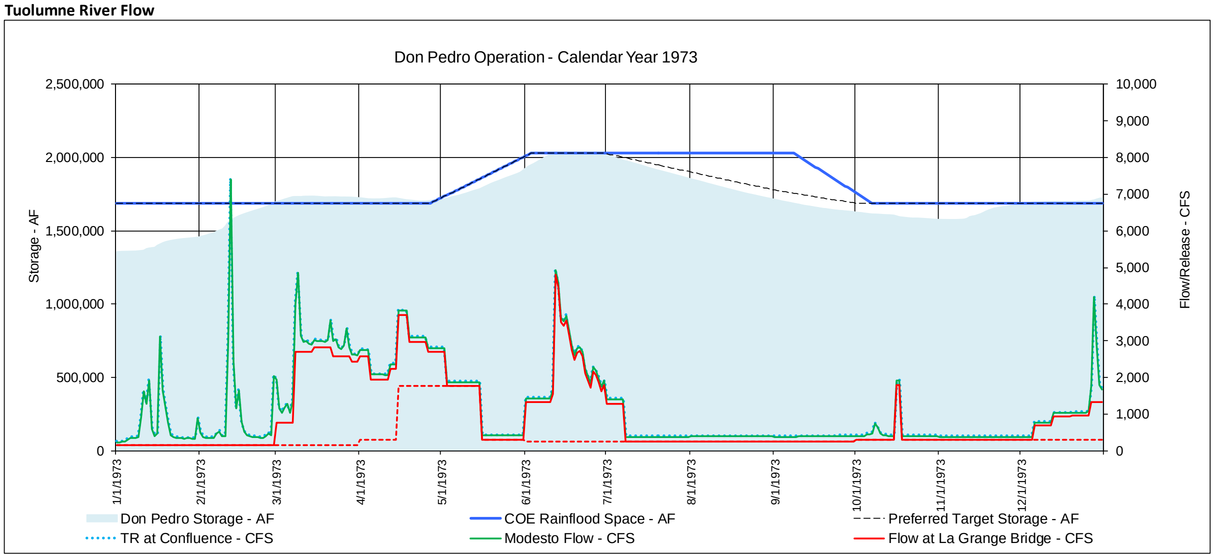


Figure 4-2. Don Pedro operations 1972 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

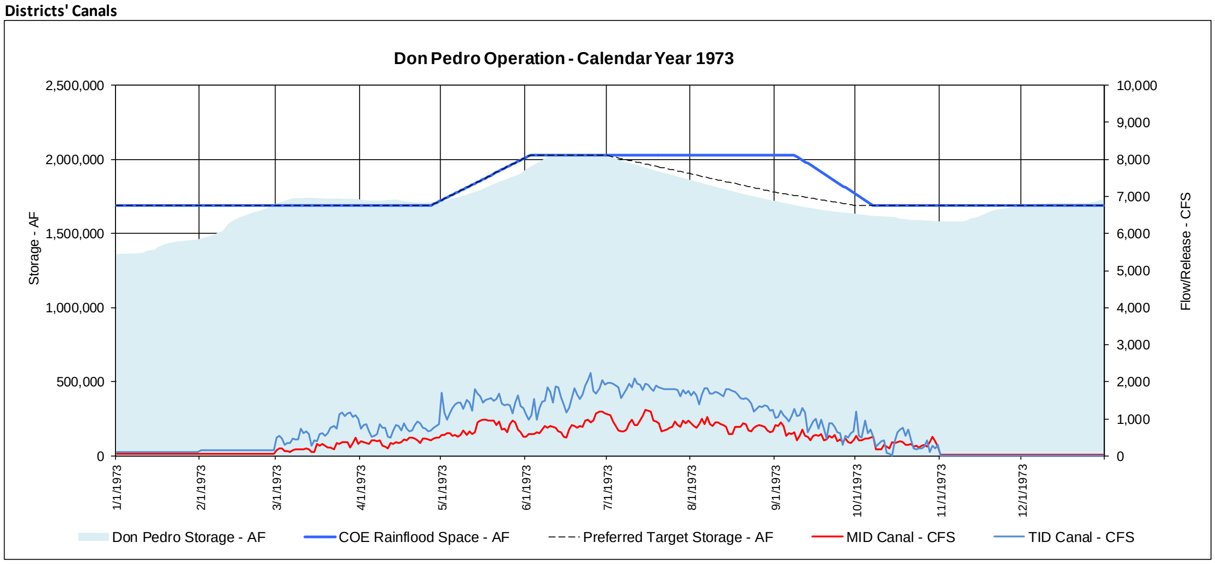
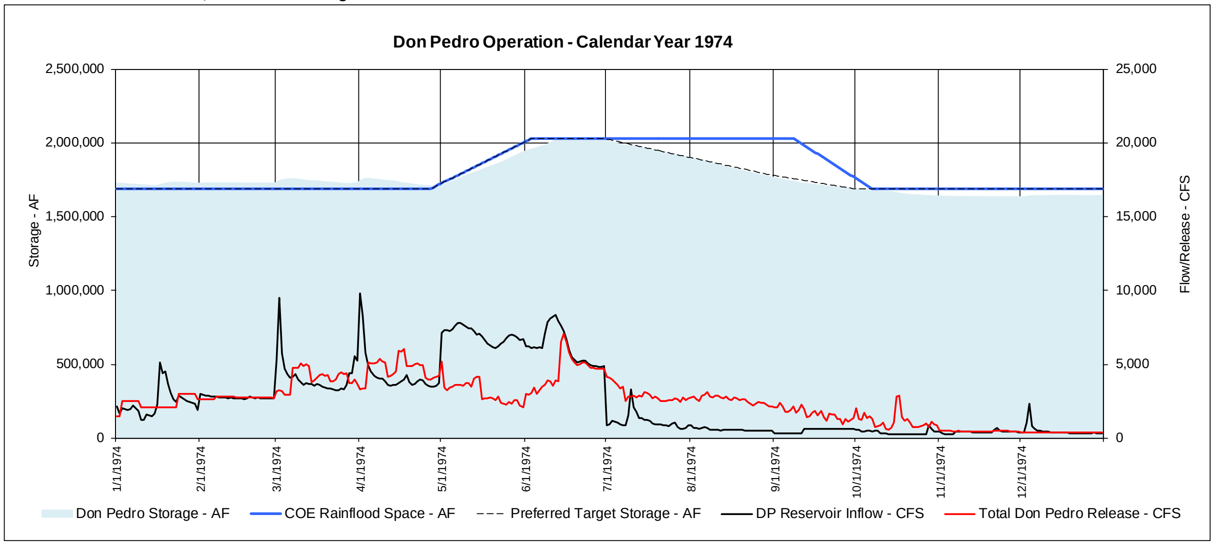
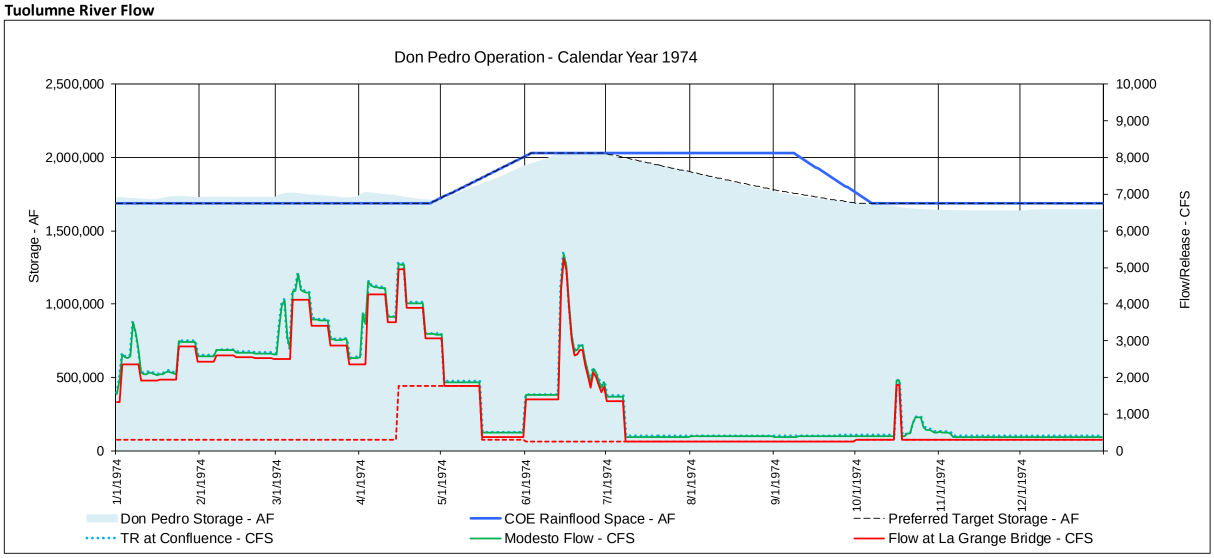


Figure 4-3. Don Pedro operations 1973 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

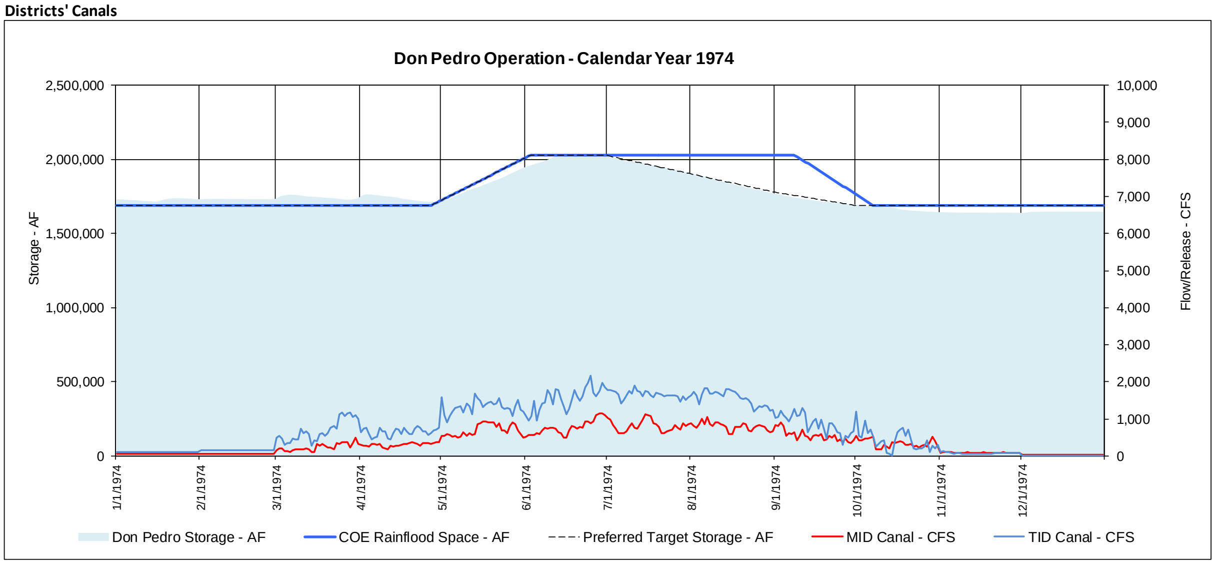
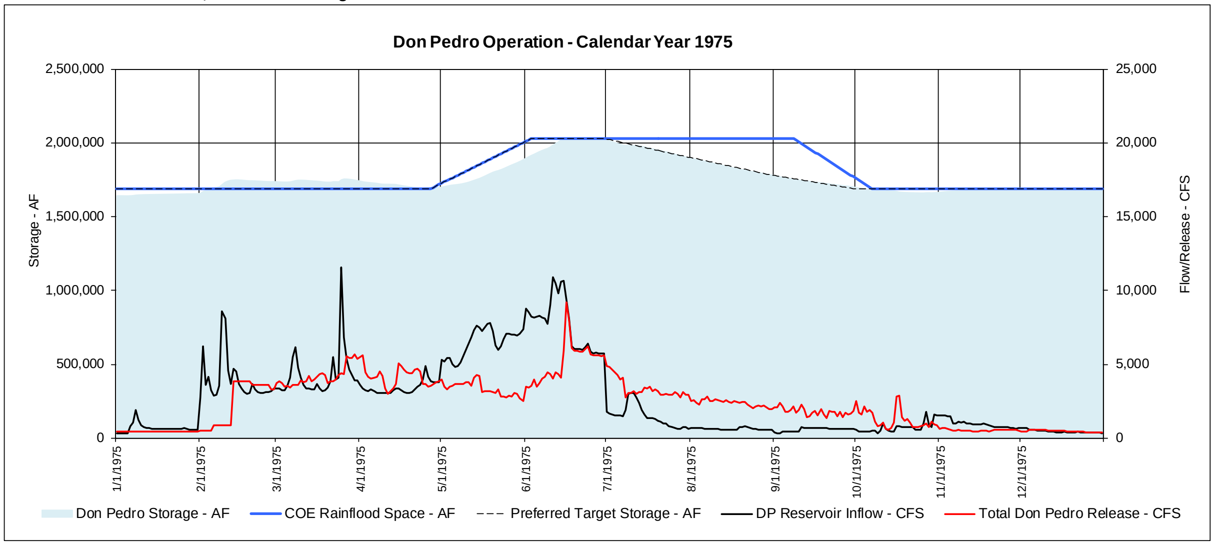
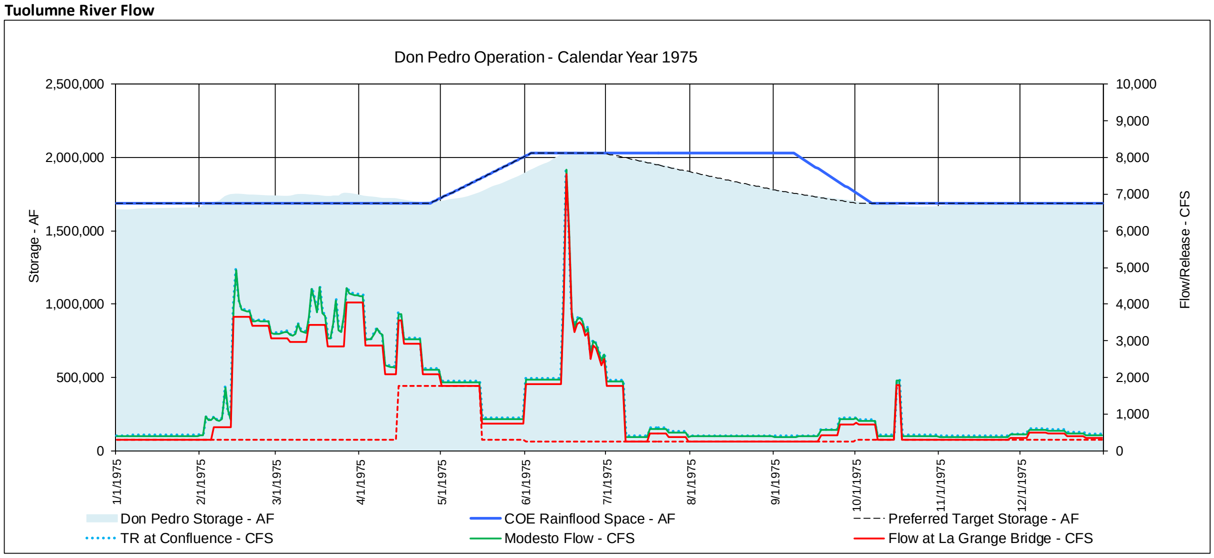


Figure 4-4. Don Pedro operations 1974 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

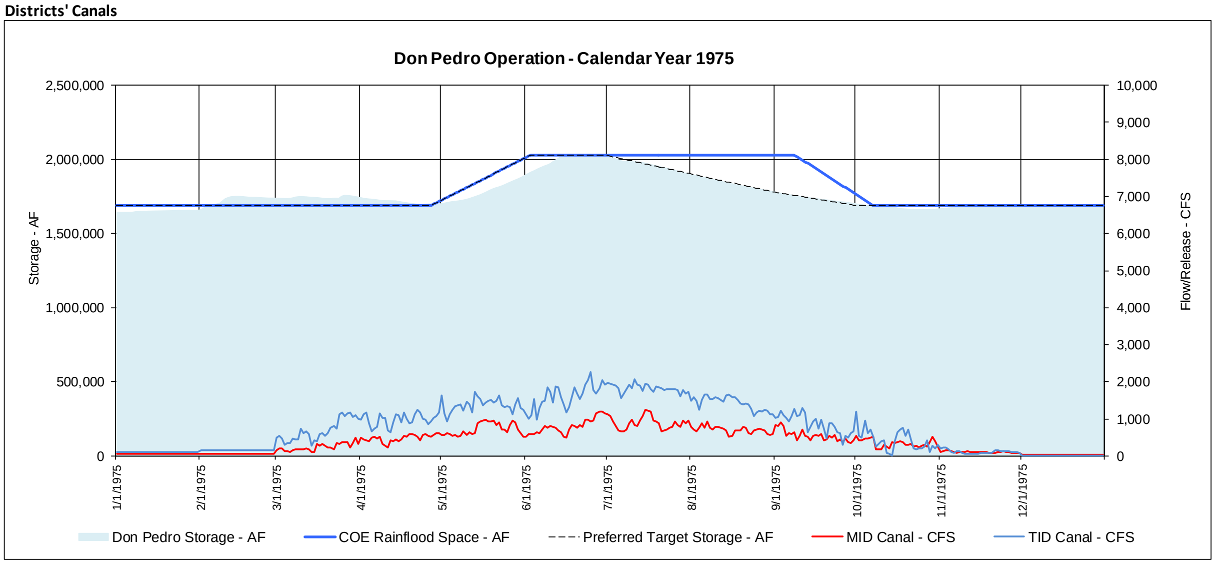
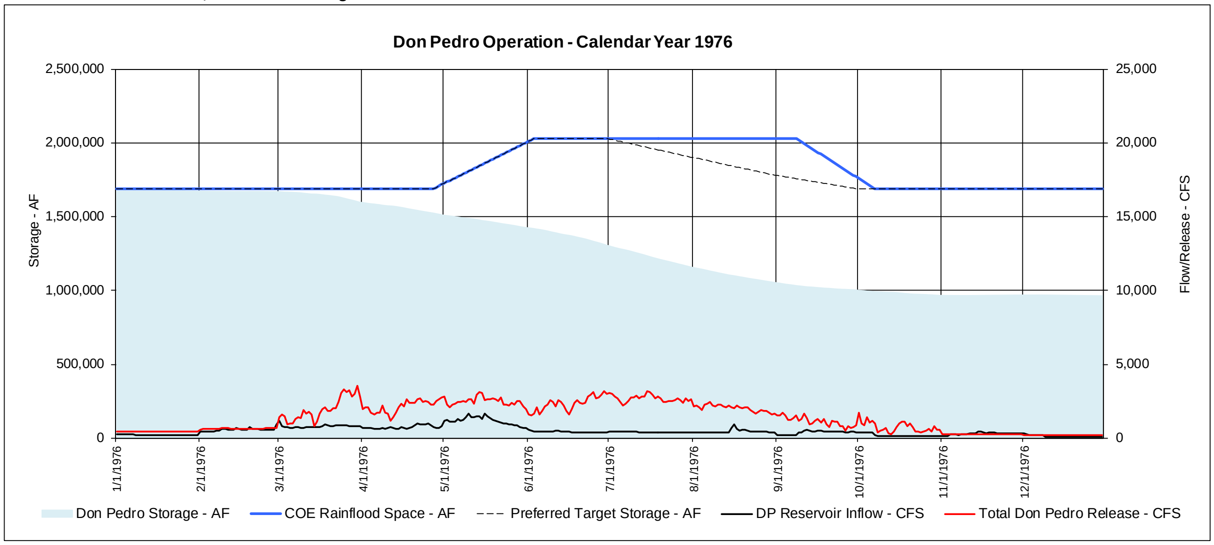
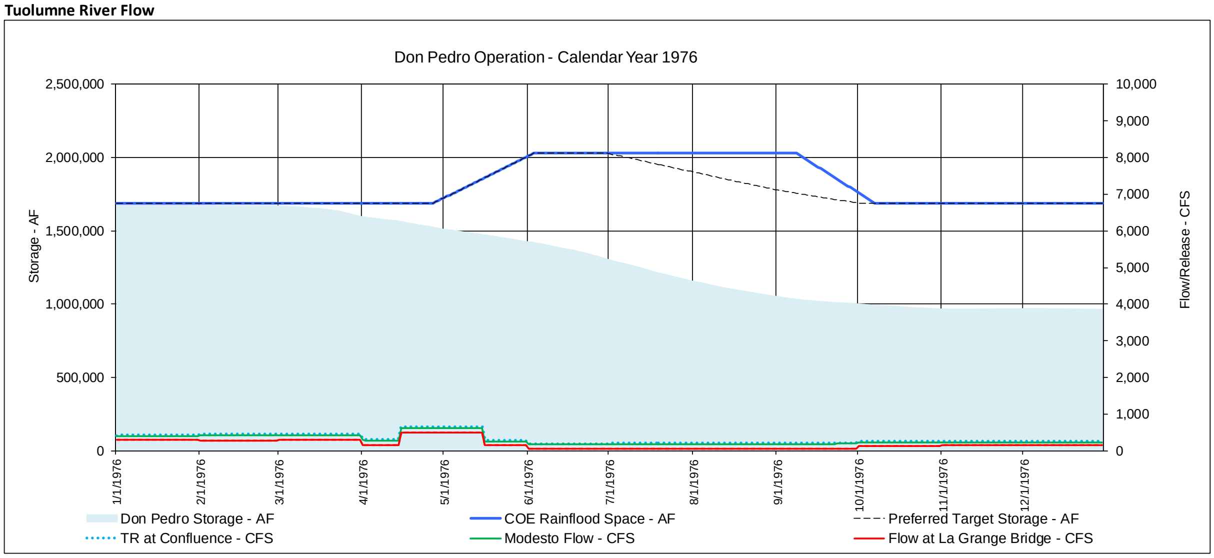


Figure 4-5. Don Pedro operations 1975 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

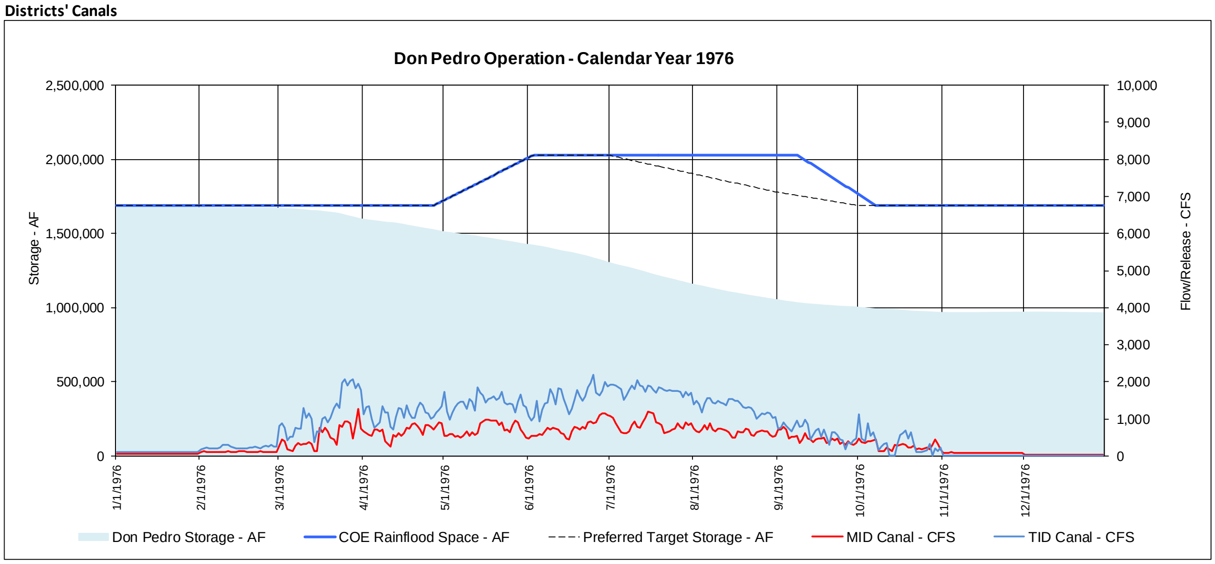
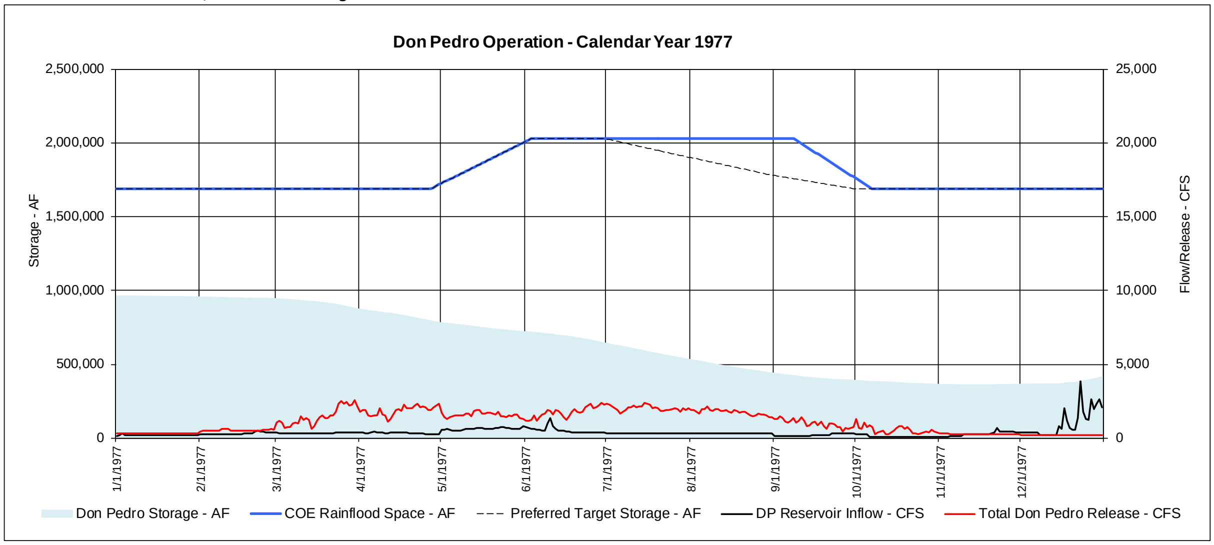
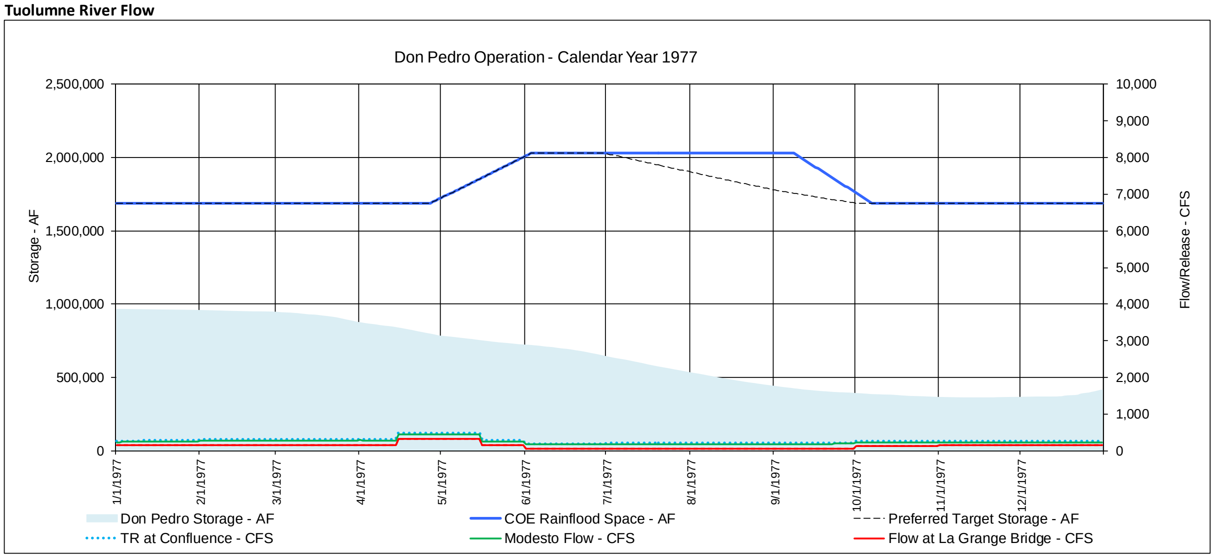


Figure 4-6. Don Pedro operations 1976 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

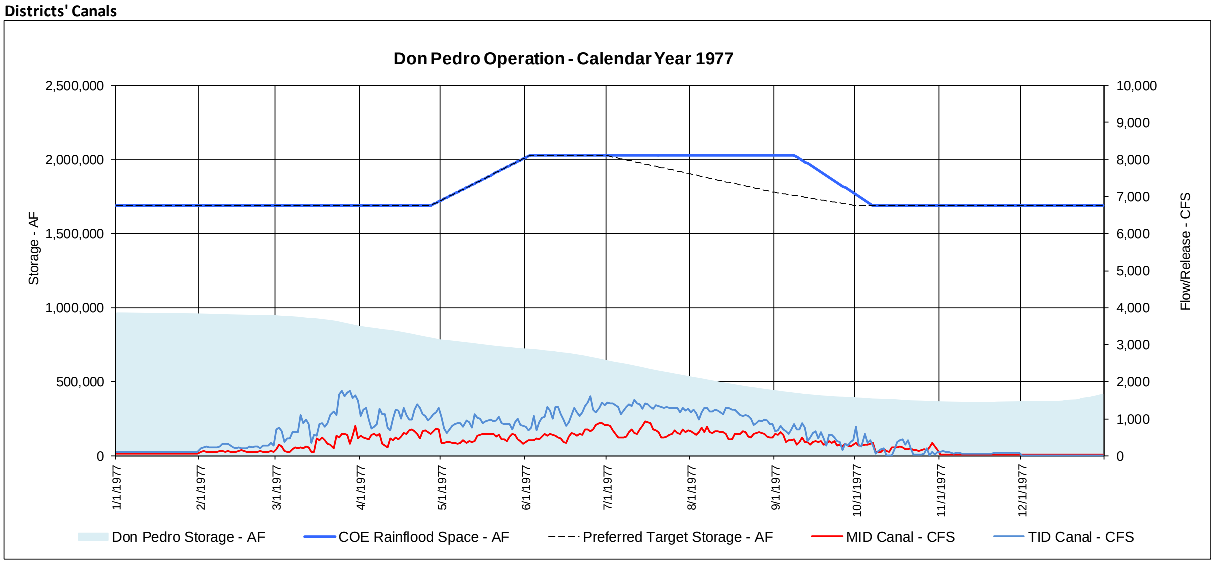
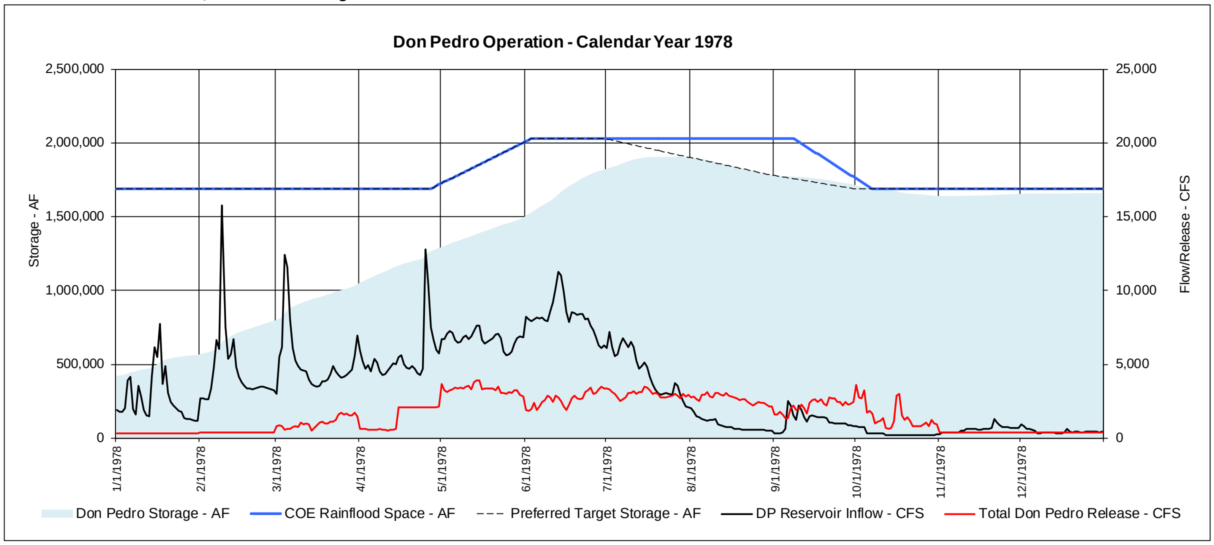
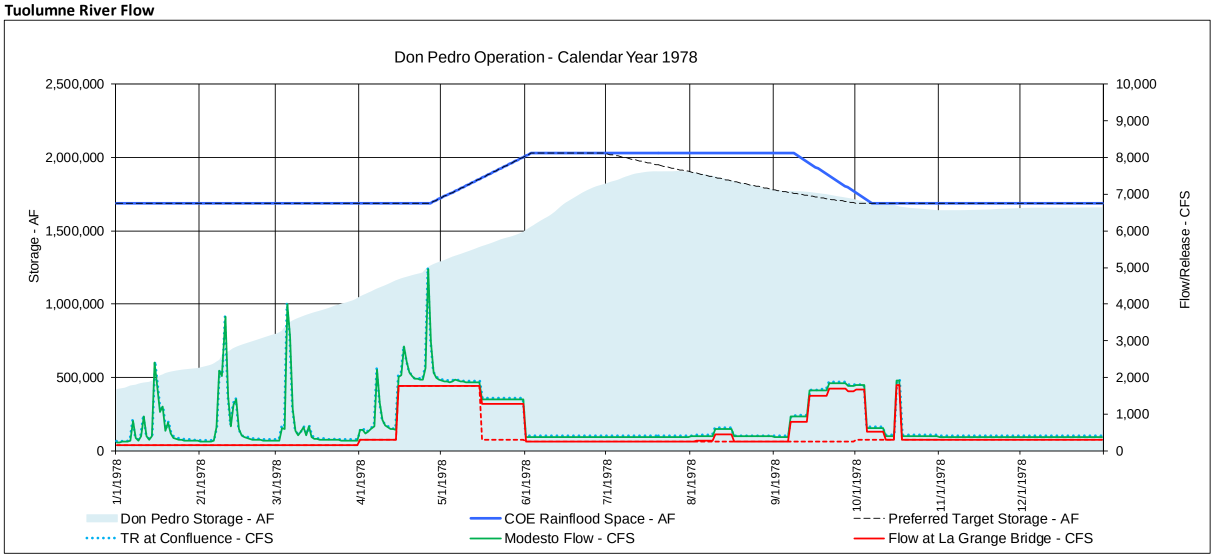


Figure 4-7. Don Pedro operations 1977 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

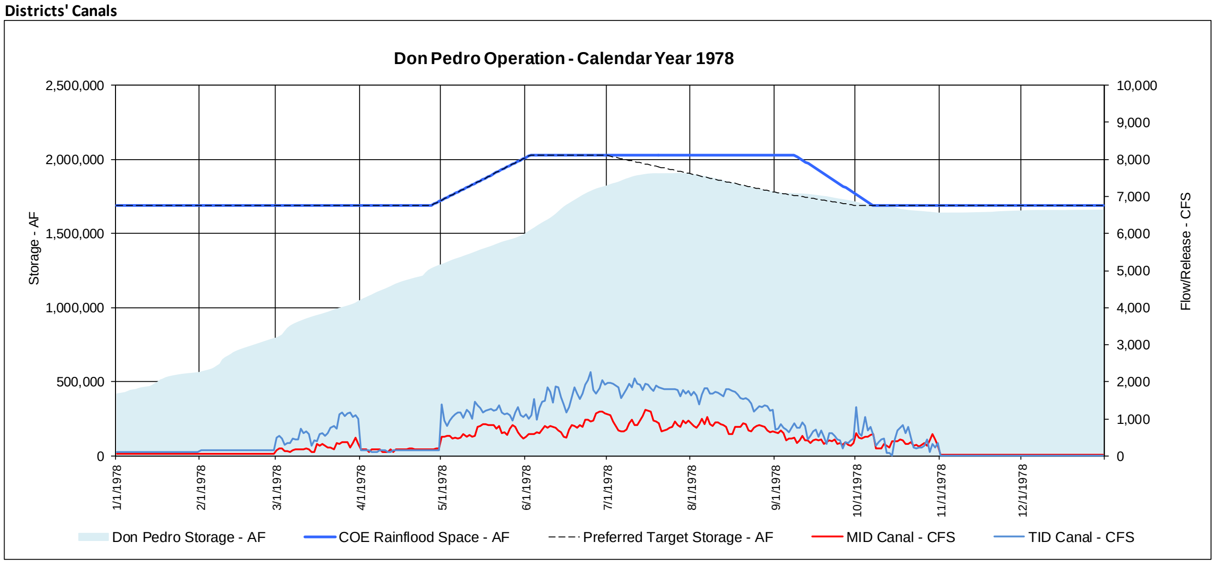
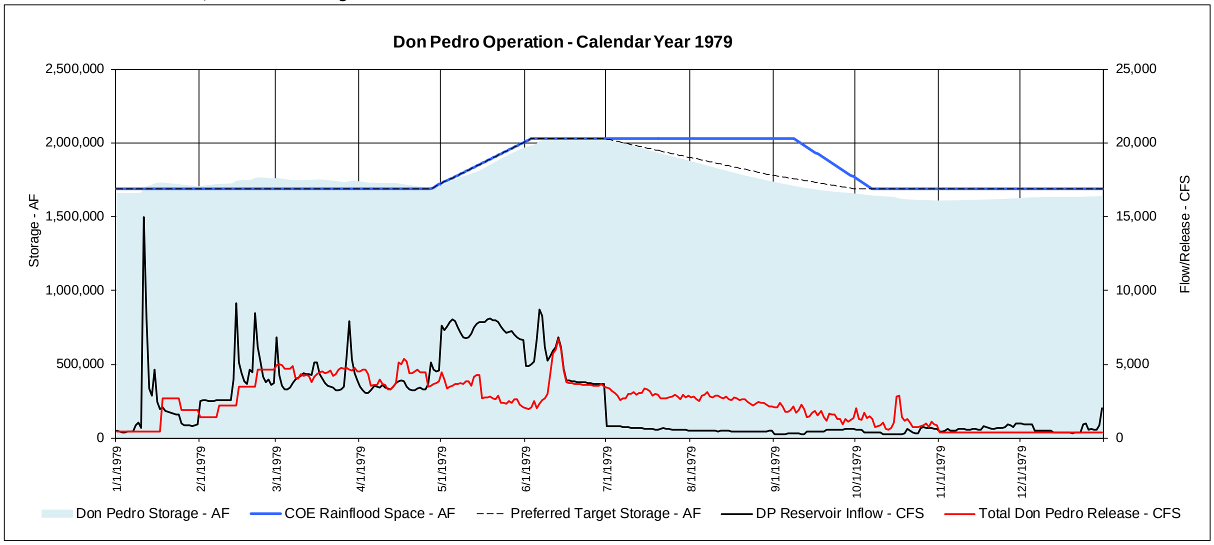
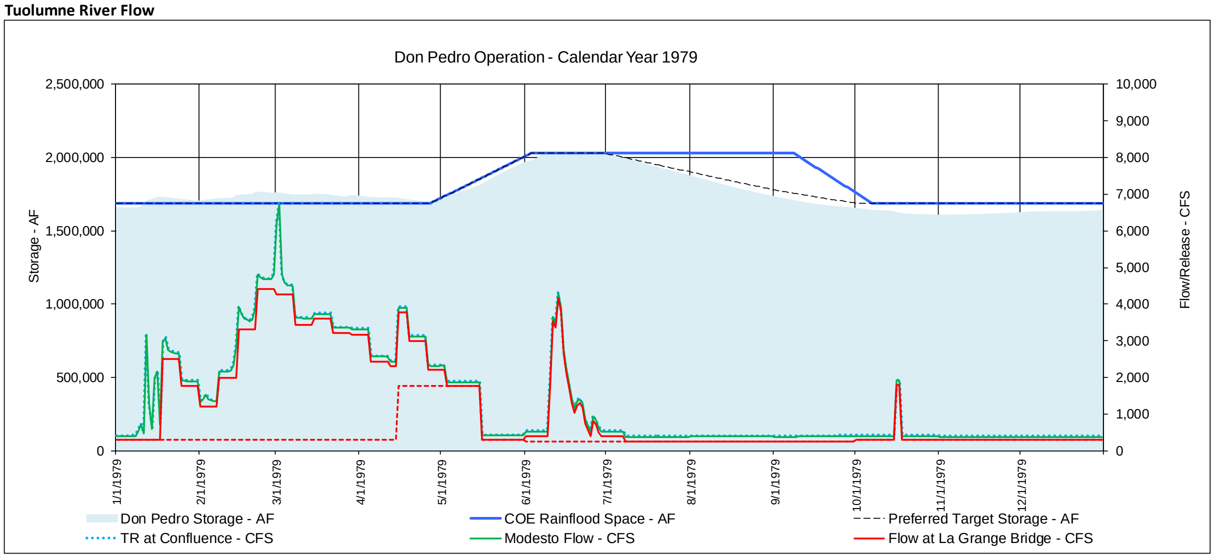


Figure 4-8. Don Pedro operations 1978 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

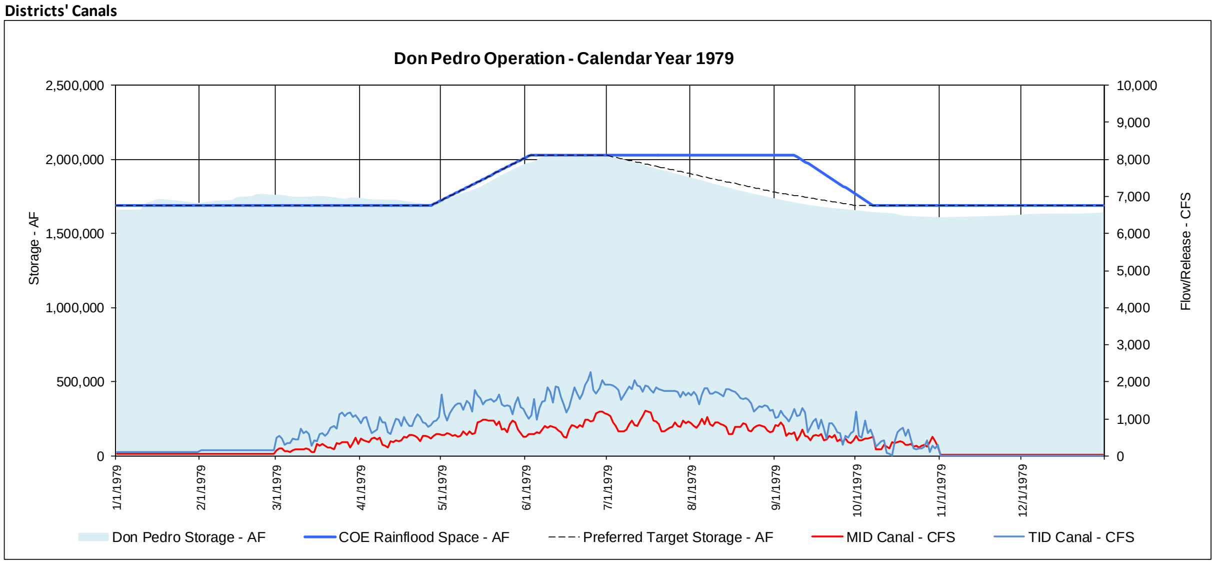
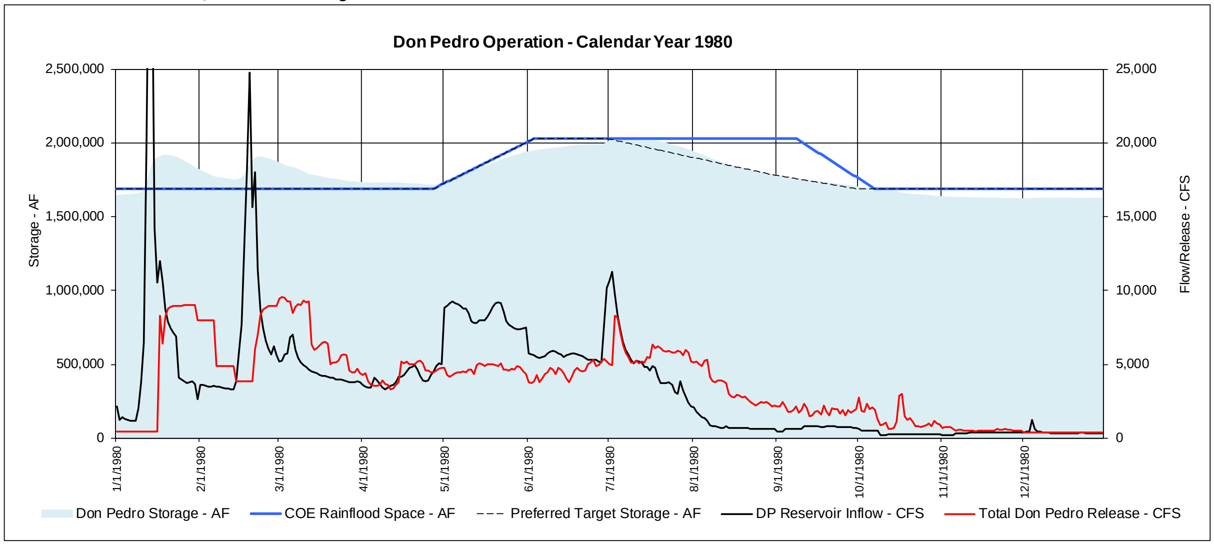
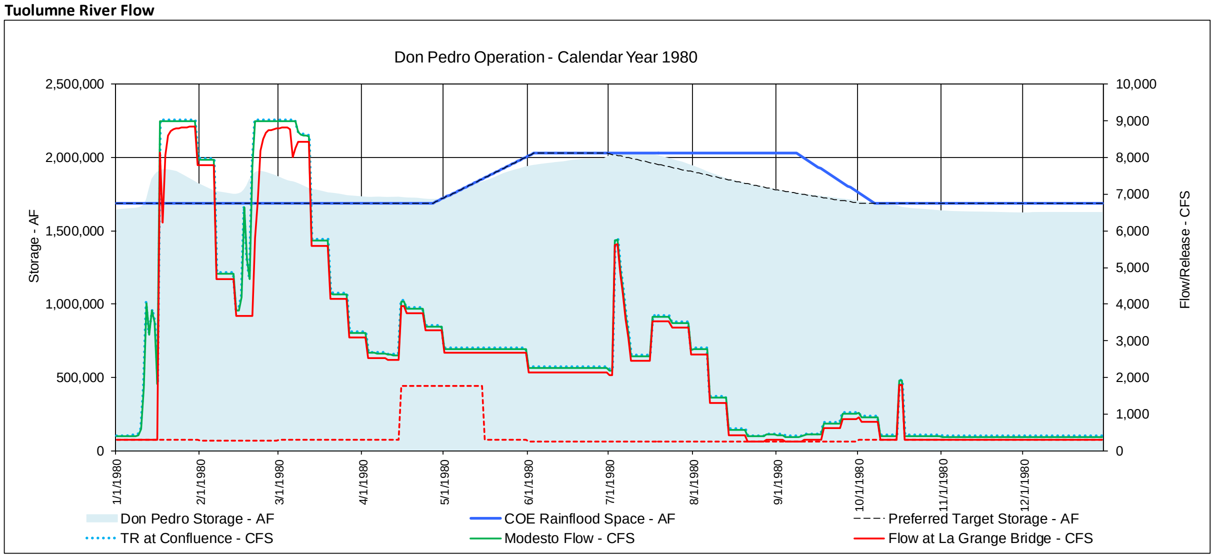


Figure 4-9. Don Pedro operations 1979 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

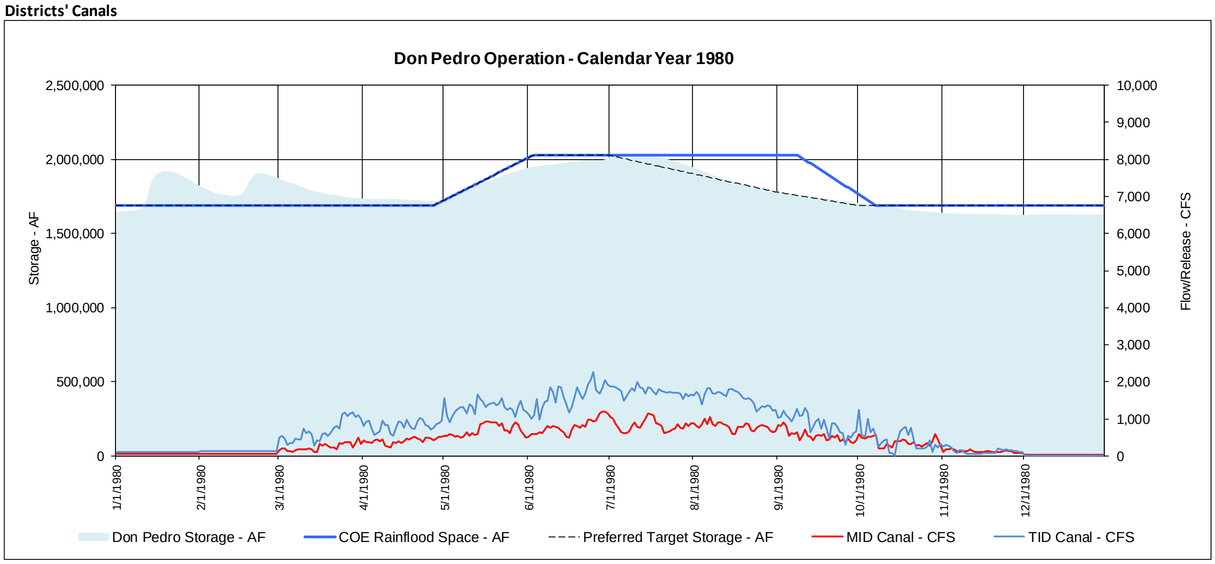
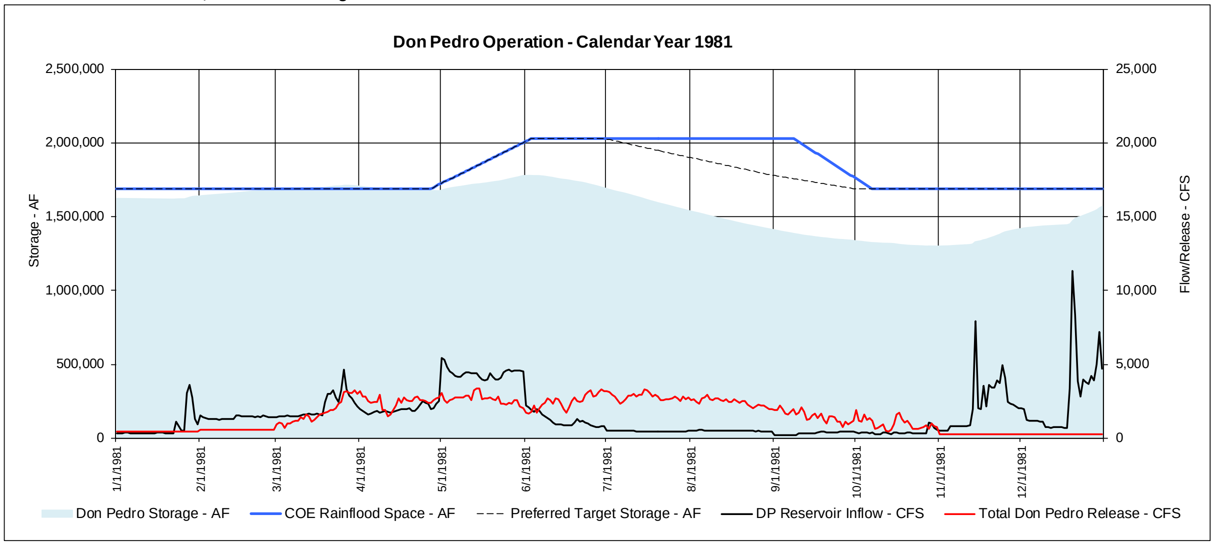
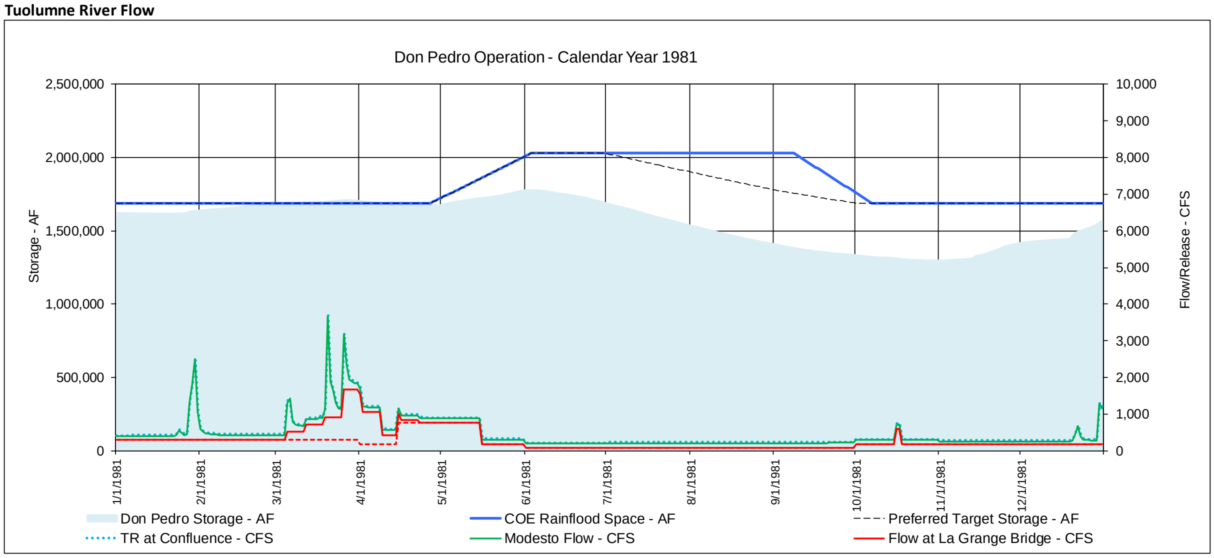


Figure 4-10. Don Pedro operations 1980 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

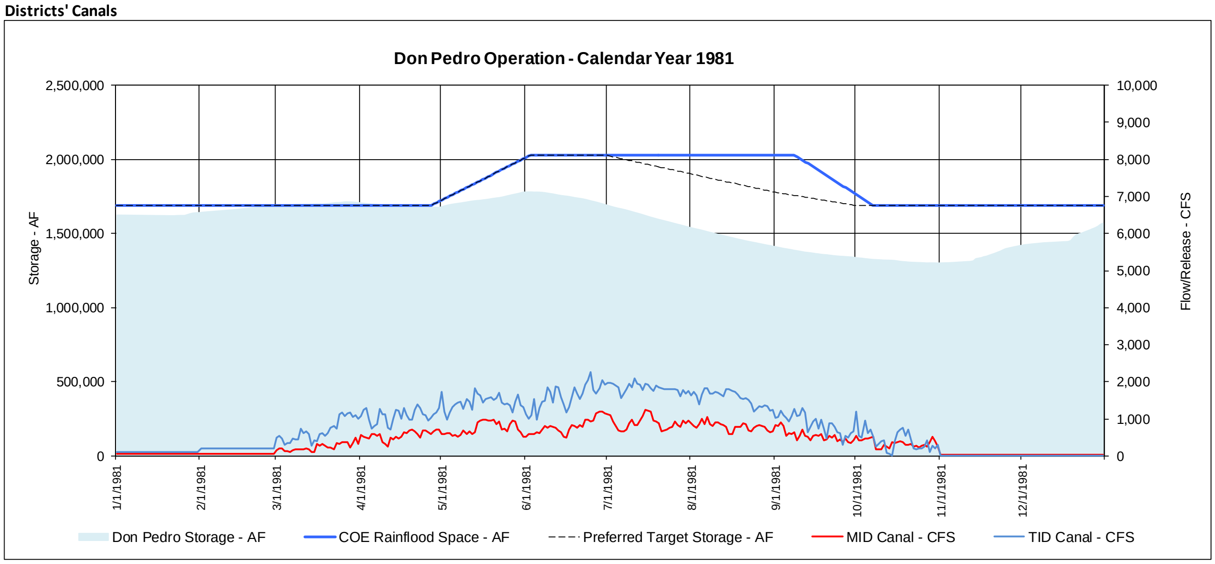
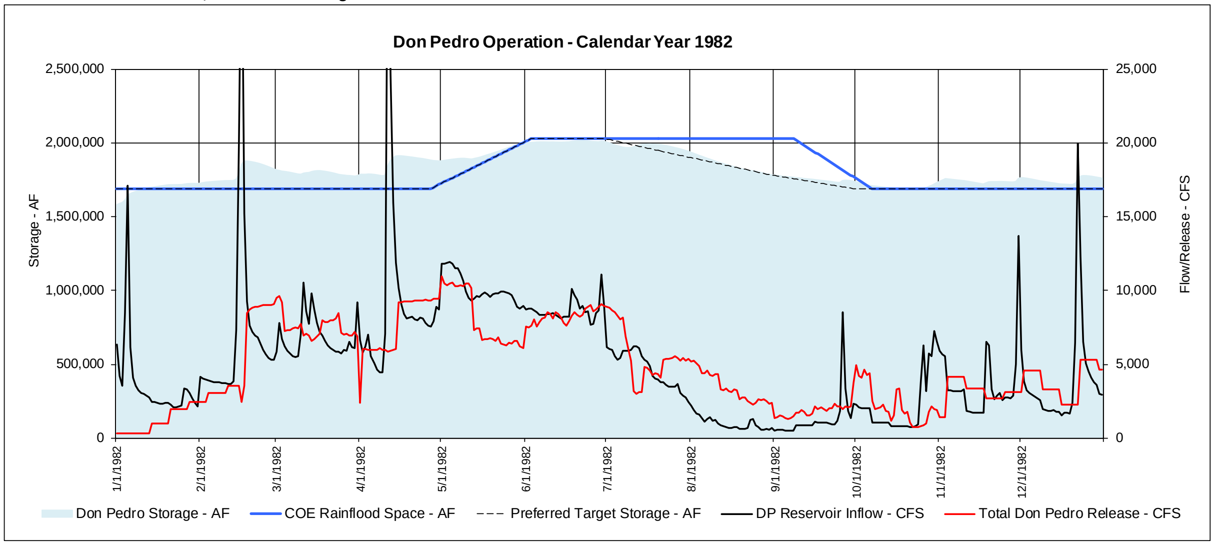
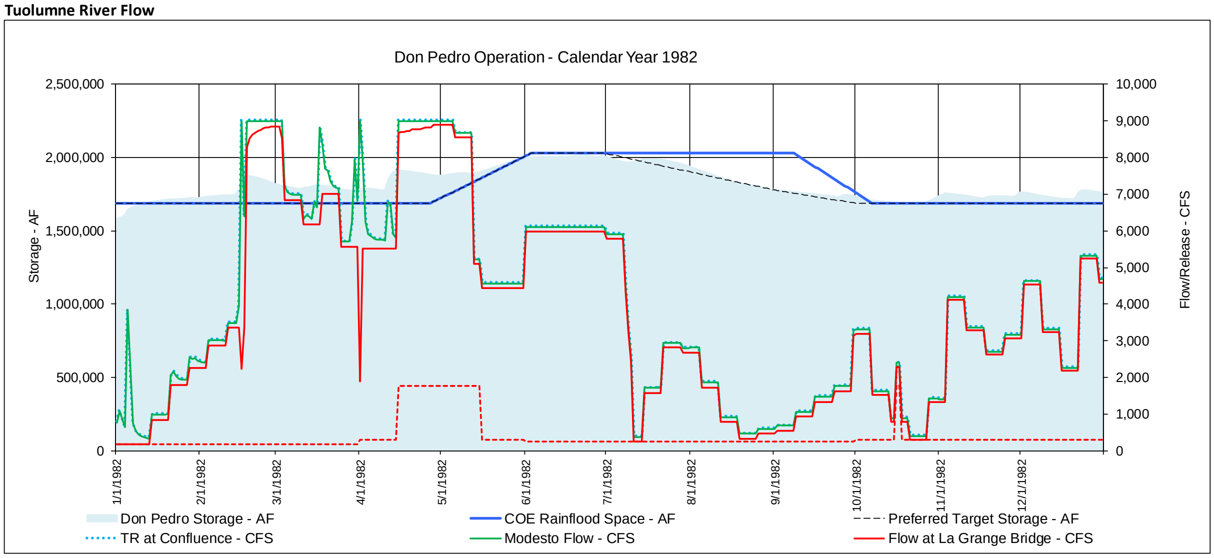


Figure 4-11. Don Pedro operations 1981 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

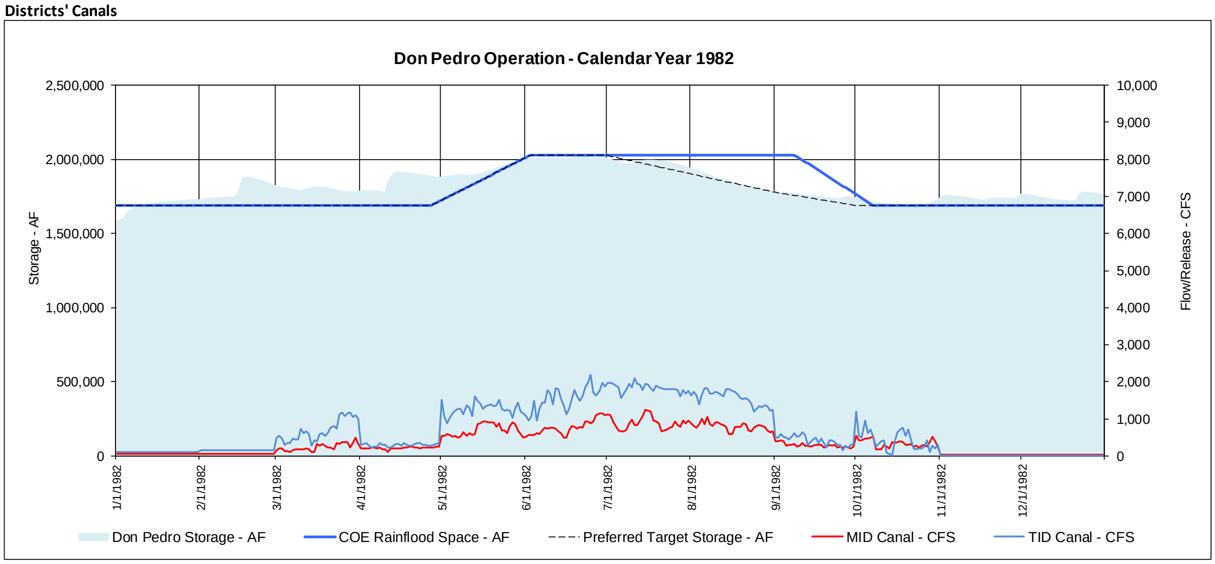
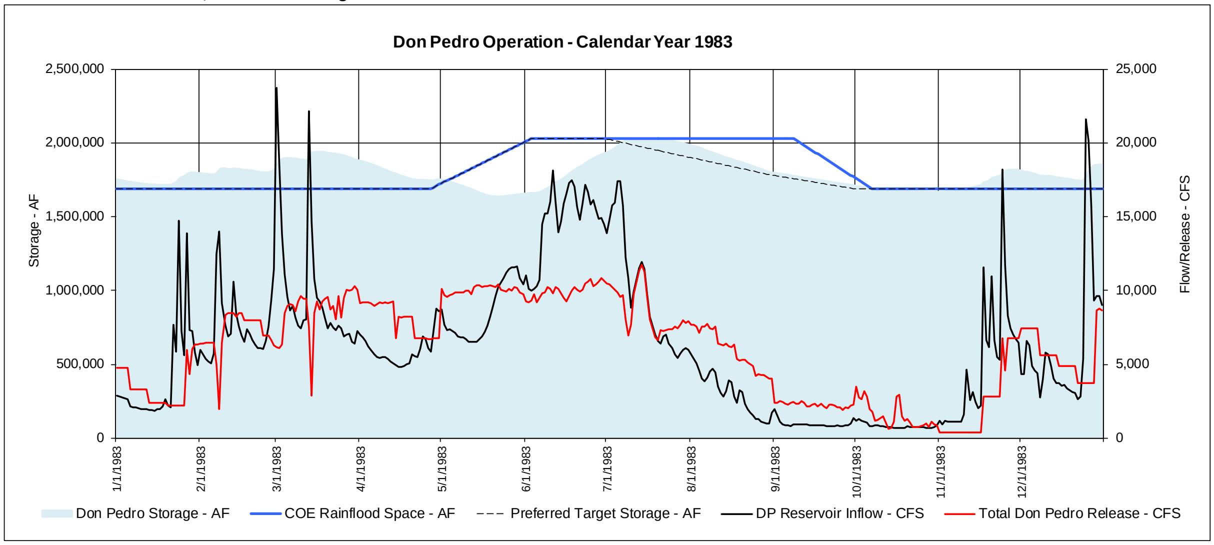
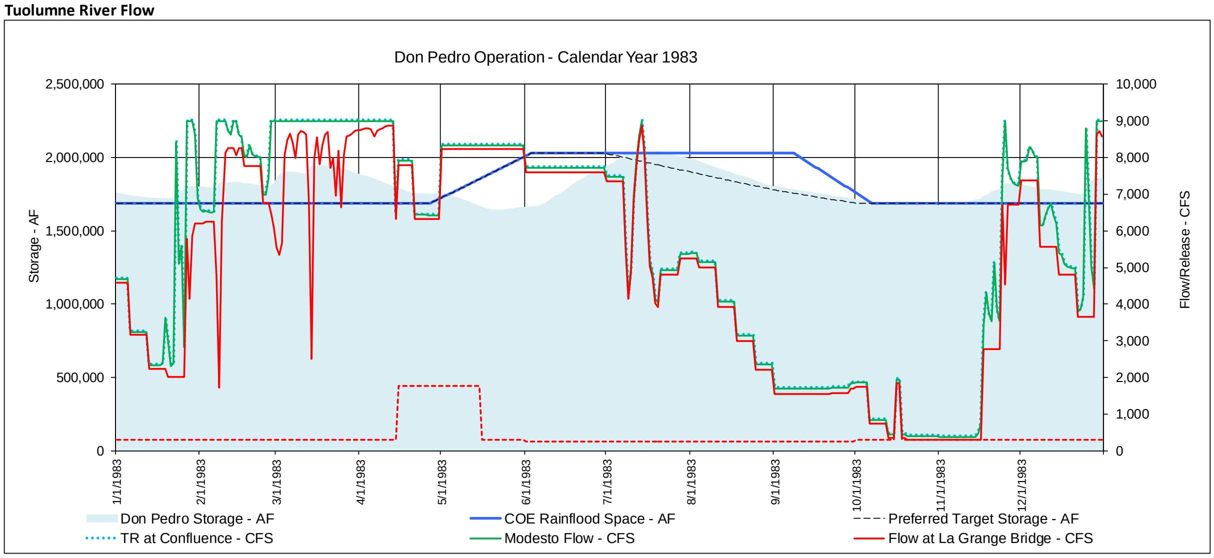


Figure 4-12. Don Pedro operations 1982 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

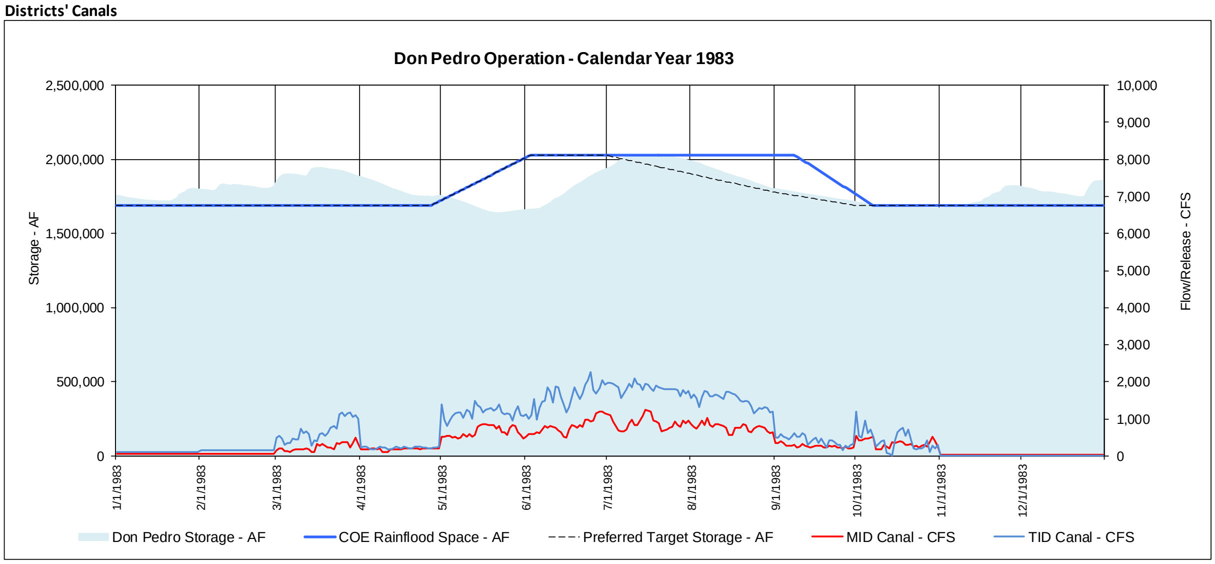
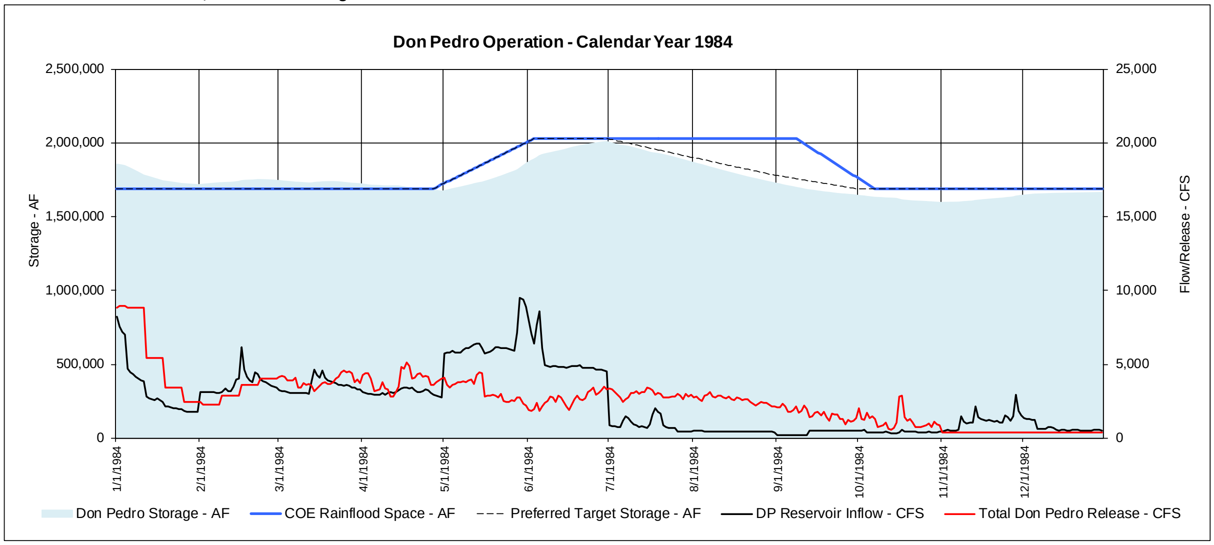
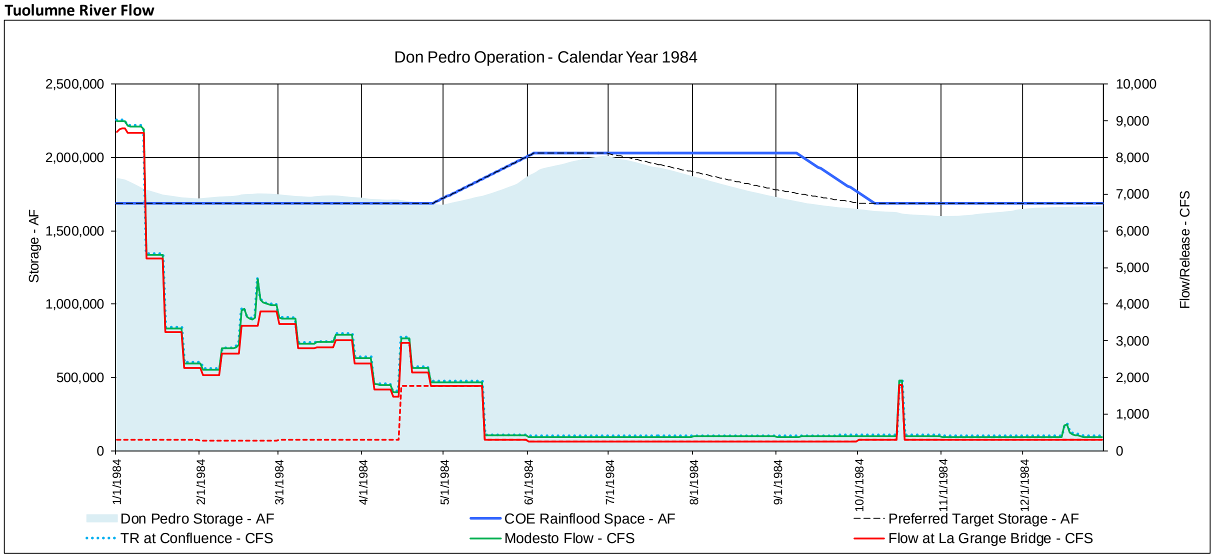


Figure 4-13. Don Pedro operations 1983 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

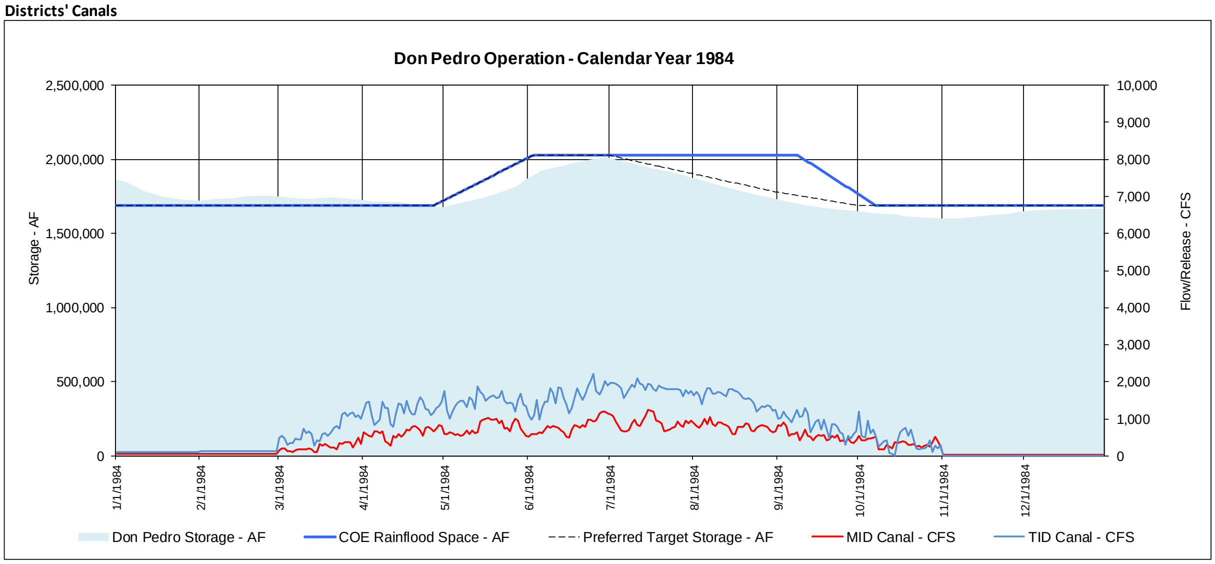
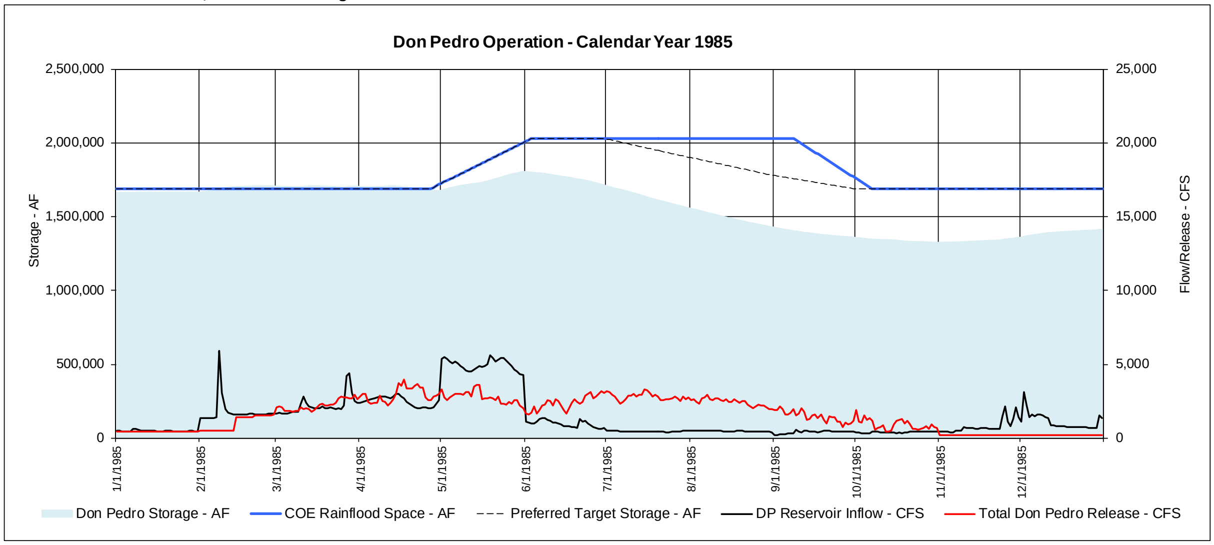
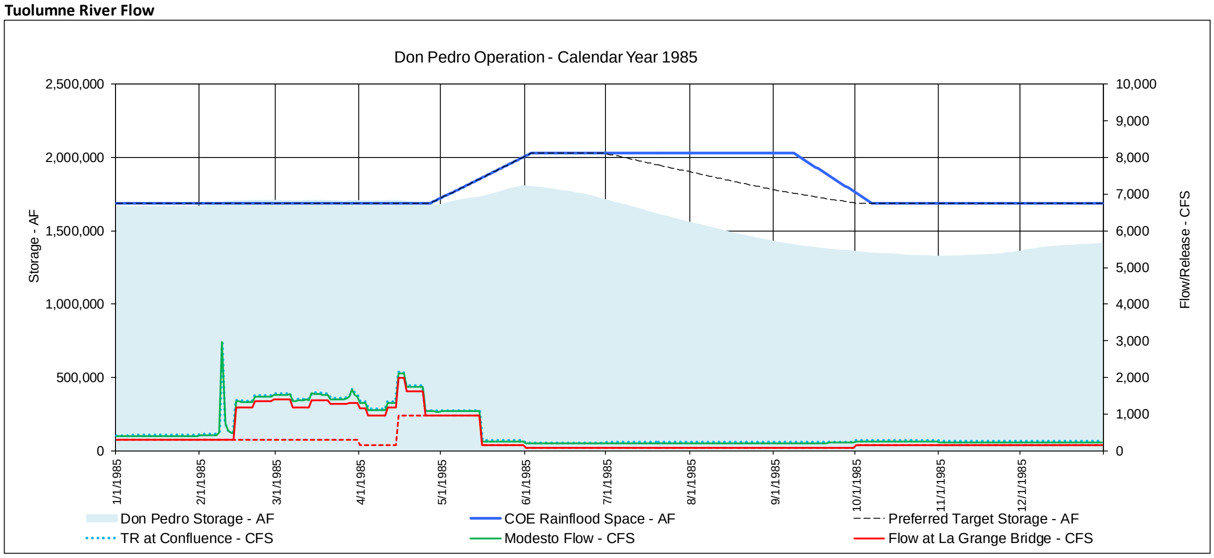


Figure 4-14. Don Pedro operations 1984 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

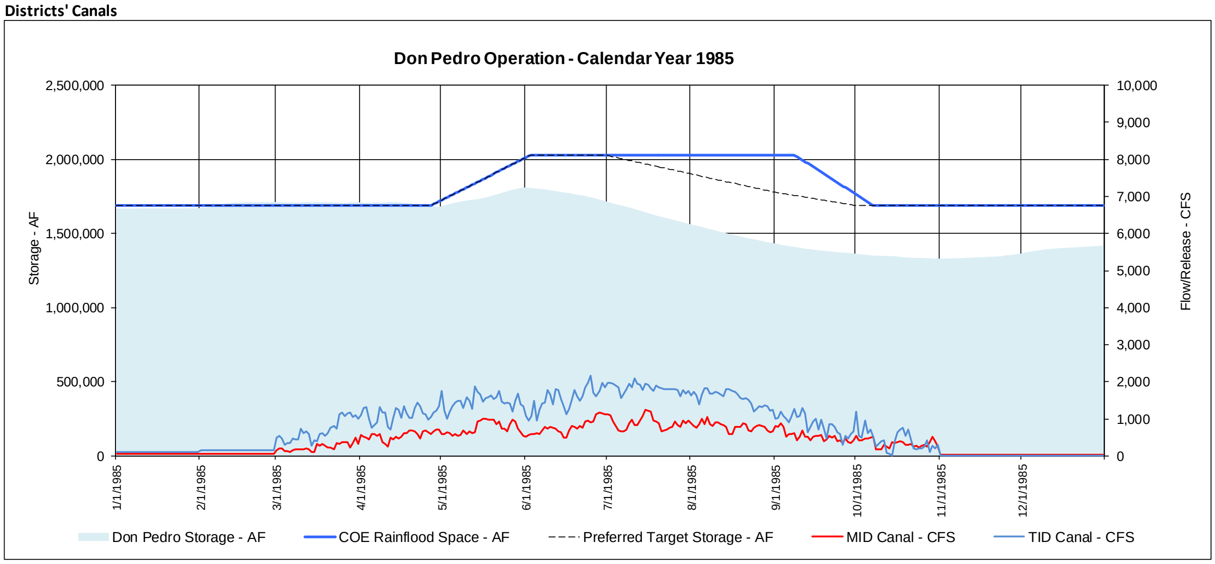
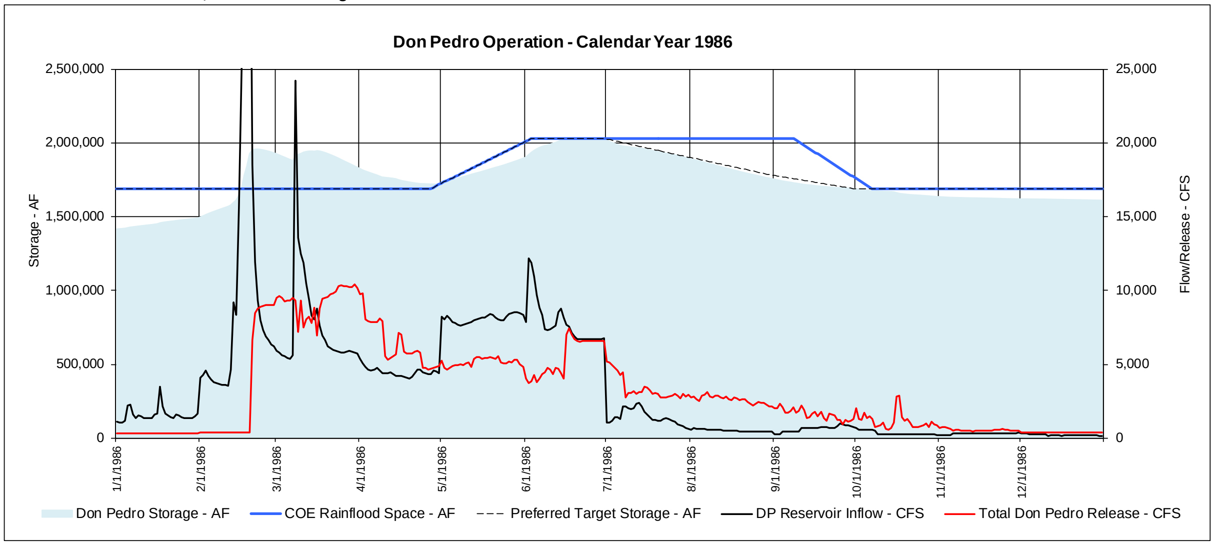
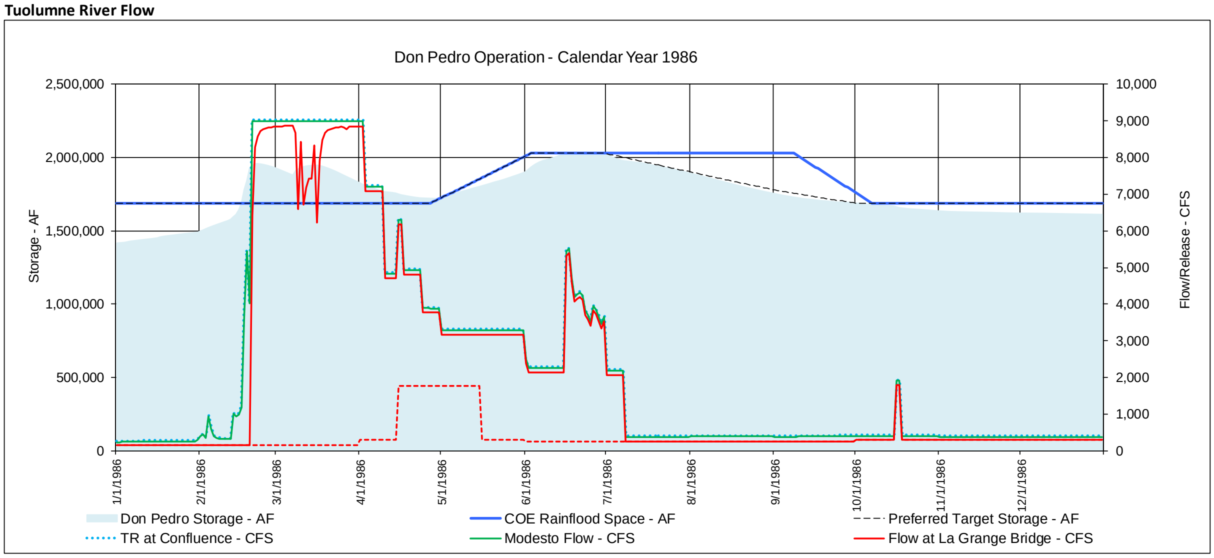


Figure 4-15. Don Pedro operations 1985 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

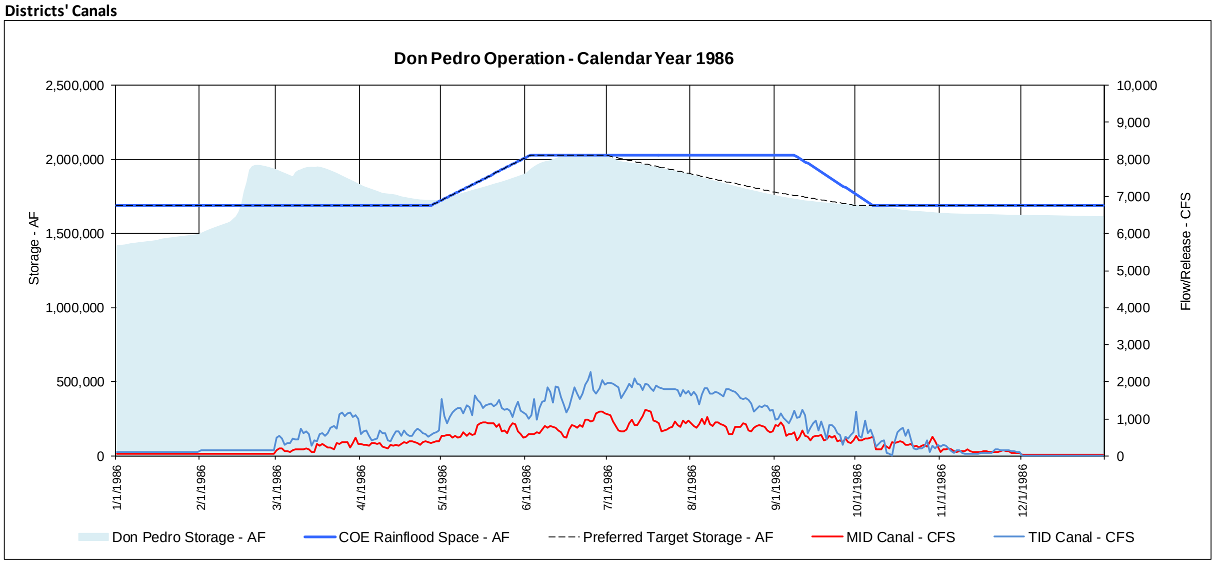
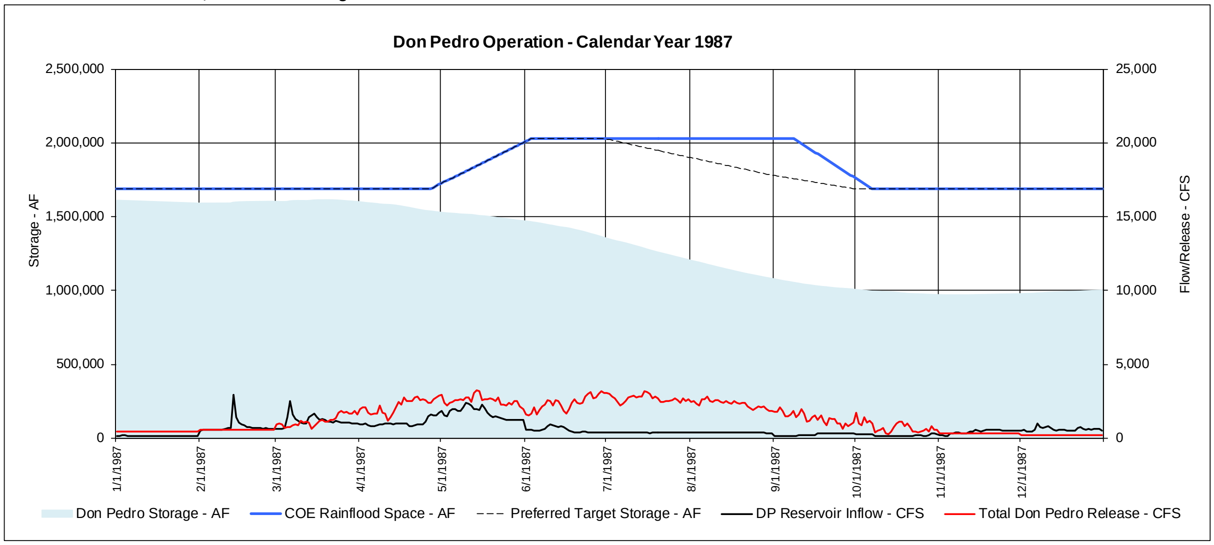
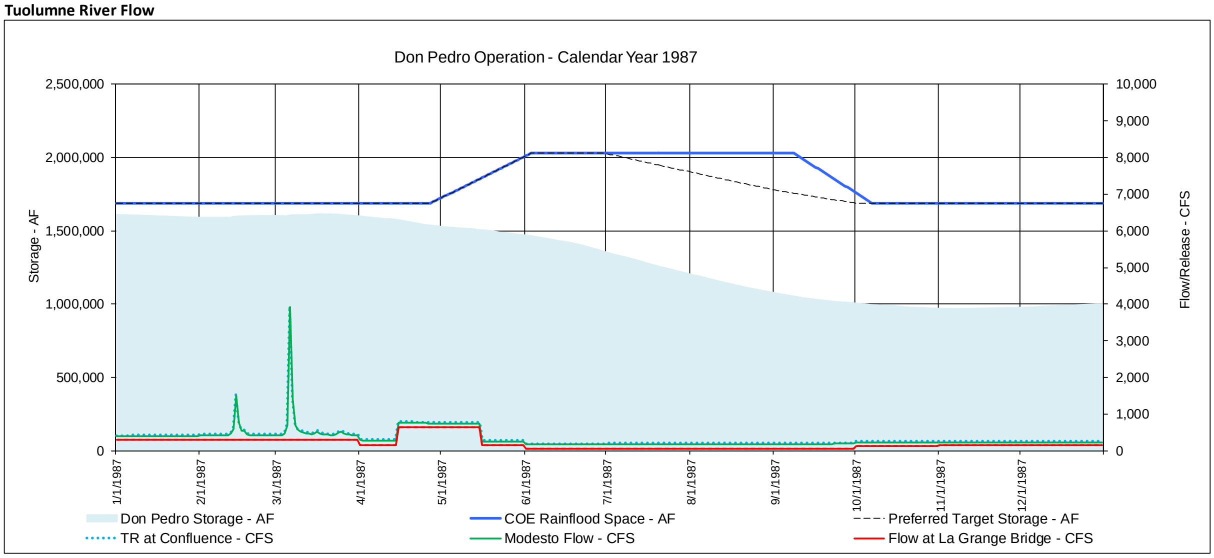


Figure 4-16. Don Pedro operations 1986 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

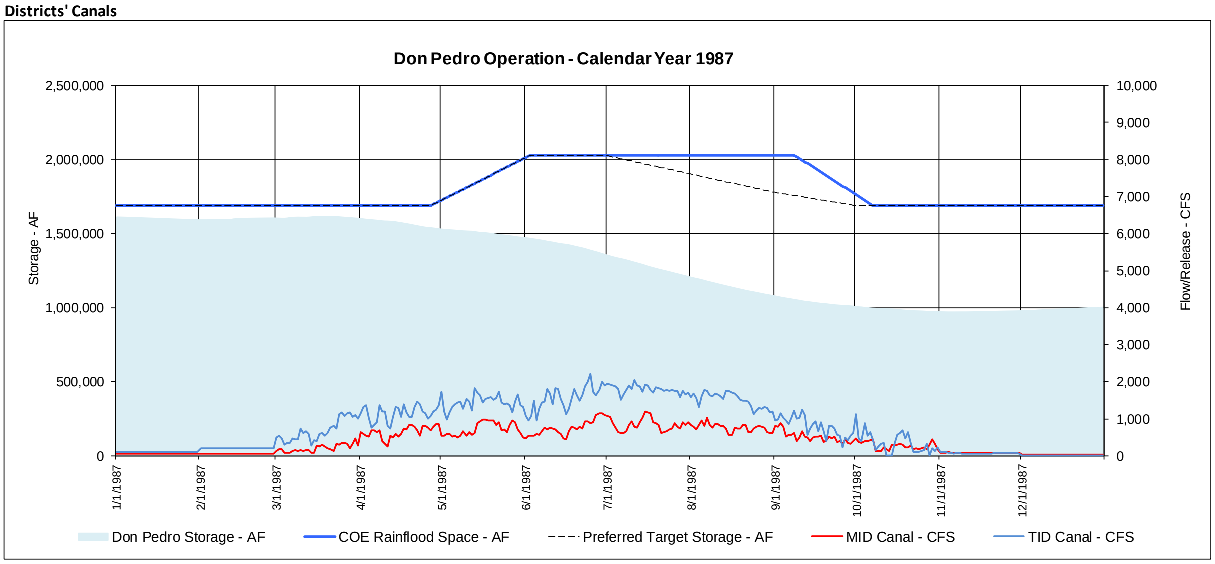
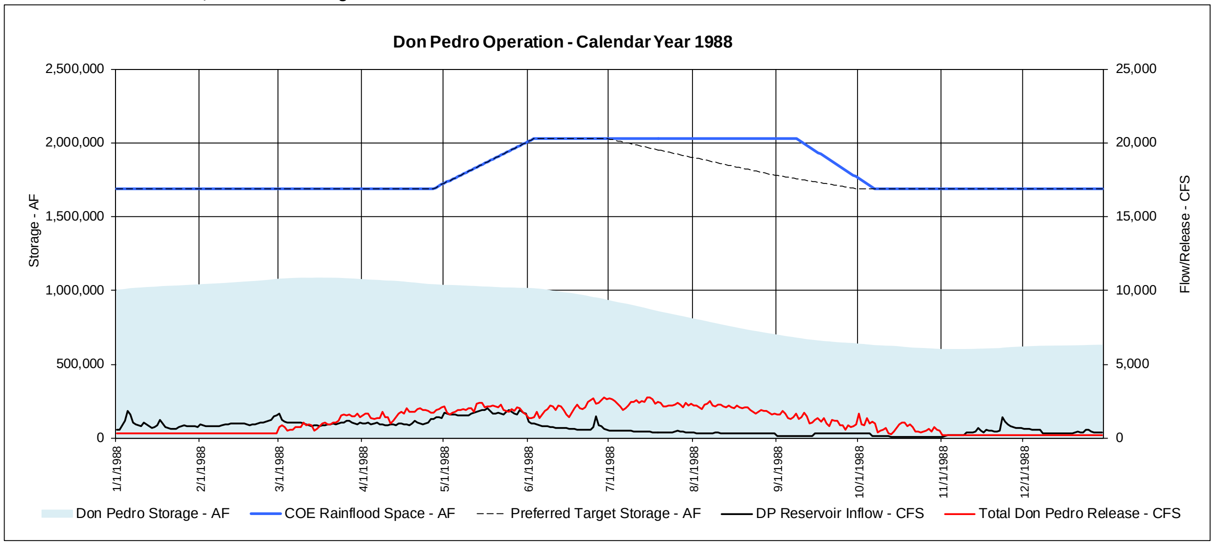
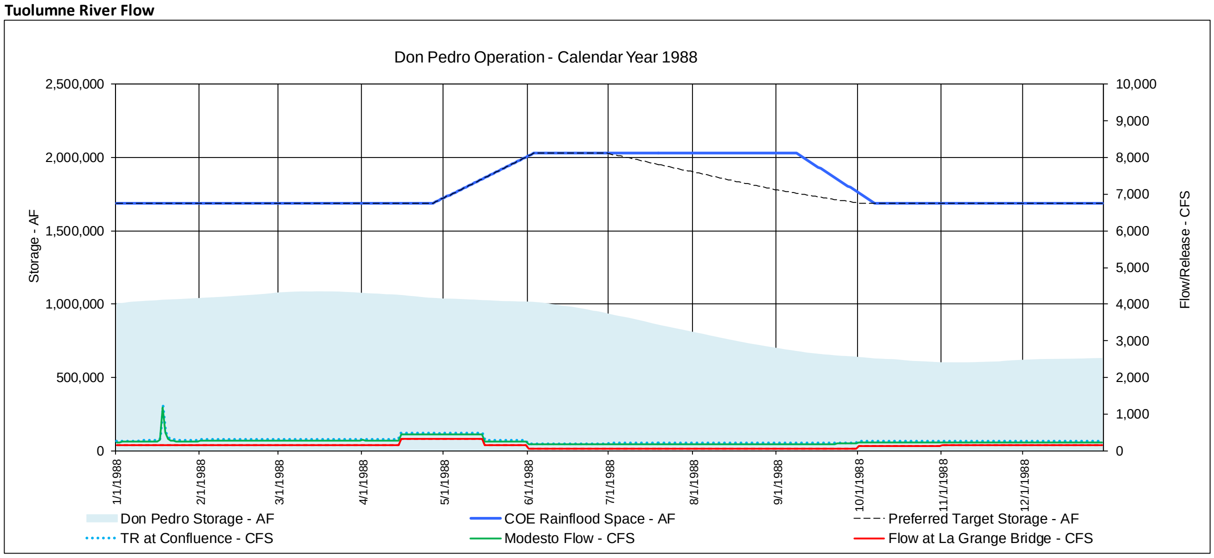


Figure 4-17. Don Pedro operations 1987 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

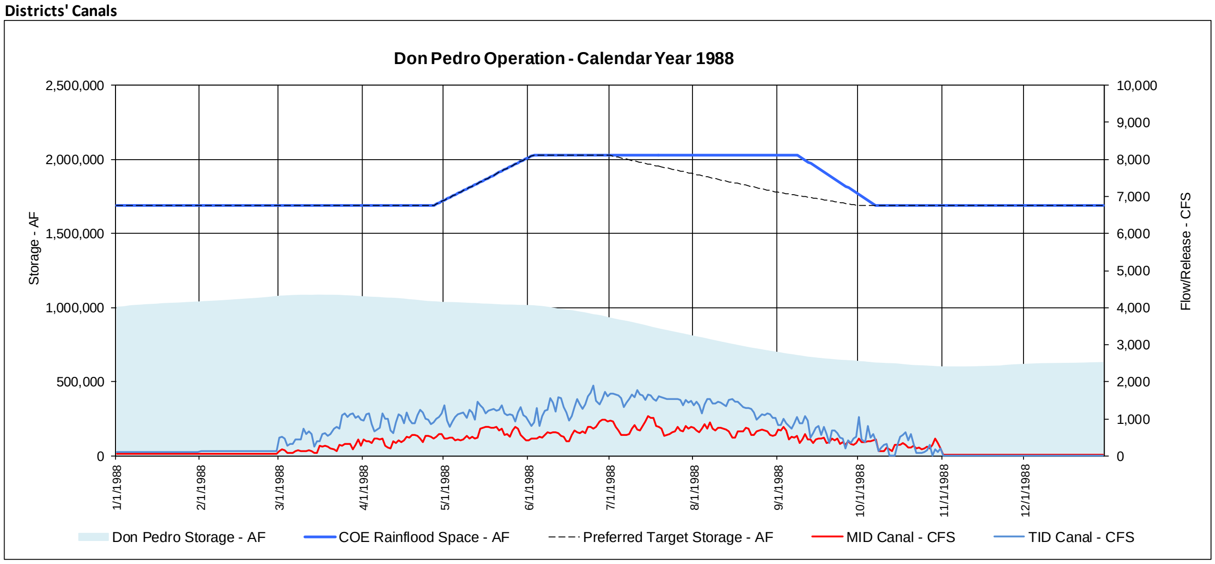
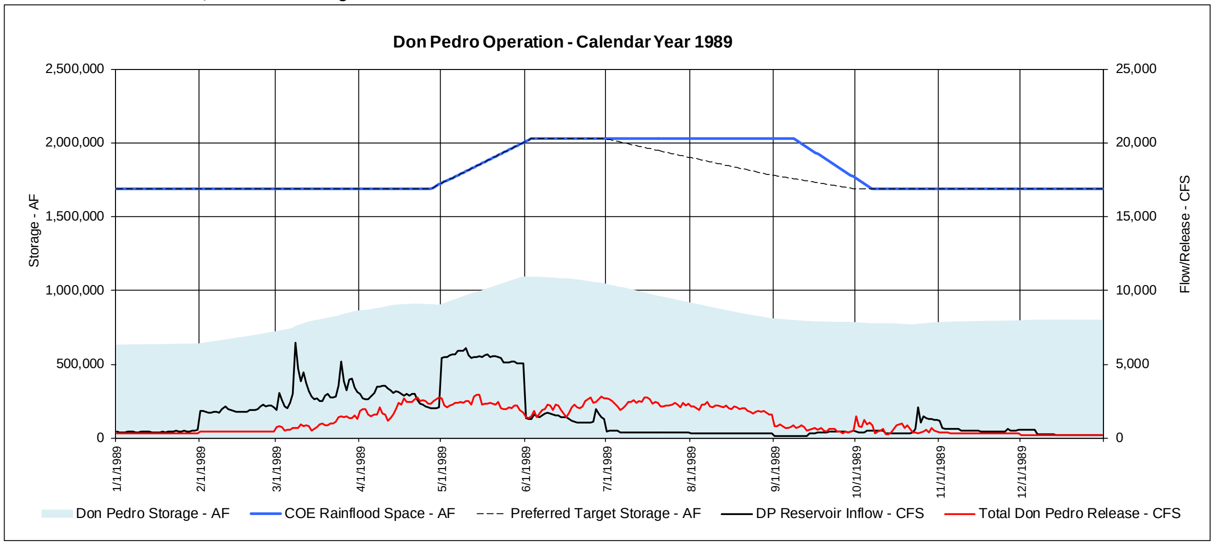
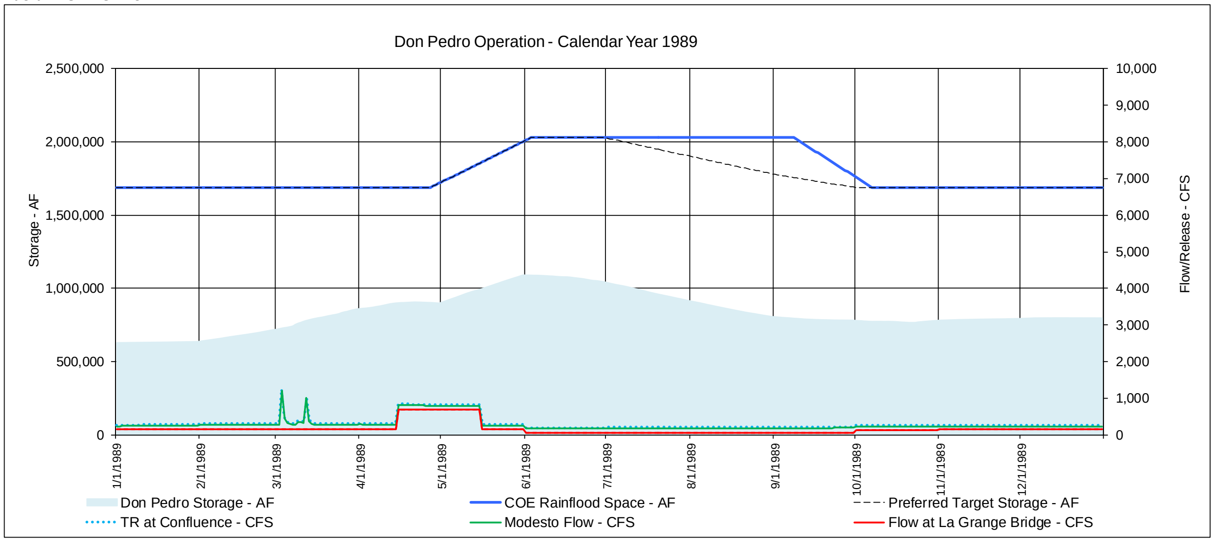


Figure 4-18. Don Pedro operations 1988 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

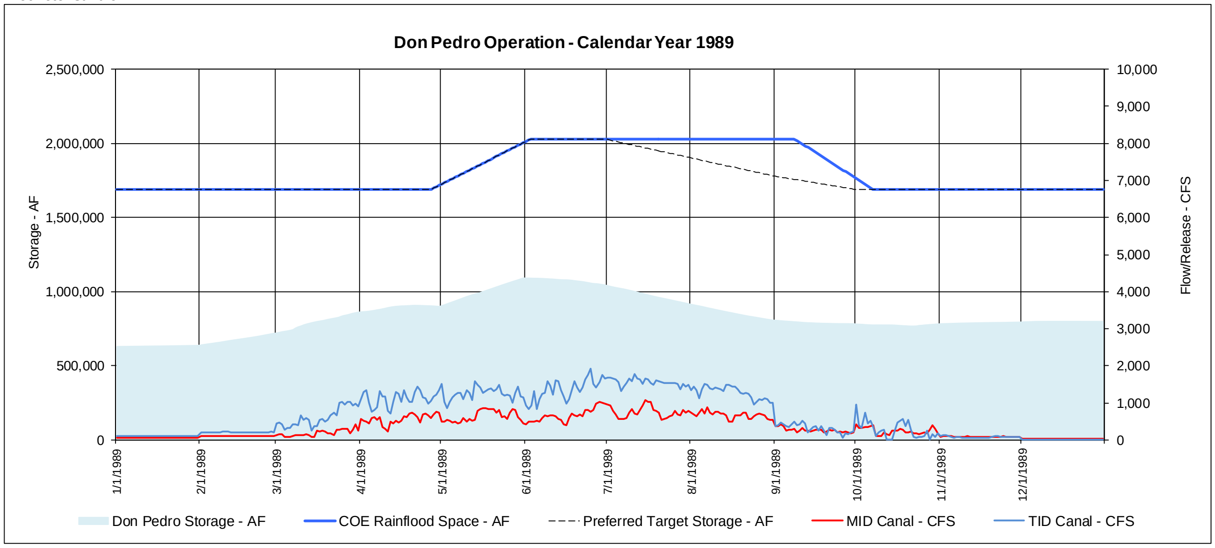
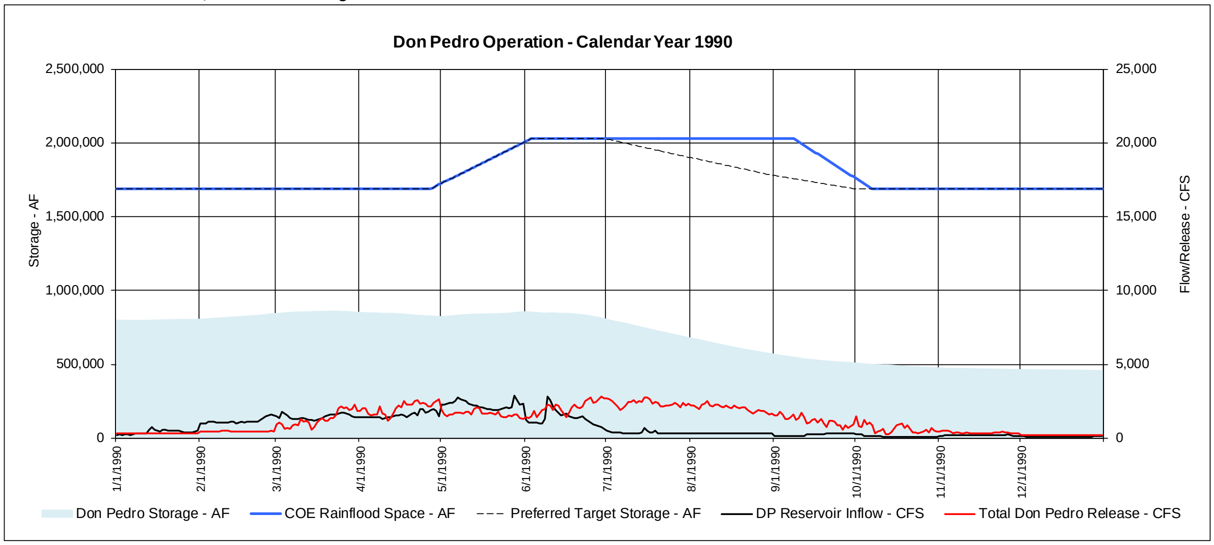
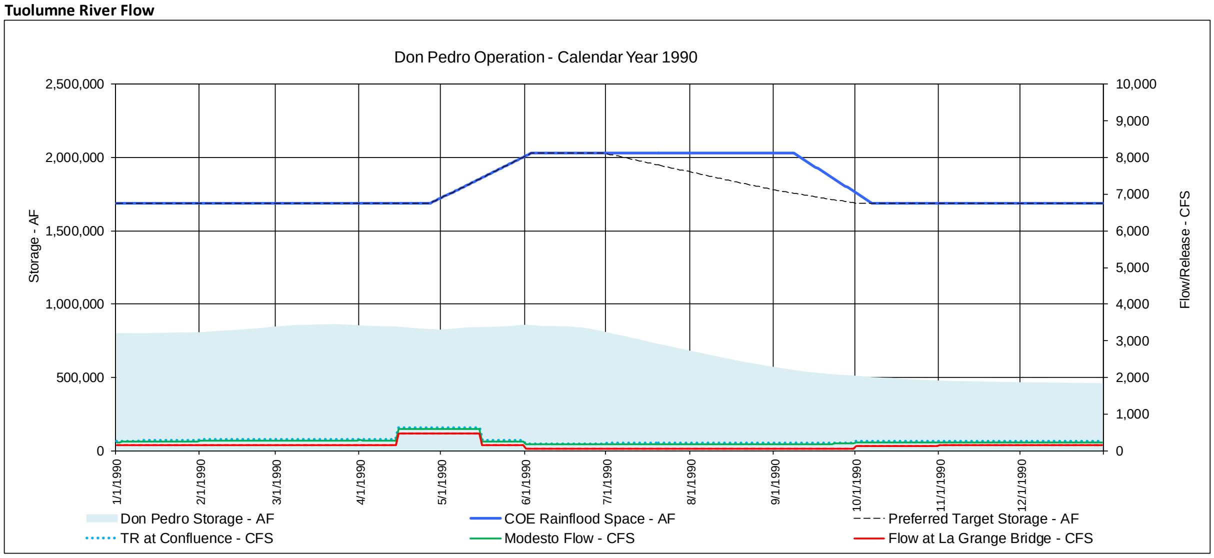


Figure 4-19. Don Pedro operations 1989 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

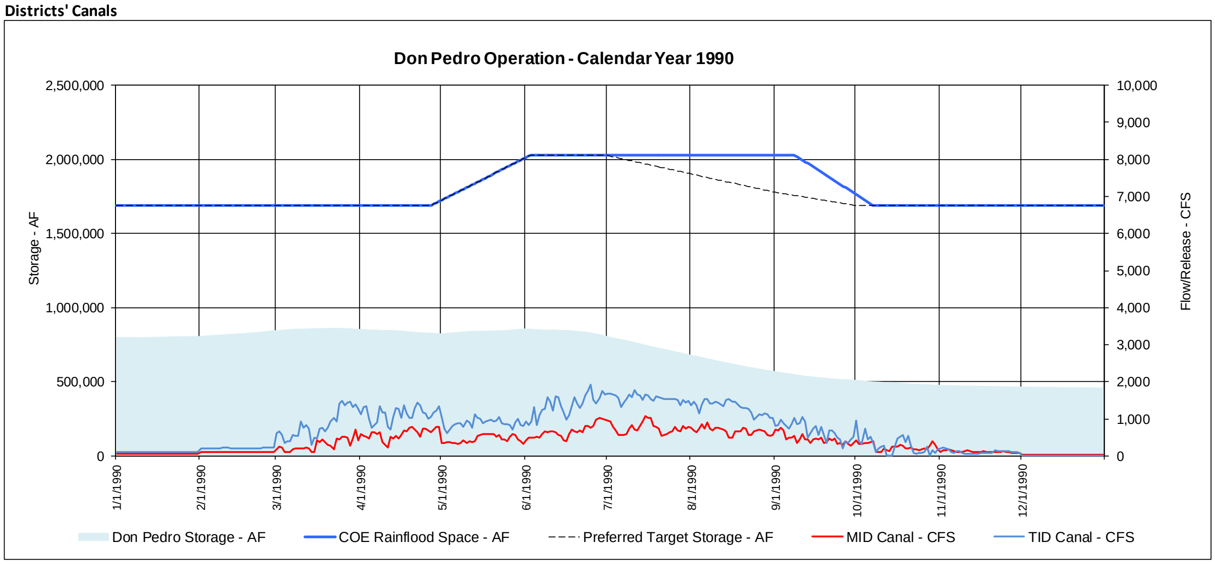
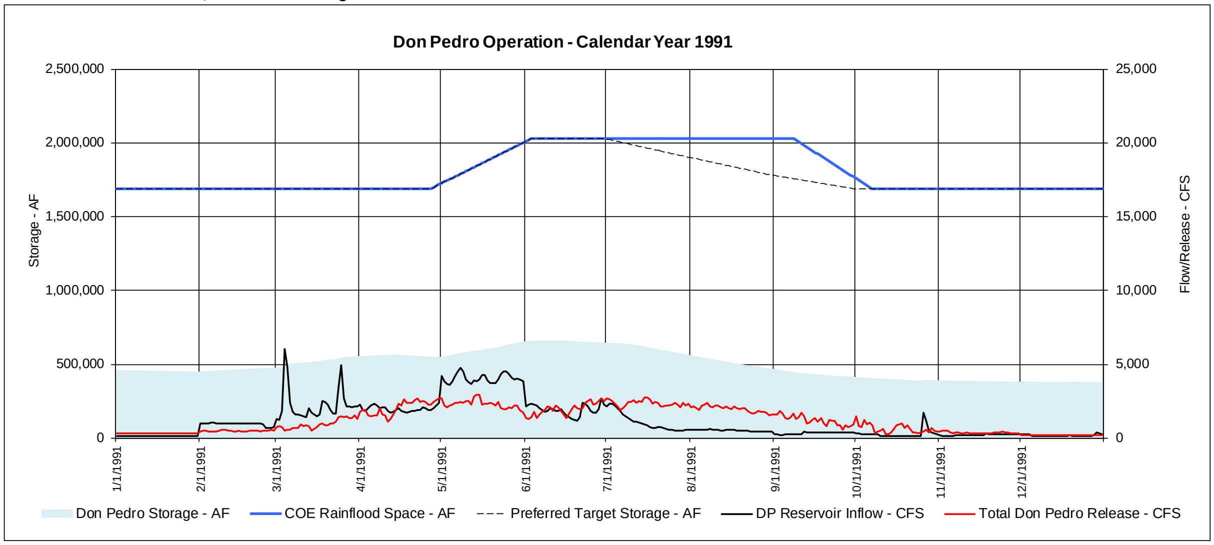
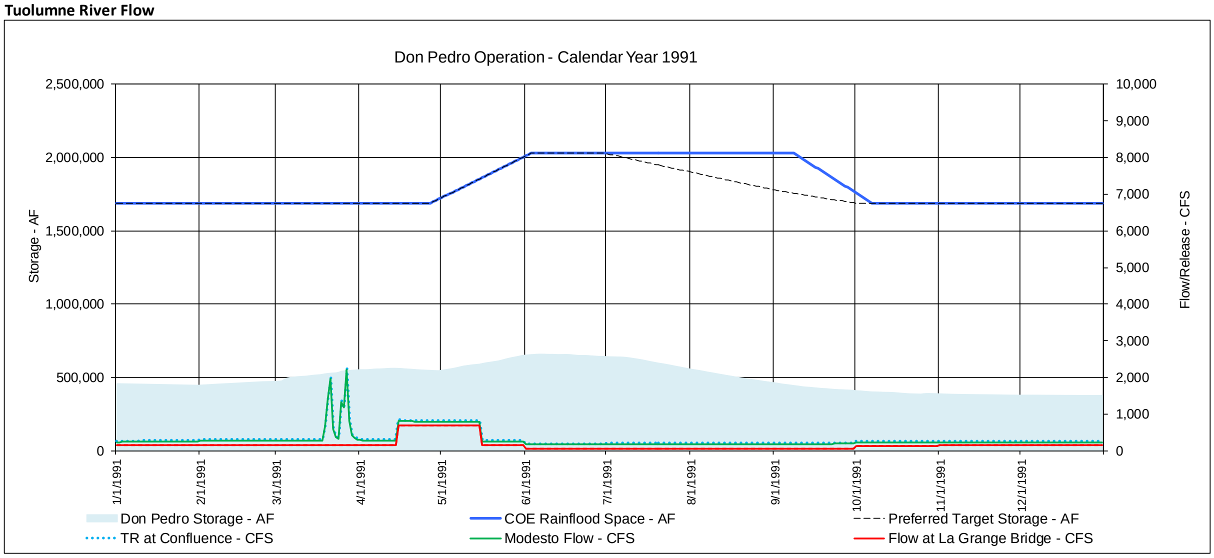


Figure 4-20. Don Pedro operations 1990 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

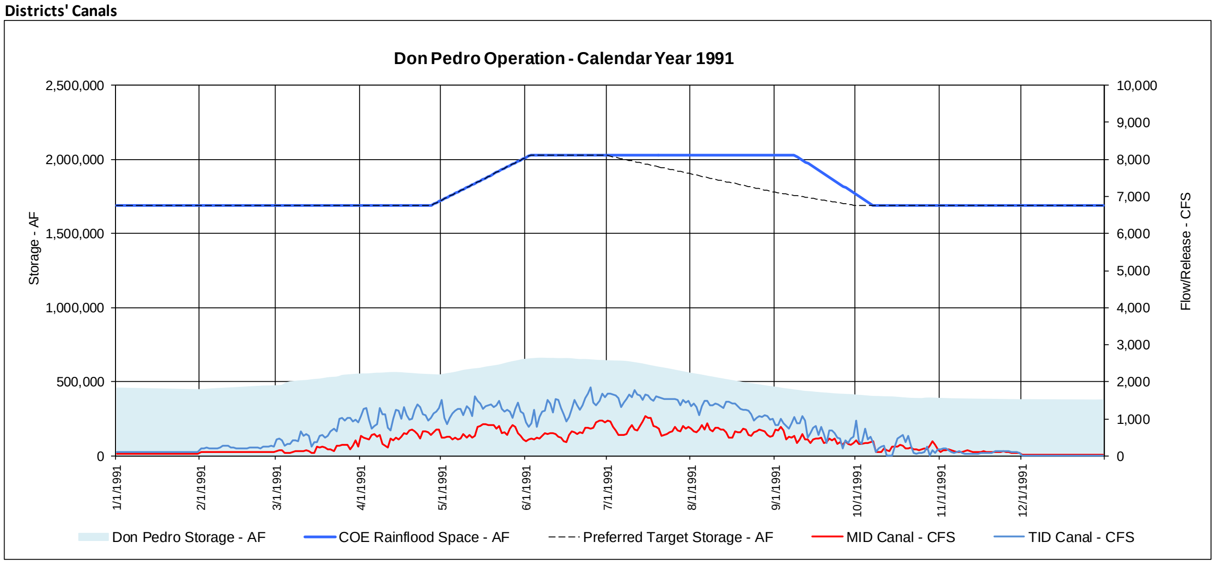
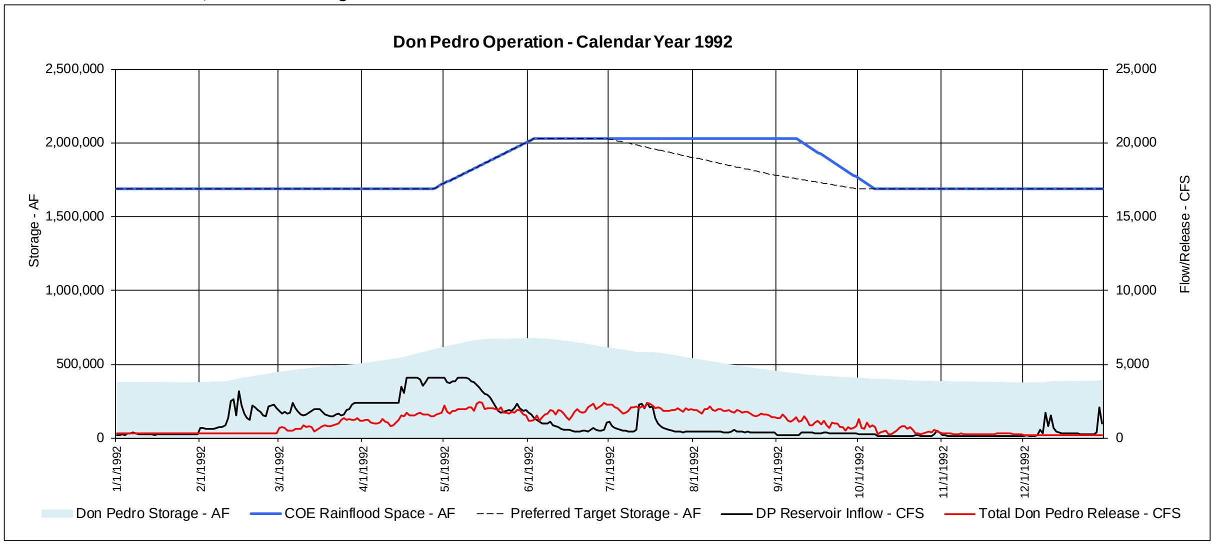
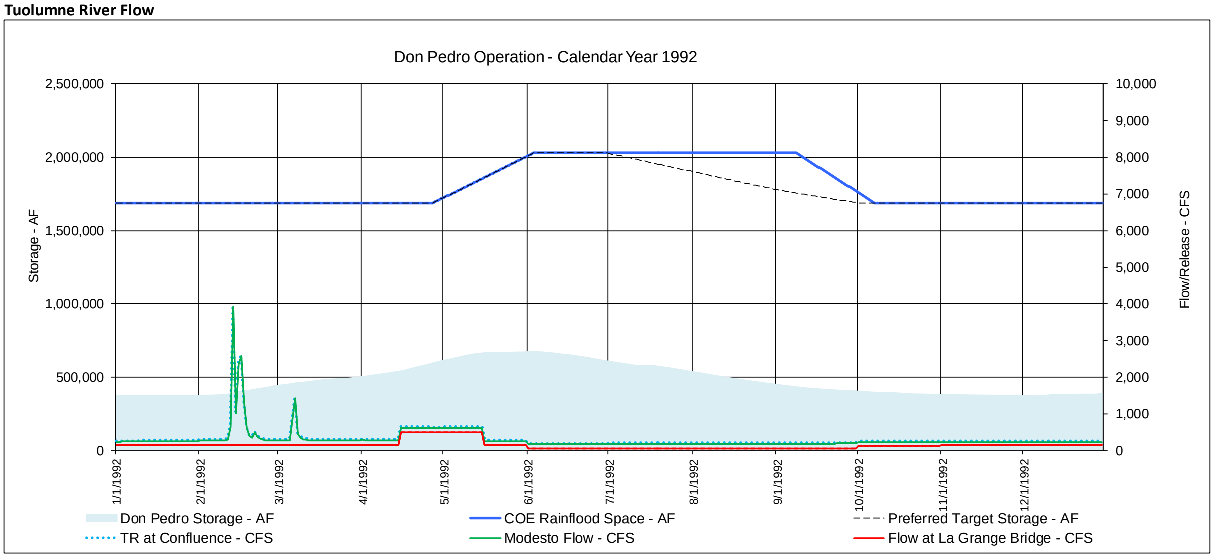


Figure 4-21. Don Pedro operations 1991 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

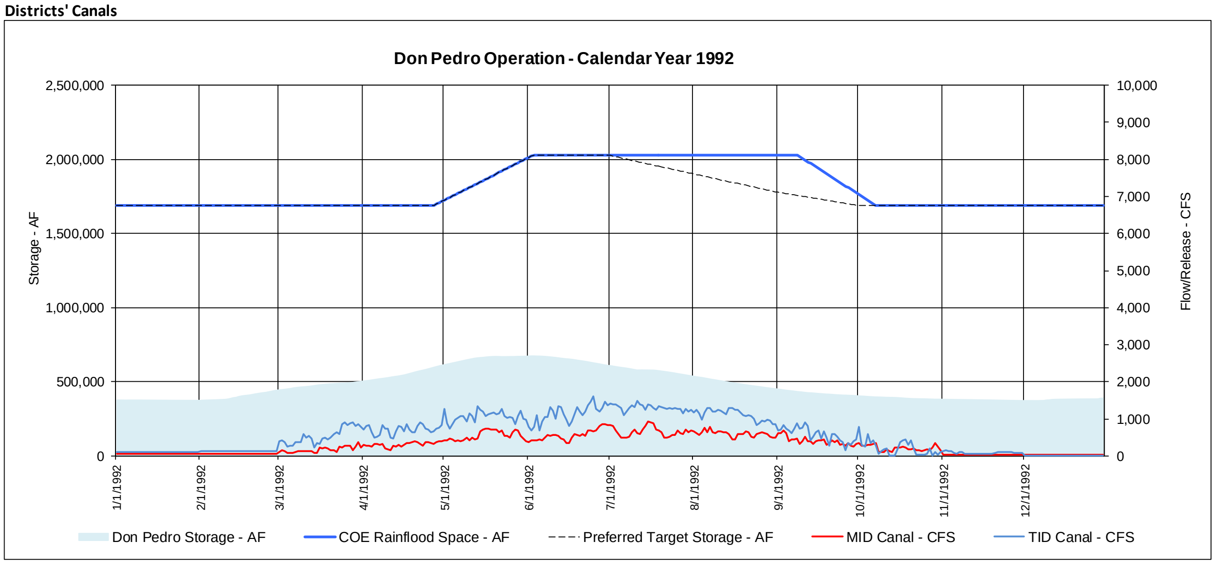
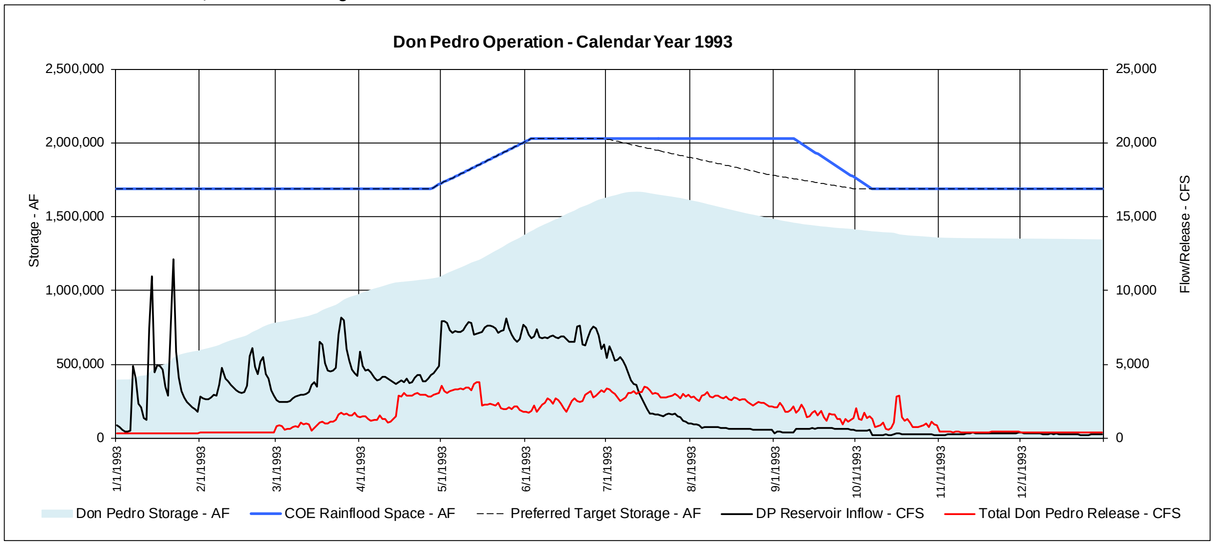
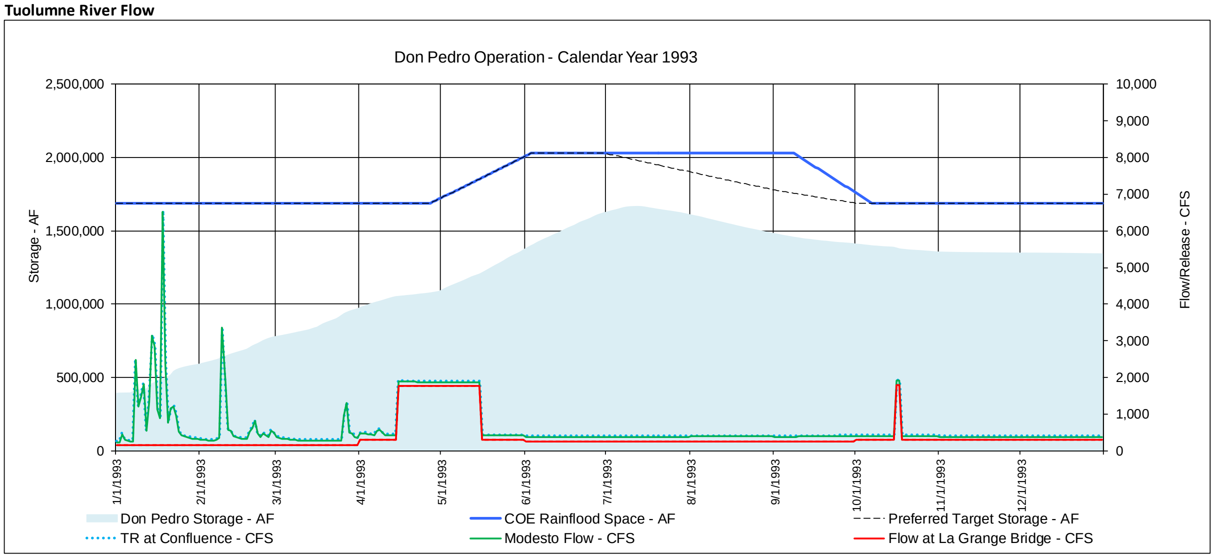


Figure 4-22 Don Pedro operations 1992 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

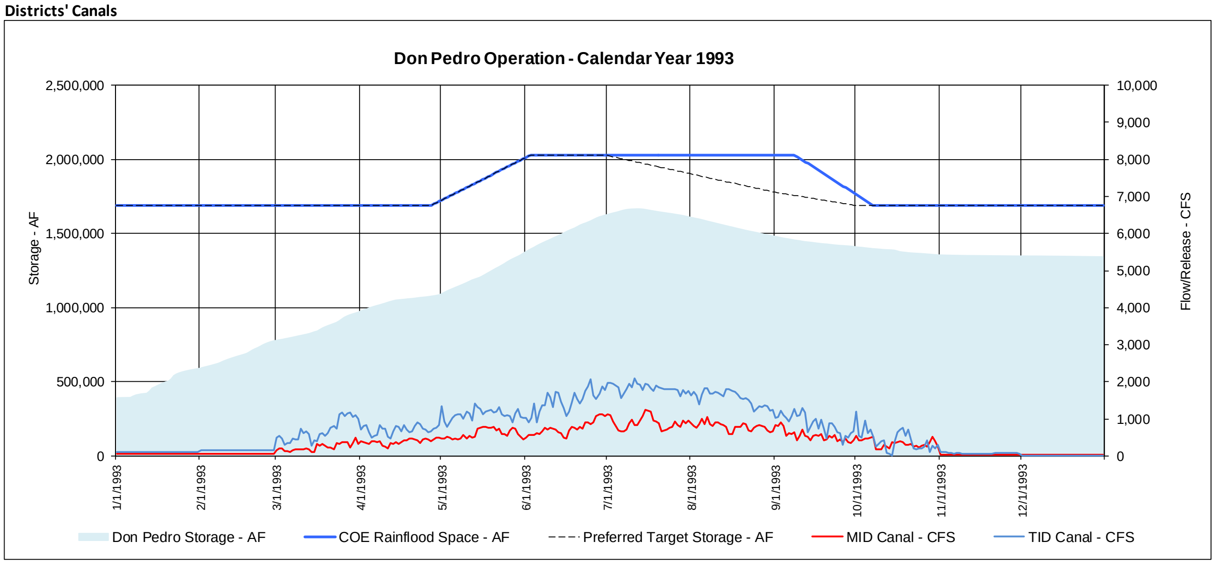
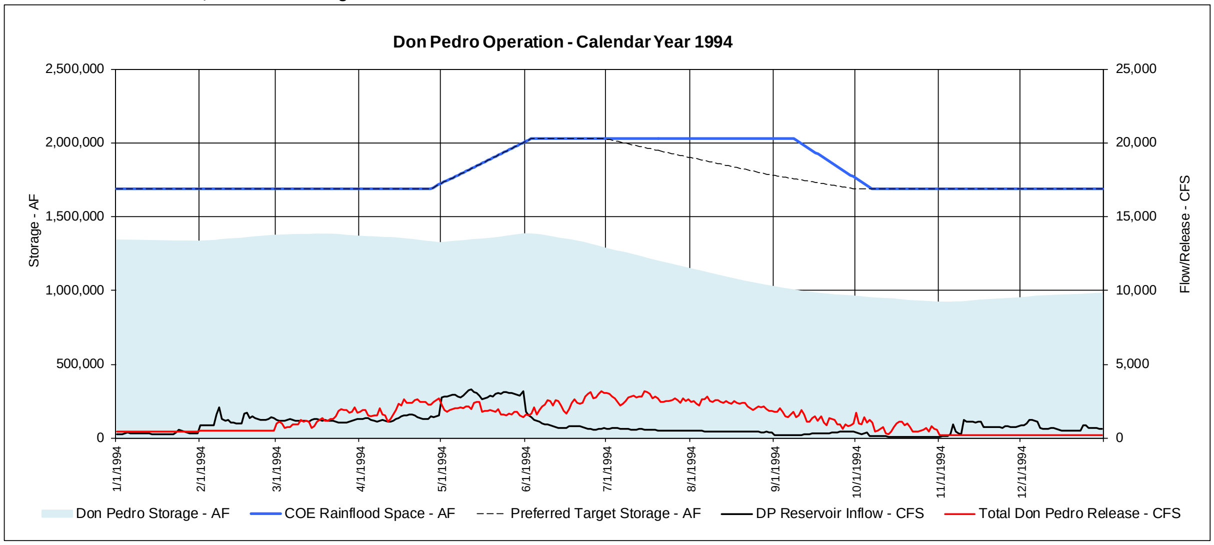
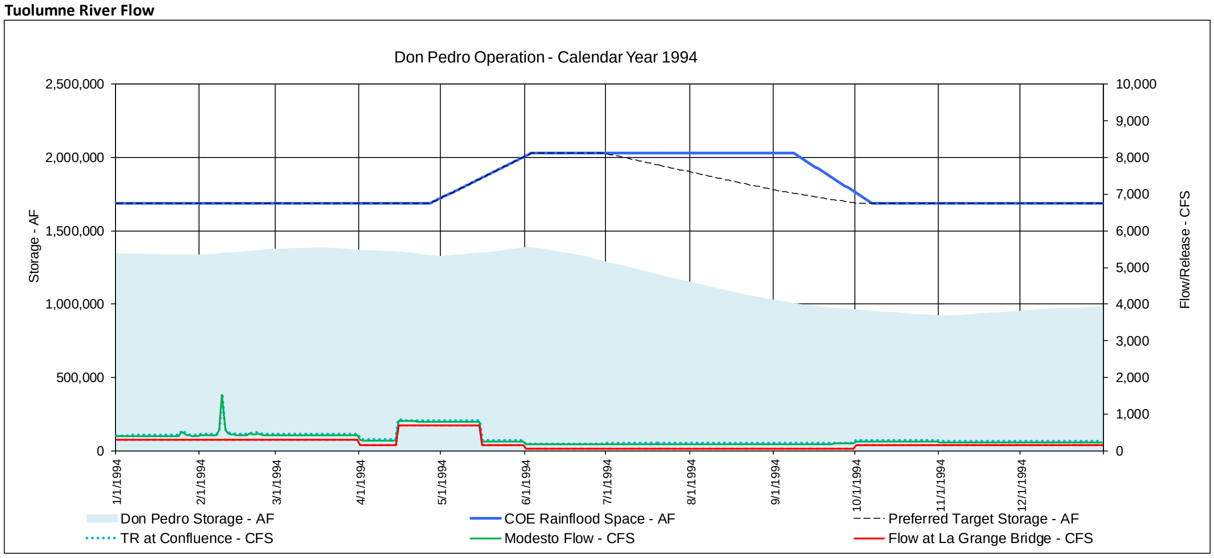


Figure 4-23. Don Pedro operations 1993 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

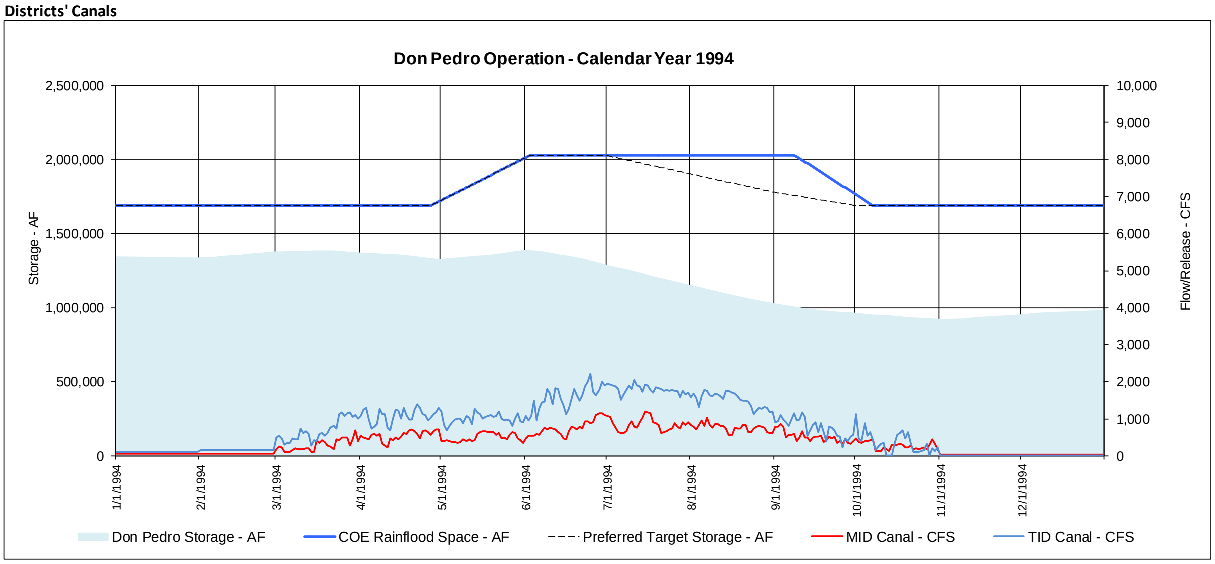
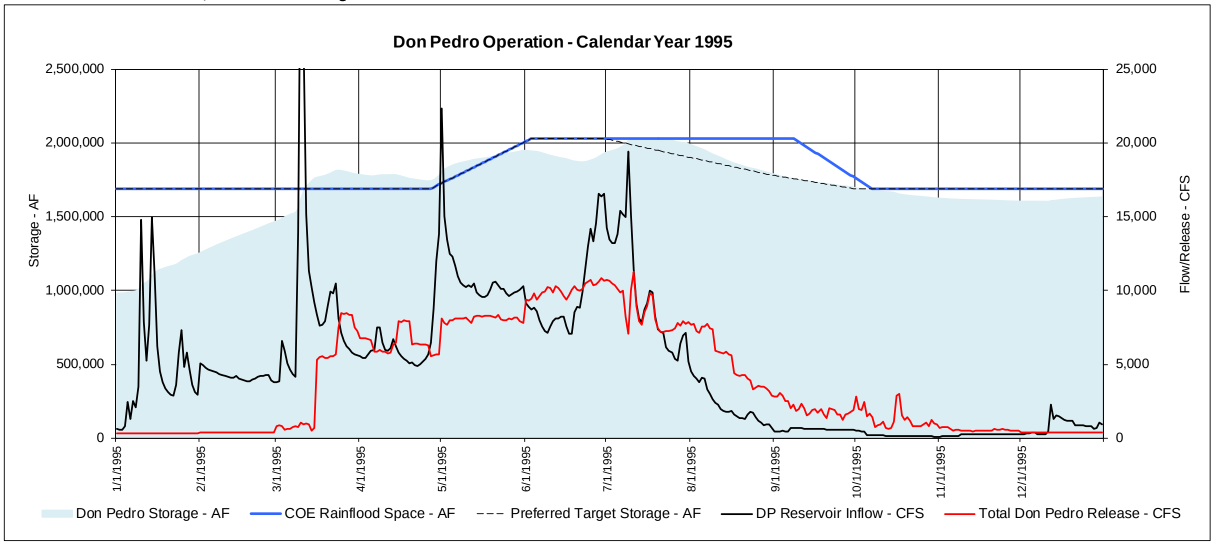
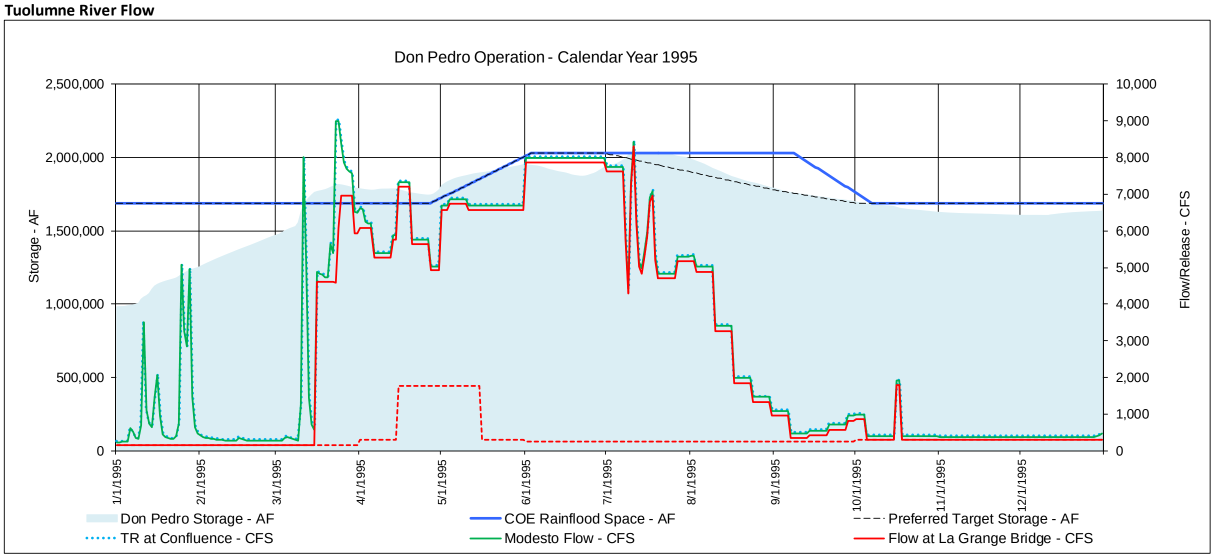


Figure 4-24. Don Pedro operations 1994 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

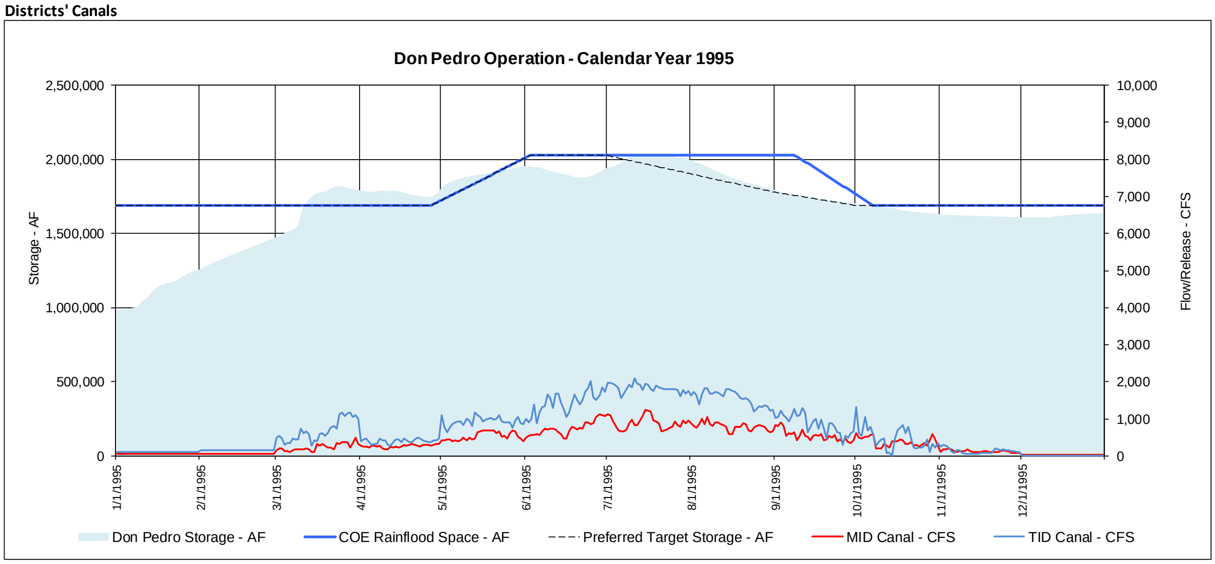
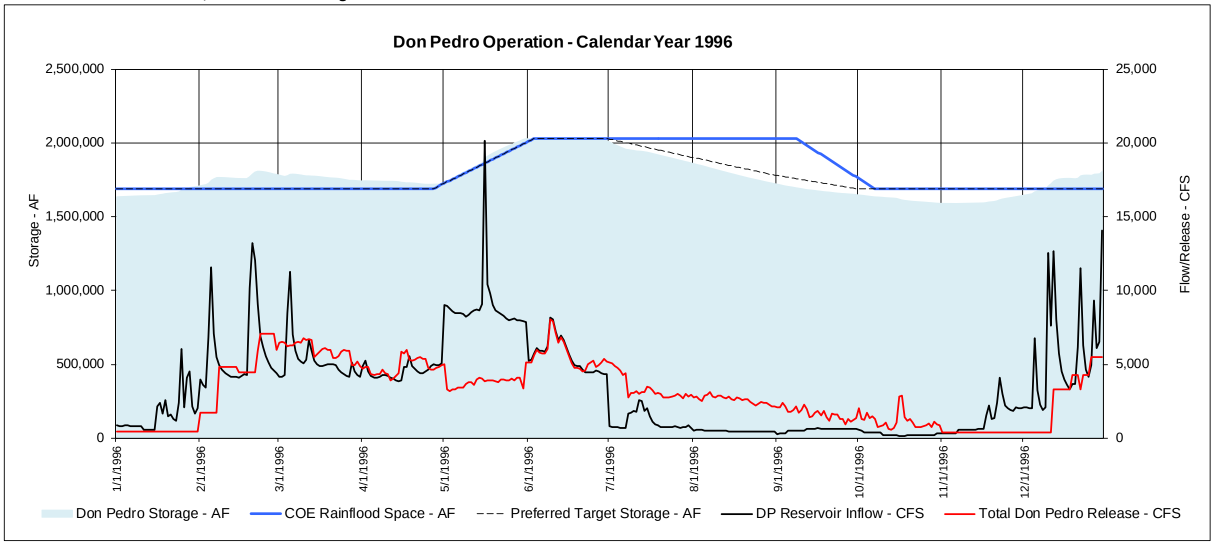
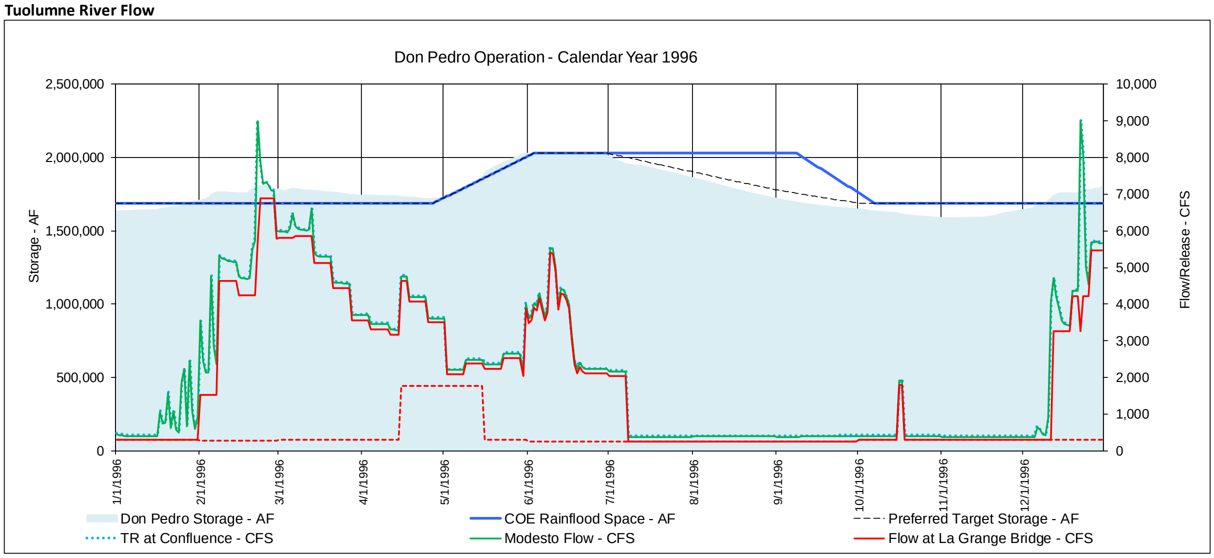


Figure 4-25. Don Pedro operations 1995 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

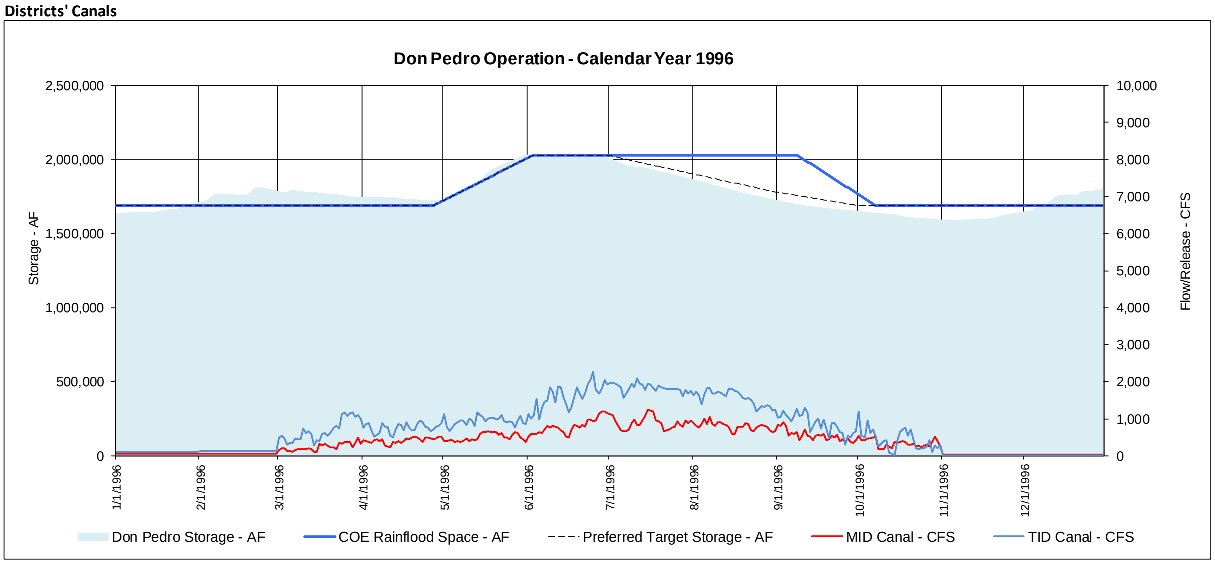
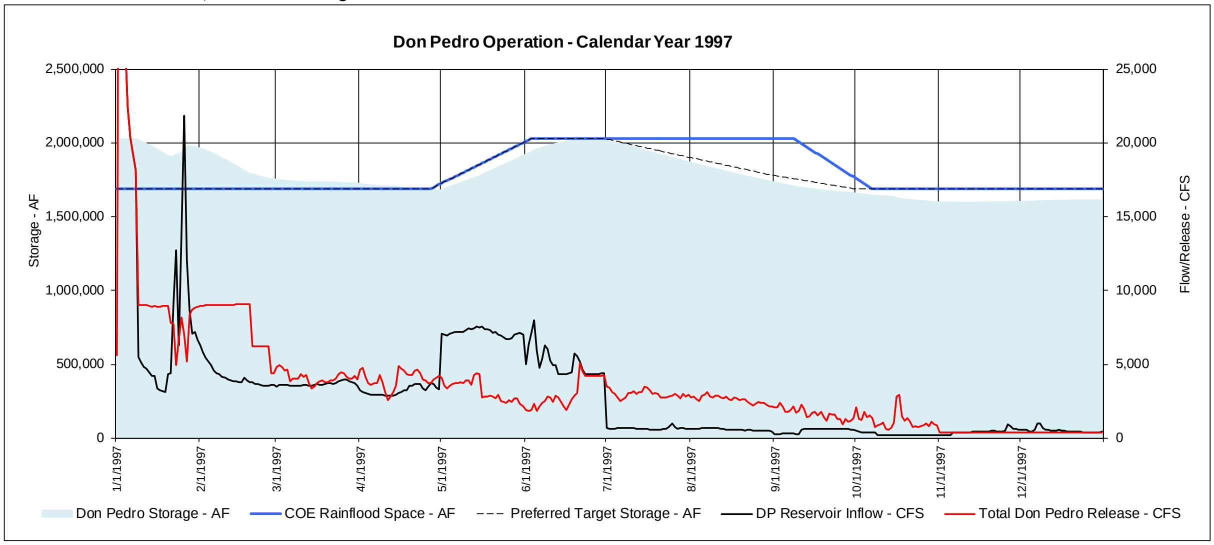
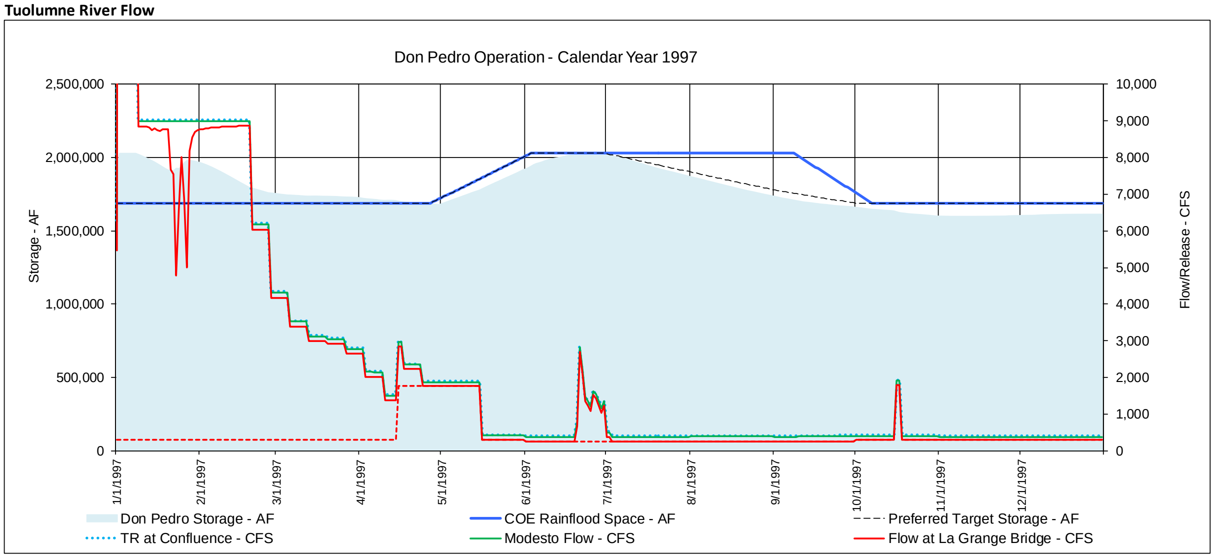


Figure 4-26. Don Pedro operations 1996 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

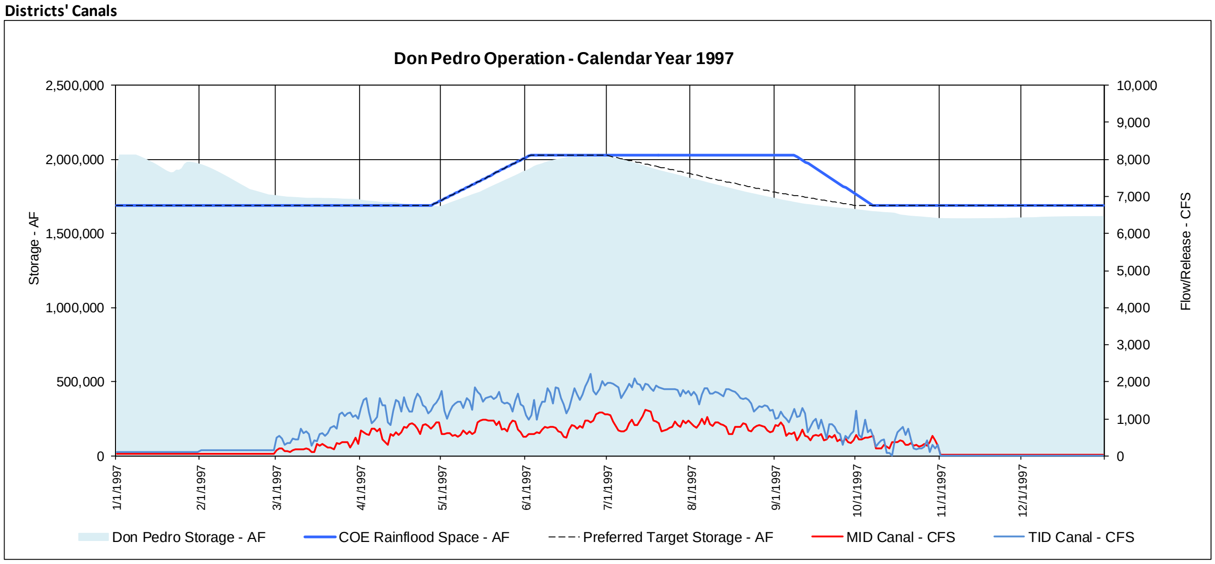
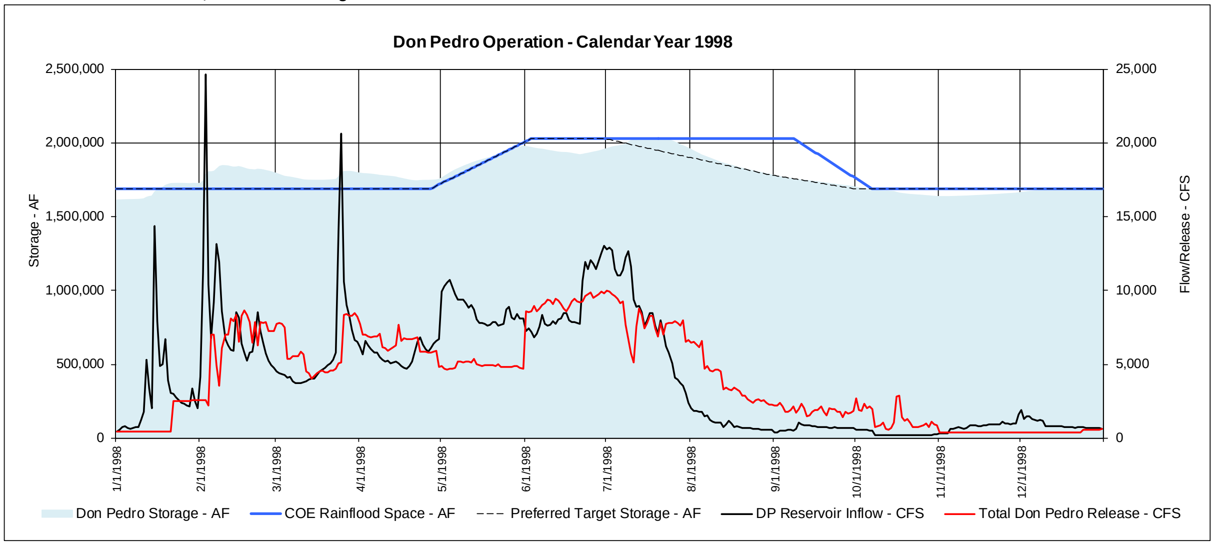
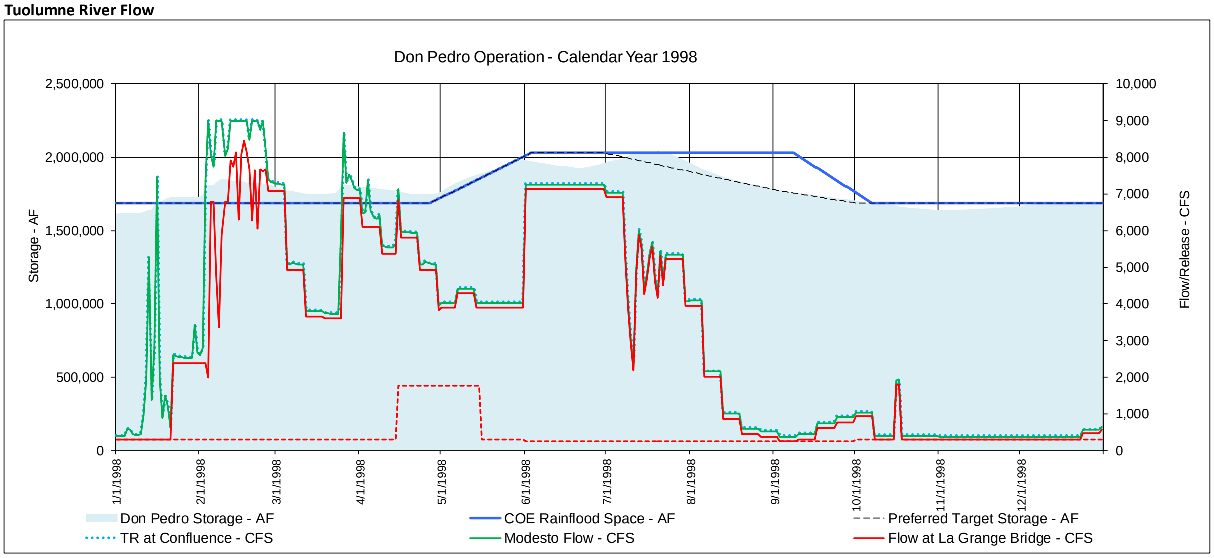


Figure 4-27. Don Pedro operations 1997 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

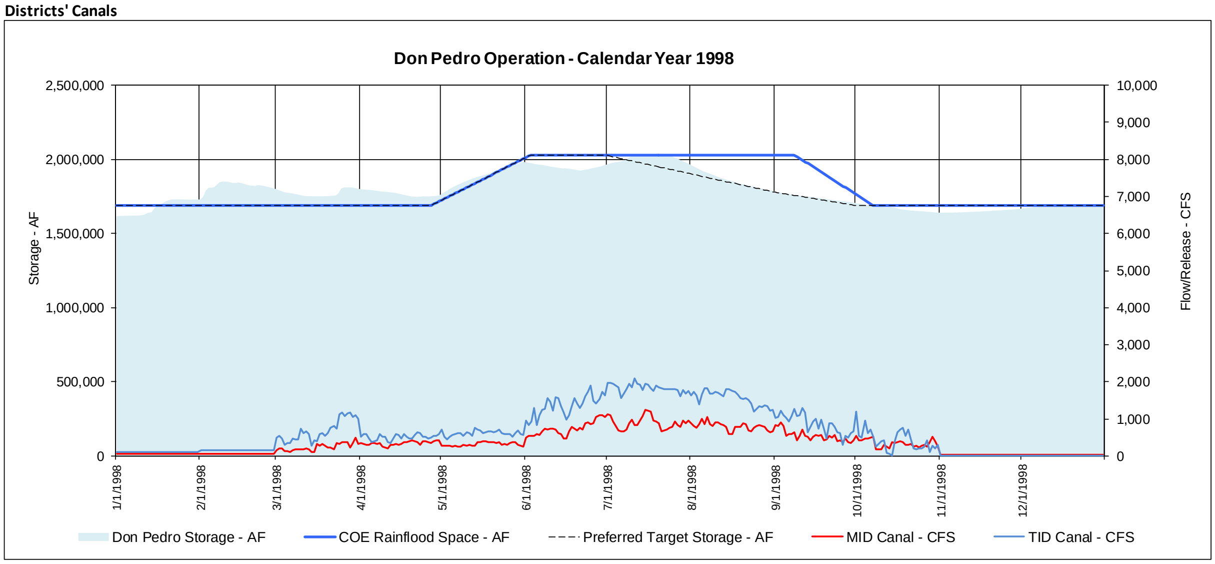
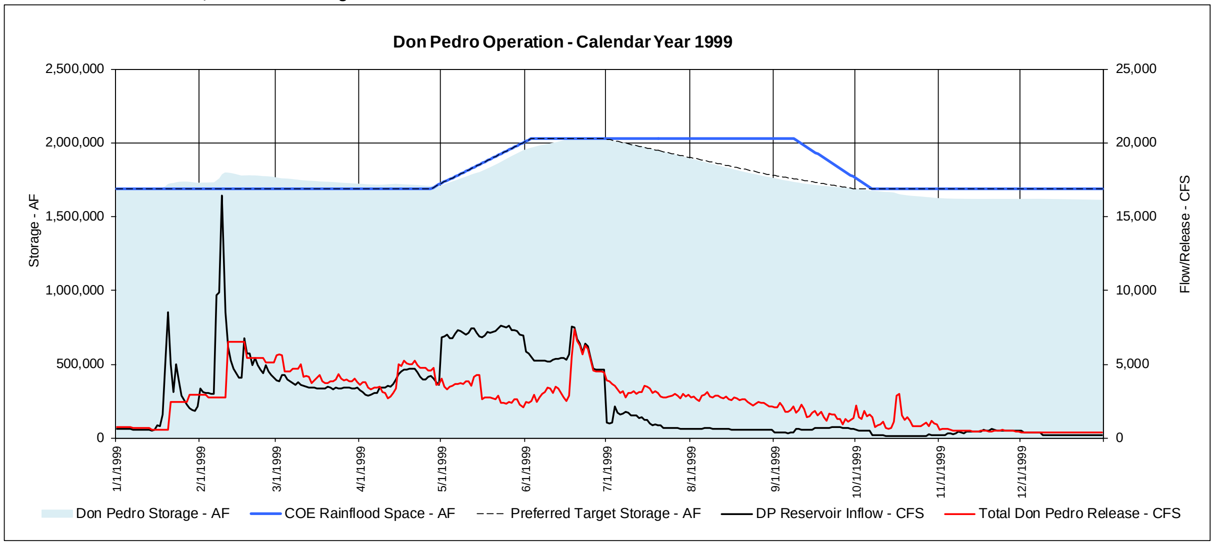
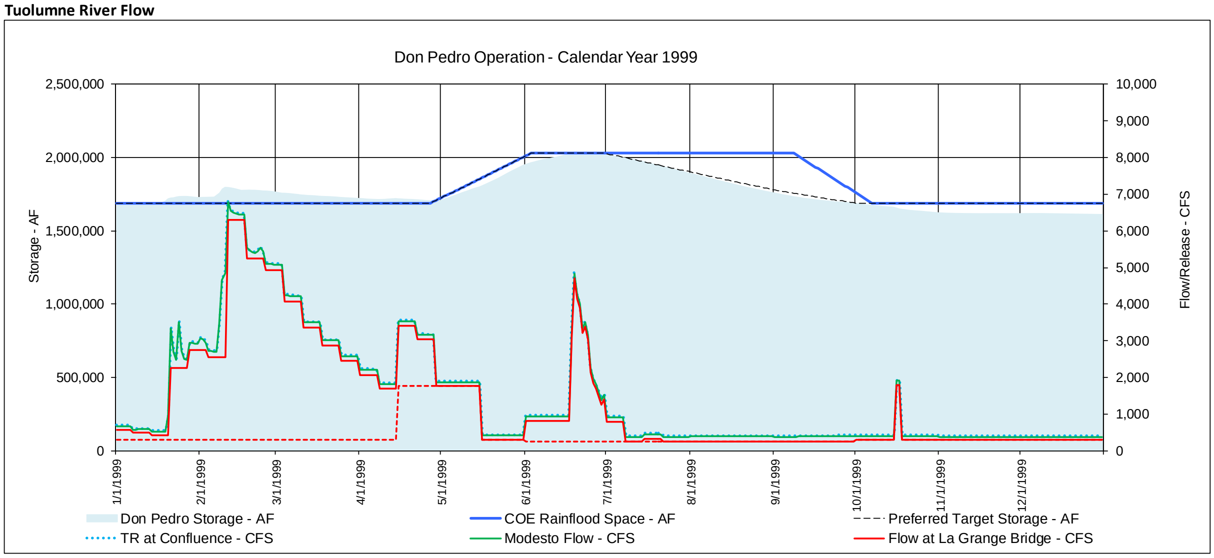


Figure 4-28. Don Pedro operations 1998 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

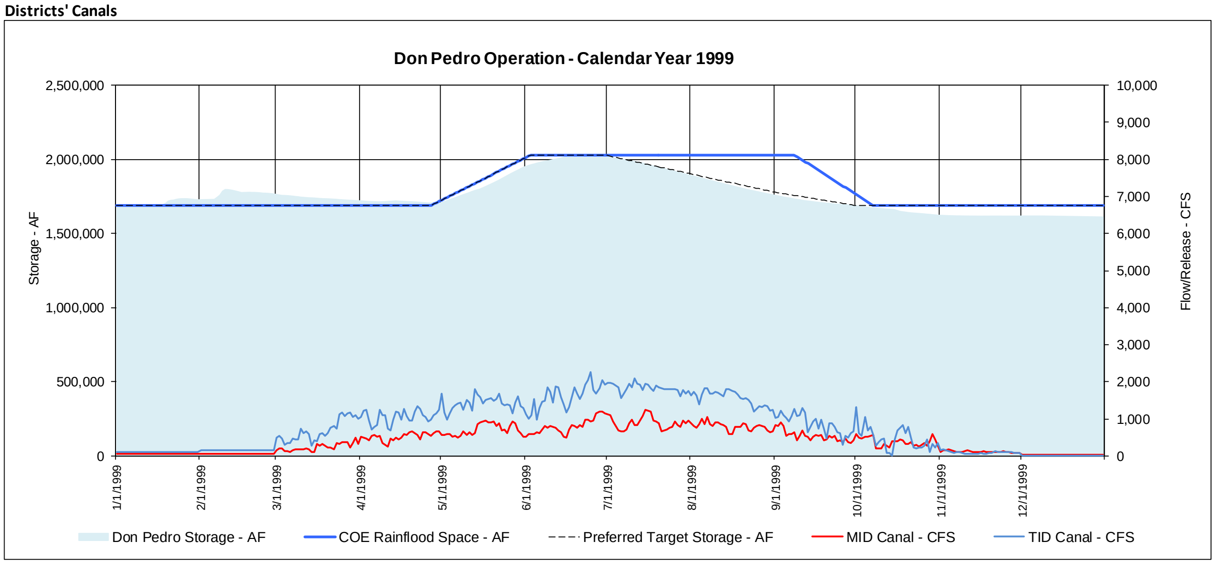
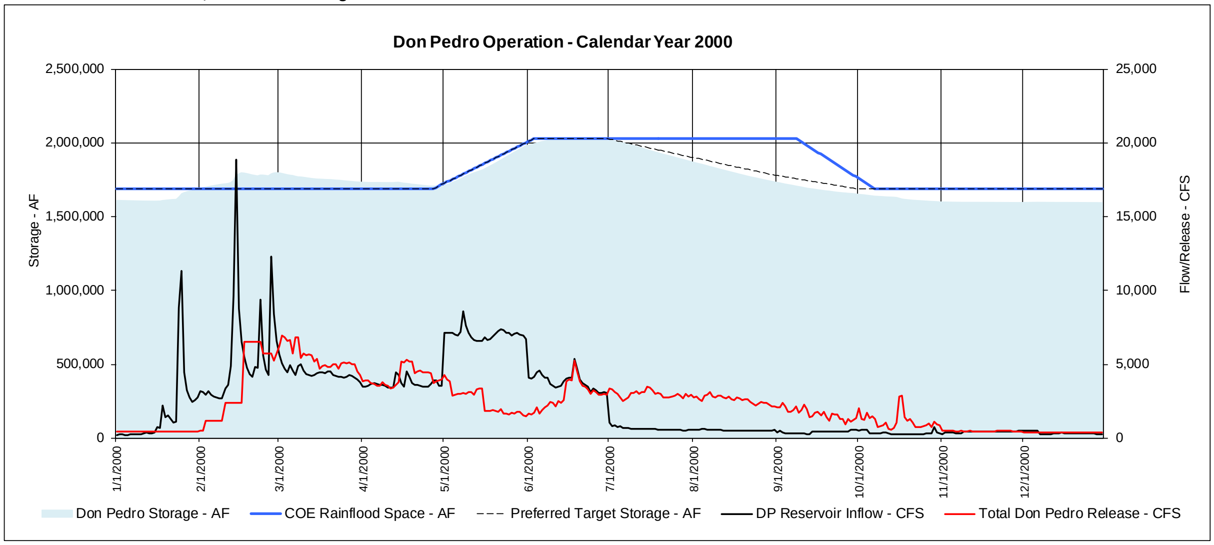
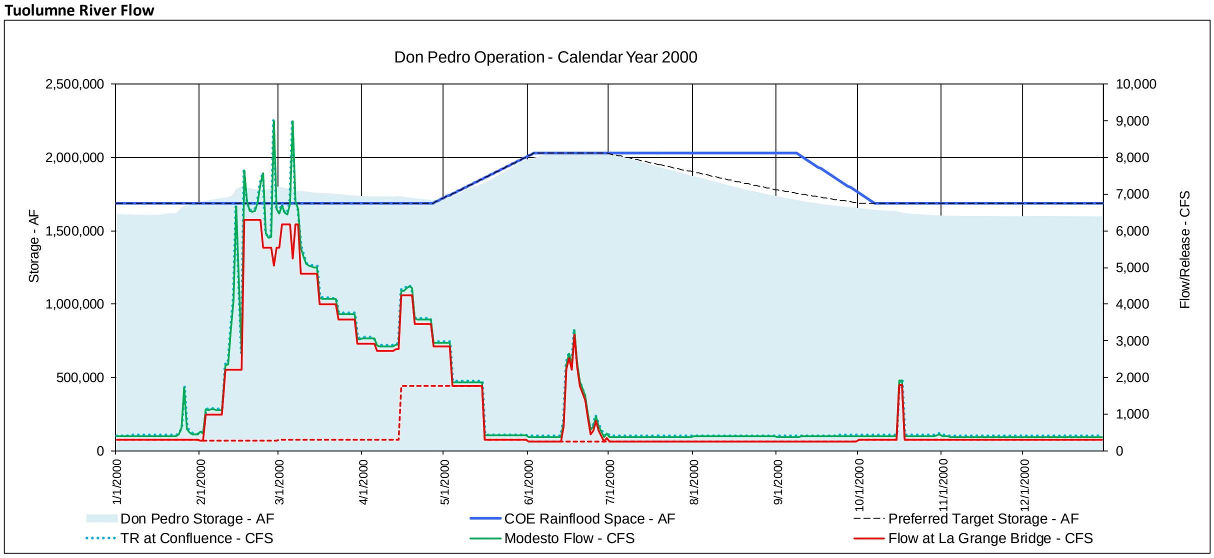


Figure 4-29. Don Pedro operations 1999 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

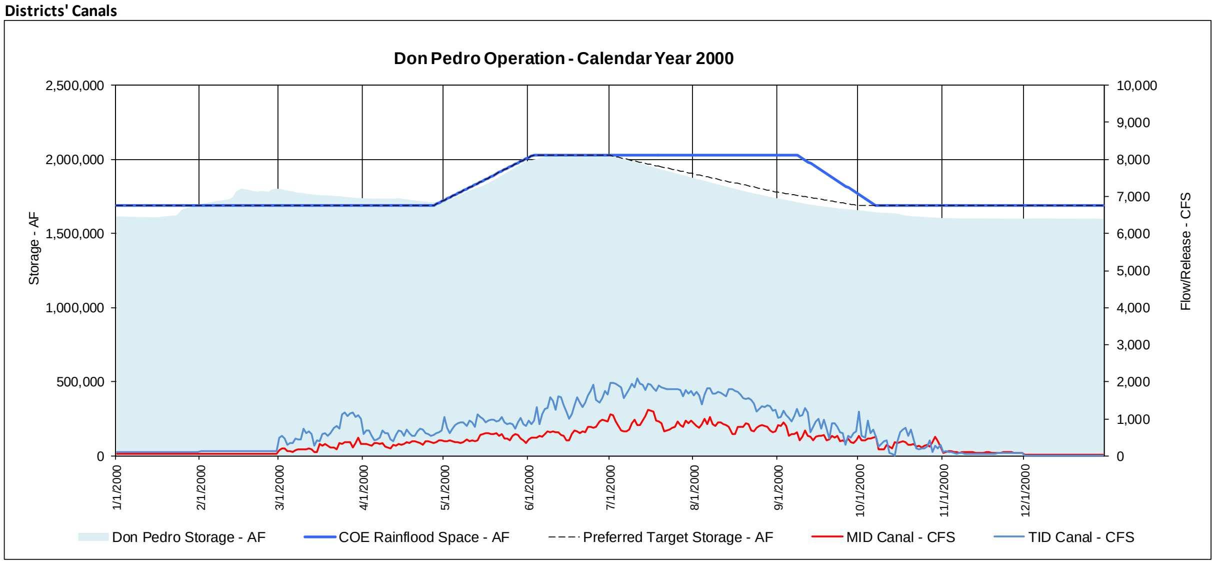
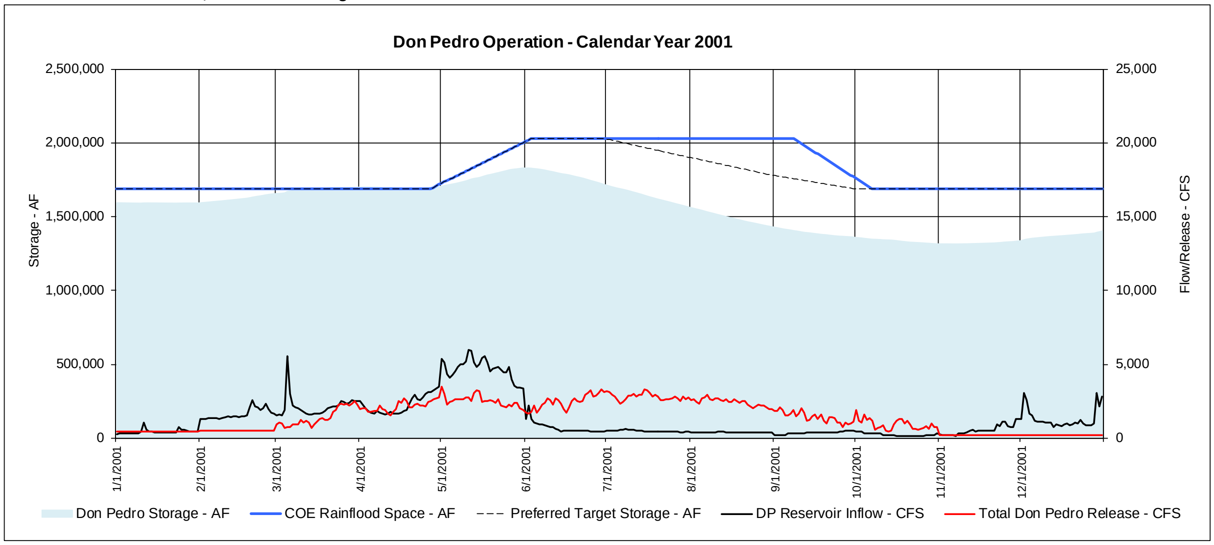
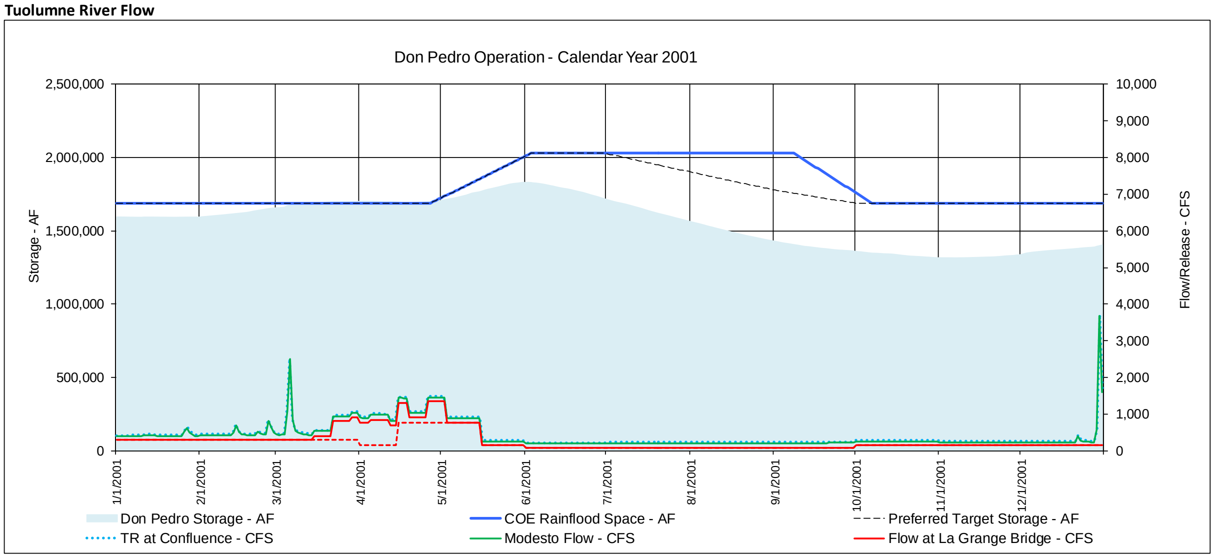


Figure 4-30. Don Pedro operations 2000 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

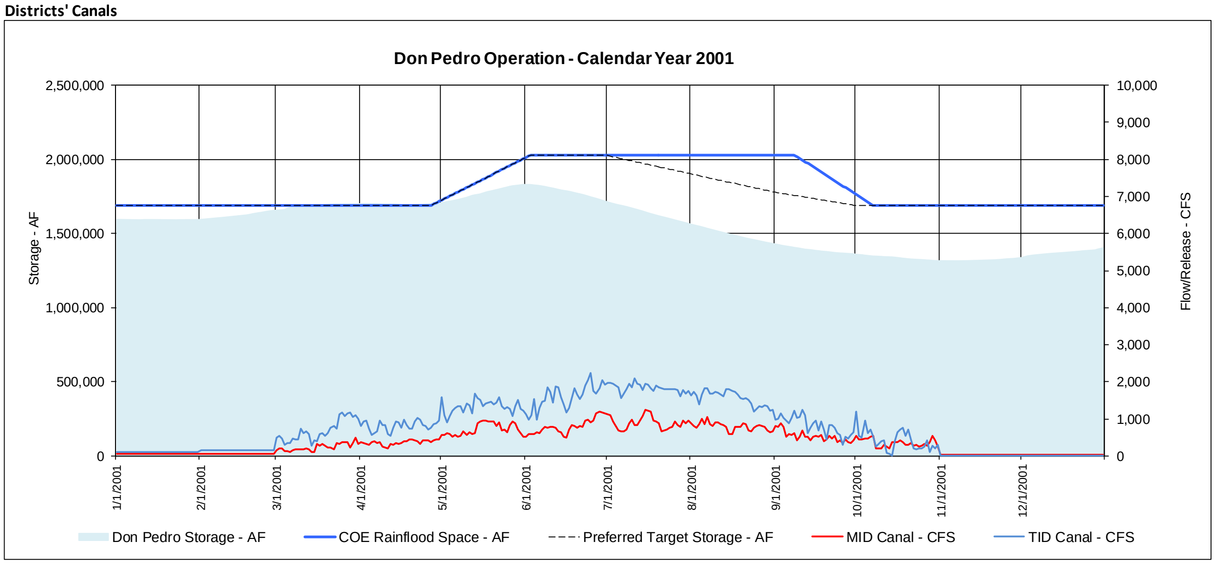
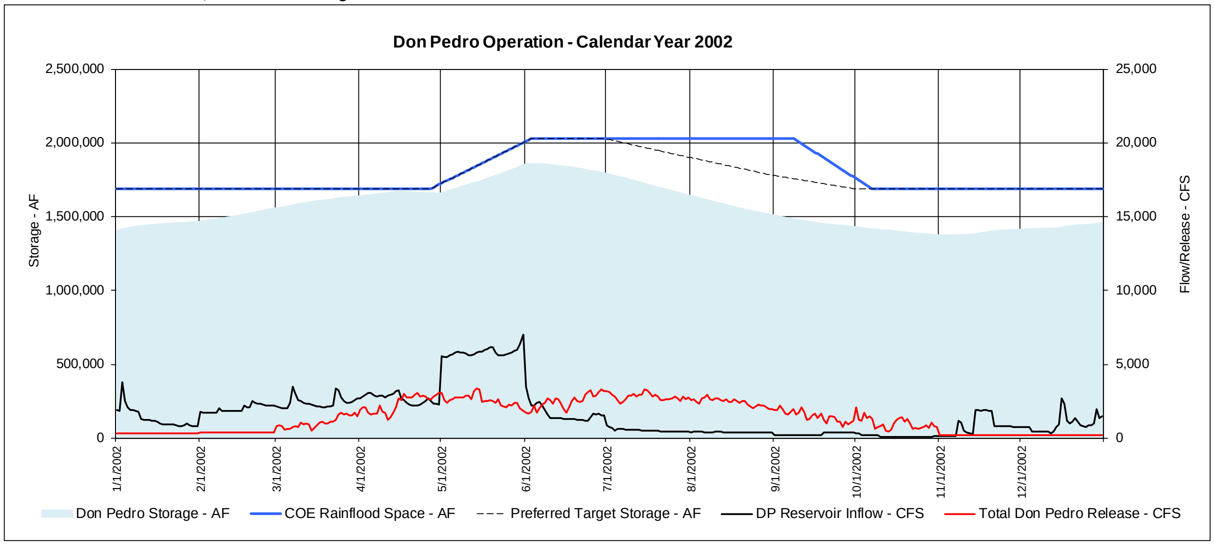
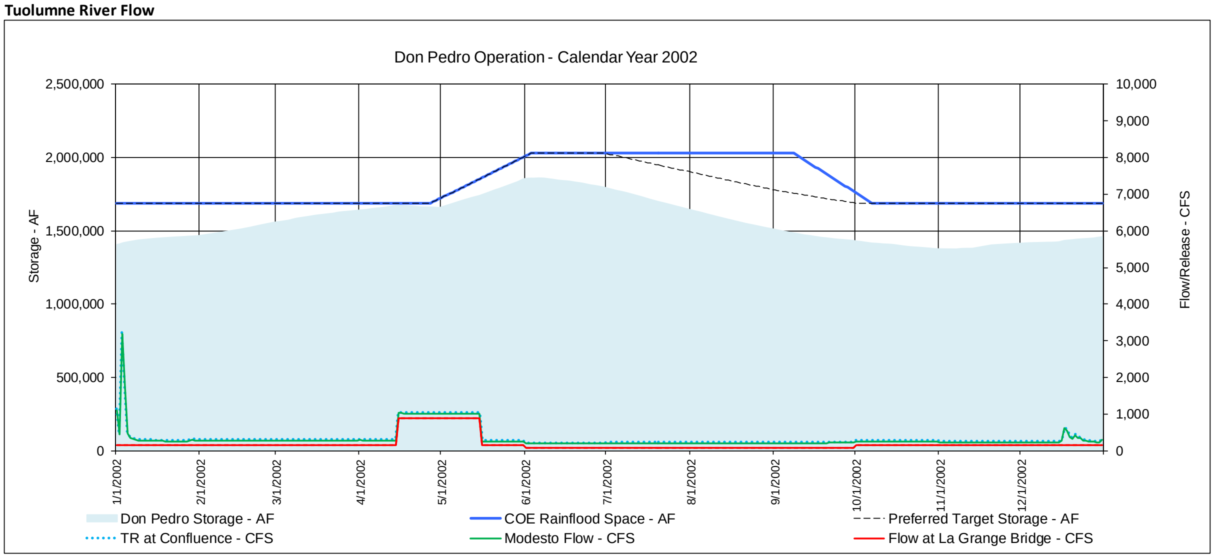


Figure 4-31. Don Pedro operations 2001 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

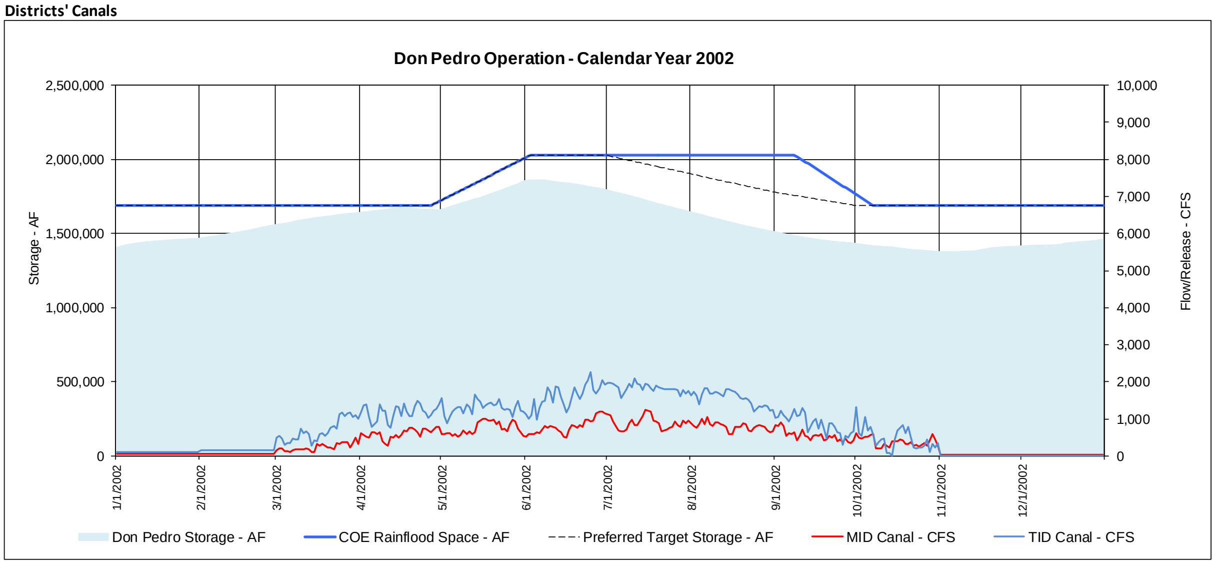
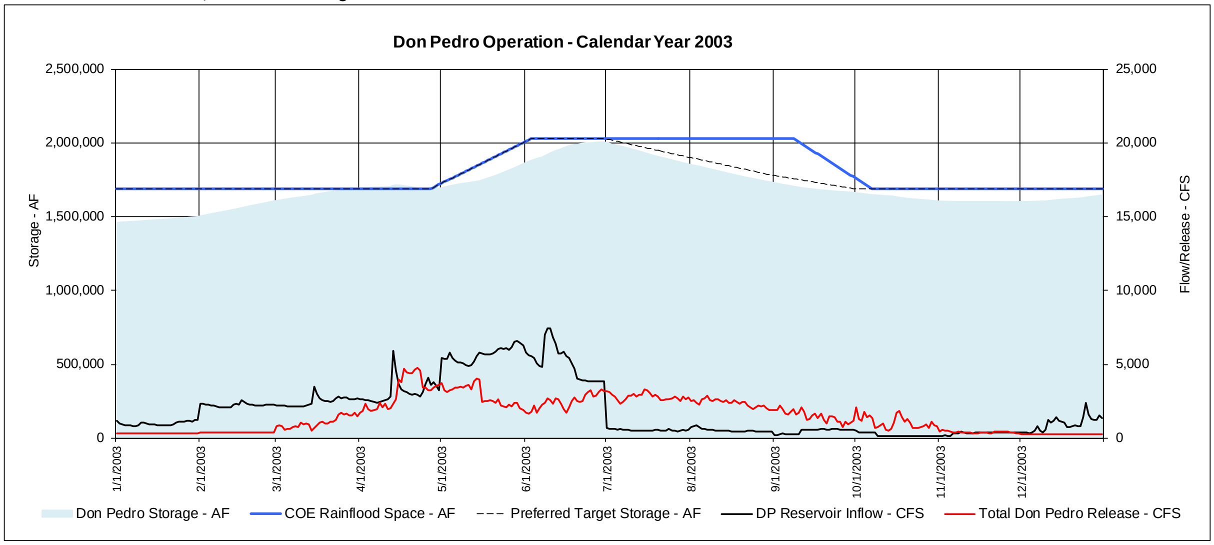
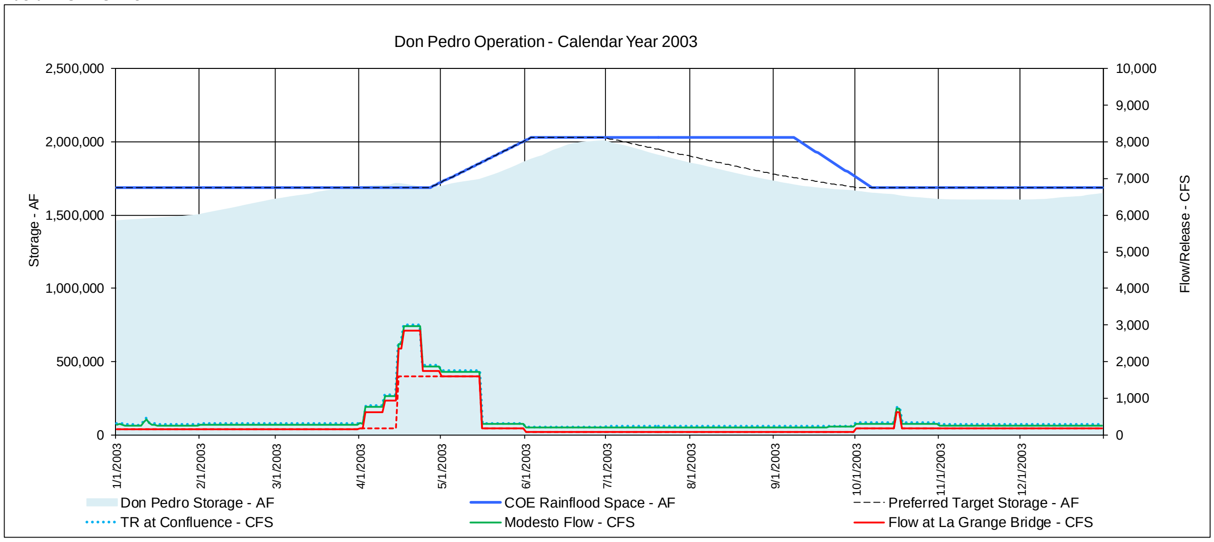


Figure 4-32. Don Pedro operations 2002 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

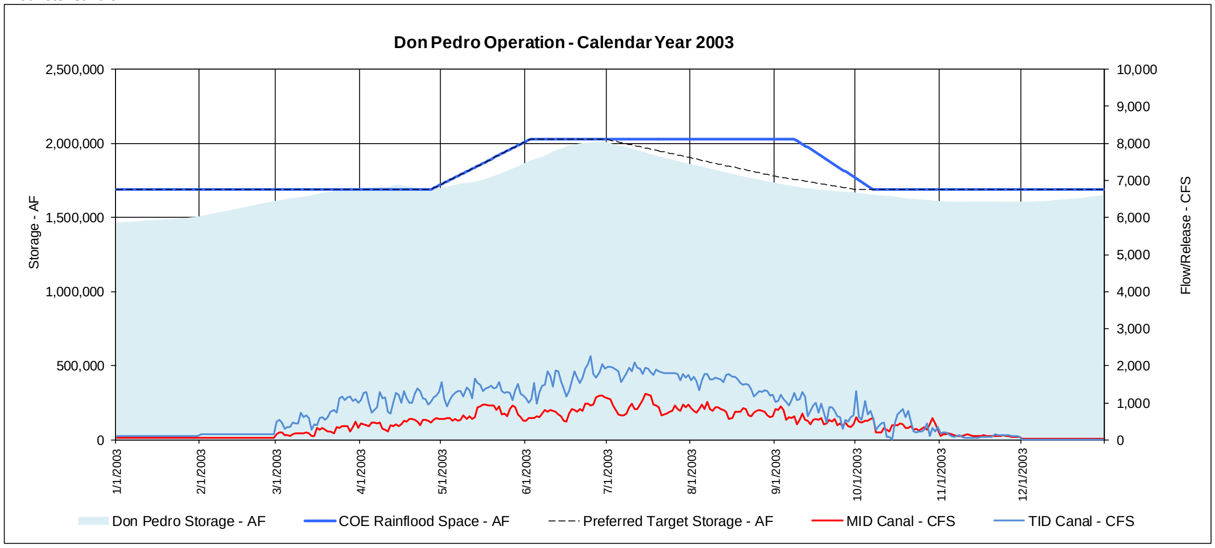
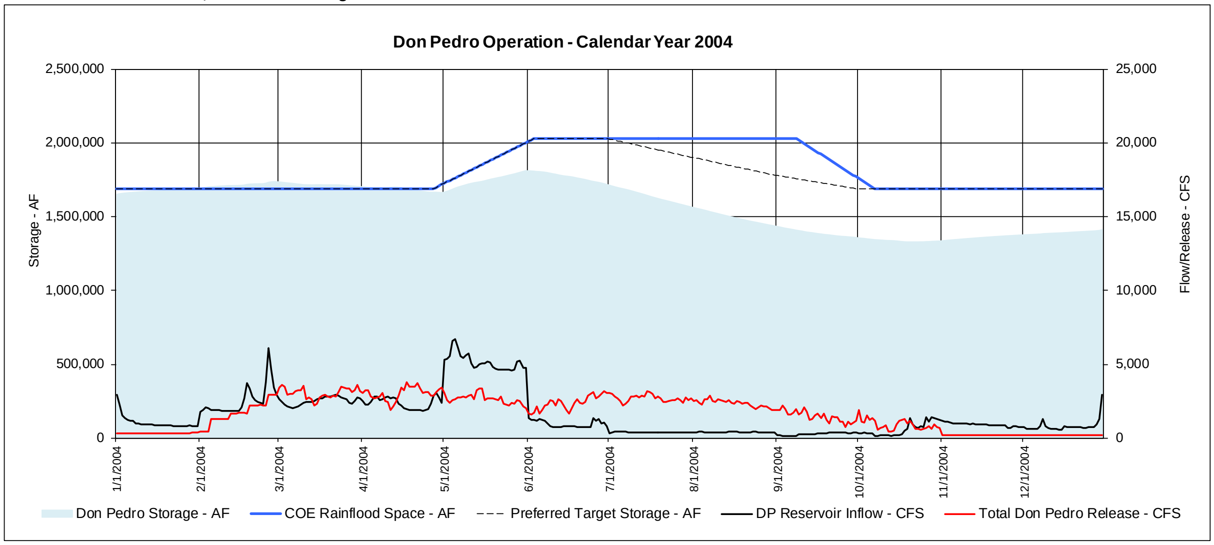
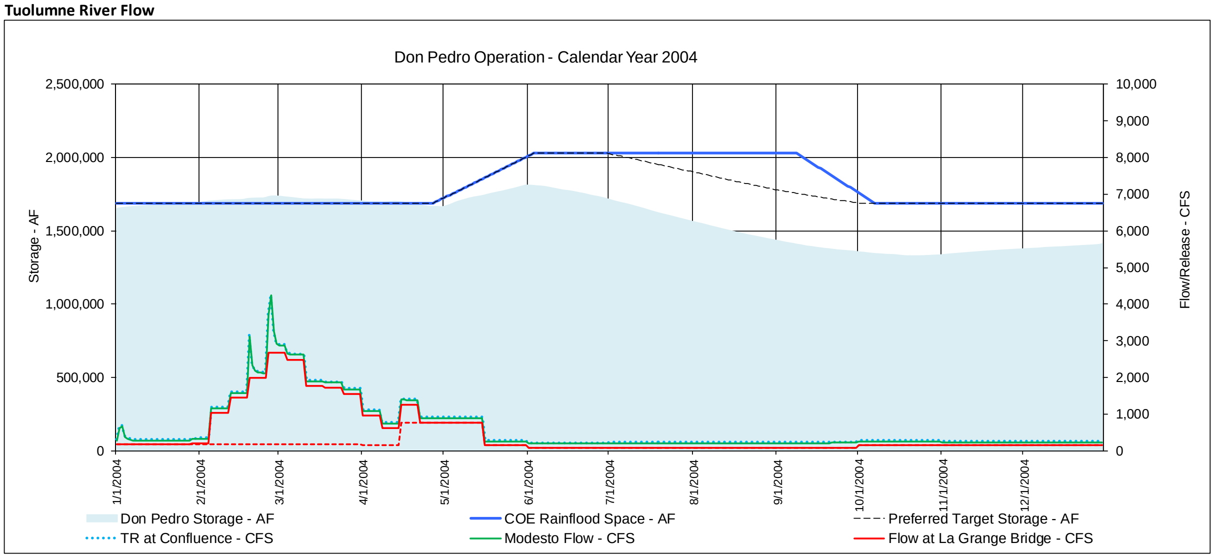


Figure 4-33. Don Pedro operations 2003 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

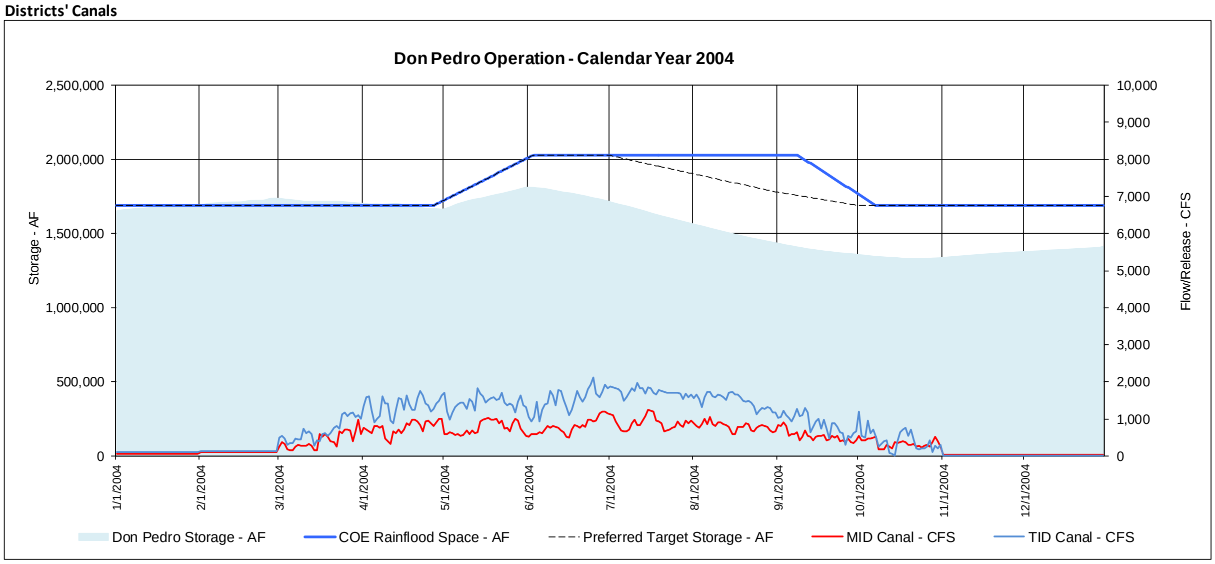
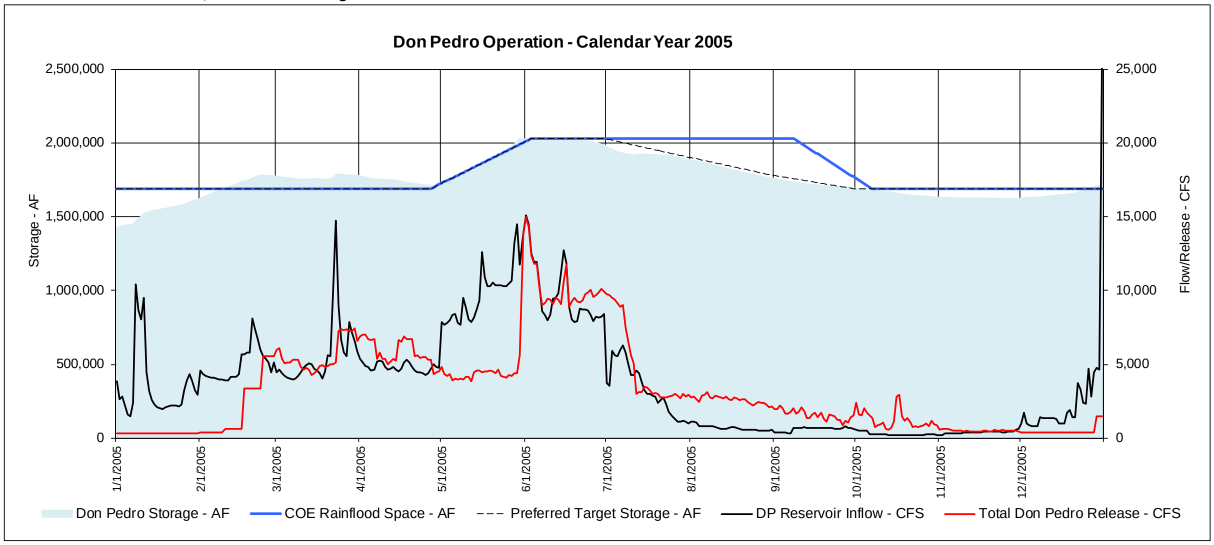
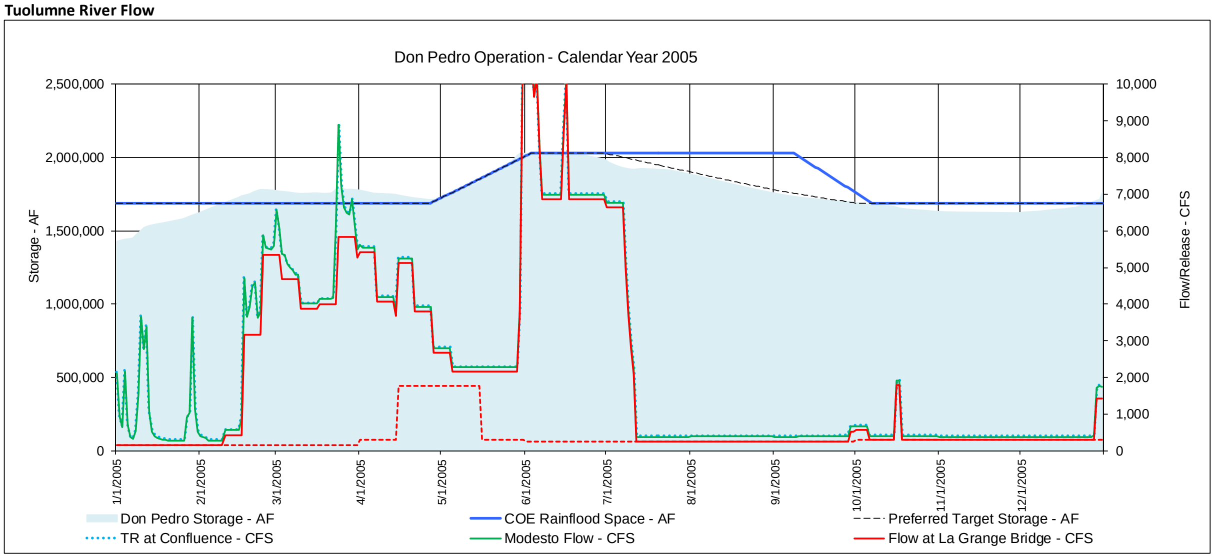


Figure 4-34. Don Pedro operations 2004 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

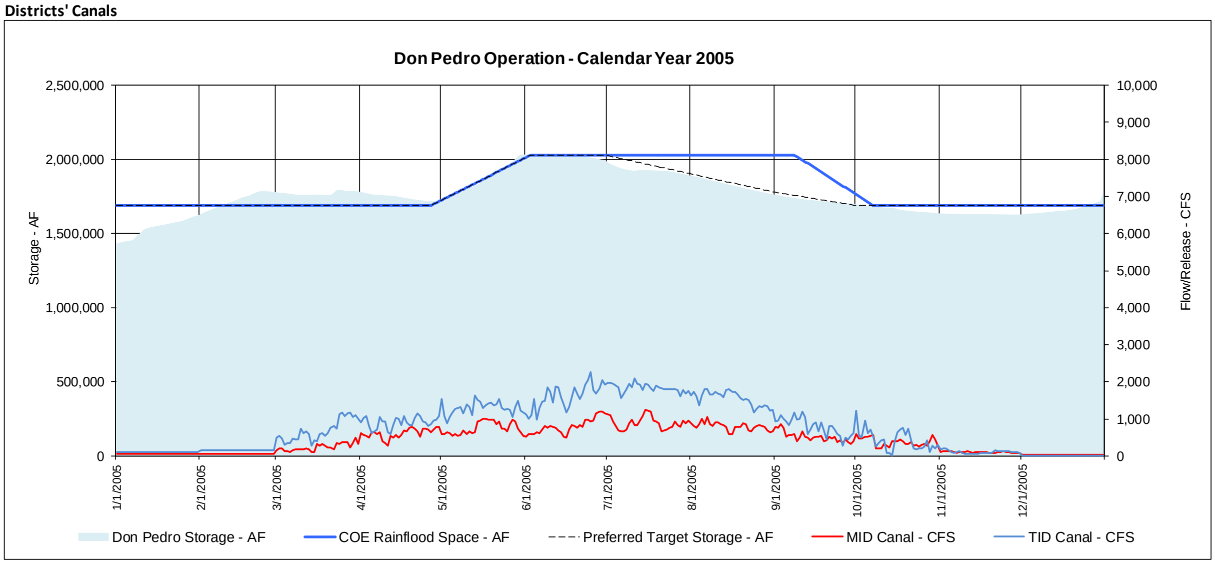
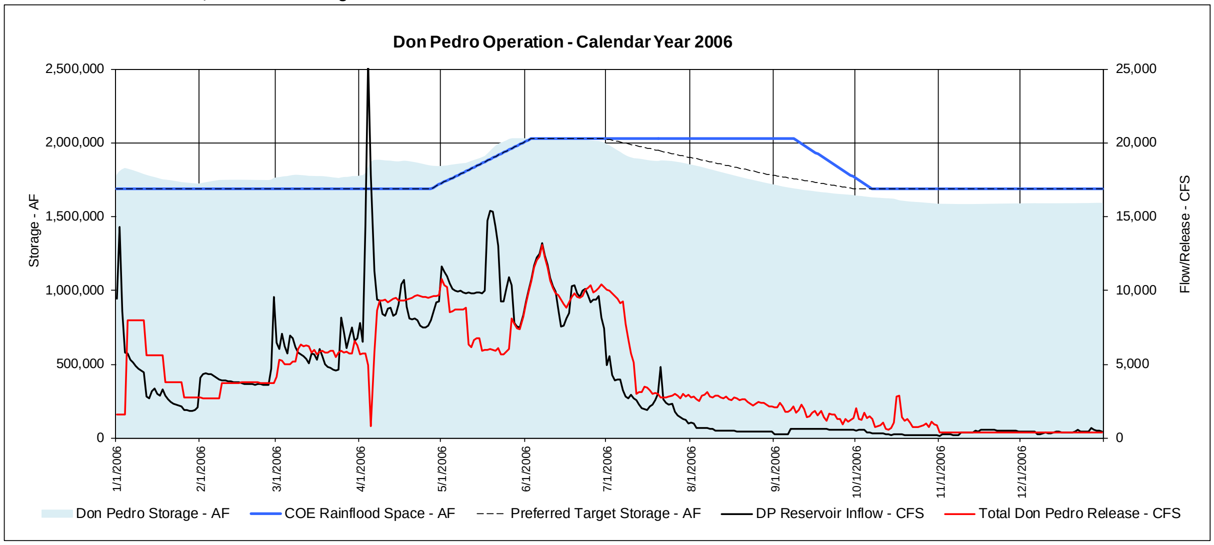
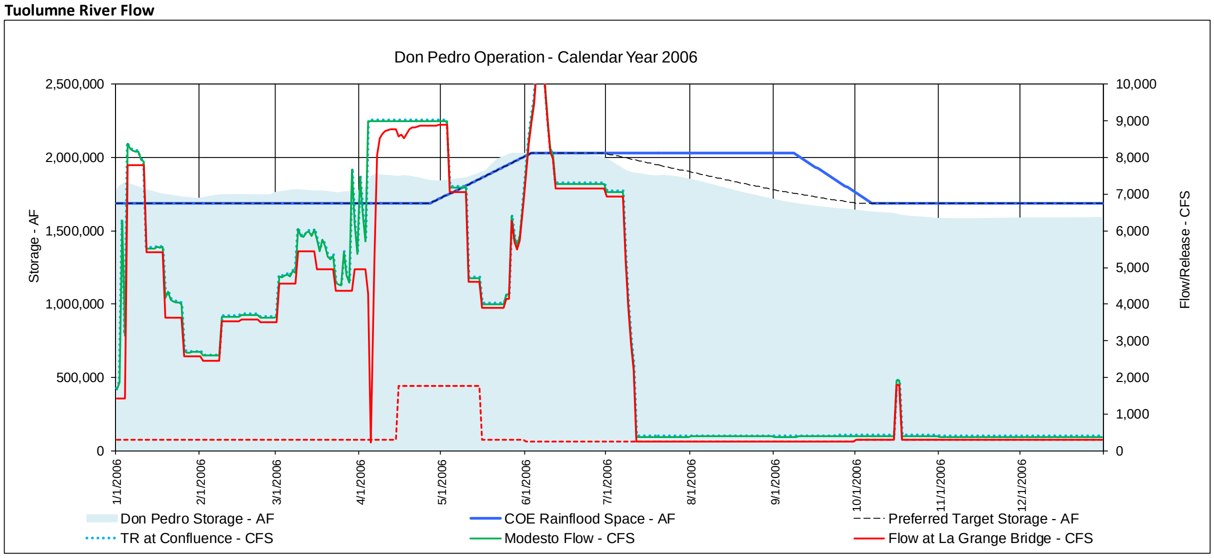


Figure 4-35. Don Pedro operations 2005 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

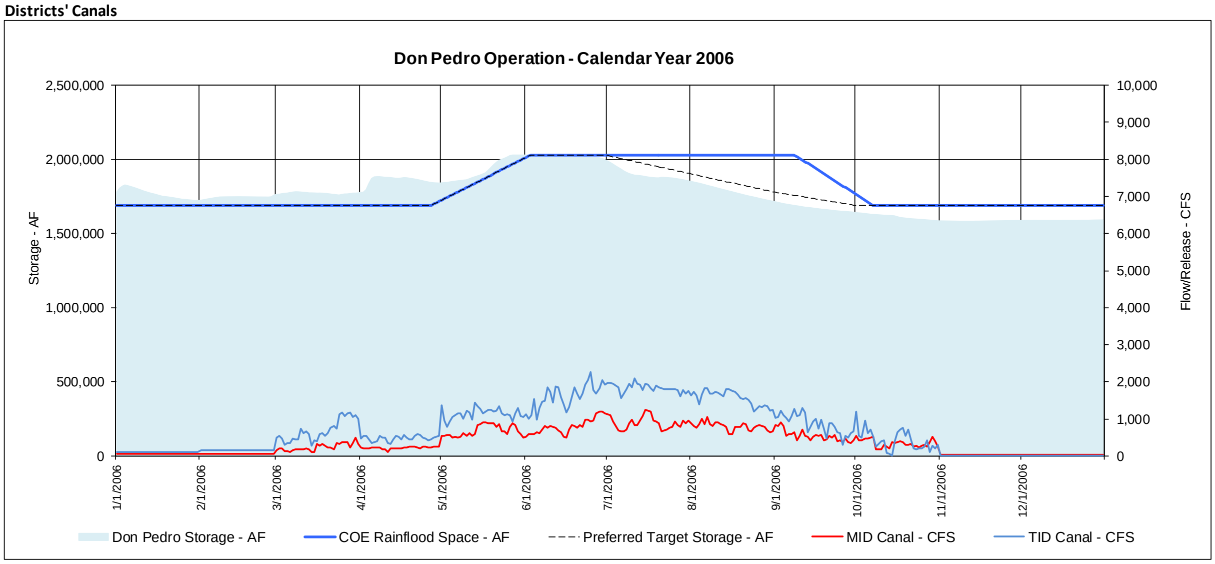
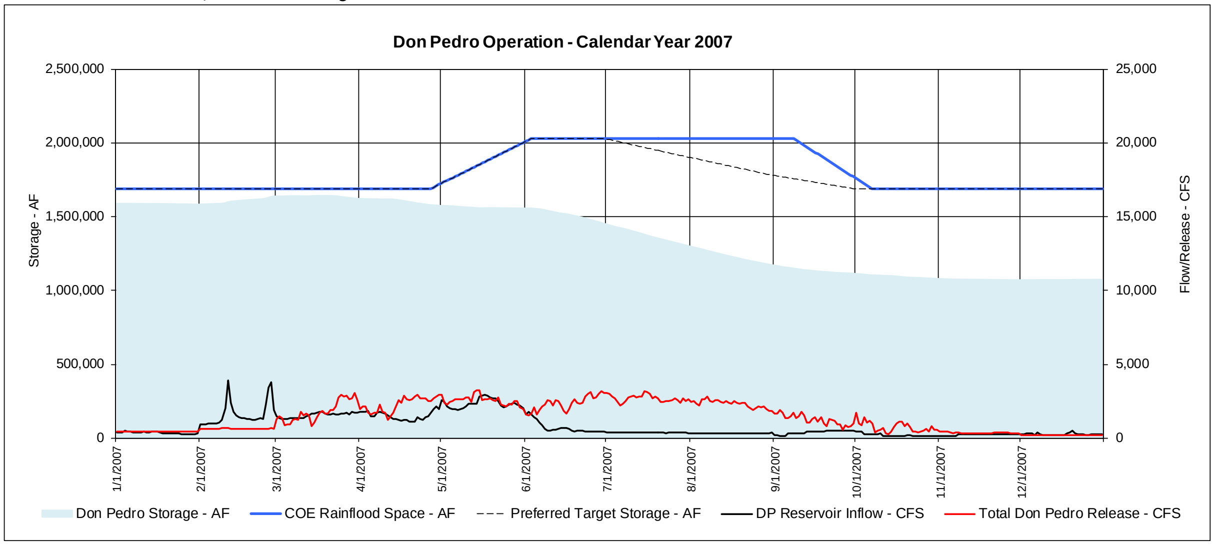
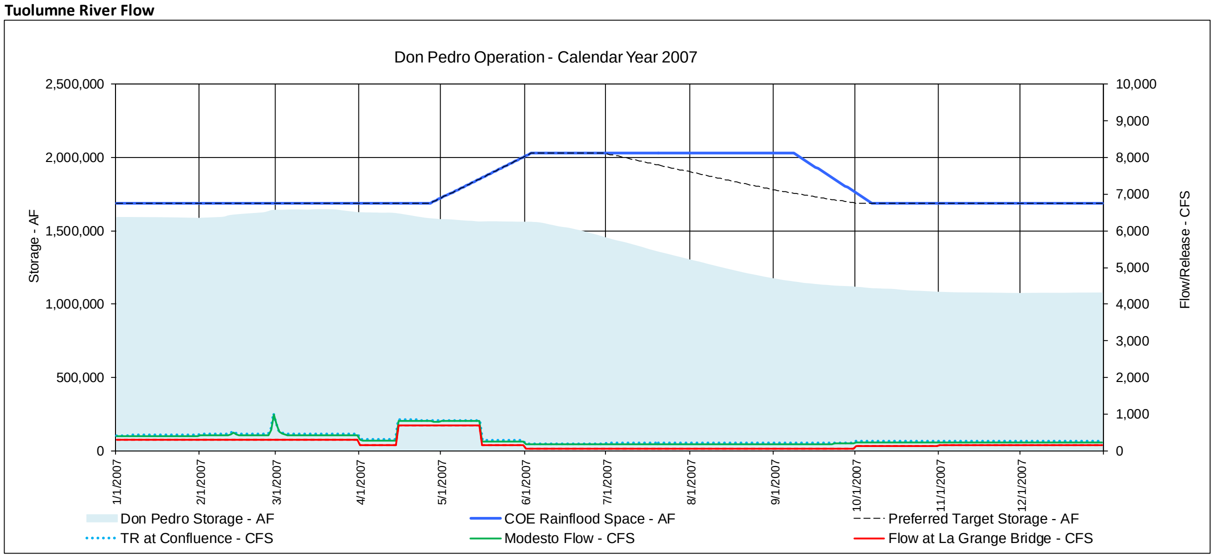


Figure 4-36. Don Pedro operations 2006 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

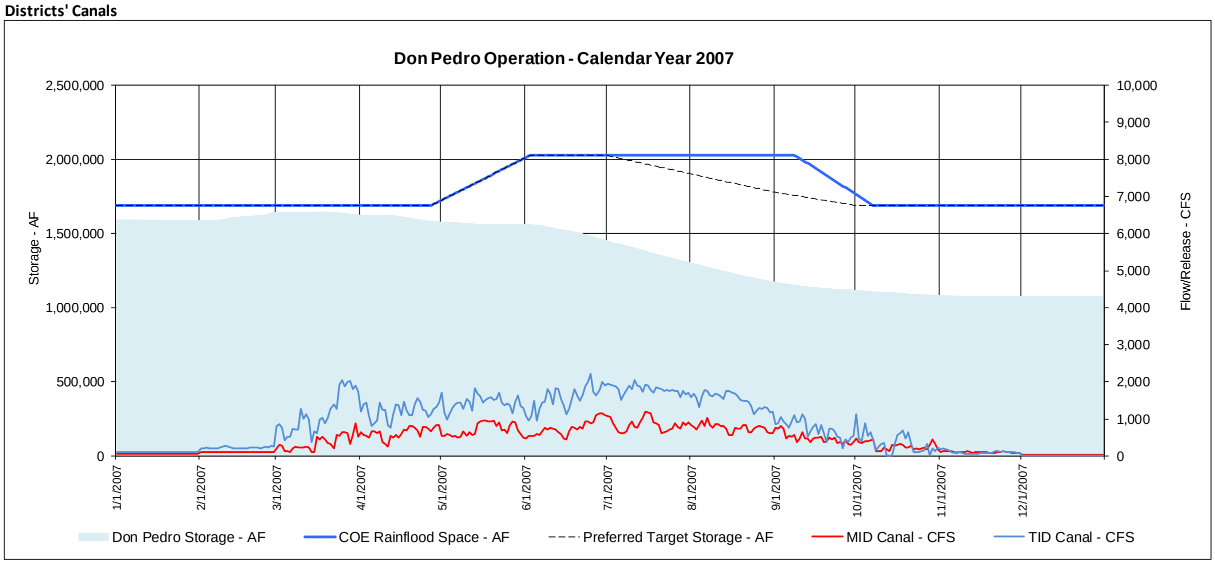
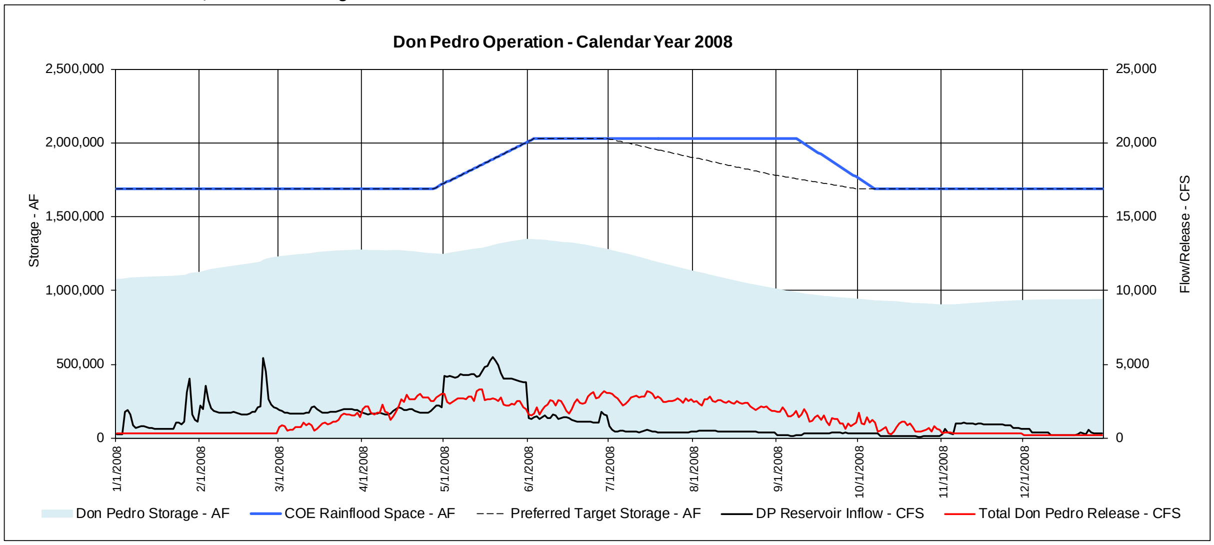
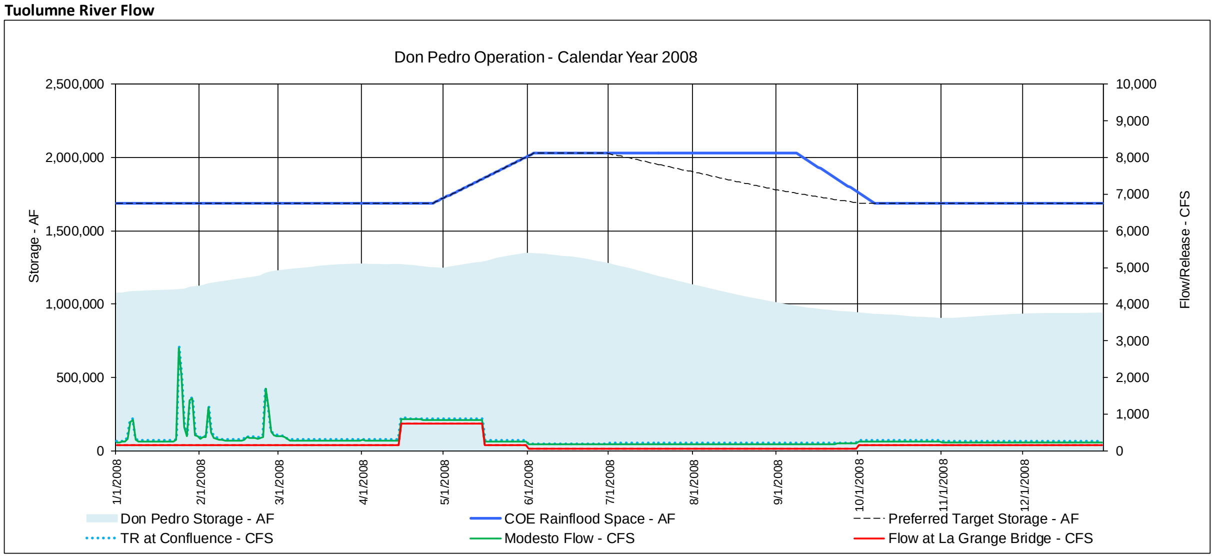


Figure 4-37. Don Pedro operations 2007 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

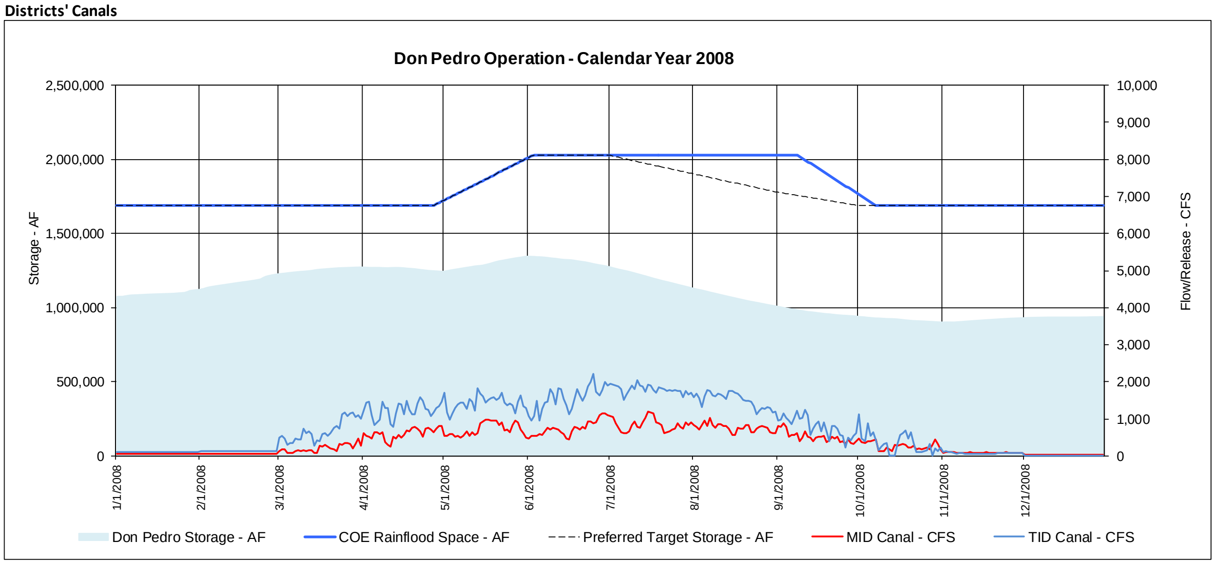
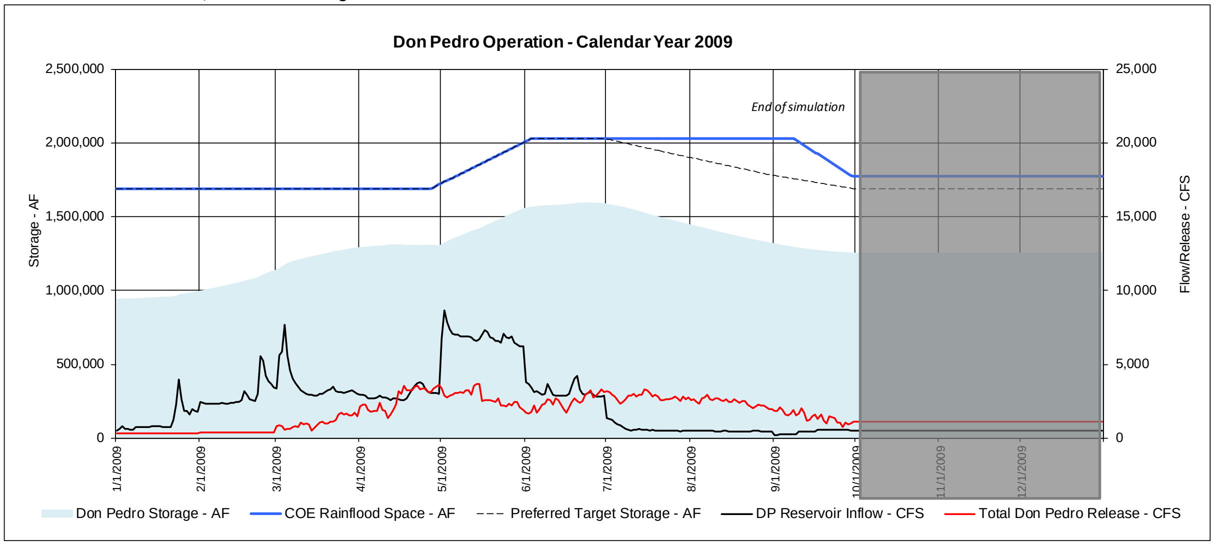
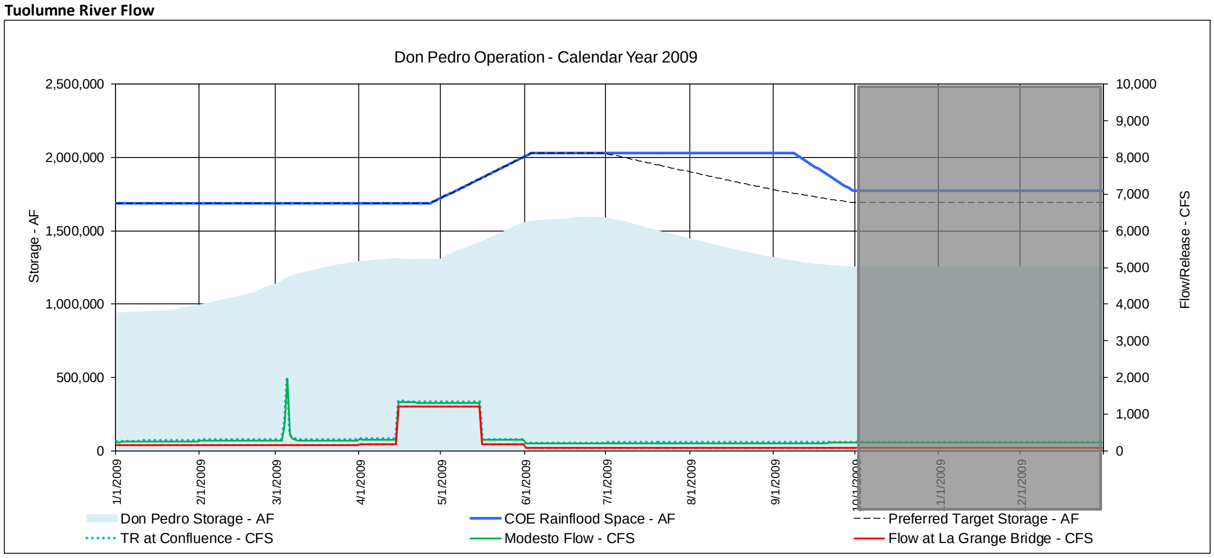


Figure 4-38. Don Pedro operations 2008 – Base Case.

Don Pedro Reservoir Inflow, Release and Storage



Tuolumne River Flow



Districts' Canals

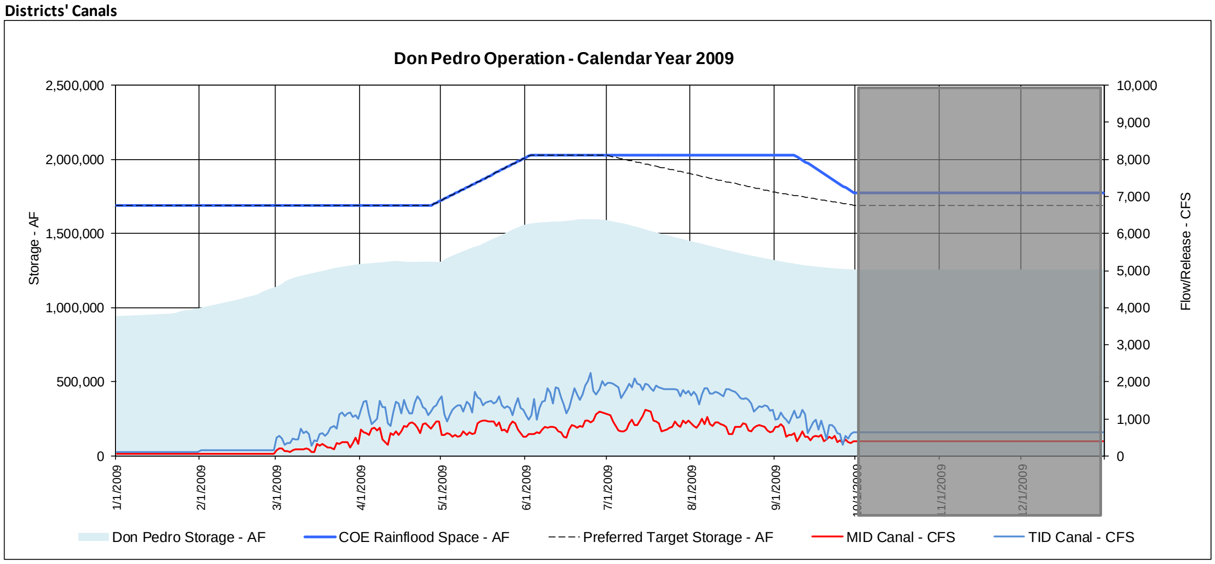


Figure 4-39. Don Pedro operations 2009 – Base Case.

Don Pedro Project
Project Operations/Water Balance Model Study Report
Attachment B – Model Description and User's Guide, Addendum 1
Revised 5-20-2013

1.0 INTRODUCTION

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) have developed a computerized Tuolumne River Daily Operations Model (Model) to assist in the relicensing of the Don Pedro Project (Project) (FERC Project 2299). The Model is fully described in the User's Guide submitted to FERC as part of the Initial Study Report (ISR), January 2013 (Model version 1.01). The purpose of the User's Guide is to describe the structure of the Model, the interfaces available for operation of the Model, and methods available for reviewing Model results. Procedures for development of input files for running scenarios for alternative future Project operations are also described and illustrated. The data presented in the ISR document referenced a "Test Case" simulation of operations for illustrative purposes. The test case was presented at a Workshop held with relicensing participants on December 7, 2012 for the purpose of training interested relicensing participants in the use of the Model.

Subsequent to the ISR submittal, the Districts proceeded to develop the "Base Case" which depicts the operation of the Don Pedro Project in accordance with the current FERC license, ACOE flood control management guidelines, and the Districts' irrigation and M&I water management practices. Under FERC policy, the Base Case represents the "No Action" alternative for purposes of evaluating future operation scenarios under NEPA. Future scenarios are compared to the Base Case to assess their impacts. As a result of the effort, including a collaborative refinement of the underlying hydrology of the Model completed at a Workshop held on March 27, 2013, several refinements and modifications to the Model have been implemented. The purpose of this Addendum 1 is to describe the refinements and modifications that have been made to the revised Model (Model Version 2.0) since the ISR submittal.

The Tuolumne River Daily Operations Model provides a depiction of the Don Pedro Project and City and County of San Francisco water operations consistent with the FERC-approved W&AR-02 study plan. The Model portrays operations that can be described systematically by various equations and algorithms. Actual project operations may vary from those depicted by the Model due to circumstantial and real-time conditions of hydrology and weather, facility operation, and human intervention. The FERC-approved study plan has identified a number of user-controlled variables. The fact that the Model provides these user-controlled inputs is not an indication that either the Districts or CCSF endorse or support any specific operational alternative developed by manipulating these inputs.

2.0 MODEL LOGIC AND EXECUTION MODIFICATIONS

Several Model logic routines were modified to provide a better or more adaptable depiction of Project operations. The specific areas of Project operations that were modified included the depiction of the current minimum flow requirements of the Don Pedro Project for the lower Tuolumne River and the reservoir operation logic during June and early July when Don Pedro Reservoir is filling. The simulation of power generation from the Project has also been revised as mentioned in the December 7, 2012 Workshop.

2.1 Don Pedro Reservoir Snow-melt Management

User's Guide reference: Section 5.12: "DonPedro" Worksheet, Section 5.12.3 Snow-melt Management

The Model computes a daily operation of Don Pedro Reservoir. Each day Don Pedro Reservoir inflow is computed from upstream CCSF System operations and unregulated inflow. The minimum stream flow requirements and the MID and TID canal diversions are assumed as the release from Don Pedro Reservoir. The prior day's reservoir evaporation is included in the calculation. If the computation produces a Don Pedro Reservoir storage value in excess of a preferred storage target, an "encroachment" is computed. If an encroachment occurs, a "check" release is computed. It is assumed that a constant supplemental "check" release (in excess of minimum releases) will be initiated. This protocol repeats itself periodically, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic "hard" releases of water to exactly conform to the target reservoir level.

A second check release is made during the April through June period for management of anticipated snow-melt runoff. Model Version 1.01 provided logic that on the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir from the date of forecast through the end of June (the assumed target date of reservoir filling). These forecasts determine the snow-melt "check" release volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. The snow-melt check release is evenly distributed across the days of the month. The release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir (2,030,000 acre-feet, elevation 830 ft) allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the Model to not exceed this storage capacity.

Through testing of alternative Model scenarios it was discovered that Version 1.01 logic could produce erratic reservoir release results during early July, whereby a relatively constant release through the end of June could be followed by an erratic large release during the first part of July. The cause of the circumstance was the result of requiring the "filling" date of the reservoir to be the end of June. The assumption could lead to a full reservoir at the end of June while substantial inflow could subsequently occur. With no empty reservoir space remaining the Model would essentially pass inflow without modulation and in some circumstances large releases in excess of downstream flood control objectives. To remedy this outcome the Model was modified to extend

the June snow-melt release check logic through July 7. All computational procedures for June remained the same except the time period upon which hydrologic information was known or assumed extends through July 7. Figure 2.1-1 illustrates the location of the revised logic within the DonPedro Worksheet, within the June computation section and designated by notes concerning the June through July 7 computational period.

Also newly incorporated into the snow-melt logic routine for the entire April through July 7 period is release change “smoothing” logic which can lessen the occurrence of modeled erratic release reductions that would otherwise sometimes occur during the transition from one month’s computed release to the next month’s computed release. During periods when the snow-melt release computation is controlling reservoir releases, user-defined values can be specified for a threshold and a rate of change that can occur from one day to the next. The threshold (C 1.13, “Control” Worksheet) defines the level of flow of the previous day for which a constraint to a next-day release reduction will occur, and the fraction (C 1.14, “Control” Worksheet) defines the reduced flow rate that can occur the next day. By illustration, if a previous day’s flow is 2,500 cfs or greater, the next day’s flow cannot be less than 0.75 of the previous day’s flow. This logic does not represent any known “ramping” constraints, but the protocol provides additional guidance to Model release decisions and produces reasonable results.

	A	B	C	D	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO
1			1																									
2	Unit Title		2																			CFS		CFS	CFS	CFS	CFS	CFS
3	Parameter Title		3																			Target SM Re		Dry Creek	LTR Accr	Tot Unreg	Trg Max LC	Modesto F
4																												
5	Acre-foot to CFS conversion																											
6	divide by :	1.983471				Lookup of	Est of	Uses	Compute	Compute	Compute	Amount		Lookup of	Est of	Uses	Compute	Compute	Compute	Amount								
7						1-May	May-Jun	Current Yr	Upstream	Availble	Total	to be		Actual	Actual	Current Yr	Upstream	Availble	Total	to be								
8						90% Exc	Portion	Canal +	Adjust	DP Stor	Excess	Released		Jun-Jul 7	Jun-Jul 7	Canal +	Adjust	DP Stor	Excess	Released		0		Original equation w/o release ramping constraint				
9						Apr-Jul	of	Min River	to	through	May-Jun	during		Runoff	Runoff	Min River	to	through	Jun-Jul 7	during		2,500		Prior day ramping threshold (C 1.13)				
10						Runoff	Apr-Jul	+Typ Evap	UF	June	Release	May				+Typ Evap	UF	7-Jul	Release	Period		0.75		Fraction of prior day flow for ramping (C 1.14)				
11																												
12																												
13		39-year Ave or Max				49	% May/May MJ					(C 1.20)								(C 1.30)							(C 1.00)	
14		Min				38	% Jun/May MJ		% of May-Jun excess rel in May			50					% of June excess rel in June-Jul 7			100						Enter Modesto FC Target:	9,000	CFS
15						May Snow-melt Release Routine								June - July 7 Snow-melt Release Routine										Modesto Flood Control Flow Objective				
16										May							June - July 7					Target		Report	Est	Total	Target	Calc
17	Month					1-May	1-May	M-Jun	M-Jun	M-Jun	M-Jun	May		June -	June -	Period	Period	Period	Period	Period		SM		Dry Creek	LTR Acc	Unreg	Max	Modesto
18	Index	Date	Day	Days		A-Jul Fcst	MJune Fcst	Can+Riv+E	USAdj	DP Avail	Excess	SM Rel		July 7 UF	July 7 UF	Can+Riv+E	USAdj	DP Avail	Excess	SM Rel		Release		Flow	Flow	Blw LG	LaGrange	Flow
19						TAF	TAF	AF	AF	AF	AF	CFS		TAF	TAF	AF	AF	AF	AF	CFS		CFS		CFS	CFS	CFS	CFS	CFS
20	1970.10	10/1/1970	T	31		0	0	0	0	0	0	0		0	0	0	0	0	0	0		0		30	80	110	8,890	410
21	1970.10	10/2/1970	F	31		0	0	0	0	0	0	0		0	0	0	0	0	0	0		0		30	80	110	8,890	410
22	1970.10	10/3/1970	S	31		0	0	0	0	0	0	0		0	0	0	0	0	0	0		0		30	80	110	8,890	410
23	1970.10	10/4/1970	S	31		0	0	0	0	0	0	0		0	0	0	0	0	0	0		0		30	80	110	8,890	410
24	1970.10	10/5/1970	M	31		0	0	0	0	0	0	0		0	0	0	0	0	0	0		0		30	80	110	8,890	410
25	1970.10	10/6/1970	T	31		0	0	0	0	0	0	0		0	0	0	0	0	0	0		0		30	80	110	8,890	410
26	1970.10	10/7/1970	W	31		0	0	0	0	0	0	0		0	0	0	0	0	0	0		0		30	80	110	8,890	410
27	1970.10	10/8/1970	T	31		0	0	0	0	0	0	0		0	0	0	0	0	0	0		0		30	80	110	8,890	410
28	1970.10	10/9/1970	F	31		0	0	0	0	0	0	0		0	0	0	0	0	0	0		0		30	80	110	8,890	410
29	1970.10	10/10/1970	S	31		0	0	0	0	0	0	0		0	0	0	0	0	0	0		0		30	80	110	8,890	410

Figure 2.1-1. Snow-melt management section.

2.2 Don Pedro Current Minimum Flow Requirement

User’s Guide reference: Section 5.17: “LaGrangeSchedule” Worksheet, Section 5.17.1 Minimum Flow Requirement Options, Section 5.17.2 April-May Daily Parsing of Flow Requirements, and Section 5.17.3 Computation of 1995 FERC Minimum Flow Requirement

The FERC license for the Don Pedro Project requires flow releases from Don Pedro Reservoir to the lower Tuolumne River. These flows are measured at the USGS gage downstream of the La Grange diversion dam. To keep the Don Pedro Reservoir required flow releases distinct from Don Pedro Reservoir releases in general the model designates “LaGrangeSchedule” Worksheet for assemblage of the minimum flow requirement for the lower Tuolumne River. By user specification (UI 1.10) either the current 1995 FERC schedule is selected (UI 1.10 = 0) or the

user defined minimum flow requirement is selected (UI 1.10 = 1). If the current 1995 FERC schedule is selected the computation of the schedule is computed in this worksheet.

When using current 1995 FERC minimum flow requirements, Version 1.01 (Switch C 1.60, “Control” Worksheet) allowed the user to direct the daily shape of release for pulse flows during April and May. Version 2.0 continues to allow the shaping of April-May migration flows to the lower Tuolumne River and also allows a shaping of October attraction flows. Figure 2.2-1 illustrates the parsing of the monthly flow requirements into daily flow requirements. The structure of this section of the worksheet is mostly the same as before, except the monthly/daily flow requirements have now been defined by “base” and “pulse” components. Also, a computational procedure has been added for October to prescribe current FERC-defined attraction flows.

	A	B	C	D	E	F	O	P	S	V	W	X	Z	AA	AB	AC
1			1		La Grange Minimum Flow Calculation											
2	Unit Title		2		CFS	AF	AF	CFS	CFS	AF	AF	CFS	CFS	AF	CFS	AF
3	Parameter Title		3		La Grange M	La Grange M	1995 FERC I	1995 FERC I	X% of TR U	Alt Test Fl	Alt Test Fl	Alt Test Fl	User-Defi	User-Defi	User-Defi	User-Defi
5	Acre-foot to CFS conversion															
6	divide by :	1.983471														

Read by DP Model as AF: 213,897

Input Option: 0

0 - Current FERC (Column O)

1 - Alt (Column AA or AC)

Existing FERC Requirements

See Cell AR1 for beginning of calculation

Required Monthly Volume — Daily Parsing Monthly

April - May Parsing

Option >> 2

(1) Even daily distribution

(2) 2-Pulse

39-yr Ave 213,897

User Defined from UserInput Worksheet

Alternative flow requirement (Column AA or AC)

Option within an option: 0

(0) if from UserInput Time Series

(1) if from UserInput YT Table

Daily time series, or average of daily by year type average (from UserInput)

39-yr Ave 558,305 231,861

TSeries (Col BM): 1, 1 — Table TSeries (Col BJ): 0, 0

Greater of FERC or X%UF Feb-Jun, with Bounds 558,305

Self-contained Computation of SWRCB Component

Alternative - SWRCB X% F-J

Row	CYMonth Index	Date	Day	Days	Model Input La Grange Daily CFS	Model Input La Grange Daily AF	Pulse Day	La Grange Monthly Base AF	La Grange Monthly Pulse/Attr AF	Base Day Percent	Pulse/Attr Day Percent	Base Day Flow CFS	Pulse/Attr Day Flow CFS	FERC Only La Grange Daily AF	FERC Only La Grange Daily CFS
22	1970.10	10/3/1970	S	31	300	595	3	18,447	5,950	0.03226	0.00000	300	0	595	300
23	1970.10	10/4/1970	S	31	300	595	4	18,447	5,950	0.03226	0.00000	300	0	595	300
24	1970.10	10/5/1970	M	31	300	595	5	18,447	5,950	0.03226	0.00000	300	0	595	300
25	1970.10	10/6/1970	T	31	300	595	6	18,447	5,950	0.03226	0.00000	300	0	595	300
26	1970.10	10/7/1970	W	31	300	595	7	18,447	5,950	0.03226	0.00000	300	0	595	300
27	1970.10	10/8/1970	T	31	300	595	8	18,447	5,950	0.03226	0.00000	300	0	595	300
28	1970.10	10/9/1970	F	31	300	595	9	18,447	5,950	0.03226	0.00000	300	0	595	300
29	1970.10	10/10/1970	S	31	300	595	10	18,447	5,950	0.03226	0.00000	300	0	595	300
30	1970.10	10/11/1970	S	31	300	595	11	18,447	5,950	0.03226	0.00000	300	0	595	300
31	1970.10	10/12/1970	M	31	300	595	12	18,447	5,950	0.03226	0.00000	300	0	595	300
32	1970.10	10/13/1970	T	31	300	595	13	18,447	5,950	0.03226	0.00000	300	0	595	300
33	1970.10	10/14/1970	W	31	300	595	14	18,447	5,950	0.03226	0.00000	300	0	595	300
34	1970.10	10/15/1970	T	31	300	595	15	18,447	5,950	0.03226	0.00000	300	0	595	300
35	1970.10	10/16/1970	F	31	1,800	3,570	16	18,447	5,950	0.03226	0.50000	300	1,500	3,570	1,800
36	1970.10	10/17/1970	S	31	1,800	3,570	17	18,447	5,950	0.03226	0.50000	300	1,500	3,570	1,800
37	1970.10	10/18/1970	S	31	300	595	18	18,447	5,950	0.03226	0.00000	300	0	595	300
38	1970.10	10/19/1970	M	31	300	595	19	18,447	5,950	0.03226	0.00000	300	0	595	300

Row	TR UF CFS	X% (35) Feb-Jun CFS	Min Cap (200) Feb-Jun CFS	Max Cap (3500) Feb-Jun CFS	w/Caps X% Req Alone AF	Max of X% Alone or FERC Alone AF	Max of X% Alone or FERC Alone CFS	UserInput User Defined Time Series Flow Reqrmnt CFS	UserInput User Defined Time Series Flow Reqrmnt AF	UserInput User Defined Yr-Type Table Flow Reqrmnt CFS	UserInput User Defined Yr-Type Table Flow Reqrmnt AF
22	129	0	0	0	0	595	300	300	595	262	519
23	133	0	0	0	0	595	300	300	595	262	519
24	135	0	0	0	0	595	300	300	595	262	519
25	137	0	0	0	0	595	300	300	595	262	519
26	139	0	0	0	0	595	300	300	595	262	519
27	142	0	0	0	0	595	300	300	595	262	519
28	144	0	0	0	0	595	300	300	595	262	519
29	149	0	0	0	0	595	300	300	595	262	519
30	144	0	0	0	0	595	300	300	595	262	519
31	142	0	0	0	0	595	300	300	595	262	519
32	142	0	0	0	0	595	300	300	595	262	519
33	141	0	0	0	0	595	300	300	595	262	519
34	147	0	0	0	0	595	300	300	595	262	519
35	146	0	0	0	0	3,570	1,800	1,800	3,570	383	759
36	138	0	0	0	0	3,570	1,800	1,800	3,570	383	759
37	146	0	0	0	0	595	300	300	595	383	759
38	148	0	0	0	0	595	300	300	595	383	759

Figure 2.2-1. Daily parsing of FERC flow requirement from Don Pedro Reservoir.

Figure 2.2-2 illustrates the area for entry of data to parse monthly-designated migration and attraction flow requirements into daily patterns during April, May and October. The “Control” Worksheet designates which parsing pattern is to be used for April and May. The examples illustrate the entry for an evenly distributed pattern of migration flow volume during the April-May 61-day period, and a pattern for which the migration flow volume (by daily fraction of the volume) has been divided between April (16 days) and May (15 days). The migration flow volume for each month has been evenly distributed during each day of the partial month period. These daily migration flows are added to the base flow component of each month. The parsing of the attraction flow volume during the month of October is similarly defined. In this example the attraction flow volume (by daily fraction of the volume) for October is distributed evenly over a two-day period beginning October 15.

Figure 2.2-3 illustrates the section of the worksheet that defines the current 1995 FERC flow requirement from Don Pedro Reservoir. Several elements of information provided in this worksheet and from the “Control” Worksheet provide the computation of flow requirement based on 1995 FERC Settlement procedures and flow rates. The basis of the year type flow requirements is the SWRCB San Joaquin River Basin 60-20-20 index. The annual flow

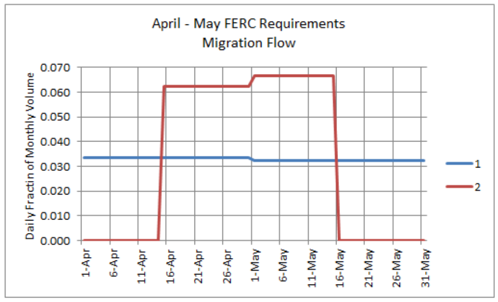
schedules are assumed to be on an April through March year, with the interpolation water of the schedules applied to April and May pulse flows. For modeling convenience the explicit FERC requirements for October base and attraction flows have been slightly modified to adapt into the evenly daily distributed base flow component of the Model.

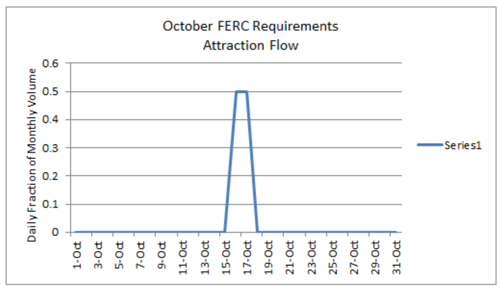
AE AF AG AH AI AJ AK AL AM AN AO AP AQ AR

Customized Daily Pulse Flow Patterns for the April - May and October Period

April - May Parsing
Daily Pattern of April-May Pulse Fishery Volumes

		Even	2-Pulse
	Option >>	1	2
1	1-Apr	0.033	0.000
2	2-Apr	0.033	0.000
3	3-Apr	0.033	0.000
4	4-Apr	0.033	0.000
5	5-Apr	0.033	0.000
6	6-Apr	0.033	0.000
7	7-Apr	0.033	0.000
8	8-Apr	0.033	0.000
9	9-Apr	0.033	0.000
10	10-Apr	0.033	0.000
11	11-Apr	0.033	0.000
12	12-Apr	0.033	0.000
13	13-Apr	0.033	0.000
14	14-Apr	0.033	0.000
15	15-Apr	0.033	0.063
16	16-Apr	0.033	0.063
17	17-Apr	0.033	0.063
18	18-Apr	0.033	0.063
19	19-Apr	0.033	0.063
20	20-Apr	0.033	0.063
21	21-Apr	0.033	0.063
22	22-Apr	0.033	0.063
23	23-Apr	0.033	0.063
24	24-Apr	0.033	0.063
25	25-Apr	0.033	0.063
26	26-Apr	0.033	0.063
27	27-Apr	0.033	0.063
28	28-Apr	0.033	0.063
29	29-Apr	0.033	0.063
30	30-Apr	0.033	0.063
31	1-May	0.032	0.067
32	2-May	0.032	0.067
33	3-May	0.032	0.067
34	4-May	0.032	0.067





October Parsing
Daily Pattern of October Attraction Fishery Volume

		Day Frac
1	1-Oct	0
2	2-Oct	0
3	3-Oct	0
4	4-Oct	0
5	5-Oct	0
6	6-Oct	0

Figure 2.2-2. Daily parsing of FERC migration and attraction flow.

BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW
FERC Flow Schedules												
								Adapted October				
Year Type	1	2	3	4	5	6	7	6				
Oct 1-15 (CFS)	100	100	150	150	180	200	300	188	*October has been modified from*			
Oct 16-31 (CFS)	150	150	150	150	180	175	300	188	*explicit FERC Schedule for modeling*			
Total Base (AF)	7,736	7,736	9,223	9,223	11,068	11,504	18,447	11,560	*simplicity. Split-month base flow has*			
Attraction (AF)	0	0	0	0	1,676	1,736	5,950	1,680	*been levelized.*			
Total Oct (AF)	7,736	7,736	9,223	9,223	12,744	13,240	24,397	13,240				
Nov (CFS)	150	150	150	150	180	175	300					
AF	8,926	8,926	8,926	8,926	10,711	10,413	17,852					
Dec (CFS)	150	150	150	150	180	175	300					
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447					
Jan (CFS)	150	150	150	150	180	175	300					
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447					
Feb (CFS)	150	150	150	150	180	175	300					
AF	8,331	8,331	8,331	8,331	9,997	9,719	16,661					
Mar (CFS)	150	150	150	150	180	175	300					
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447					
Apr (CFS)	150	150	150	150	180	175	300					
AF	8,926	8,926	8,926	8,926	10,711	10,413	17,852					
May (CFS)	150	150	150	150	180	175	300					
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447					
Migration Flow												
AF	11,091	20,091	32,619	37,060	35,920	60,027	89,882					
Jun (CFS)	50	50	50	75	75	75	250					
AF	2,975	2,975	2,975	4,463	4,463	4,463	14,876					
Jul (CFS)	50	50	50	75	75	75	250					
AF	3,074	3,074	3,074	4,612	4,612	4,612	15,372					
Aug (CFS)	50	50	50	75	75	75	250					
AF	3,074	3,074	3,074	4,612	4,612	4,612	15,372					
Sep (CFS)	50	50	50	75	75	75	250					
AF	2,975	2,975	2,975	4,463	4,463	4,463	14,876					
Total Annual	94,001	103,001	117,017	127,508	142,503	165,004	300,926					

Figure 2.2-3. 1995 FERC minimum flow requirement schedule.

Figure 2.2-4 illustrates the revised computational section of the “LaGrangeSchedule” Worksheet that computes the components of base and total required schedule annual volumes, October attraction flow volume, and April-May migration flow volume. Other sections of the worksheet have been revised to define the monthly distribution of annual volumes for incorporation into the daily parsing routines shown above.

AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI
Current FERC Requirements														
	Tuolumne River Flow Interpolation - Year 2011 Revised Distribution													
	Flow Year Type			SJR Basin Index				Flow Requirement						October
													Base	Attraction
	1		<	1510								94000	82,910	0
	2			1510	- <	2000		0.0286	x (Index -	1510	) +	103000	82,910	0
	3			2000	- <	2190		0.0552	x (Index -	2000	) +	117016	84,398	0
	4			2190	- <	2440		0.0600	x (Index -	2190	) +	127507	90,448	0
	5			2440	- <	2720		0.0804	x (Index -	2440	) +	142502	104,907	1,676
	6			2720	- <	3180		0.2955	x (Index -	2720	) +	165002	103,297	1,680
	7			3180	and Greater							300923	205,094	5,950
									Option >>	1	2	3	4	5
	1	<<Option			Ave	219,421	146,114	70,146		Actual	90% Exc.	75% Exc.	Med.	10% Exc.
	SJR				TR	Tuolumne	Tuolumne	Pulse	Base	SJR	Apr SJR	Apr SJR	Apr SJR	Apr SJR
	Index	Year			October	River	River	Flow	Year	Index	Index	Index	Index	Index
	602020	Class		Year	Attraction	Require	Base	Calc	Type	602020	Fcast	Fcast	Fcast	Fcast
	4,543,729	Wet		1922	5,950	300,923	205,094	89,879	7	4,543,729	2,424,373	2,561,322	2,674,495	2,921,846
	3,549,358	Above		1923	5,950	300,923	205,094	89,879	7	3,549,358	1,765,568	1,897,976	2,007,411	2,246,643
	1,419,746	Critical		1924	0	94,000	82,910	11,090	1	1,419,746	799,642	853,197	957,737	1,186,335
	2,929,617	Below		1925	1,680	226,944	103,297	121,967	6	2,929,617	2,042,878	2,179,628	2,292,637	2,539,632
	2,300,567	Dry		1926	0	134,141	90,448	43,693	4	2,300,567	1,256,470	1,387,014	1,494,917	1,730,818
	3,558,955	Above		1927	5,950	300,923	205,094	89,879	7	3,558,955	2,147,110	2,284,156	2,397,408	2,644,932
	2,632,407	Below		1928	1,676	157,972	104,907	51,388	5	2,632,407	1,934,163	2,068,826	2,180,117	2,423,380
	2,004,815	Critical		1929	0	117,282	84,398	32,884	3	2,004,815	1,140,712	1,270,277	1,377,372	1,611,521

Figure 2.2-4. 1995 FERC flow requirements from Don Pedro Reservoir.

2.3 Don Pedro Project Generation

User's Guide reference: Section 5.12: "DonPedro" Worksheet, Section 5.12.5 Don Pedro Project Generation and River Flows

The hydroelectric generation characteristics of any modeled Project operation scenario are modeled incidental to Project hydrologic operations. The power generation of the Project is computed from the simulation of daily time step operations and is incoporated into the "DonPedro" Worksheet. Input to the power component includes daily average flow past Don Pedro Dam (flow through the dam and through the spillway, if any) and Don Pedro Reservoir storage. The power component computes gross and net head, flow through turbines, efficiency and power output based on a group of reservoir rating, tailwater rating and manufacturer's performance characteristic curves, and generalized equations for head losses.

Figure 2.3-1 illustrates the components of computational procedure that derives power output of the Project. The power characteristics of the turbine generators are defined for a range of head and flow combinations. "Cutoff" of generation that would otherwise be indicated by the performance curves is provided through user defined switches entered in the "Control" Worksheet. Switch C 1.20 defines the minimum reservoir storage level at which generation occurs, and Switch C 1.22 defines the maximum flow through the powerplant. In this illustration generation will not occur when Don Pedro Reservoir storage is less than 308,960 acre-feet (elevation 600 ft). The performance curves indicate that generation may occur up to a flow rate of approximately 5,500 cfs. Switch C 1.22 has been set higher than this value to not impede the computation.

	A	B	C	D	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ
1			1																	
2	*Unit Title*		2			CFS														
3	*Parameter Title*		3			Total Dam Release														
4																				
5	*Acre-foot to CFS conversion*																			
6	*divide by :*	*1.983471*																		
7																				
8					*TEST*															
9					*11/21/1977*	*289*	*361,955*	*614.3*	*298.0*	*316.3*	*316.2*	*310*	*325*	*0*		*3*	*1*	*10*	*4550*	*289*
10																				
11							*308,960*	*(C 1.20) Cutoff of generation, DP Storage (sets available units to zero)*												
12						*Penstock Loss:*		*9.66E-07*	*ft/cfs²*	*Scheduled Maintenance? (1) Yes, (0) No:*				*0*					*6,000*	
13				*39-year Ave or Max*	*Max*	*67,039*		*830*	*298*	*532*	*527*	*530*	*525*			*3*	*1*	*10*	*5,655*	*5,500*
14				*Min*	*Min*	*207*		*614*	*298*	*316*	*316*	*310*	*325*			*3*	*1*	*10*	*4,550*	*207*
15					**Don Pedro Power Generation**															
16						Don	Don	Don	Approx			Net H	Net H		Unsched	Number	Number	Min	Max	Potential
17	Month					Pedro	Pedro	Pedro	Tailwater	Gross	Approx	Look-up	Look-up	Sched	Outage /	Available	Available	Plant	Plant	Plant
18	Index	Date	Day	Days		Release	Storage	Elevation	Elevation	Head	Net H	Units 1-3	Unit 4	Outage	Bypass	Units 1-3	Unit 4	Flow	Flow	Flow
19						CFS	Ave-AF	FT elev	FT elev	FT	FT	FT	FT	unit #	unit #			CFS	CFS	CFS
20	1970.10	10/1/1970	T	31		2,037	1,669,232	800.0	298.0	502.0	498.0	490	500	0		3	1	10	5500	2,037
21	1970.10	10/2/1970	F	31		1,288	1,666,644	799.7	298.0	501.7	500.1	510	500	0		3	1	10	5500	1,288
22	1970.10	10/3/1970	S	31		1,209	1,664,882	799.6	298.0	501.6	500.2	510	500	0		3	1	10	5500	1,209
23	1970.10	10/4/1970	S	31		1,718	1,662,698	799.4	298.0	501.4	498.6	490	500	0		3	1	10	5500	1,718
24	1970.10	10/5/1970	M	31		1,378	1,660,351	799.2	298.0	501.2	499.4	490	500	0		3	1	10	5500	1,378
25	1970.10	10/6/1970	T	31		1,502	1,658,222	799.0	298.0	501.0	498.8	490	500	0		3	1	10	5500	1,502
26	1970.10	10/7/1970	W	31		1,322	1,656,151	798.8	298.0	500.8	499.1	490	500	0		3	1	10	5500	1,322
27	1970.10	10/8/1970	T	31		728	1,654,638	798.7	298.0	500.7	500.2	510	500	0		3	1	10	5500	728
28	1970.10	10/9/1970	F	31		827	1,653,407	798.5	298.0	500.5	499.8	490	500	0		3	1	10	5500	827
29	1970.10	10/10/1970	S	31		898	1,652,016	798.4	298.0	500.4	499.6	490	500	0		3	1	10	5500	898

	A	B	C	D	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL
1			1													
2	*Unit Title*		2						CFS							kWh
3	*Parameter Title*		3						Total Plant Flow							Modeled D
4																
5	*Acre-foot to CFS conversion*															
6	*divide by :*	*1.983471*														
7																
8																
9					*1*	*289*	*0*	*0*	*289*	*315.9*	*60.0%*	*0.0%*	*4,648*	*0*	*4,648*	*111,544*
10																
11																
12								*39-yr Annual Ave (AF):*	*1,501,380*						*39-yr Annual Ave (MWh):*	*603,718*
13				*39-year Ave or Max*	*3*		*1*	*1,000*	*5,500*	*525*	*0.90*	*0.92*	*172,991*	*38,653*	*208,219*	*4,997,256*
14				*Min*	*1*		*0*	*0*	*207*	*316*	*0.60*	*0.00*	*3,333*	*0*	*3,333*	*80,003*
15																
16						Flow		Flow			Plant	Plant				Plant
17	Month				Operation	Through	Operation	Through	Plant	Net	Effic	Effic	Power	Power	Plant	Daily
18	Index	Date	Day	Days	Units 1-3	Units 1-3	Unit 4	Unit 4	Flow	Head	Units 1-3	Unit 4	Units 1-3	Unit 4	Power	Generation
19					Count	CFS		CFS	CFS	FT	%	%	kW	kW	kW	kWh
20	1970.10	10/1/1970	T	31	3	679	0	0	2037	495.0	77.2%	0.0%	65,942	0	65,942	1,582,609
21	1970.10	10/2/1970	F	31	3	429	0	0	1288	498.2	65.2%	0.0%	35,423	0	35,423	850,156
22	1970.10	10/3/1970	S	31	3	403	0	0	1209	498.3	63.9%	0.0%	32,602	0	32,602	782,449
23	1970.10	10/4/1970	S	31	3	573	0	0	1718	496.0	73.4%	0.0%	53,001	0	53,001	1,272,019
24	1970.10	10/5/1970	M	31	3	459	0	0	1378	497.3	67.8%	0.0%	39,381	0	39,381	945,135
25	1970.10	10/6/1970	T	31	3	501	0	0	1502	496.5	70.3%	0.0%	44,432	0	44,432	1,066,359
26	1970.10	10/7/1970	W	31	3	441	0	0	1322	497.1	67.0%	0.0%	37,296	0	37,296	895,105
27	1970.10	10/8/1970	T	31	2	364	0	0	728	499.0	60.0%	0.0%	18,467	0	18,467	443,214
28	1970.10	10/9/1970	F	31	3	276	0	0	827	498.5	60.0%	0.0%	20,971	0	20,971	503,311
29	1970.10	10/10/1970	S	31	3	299	0	0	898	498.3	60.0%	0.0%	22,759	0	22,759	546,222

Figure 2.3-1. Project power computational procedure.

A validation of the computational process was made by comparing Model-produced generation to historically reported generation. Table 2.3-1 shows a comparison between computed and reported generation for a 2002 – 2009 period of record. The results show that Project generation is well depicted with the computational procedures, with minimal annual differences. This period of record includes a dry (reduced reservoir and releases) to wet (full reservoir and large releases) range of hydrologic conditions. Figure 2.3-2 illustrates the comparison of Model-produced daily generation and historically reported generation for calendar year 2003, which had a range of reservoir storage and release conditions.

Table 2.3-1. Modeled and reported Project power.

Reported Generation (MWh)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2002	5,079	4,259	38,044	61,819	54,412	54,341	66,448	52,811	28,790	18,760	6,073	7,005	397,840
2003	5,395	11,275	25,076	39,599	51,964	68,313	75,800	61,667	32,692	33,135	8,343	6,261	419,520
2004	7,509	12,122	62,985	72,157	58,301	58,788	68,904	54,145	25,452	23,118	4,565	4,402	452,449
2005	12,339	48,759	98,233	137,057	143,777	137,291	122,689	84,793	43,861	22,203	9,831	33,044	893,877
2006	111,669	72,155	125,741	110,498	131,217	124,759	97,387	80,643	46,356	26,152	11,631	8,204	946,413
2007	12,597	15,207	45,088	48,189	54,255	57,216	64,531	53,546	22,957	15,461	7,032	3,780	399,859
2008	3,184	5,562	37,289	43,158	58,312	45,852	54,811	46,690	22,417	11,467	4,647	6,114	339,501
2009	4,912	5,326	21,733	41,084	55,267	56,222	67,625	53,082	28,388	18,051	7,781	5,495	364,965
Average	20,335	21,833	56,774	69,195	75,938	75,348	77,274	60,922	31,364	21,043	7,488	9,288	526,803
Ann Dist	4%	4%	11%	13%	14%	14%	15%	12%	6%	4%	1%	2%	100%

Modeled Generation (MWh)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2002	4,692	4,343	36,119	63,521	54,701	56,249	69,864	53,614	27,334	17,457	5,765	6,422	400,081
2003	5,104	10,231	23,762	39,691	51,839	67,021	80,295	64,791	31,953	31,070	7,742	5,434	418,932
2004	6,696	11,128	62,972	75,770	60,036	59,137	70,224	55,786	24,403	21,785	5,131	4,488	457,555
2005	13,839	50,180	109,404	139,619	146,930	147,343	132,278	89,284	44,552	21,561	10,306	35,026	940,321
2006	102,499	71,293	130,498	108,499	113,092	111,410	102,790	82,253	45,051	24,484	11,237	7,320	910,425
2007	11,023	13,343	43,437	47,548	54,298	59,601	67,647	56,301	22,600	14,898	6,724	4,165	401,585
2008	3,820	5,733	37,688	43,469	59,007	45,476	56,320	49,154	21,603	10,833	4,542	6,150	343,795
2009	4,985	5,740	21,720	40,985	55,636	58,102	72,166	56,015	28,577	16,255	7,465	5,421	373,066
Average	19,082	21,499	58,200	69,888	74,443	75,542	81,448	63,400	30,759	19,793	7,364	9,303	530,720
Generation	4%	4%	11%	13%	14%	14%	15%	12%	6%	4%	1%	2%	100%

% Deviation ((Reported-Actual)/Actual)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2002	-8%	2%	-5%	3%	1%	4%	5%	2%	-5%	-7%	-5%	-8%	1%
2003	-5%	-9%	-5%	0%	0%	-2%	6%	5%	-2%	-6%	-7%	-13%	0%
2004	-11%	-8%	0%	5%	3%	1%	2%	3%	-4%	-6%	12%	2%	1%
2005	12%	3%	11%	2%	2%	7%	8%	5%	2%	-3%	5%	6%	5%
2006	-8%	-1%	4%	-2%	-14%	-11%	6%	2%	-3%	-6%	-3%	-11%	-4%
2007	-12%	-12%	-4%	-1%	0%	4%	5%	5%	-2%	-4%	-4%	10%	0%
2008	20%	3%	1%	1%	1%	-1%	3%	5%	-4%	-6%	-2%	1%	1%
2009	1%	8%	0%	0%	1%	3%	7%	6%	1%	-10%	-4%	-1%	2%
Average	-6%	-2%	3%	1%	-2%	0%	5%	4%	-2%	-6%	-2%	0%	1%

Modeled generation includes assumptions for historical outages of units.

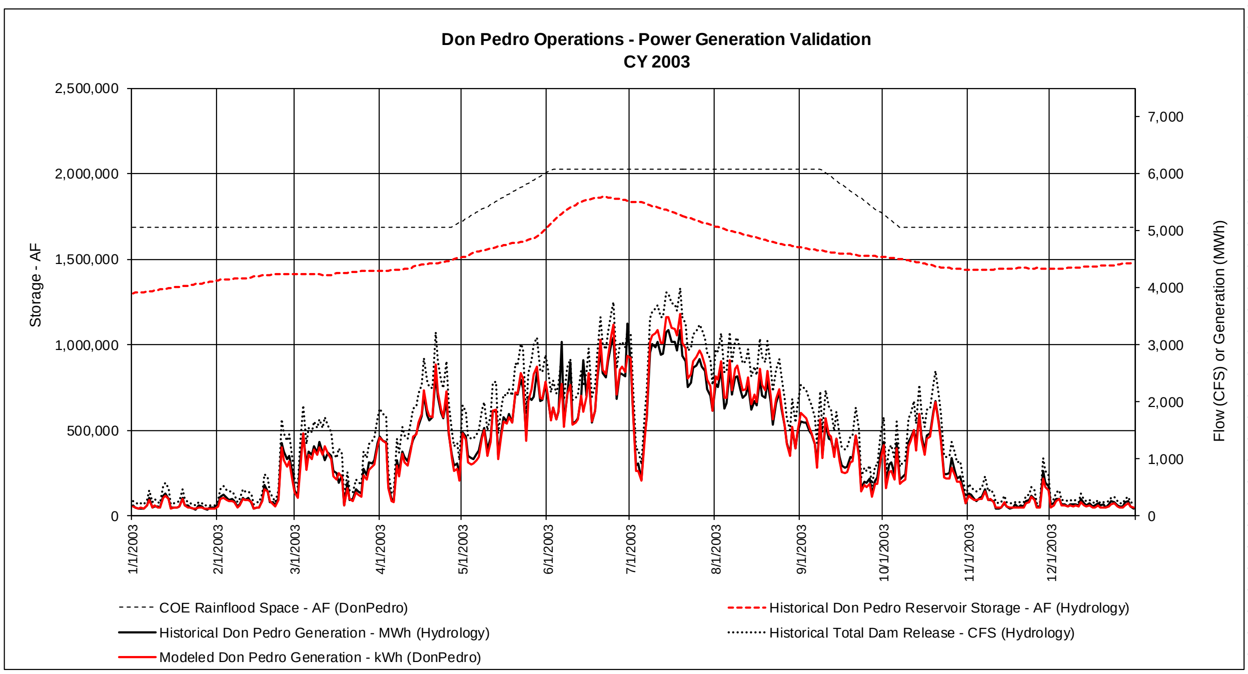


Figure 2.3-2. Project power daily generation.

3.0 INPUT AND HYDROLOGY MODIFICATIONS

Several changes to underlying hydrology and data assumptions have been implemented in the Model (Version 2.0).

3.1 Unimpaired Runoff

User's Guide reference: Section 5.22: "Hydrology" Worksheet

Concern was raised regarding the sometimes erratic daily pattern of computed unimpaired runoff for various components of the historical record, and the occassional computation of a "negative" value of flow. Although the use of the historically computed data are known to not adversely affect Model results, the Districts forwarded an approach to developing a hybrid gauge summation/gage proration hydrologic record for Tuolumne River unimpaired flow that would provide a "smoother" hydrograph. At a Workshop on March 27, 2013, RPs and the Districts worked through the approach and came to a consensus on an acceptable record of unimpaired flow for the Tuolumne River. It was clearly stated that the Districts and CCSF will not change their historical methods for calculating their respective water supplies from the Tuolumne River or the historical record of water bank operations. This modified data set will only be used to estimate unimpaired flow for the FERC relicensing.

Modified sub-basin hydrology was implemented for Hetch Hetchy Reservoir inflow, Cherry/Eleanor inflow, and the unregulated inflow to Don Pedro Reservoir. With only one month of exception, the historically computed monthly volumes of total runoff above La Grange were maintained in the modified data set. However, the daily shaping of the sub-basin runoff was modified, and on occasion rebalanced between the sub-basins to rectify historically computed negative volumes. Figure 3.1-1 illustrates the location and an example of the modified hydrology implemented in the "Hydrology" Worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1			1		Hydrology								
2			2		CFS	CFS	CFS	CFS	CFS		CFS	CFS	CFS
3			3		Unimpaire	Unimpaire	Unimpaire	Revised Ur	Unregulated Inflow tc		Dry Creek	Total LTR Ac	Modesto to
4													
5													
6					Read by	Read by	Read by		Read by		Read by	Read by	Read by
7					Model	Model	Model		Model		Model	Model	Model
8													
9													
10													
11													
12												LTR Accretions	
13					March 26, 2013 Prorated Hydrology						Nov 2012	Nov 2012	
14											Dry Creek	Lower	Modesto
15					1,934,193	762,930	487,867		683,396		Flow @	Tuolumne	to
16						Unimpaired Flow			Computed Flow		Modesto	River	Confluence
17	Month					Hetch	Cherry/		Unregul		HDR est.	Acc abv	
18	Index	Date	Day		La Grange	Hetchy	Eleanor		blw SF			Modesto	
19					CFS	CFS	CFS		CFS		CFS	CFS	CFS
20	1970.10	10/1/1970	T		125	4	14		107		30	80	32
21	1970.10	10/2/1970	F		130	4	14		111		30	80	32
22	1970.10	10/3/1970	S		129	4	14		111		30	80	32
23	1970.10	10/4/1970	S		133	4	15		115		30	80	32
24	1970.10	10/5/1970	M		135	4	15		117		30	80	32
25	1970.10	10/6/1970	T		137	4	15		118		30	80	32
26	1970.10	10/7/1970	W		139	4	15		119		30	80	32
27	1970.10	10/8/1970	T		142	4	15		122		30	80	32
28	1970.10	10/9/1970	F		144	4	15		124		30	80	32
29	1970.10	10/10/1970	S		149	4	16		130		30	80	32

Figure 3.1-1. Unimpaired runoff data set.

3.2 District Canal Operation Assumptions

User's Guide reference: Section 5.18: "DailyCanalsCompute" Worksheet, Section 5.18.3 Daily Canal Operation Assumptions

The "DailyCanalsCompute" Worksheet performs the computation of the daily canal demands of the MID and TID. The computation of canal demands incorporate the PDAW and canal operations practices of the Districts. Canal operation assumptions include regulating reservoir operation, seepage and losses, nominal groundwater pumping and canal operational spills. Since the initial development of data for the Model, a recent review of the Districts' operation records associated with the Districts' preparation and filing of their 5-year Agricultural Water Management Plans has led to the refinement of certain canal operations assumptions. Model (Version 2.0) assumptions for each District are shown Figure 3.2-1.

Modesto Irrigation District

Month	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Modesto Res	Intercepted Flows	Nominal MID GW Pumping	Modesto Res and Upper Canal Losses/Div	Municipal Delivery from Modesto Res	Modesto Res Target Storage	Modesto Res Target Storage Change
	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0	2.0
February	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0	1.0
March	65.0	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0	0.0
April	70.0	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0	1.0
May	85.0	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0	1.0
June	85.0	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0	0.0
July	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0	1.0
August	70.0	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0	1.0
September	65.0	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0	-2.0
October	40.0	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0	-3.0
November	30.0	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0	-2.0
December	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0	0.0
Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5		

MID March TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	65.0
9.9	65.0
13.2	65.0
20.0	65.0
9999.0	65.0

TID March TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	65.0
19.8	65.0
27.5	65.0
40.0	65.0
9999.0	65.0

MID April TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	70.0
10.0	70.0
17.5	70.0
25.0	80.0
9999.0	80.0

TID April TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	57.5
20.0	57.5
35.0	70.0
50.0	80.0
9999.0	80.0

Turlock Irrigation District

Month	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Turlock Lk	Intercepted and Other Flows	Nominal TID GW Pumping	Turlock Lk and Upper Canal Losses	Other Delivery from Turlock Lk	Turlock Lk Target Storage	Turlock Lk Target Storage Change
	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0	5.0
February	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0	7.0
March	65.0	1.2	3.0	3.0	4.5	0.5	4.1	1.0	0.0	30.0	5.0
April	57.5	2.4	5.1	6.3	4.5	1.0	8.0	6.6	0.0	30.0	0.0
May	85.0	3.6	4.6	6.7	4.5	1.3	10.3	7.7	0.0	32.0	2.0
June	92.5	5.2	4.2	6.7	4.5	1.3	12.4	8.2	0.0	32.0	0.0
July	75.0	6.4	4.2	6.7	4.5	1.5	14.6	8.7	0.0	32.0	0.0
August	65.0	6.2	4.0	7.3	4.5	1.5	13.3	9.0	0.0	30.0	-2.0
September	67.5	3.9	3.2	7.3	4.5	1.0	9.1	5.0	0.0	27.0	-3.0
October	40.0	2.4	2.3	7.3	4.5	0.5	5.3	2.0	0.0	13.0	-14.0
November	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
December	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
Total		31.3	38.6	59.3	39.2	8.5	77.1	52.2	0.0		

Figure 3.2-1. Districts' canal demand components.

The change that has occurred to the data set is the estimation of "intercepted and other flows" for the TID canal system. The change reflects the addition of a component of canal water supply that was previously not recognized in the data set. Also refined in the data set and computational process for both Districts were several of the monthly turnout delivery factors. The turnout delivery factors are unique to each District and represent a modeling mechanism to adjust the PDAW for irrigation practices that are not included in the estimation of the CUAW, such as irrigation that provides for groundwater recharge. Data identified in this worksheet are entered through the Control Worksheet.

3.3 Don Pedro Water Supply Factor

User's Guide reference: Section 5.20: "DPWSF" Worksheet

The "DPSWF" Worksheet computes the Don Pedro Water Supply Factor (WSF). The premise of the WSF factor is to reduce the amount of water diverted to the canals during years when lack of carryover storage at Don Pedro Reservoir becomes a concern. The modeling mechanism used to reduce canal diversions is a factor applied to the PDAW of the canal demand. This mechanism results in a reduction to the amount of water "turned out" to the customers. Changes to estimated canal demands and underlying hydrology, in combination with the review of projected operations has led to a change in the WSF to be used for the Base Case. Figure 3.3-1 illustrates the Base Case WSF components in the Model (Version 2.0). The values are entered in the "Control" Worksheet.

Don Pedro Reservoir Inflow Forecast for Diversion of Water Supply

Reservoir Index Method - Active Matrix

	M/T NDP Stor + Infl Index	M/TID WS Factor	+1	+1
	kaf	%		
Enter	0	0.75	1090	0.75
Values	1090	0.75	1090	0.875
From	1090	0.875	1700	0.875
C1.90	1700	0.875	1700	1
	1700	1	2300	1
	2300	1	9999	1
	9999	1		

(W)ater (S)upply (F)actor is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir.

Forecast begins for February:
EO-January storage + Feb-July UF - Feb-July US adj - Feb-Mar minimum river
March Forecast:
EO-February storage + Mar-July UF - Mar-July US adj - Mar minimum river
April Forecast: (final)
EO-March storage + Apr-July UF - Apr-July US adj

Factor Table is April Forecast based
February and March Forecasts act as adjustments to estimate April 1 state.

Figure 3.3-1. Don Pedro water supply forecast factors.

3.5 Lower Tuolumne River Accretions below Modesto

The Model (Version 1.0) incorporated a synthesized data set for lower Tuolumne River accretions above the "Modesto" gage and estimated flow from Dry Creek. These data sets inform the Model of flow that could influence Don Pedro Reservoir releases during flood control operations. Recent, actual field measurements for flow in the Tuolumne River and for Dry Creek have confirmed general assumptions of the data sets. Also acquired during these field measurements has been flow data for the reach of the lower Tuolumne River below the "Modesto" gage and above the confluence with the San Joaquin River. Based on these measurements, an accretion of 32 cfs has been assumed to occur below the USGS "Modesto" gage. This data set has been added to the "Hydrology" Worksheet, Column M ("Modesto to Confluence"), incorporated into computations of river flow in the "DonPedro" Worksheet,

Column CP ("TR at Confluence"), and the projected flow at the confluence is reported in the "Output" Worksheet, Column AR ("Flow-Confluence").

3.5 Miscellaneous Reference Case Data Revisions

As the result of defining a Base Case in the Model (Version 2.0), several data sets required update or revision to facilitate automated comparisons between the Base Case results and alternative scenario results. Changes to Base Case reference values occurred in table values or time series sets for:

"UserInput" Worksheet

- Existing FERC Flow Requirements at La Grange Bridge Gage
- Base Case MID Canal Diversion
- Base Case TID Canal Diversion
- Base Case Supplemental Releases

"WaterBankRel" Worksheet

- Water Bank Supplemental Release (Column T)

"DonPedro" Worksheet

- Base Case Full Diversion Demand (Column I – Column L)

"SFWaterBankRel" Worksheet

- Water Bank Supplemental Release (Column AN)

"DailyCanalsCompute" Worksheet

- DP Water Supply Factor Base Case (Column F)

"DailyCanals" Worksheet

- Base MID Canal Diversion (Column L)
- Base TID Canal Diversion (Column N)

4.0 MODEL EXECUTION

To aid in the execution, completion and recording of an alternative operation scenario, several "macro" tools have been incorporated into the Model.

4.1 Water Bank Supplemental Release Macro

A variation from Base Case Don Pedro Reservoir operation assumptions will normally cause a change in results to the CCSF Water Bank Account Balance. If needing revision from Base Case conditions (e.g., revised supplemental releases to maintain a positive Water Bank Account Balance) supplemental releases can be automatically computed by use of a macro implemented for the "WaterBankRel" Worksheet. This macro will replicate the manual action of the user to provide the day-by-day supplemental release exactly needed to maintain no less than a zero Water Bank Balance.

Figure 4.1-1 illustrates the location of the macro button in the "WaterBankRel" Worksheet. To "run" the macro the user simply "clicks" on the button identified by the label "Supplemental Release". By invoking the macro, values will be automatically placed into Column T to maintain a positive Water Bank Account Balance. The macro will iterate computations up to 24 times to complete the process. It is advised to initialize Column T with zeroes prior to invoking the macro. It is also advised to set the Excel worksheet "Options" to a manual calculation mode prior to invoking the macro.

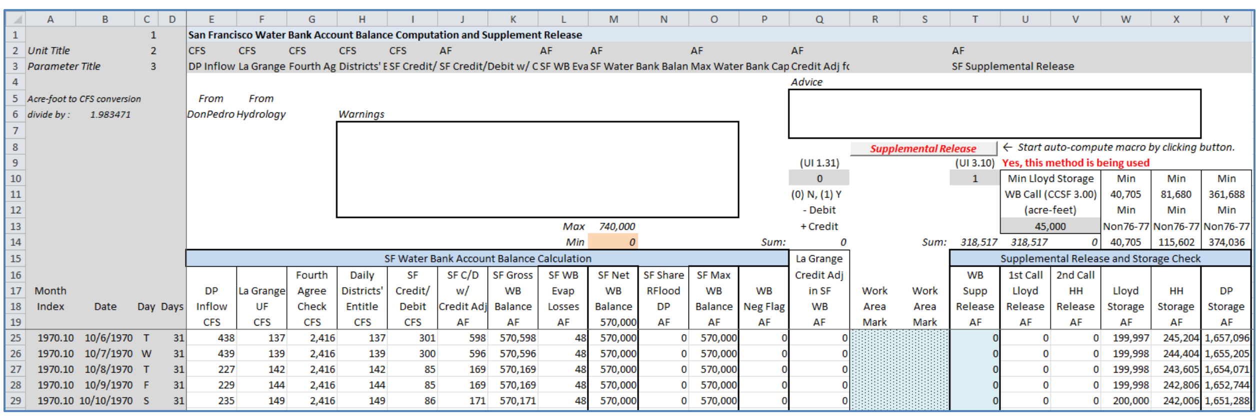


Figure 4.1-1. Water bank supplemental release macro.

4.2 Copy Output Worksheet Macro

The "Output" Worksheet provides an interface between Model computations and summary and analysis tools. It also provides a formatted set of information usable for exchange into an HEC-DSS database file. Results provided in the worksheet are directly linked to the computational and input worksheets of the Model. As such, any change to model assumptions or data which causes a recalculation by the Model will automatically update the values in the worksheet. To preserve or store the results of a particular study a copy of the worksheet should be created with a unique tab name and its contents converted to values. The user can either use Excel keystroke or menu commands to create the worksheet copy, or can invoke a macro. Figure 4.2-1 illustrates the location of the macro button in the “Output” Worksheet. To “run” the macro the user simply “clicks” on the button identified by the label “Copy Sheet / Values”. By invoking the macro, the worksheet will be “copied” as “values” into an adjacent worksheet and given a name identified by Switch UI 1.00 in the “UserInput” Worksheet. The user must save the entire workbook to not lose the new worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	1	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE
2	2	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO
3	3	FLOW-LAGRANGEUNIMP	FLOW-HHUNIMP	FLOW-LLOYDUNIMP	FLOW-ELEANORUNIMP	FLOW-UNREGUNIMP	FLOW-TOTINFLOW	FLOW-SUP1INFLOWLL	FLOW-SUP2INFLOWHH	FLOW-INFLOWHH	FLOW-INFLOWLL	FLOW-INFLOWEL	STORAGE
4	4	2	3	4	5	6	7	8	9	10	11	12	13
5	5	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY
6	6	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case
7	*Save study results* 7	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70
8	*as unique* 8	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
9	*worksheet by* 9	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09
10	*clicking button* 10	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
11	↓ 11	CFS	CFS	CFS	CFS	CFS	CFS	AF	AF	CFS	CFS	CFS	AF
12	*Copy Sheet / Values*	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER
13	10/1/1970	125	4	10	4	107	427	0	0	90	220	10	1,667,564
14	10/2/1970	130	4	10	4	111	431	0	0	90	220	10	1,665,724
15	10/3/1970	129	4	10	4	111	431	0	0	90	220	10	1,664,041
16	10/4/1970	133	4	10	5	115	435	0	0	90	220	10	1,661,355
17	10/5/1970	135	4	10	5	117	437	0	0	90	220	10	1,659,348
18	10/6/1970	137	4	10	5	118	438	0	0	90	220	10	1,657,096
19	10/7/1970	139	4	10	5	119	439	0	0	90	220	10	1,655,205
20	10/8/1970	142	4	10	5	122	227	0	0	90	5	10	1,654,071
21	10/9/1970	144	4	10	5	124	229	0	0	90	5	10	1,652,744
22	10/10/1970	149	4	11	5	130	235	0	0	90	5	10	1,651,288

Figure 4.2-1. “Output” Worksheet copy values macro.

FOR HDR USE ONLY	
Run #	

DRAFT SCENARIO SHEET
Operations Model Run Request

Originator: Date Requested:
Relicensing Participant Group: Needed By:

Instructions: Complete this entire form, including a brief narrative description of your request. The narrative description should include specific questions you think this model run will answer and/or be specific how flow requirements should be modified. Empty scenario values will be assumed to be equal to Base Case.

Decription:____
____
____
____

Section 1—Minimum Flow Requirements at La Grange Bridge	
☐ Existing 1995 FERC Requirement ☐ Alternative, provided as daily time series___________ ☐ Alternative, provided as Year Type Schedule___________ ☐ Alternative, previous Run #___________ ☐ Shared CCSF/Districts Responsibility	*Instructions: Attach alternative flow requirements or provide location of file containing alternative flow requirements*
Section 2—Canal Diversions of Modesto Irrigation District and Turlock Irrigation District	
☐ Base Case Diversions ☐ Alternative diversions, volume by month ☐ Alternative, previous Run #___________	*Instructions: Attach alternative diversions or provide location of file containing alternative diversions*
Section 3—Supplemental Releases to Water Bank from San Francisco	
☐ "WaterBankRel" Worksheet ☐ Alternative releases, volume by month, add to Base Case ☐ Alternative releases, volume by month, replace Base Case ☐ Alternative, previous Run #___________	*Instructions: Attach alternative diversion, worksheet, or provide location of file containing alternative diversions*
Section 4—San Joaquin Pipeline Diversions of San Francisco	
☐ Base Case San Joaquin Pipeline Diversions ☐ Alternative diversions, volume by month ☐ Alternative, previous Run #___________	*Instructions: Attach alternative diversions or provide location of file containing alternative diversions*
Section 5—Additional Operational Objectives	

Attachment B

CDFW's July 19, 2013 comment letter to FERC

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Central Region
1234 East Shaw Avenue
Fresno, California 93710
(559) 243-4005
www.wildlife.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

July 19, 2013

Via Electronic Submission

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

Steven Boyd
Turlock Irrigation District
Post Office Box 949
Turlock, California 95381

Greg Dias
Modesto Irrigation District
Post Office Box 4060
Modesto, California 95352

Subject: California Department of Fish and Wildlife Comments on Meeting Notes of the Workshops regarding Water & Aquatic Resources (W&AR) Studies Nos. 2, 3 and 16 (Project Operations/Water Balance, Don Pedro Reservoir and Lower Tuolumne River Water Temperature Modeling), Don Pedro Hydroelectric Project No. 2299, Tuolumne River

Dear Secretary Bose and Messrs. Boyd and Dias:

The California Department of Fish and Wildlife[1] (CDFW) has reviewed meeting notes from a June 4, 2013 modeling workshop posted on the Don Pedro Hydroelectric Project (Project) relicensing website (www.donpedro-relicensing.com). This workshop was hosted by the Turlock Irrigation District and Modesto Irrigation District (collectively, the Districts) at the HDR Engineering Inc., headquarters in Sacramento. The Districts also hosted a workshop the following day, June 5, 2013, for parties interested in using three related modeling tools in sequence (the Districts' Project Operations/Water Balance Model, Reservoir Temperature Model, and River Temperature Model). By this letter, CDFW respectfully provides comments on the modeling workshops and associated meeting notes.

[1] Please note that as of January 1, 2013, our new name is the California Department of Fish and Wildlife (CDFW).

The CDFW acknowledges the Districts' outreach to demonstrate the interrelated operations/water balance and water temperature modeling tools. Unfortunately due to a combination of server security issues and computing demands, the ability for hands-on experimentation by more than one user at a time was extremely limited. Given the complexity of linking three modeling tools and a lack of familiarity with the Districts' models (particularly the MIKE3 platform), CDFW staff cannot at this time provide specific comments on the utility of the subject modeling tools. As workloads permit, CDFW staff will attempt to independently assess the modeling tools and run test scenarios. Once we have the opportunity to perform test runs and assess outputs, CDFW staff will contact the Districts' representatives if there are questions or concerns.

At this point, CDFW reiterates the concern over a lack of validation comparing the Operations Model Base Case rules with current project operations. The Districts maintain the Operations Model is not intended to replicate actual water use and the recent past would not be appropriate for modeling purposes. As such, the Operations Model Base Case does not attempt to represent current operations and is simply a starting point for future alternative analyses. The Districts have also referred CDFW staff to an Operations Model Draft Validation Report issued in December 2012.

It is important to note that subsequent to the December 2012 Draft Validation Report, the Districts made several significant changes to the Operations Model, including:

1. New model logic regarding the management of reservoir releases during early-July;
2. New model logic that differentiates between base flow releases and pulse flow releases below LaGrange Dam and that implements current October attraction flow requirements;
3. Inclusion of the new hydrologic data set presented at the March 27, 2013 workshop, which includes "daily shaping of the sub-basin runoff" and the occasional rebalance between the sub-basins "to rectify historically computed negative volumes";
4. Refinement of canal operational assumptions such as "the addition of a component of canal water supply that was previously not recognized in the data set" and the refinement of "monthly turnout delivery factors"; and
5. Changes to the water supply factor based on changes to estimated canal demands and underlying hydrology and a review of ***projected operations***.

These changes are described in further detail in Enclosure A – Don Pedro Project Operations/Water Balance Model Study Report Attachment B – Model Description and User's Guide, Addendum 1 Revised 5-20-2013. These model refinements may be reasonable, but they should be validated against recent historic operation of the project. Given this information, it would appear that "Base Case" is a misnomer, with the subject set of repeatable equations and algorithms and anticipated improvements being more of a "Planning Case" than an actual baseline condition.

Moving beyond concerns over the validation of a Base Case, one aspect that became evident during the workshops is that the interrelated models are constructed to begin with project operational scenarios. One submits a scenario request form (see Enclosure B); the Districts then run the test scenario through the operations model and input the resulting hydrology into the water temperature models. If desired water temperature objectives are not achieved by a test scenario, another set of operational rules must be developed, creating an iterative and somewhat labor intensive process.

Going forward, CDFW is interested in a set of modeling tools that will allow interested parties to start with water temperature objectives and explore subsequent impacts on project operations. CDFW respectfully notes a recently released HEC-5Q model for the San Joaquin River basin has the ability to run such "bottom-up" analyses. Using this tool one can begin with desired temperature conditions (for example, the Environmental Protection Agency (EPA) criteria for salmonids (EPA, 2003)), and then direct the model to develop operational scenarios capable of meeting the selected temperature objectives. The supporting HEC-5Q technical documentation is publically available at: www.rmanet.com/CDFW/HEC5Q-June-13.zip. CDFW encourages interested parties to download this material and become familiar with this modeling tool as it has the potential to provide valuable insight into the development of future mitigation measures.

CDFW appreciates the opportunity to provide comments on the proposed modeling efforts on the Don Pedro Reservoir and Lower Tuolumne River. If you have any questions regarding CDFW's comments provided in this letter, please contact Annie Manji, Staff Environmental Scientist at (530) 224-4924 or Annie.Manji@wildlife.ca.gov.

Sincerely,

Jeffrey R. Single, Ph.D.
Regional Manager, Central Region

Enclosures

cc: See Page Four

cc: Jim Hastreiter
Office of Energy Projects
805 SW Broadway
Fox Tower - Suite 550
Portland, Oregon 97205

Reference

Environmental Protection Agency. 2003. Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. Region 10 Office of Water, Seattle, WA. 57 pp.

Don Pedro Project
Project Operations/Water Balance Model Study Report
Attachment B – Model Description and User's Guide, Addendum 1
Revised 5-20-2013

1.0 INTRODUCTION

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) have developed a computerized Tuolumne River Daily Operations Model (Model) to assist in the relicensing of the Don Pedro Project (Project) (FERC Project 2299). The Model is fully described in the User's Guide submitted to FERC as part of the Initial Study Report (ISR), January 2013 (Model version 1.01). The purpose of the User's Guide is to describe the structure of the Model, the interfaces available for operation of the Model, and methods available for reviewing Model results. Procedures for development of input files for running scenarios for alternative future Project operations are also described and illustrated. The data presented in the ISR document referenced a "Test Case" simulation of operations for illustrative purposes. The test case was presented at a Workshop held with relicensing participants on December 7, 2012 for the purpose of training interested relicensing participants in the use of the Model.

Subsequent to the ISR submittal, the Districts proceeded to develop the "Base Case" which depicts the operation of the Don Pedro Project in accordance with the current FERC license, ACOE flood control management guidelines, and the Districts' irrigation and M&I water management practices. Under FERC policy, the Base Case represents the "No Action" alternative for purposes of evaluating future operation scenarios under NEPA. Future scenarios are compared to the Base Case to assess their impacts. As a result of the effort, including a collaborative refinement of the underlying hydrology of the Model completed at a Workshop held on March 27, 2013, several refinements and modifications to the Model have been implemented. The purpose of this Addendum 1 is to describe the refinements and modifications that have been made to the revised Model (Model Version 2.0) since the ISR submittal.

The Tuolumne River Daily Operations Model provides a depiction of the Don Pedro Project and City and County of San Francisco water operations consistent with the FERC-approved W&AR-02 study plan. The Model portrays operations that can be described systematically by various equations and algorithms. Actual project operations may vary from those depicted by the Model due to circumstantial and real-time conditions of hydrology and weather, facility operation, and human intervention. The FERC-approved study plan has identified a number of user-controlled variables. The fact that the Model provides these user-controlled inputs is not an indication that either the Districts or CCSF endorse or support any specific operational alternative developed by manipulating these inputs.

2.0 MODEL LOGIC AND EXECUTION MODIFICATIONS

Several Model logic routines were modified to provide a better or more adaptable depiction of Project operations. The specific areas of Project operations that were modified included the depiction of the current minimum flow requirements of the Don Pedro Project for the lower Tuolumne River and the reservoir operation logic during June and early July when Don Pedro Reservoir is filling. The simulation of power generation from the Project has also been revised as mentioned in the December 7, 2012 Workshop.

2.1 Don Pedro Reservoir Snow-melt Management

User's Guide reference: Section 5.12: "DonPedro" Worksheet, Section 5.12.3 Snow-melt Management

The Model computes a daily operation of Don Pedro Reservoir. Each day Don Pedro Reservoir inflow is computed from upstream CCSF System operations and unregulated inflow. The minimum stream flow requirements and the MID and TID canal diversions are assumed as the release from Don Pedro Reservoir. The prior day's reservoir evaporation is included in the calculation. If the computation produces a Don Pedro Reservoir storage value in excess of a preferred storage target, an "encroachment" is computed. If an encroachment occurs, a "check" release is computed. It is assumed that a constant supplemental "check" release (in excess of minimum releases) will be initiated. This protocol repeats itself periodically, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic "hard" releases of water to exactly conform to the target reservoir level.

A second check release is made during the April through June period for management of anticipated snow-melt runoff. Model Version 1.01 provided logic that on the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir from the date of forecast through the end of June (the assumed target date of reservoir filling). These forecasts determine the snow-melt "check" release volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. The snow-melt check release is evenly distributed across the days of the month. The release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir (2,030,000 acre-feet, elevation 830 ft) allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the Model to not exceed this storage capacity.

Through testing of alternative Model scenarios it was discovered that Version 1.01 logic could produce erratic reservoir release results during early July, whereby a relatively constant release through the end of June could be followed by an erratic large release during the first part of July. The cause of the circumstance was the result of requiring the "filling" date of the reservoir to be the end of June. The assumption could lead to a full reservoir at the end of June while substantial inflow could subsequently occur. With no empty reservoir space remaining the Model would essentially pass inflow without modulation and in some circumstances large releases in excess of downstream flood control objectives. To remedy this outcome the Model was modified to extend

the June snow-melt release check logic through July 7. All computational procedures for June remained the same except the time period upon which hydrologic information was known or assumed extends through July 7. Figure 2.1-1 illustrates the location of the revised logic within the DonPedro Worksheet, within the June computation section and designated by notes concerning the June through July 7 computational period.

Also newly incorporated into the snow-melt logic routine for the entire April through July 7 period is release change "smoothing" logic which can lessen the occurrence of modeled erratic release reductions that would otherwise sometimes occur during the transition from one month's computed release to the next month's computed release. During periods when the snow-melt release computation is controlling reservoir releases, user-defined values can be specified for a threshold and a rate of change that can occur from one day to the next. The threshold (C 1.13, "Control" Worksheet) defines the level of flow of the previous day for which a constraint to a next-day release reduction will occur, and the fraction (C 1.14, "Control" Worksheet) defines the reduced flow rate that can occur the next day. By illustration, if a previous day's flow is 2,500 cfs or greater, the next day's flow cannot be less than 0.75 of the previous day's flow. This logic does not represent any known "ramping" constraints, but the protocol provides additional guidance to Model release decisions and produces reasonable results.

	A	B	C	D	AS	AT	AU	AV	AW	AX	AY	BA	BB	BC	BD	BE	BF	BG	BI	BK	BL	BM	BN	BO
1			1																					
2	Unit Title		2																CFS	CFS	CFS	CFS	CFS	CFS
3	Parameter Title		3																Target SM Re	Dry Creek	LTR Accr	Tot Unreg	Trg Max L(	Modesto F
4																								
5	Acre-foot to CFS conversion																							
6	divide by :	1.983471			Lookup of 1-May 90% Exc Apr-Jul Runoff	Est of May-Jun Portion of Apr-Jul	Uses Current Yr Canal + Min River +Typ Evap	Compute Upstream Adjust to UF	Compute Availble DP Stor through June	Compute Total Excess May-Jun Release	Amount to be Released during May	Lookup of Actual Jun-Jul 7 Runoff	Est of Actual Jun-Jul 7 Runoff	Uses Current Yr Canal + Min River +Typ Evap	Compute Upstream Adjust to UF	Compute Availble DP Stor through 7-Jul	Compute Total Excess Jun-Jul 7 Release	Amount to be Released during Period						
8																			0	Original equation w/o release ramping constraint				
9																			2,500	Prior day ramping threshold (C 1.13)				
10																			0.75	Fraction of prior day flow for ramping (C 1.14)				
13		39-year Ave or Max			49	% May/May MJ					(C 1.20)							(C 1.30)					(C 1.00)	
14		Min			38	% Jun/May MJ		% of May-Jun excess rel in May			50				% of June excess rel in June-Jul 7			100			Enter Modesto FC Target:		9,000	CFS
15					May Snow-melt Release Routine							June - July 7 Snow-melt Release Routine								Modesto Flood Control Flow Objective				
16					May							June - July 7							Target	Report	Est	Total	Target	Calc
17	Month				1-May	1-May	M-Jun	M-Jun	M-Jun	M-Jun	May	June -	June -	Period	Period	Period	Period	Period	SM	Dry Creek	LTR Acc	Unreg	Max	Modesto
18	Index	Date	Day	Days	A-Jul Fcst	MJune Fcst	Can+Riv+E	USAdj	DP Avail	Excess	SM Rel	July 7 UF	July 7 UF	Can+Riv+E	USAdj	DP Avail	Excess	SM Rel	Release	Flow	Flow	Blw LG	LaGrange	Flow
19					TAF	TAF	AF	AF	AF	AF	CFS	TAF	TAF	AF	AF	AF	AF	CFS	CFS	CFS	CFS	CFS	CFS	CFS
20	1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
21	1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
22	1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
23	1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
24	1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
25	1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
26	1970.10	10/7/1970	W	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
27	1970.10	10/8/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
28	1970.10	10/9/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410
29	1970.10	10/10/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	110	8,890	410

Figure 2.1-1. Snow-melt management section.

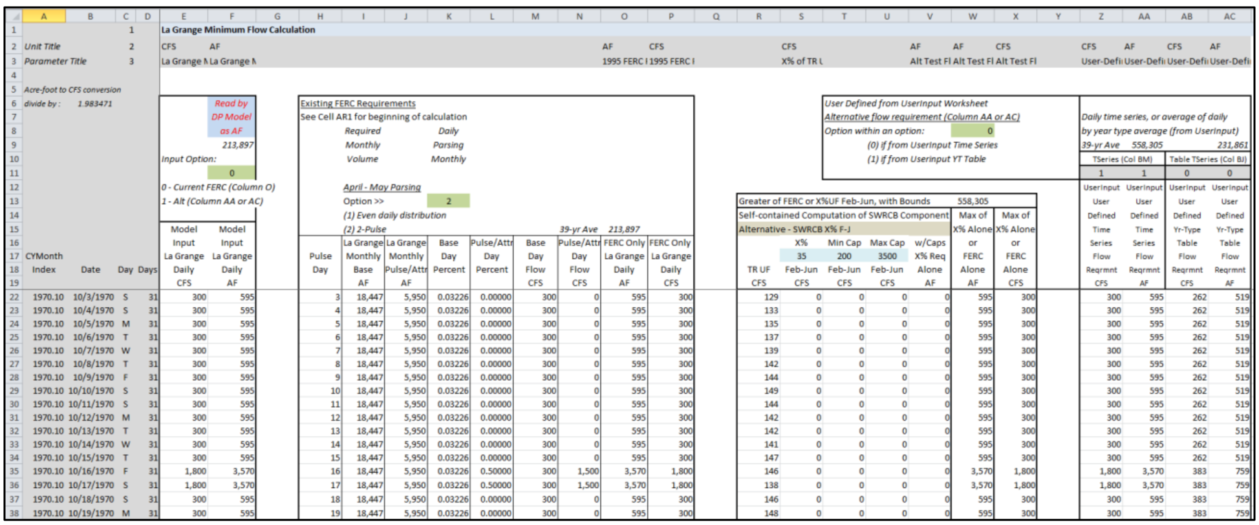
2.2 Don Pedro Current Minimum Flow Requirement

User's Guide reference: Section 5.17: "LaGrangeSchedule" Worksheet, Section 5.17.1 Minimum Flow Requirement Options, Section 5.17.2 April-May Daily Parsing of Flow Requirements, and Section 5.17.3 Computation of 1995 FERC Minimum Flow Requirement

The FERC license for the Don Pedro Project requires flow releases from Don Pedro Reservoir to the lower Tuolumne River. These flows are measured at the USGS gage downstream of the La Grange diversion dam. To keep the Don Pedro Reservoir required flow releases distinct from Don Pedro Reservoir releases in general the model designates "LaGrangeSchedule" Worksheet for assemblage of the minimum flow requirement for the lower Tuolumne River. By user specification (UI 1.10) either the current 1995 FERC schedule is selected (UI 1.10 = 0) or the

user defined minimum flow requirement is selected (UI 1.10 = 1). If the current 1995 FERC schedule is selected the computation of the schedule is computed in this worksheet.

When using current 1995 FERC minimum flow requirements, Version 1.01 (Switch C 1.60, “Control” Worksheet) allowed the user to direct the daily shape of release for pulse flows during April and May. Version 2.0 continues to allow the shaping of April-May migration flows to the lower Tuolumne River and also allows a shaping of October attraction flows. Figure 2.2-1 illustrates the parsing of the monthly flow requirements into daily flow requirements. The structure of this section of the worksheet is mostly the same as before, except the monthly/daily flow requirements have now been defined by “base” and “pulse” components. Also, a computational procedure has been added for October to prescribe current FERC-defined attraction flows.



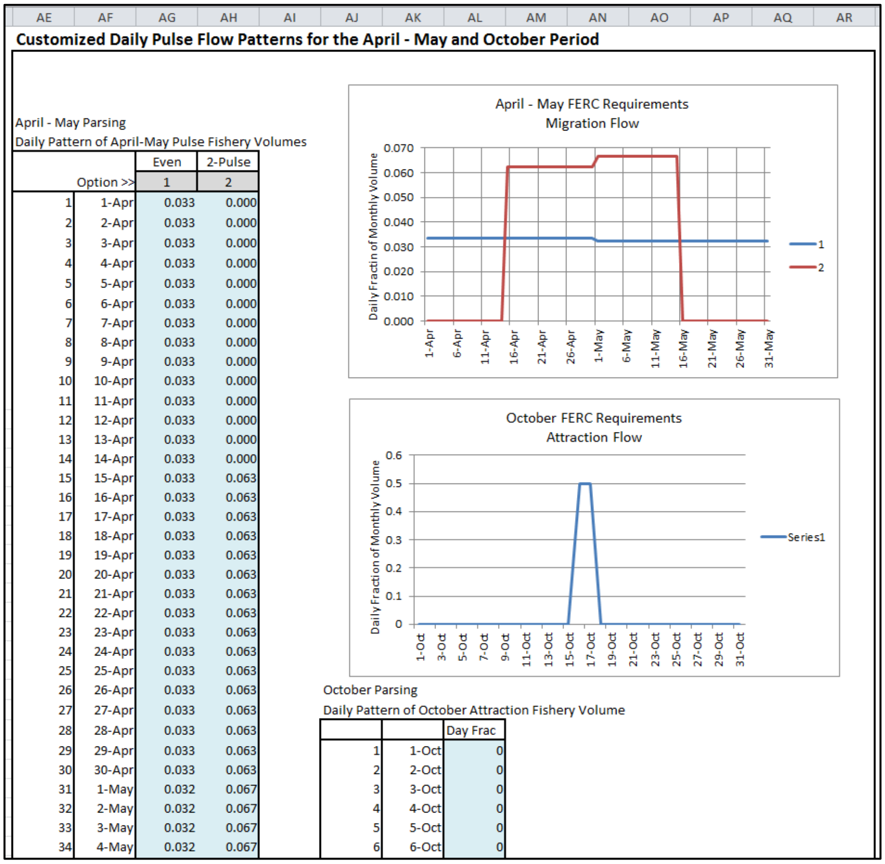
Row	CYMonth Index	Date	Day	Days	Model Input La Grange Daily CFS	Model Input La Grange Daily AF	Pulse Day	La Grange Monthly Base AF	La Grange Monthly Pulse/Attr AF	Base Day Percent	Pulse/Attr Day Percent	Base Day Flow CFS	Pulse/Attr Day Flow CFS	FERC Only La Grange Daily AF	FERC Only La Grange Daily CFS	TR UF CFS	X% Feb-Jun CFS	Min Cap Feb-Jun CFS	Max Cap Feb-Jun CFS	w/Caps X% Req Alone AF	Max of X% Alone or FERC Alone AF	Max of X% Alone or FERC Alone CFS	UserInput User Defined Time Series Flow Reqrmnt CFS	UserInput User Defined Time Series Flow Reqrmnt AF	UserInput User Defined Yr-Type Table Flow Reqrmnt CFS	UserInput User Defined Yr-Type Table Flow Reqrmnt AF
22	1970.10	10/3/1970	S	31	300	595	3	18,447	5,950	0.03226	0.00000	300	0	595	300	129	0	0	0	0	595	300	300	595	262	519
23	1970.10	10/4/1970	S	31	300	595	4	18,447	5,950	0.03226	0.00000	300	0	595	300	133	0	0	0	0	595	300	300	595	262	519
24	1970.10	10/5/1970	M	31	300	595	5	18,447	5,950	0.03226	0.00000	300	0	595	300	135	0	0	0	0	595	300	300	595	262	519
25	1970.10	10/6/1970	T	31	300	595	6	18,447	5,950	0.03226	0.00000	300	0	595	300	137	0	0	0	0	595	300	300	595	262	519
26	1970.10	10/7/1970	W	31	300	595	7	18,447	5,950	0.03226	0.00000	300	0	595	300	139	0	0	0	0	595	300	300	595	262	519
27	1970.10	10/8/1970	T	31	300	595	8	18,447	5,950	0.03226	0.00000	300	0	595	300	142	0	0	0	0	595	300	300	595	262	519
28	1970.10	10/9/1970	F	31	300	595	9	18,447	5,950	0.03226	0.00000	300	0	595	300	144	0	0	0	0	595	300	300	595	262	519
29	1970.10	10/10/1970	S	31	300	595	10	18,447	5,950	0.03226	0.00000	300	0	595	300	149	0	0	0	0	595	300	300	595	262	519
30	1970.10	10/11/1970	S	31	300	595	11	18,447	5,950	0.03226	0.00000	300	0	595	300	144	0	0	0	0	595	300	300	595	262	519
31	1970.10	10/12/1970	M	31	300	595	12	18,447	5,950	0.03226	0.00000	300	0	595	300	142	0	0	0	0	595	300	300	595	262	519
32	1970.10	10/13/1970	T	31	300	595	13	18,447	5,950	0.03226	0.00000	300	0	595	300	142	0	0	0	0	595	300	300	595	262	519
33	1970.10	10/14/1970	W	31	300	595	14	18,447	5,950	0.03226	0.00000	300	0	595	300	141	0	0	0	0	595	300	300	595	262	519
34	1970.10	10/15/1970	T	31	300	595	15	18,447	5,950	0.03226	0.00000	300	0	595	300	147	0	0	0	0	595	300	300	595	262	519
35	1970.10	10/16/1970	F	31	1,800	3,570	16	18,447	5,950	0.03226	0.50000	300	1,500	3,570	1,800	146	0	0	0	0	3,570	1,800	1,800	3,570	383	759
36	1970.10	10/17/1970	S	31	1,800	3,570	17	18,447	5,950	0.03226	0.50000	300	1,500	3,570	1,800	138	0	0	0	0	3,570	1,800	1,800	3,570	383	759
37	1970.10	10/18/1970	S	31	300	595	18	18,447	5,950	0.03226	0.00000	300	0	595	300	146	0	0	0	0	595	300	300	595	383	759
38	1970.10	10/19/1970	M	31	300	595	19	18,447	5,950	0.03226	0.00000	300	0	595	300	148	0	0	0	0	595	300	300	595	383	759

Figure 2.2-1. Daily parsing of FERC flow requirement from Don Pedro Reservoir.

Figure 2.2-2 illustrates the area for entry of data to parse monthly-designated migration and attraction flow requirements into daily patterns during April, May and October. The “Control” Worksheet designates which parsing pattern is to be used for April and May. The examples illustrate the entry for an evenly distributed pattern of migration flow volume during the April-May 61-day period, and a pattern for which the migration flow volume (by daily fraction of the volume) has been divided between April (16 days) and May (15 days). The migration flow volume for each month has been evenly distributed during each day of the partial month period. These daily migration flows are added to the base flow component of each month. The parsing of the attraction flow volume during the month of October is similarly defined. In this example the attraction flow volume (by daily fraction of the volume) for October is distributed evenly over a two-day period beginning October 15.

Figure 2.2-3 illustrates the section of the worksheet that defines the current 1995 FERC flow requirement from Don Pedro Reservoir. Several elements of information provided in this worksheet and from the “Control” Worksheet provide the computation of flow requirement based on 1995 FERC Settlement procedures and flow rates. The basis of the year type flow requirements is the SWRCB San Joaquin River Basin 60-20-20 index. The annual flow

schedules are assumed to be on an April through March year, with the interpolation water of the schedules applied to April and May pulse flows. For modeling convenience the explicit FERC requirements for October base and attraction flows have been slightly modified to adapt into the evenly daily distributed base flow component of the Model.



April - May Parsing
Daily Pattern of April-May Pulse Fishery Volumes

		Even	2-Pulse
	Option >>	1	2
1	1-Apr	0.033	0.000
2	2-Apr	0.033	0.000
3	3-Apr	0.033	0.000
4	4-Apr	0.033	0.000
5	5-Apr	0.033	0.000
6	6-Apr	0.033	0.000
7	7-Apr	0.033	0.000
8	8-Apr	0.033	0.000
9	9-Apr	0.033	0.000
10	10-Apr	0.033	0.000
11	11-Apr	0.033	0.000
12	12-Apr	0.033	0.000
13	13-Apr	0.033	0.000
14	14-Apr	0.033	0.000
15	15-Apr	0.033	0.063
16	16-Apr	0.033	0.063
17	17-Apr	0.033	0.063
18	18-Apr	0.033	0.063
19	19-Apr	0.033	0.063
20	20-Apr	0.033	0.063
21	21-Apr	0.033	0.063
22	22-Apr	0.033	0.063
23	23-Apr	0.033	0.063
24	24-Apr	0.033	0.063
25	25-Apr	0.033	0.063
26	26-Apr	0.033	0.063
27	27-Apr	0.033	0.063
28	28-Apr	0.033	0.063
29	29-Apr	0.033	0.063
30	30-Apr	0.033	0.063
31	1-May	0.032	0.067
32	2-May	0.032	0.067
33	3-May	0.032	0.067
34	4-May	0.032	0.067

October Parsing
Daily Pattern of October Attraction Fishery Volume

		Day Frac
1	1-Oct	0
2	2-Oct	0
3	3-Oct	0
4	4-Oct	0
5	5-Oct	0
6	6-Oct	0

Figure 2.2-2. Daily parsing of FERC migration and attraction flow.

BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW

FERC Flow Schedules

Year Type	1	2	3	4	5	6	7	Adapted October 6
Oct 1-15 (CFS)	100	100	150	150	180	200	300	188
Oct 16-31 (CFS)	150	150	150	150	180	175	300	188
Total Base (AF)	7,736	7,736	9,223	9,223	11,068	11,504	18,447	11,560
Attraction (AF)	0	0	0	0	1,676	1,736	5,950	1,680
Total Oct (AF)	7,736	7,736	9,223	9,223	12,744	13,240	24,397	13,240
Nov (CFS)	150	150	150	150	180	175	300	
AF	8,926	8,926	8,926	8,926	10,711	10,413	17,852	
Dec (CFS)	150	150	150	150	180	175	300	
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447	
Jan (CFS)	150	150	150	150	180	175	300	
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447	
Feb (CFS)	150	150	150	150	180	175	300	
AF	8,331	8,331	8,331	8,331	9,997	9,719	16,661	
Mar (CFS)	150	150	150	150	180	175	300	
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447	
Apr (CFS)	150	150	150	150	180	175	300	
AF	8,926	8,926	8,926	8,926	10,711	10,413	17,852	
May (CFS)	150	150	150	150	180	175	300	
AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447	
Migration Flow								
AF	11,091	20,091	32,619	37,060	35,920	60,027	89,882	
Jun (CFS)	50	50	50	75	75	75	250	
AF	2,975	2,975	2,975	4,463	4,463	4,463	14,876	
Jul (CFS)	50	50	50	75	75	75	250	
AF	3,074	3,074	3,074	4,612	4,612	4,612	15,372	
Aug (CFS)	50	50	50	75	75	75	250	
AF	3,074	3,074	3,074	4,612	4,612	4,612	15,372	
Sep (CFS)	50	50	50	75	75	75	250	
AF	2,975	2,975	2,975	4,463	4,463	4,463	14,876	
Total Annual	94,001	103,001	117,017	127,508	142,503	165,004	300,926	

October has been modified from explicit FERC Schedule for modeling simplicity. Split-month base flow has been levelized.

Figure 2.2-3. 1995 FERC minimum flow requirement schedule.

Figure 2.2-4 illustrates the revised computational section of the “LaGrangeSchedule” Worksheet that computes the components of base and total required schedule annual volumes, October attraction flow volume, and April-May migration flow volume. Other sections of the worksheet have been revised to define the monthly distribution of annual volumes for incorporation into the daily parsing routines shown above.

AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI
Current FERC Requirements														
	Tuolumne River Flow Interpolation - Year 2011 Revised Distribution													
	Flow Year Type			SJR Basin Index				Flow Requirement						October
													Base	Attraction
	1		<	1510								94000	82,910	0
	2			1510	- <	2000		0.0286	x (Index -	1510	) +	103000	82,910	0
	3			2000	- <	2190		0.0552	x (Index -	2000	) +	117016	84,398	0
	4			2190	- <	2440		0.0600	x (Index -	2190	) +	127507	90,448	0
	5			2440	- <	2720		0.0804	x (Index -	2440	) +	142502	104,907	1,676
	6			2720	- <	3180		0.2955	x (Index -	2720	) +	165002	103,297	1,680
	7			3180	and Greater							300923	205,094	5,950
									Option >>	1	2	3	4	5
	1	<<Option			Ave	219,421	146,114	70,146		Actual	90% Exc.	75% Exc.	Med.	10% Exc.
	SJR				TR	Tuolumne	Tuolumne	Pulse	Base	SJR	Apr SJR	Apr SJR	Apr SJR	Apr SJR
	Index	Year			October	River	River	Flow	Year	Index	Index	Index	Index	Index
	602020	Class		Year	Attraction	Require	Base	Calc	Type	602020	Fcast	Fcast	Fcast	Fcast
	4,543,729	Wet		1922	5,950	300,923	205,094	89,879	7	4,543,729	2,424,373	2,561,322	2,674,495	2,921,846
	3,549,358	Above		1923	5,950	300,923	205,094	89,879	7	3,549,358	1,765,568	1,897,976	2,007,411	2,246,643
	1,419,746	Critical		1924	0	94,000	82,910	11,090	1	1,419,746	799,642	853,197	957,737	1,186,335
	2,929,617	Below		1925	1,680	226,944	103,297	121,967	6	2,929,617	2,042,878	2,179,628	2,292,637	2,539,632
	2,300,567	Dry		1926	0	134,141	90,448	43,693	4	2,300,567	1,256,470	1,387,014	1,494,917	1,730,818
	3,558,955	Above		1927	5,950	300,923	205,094	89,879	7	3,558,955	2,147,110	2,284,156	2,397,408	2,644,932
	2,632,407	Below		1928	1,676	157,972	104,907	51,388	5	2,632,407	1,934,163	2,068,826	2,180,117	2,423,380
	2,004,815	Critical		1929	0	117,282	84,398	32,884	3	2,004,815	1,140,712	1,270,277	1,377,372	1,611,521

Figure 2.2-4. 1995 FERC flow requirements from Don Pedro Reservoir.

2.3 Don Pedro Project Generation

User's Guide reference: Section 5.12: "DonPedro" Worksheet, Section 5.12.5 Don Pedro Project Generation and River Flows

The hydroelectric generation characteristics of any modeled Project operation scenario are modeled incidental to Project hydrologic operations. The power generation of the Project is computed from the simulation of daily time step operations and is incoporated into the "DonPedro" Worksheet. Input to the power component includes daily average flow past Don Pedro Dam (flow through the dam and through the spillway, if any) and Don Pedro Reservoir storage. The power component computes gross and net head, flow through turbines, efficiency and power output based on a group of reservoir rating, tailwater rating and manufacturer's performance characteristic curves, and generalized equations for head losses.

Figure 2.3-1 illustrates the components of computational procedure that derives power output of the Project. The power characteristics of the turbine generators are defined for a range of head and flow combinations. "Cutoff" of generation that would otherwise be indicated by the performance curves is provided through user defined switches entered in the "Control" Worksheet. Switch C 1.20 defines the minimum reservoir storage level at which generation occurs, and Switch C 1.22 defines the maximum flow through the powerplant. In this illustration generation will not occur when Don Pedro Reservoir storage is less than 308,960 acre-feet (elevation 600 ft). The performance curves indicate that generation may occur up to a flow rate of approximately 5,500 cfs. Switch C 1.22 has been set higher than this value to not impede the computation.

	A	B	C	D	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ
1			1																	
2	*Unit Title*		2			CFS														
3	*Parameter Title*		3			Total Dam Release														
4																				
5	*Acre-foot to CFS conversion*																			
6	*divide by :*	*1.983471*																		
7																				
8					*TEST*															
9					*11/21/1977*	*289*	*361,955*	*614.3*	*298.0*	*316.3*	*316.2*	*310*	*325*	*0*		*3*	*1*	*10*	*4550*	*289*
10																				
11							*308,960*	*(C 1.20) Cutoff of generation, DP Storage (sets available units to zero)*												
12						*Penstock Loss:*	*9.66E-07*	*ft/cfs²*		*Scheduled Maintenance? (1) Yes, (0) No:*				*0*					*6,000*	
13				*39-year Ave or Max*	*Max*	*67,039*		*830*	*298*	*532*	*527*	*530*	*525*			*3*	*1*	*10*	*5,655*	*5,500*
14				*Min*	*Min*	*207*		*614*	*298*	*316*	*316*	*310*	*325*			*3*	*1*	*10*	*4,550*	*207*
15					**Don Pedro Power Generation**															
16						Don	Don	Don	Approx			Net H	Net H		Unsched	Number	Number	Min	Max	Potential
17	Month					Pedro	Pedro	Pedro	Tailwater	Gross	Approx	Look-up	Look-up	Sched	Outage /	Available	Available	Plant	Plant	Plant
18	Index	Date	Day	Days		Release	Storage	Elevation	Elevation	Head	Net H	Units 1-3	Unit 4	Outage	Bypass	Units 1-3	Unit 4	Flow	Flow	Flow
19						CFS	Ave-AF	FT elev	FT elev	FT	FT	FT	FT	unit #	unit #			CFS	CFS	CFS
20	1970.10	10/1/1970	T	31		2,037	1,669,232	800.0	298.0	502.0	498.0	490	500	0		3	1	10	5500	2,037
21	1970.10	10/2/1970	F	31		1,288	1,666,644	799.7	298.0	501.7	500.1	510	500	0		3	1	10	5500	1,288
22	1970.10	10/3/1970	S	31		1,209	1,664,882	799.6	298.0	501.6	500.2	510	500	0		3	1	10	5500	1,209
23	1970.10	10/4/1970	S	31		1,718	1,662,698	799.4	298.0	501.4	498.6	490	500	0		3	1	10	5500	1,718
24	1970.10	10/5/1970	M	31		1,378	1,660,351	799.2	298.0	501.2	499.4	490	500	0		3	1	10	5500	1,378
25	1970.10	10/6/1970	T	31		1,502	1,658,222	799.0	298.0	501.0	498.8	490	500	0		3	1	10	5500	1,502
26	1970.10	10/7/1970	W	31		1,322	1,656,151	798.8	298.0	500.8	499.1	490	500	0		3	1	10	5500	1,322
27	1970.10	10/8/1970	T	31		728	1,654,638	798.7	298.0	500.7	500.2	510	500	0		3	1	10	5500	728
28	1970.10	10/9/1970	F	31		827	1,653,407	798.5	298.0	500.5	499.8	490	500	0		3	1	10	5500	827
29	1970.10	10/10/1970	S	31		898	1,652,016	798.4	298.0	500.4	499.6	490	500	0		3	1	10	5500	898

	A	B	C	D	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL
1			1													
2	*Unit Title*		2						CFS							kWh
3	*Parameter Title*		3						Total Plant Flow							Modeled D
4																
5	*Acre-foot to CFS conversion*															
6	*divide by :*	*1.983471*														
7																
8																
9					*1*	*289*	*0*	*0*	*289*	*315.9*	*60.0%*	*0.0%*	*4,648*	*0*	*4,648*	*111,544*
10																
11																
12								*39-yr Annual Ave (AF):*	*1,501,380*						*39-yr Annual Ave (MWh):*	*603,718*
13				*39-year Ave or Max*	*3*		*1*	*1,000*	*5,500*	*525*	*0.90*	*0.92*	*172,991*	*38,653*	*208,219*	*4,997,256*
14				*Min*	*1*		*0*	*0*	*207*	*316*	*0.60*	*0.00*	*3,333*	*0*	*3,333*	*80,003*
15																
16						Flow		Flow			Plant	Plant				Plant
17	Month				Operation	Through	Operation	Through	Plant	Net	Effic	Effic	Power	Power	Plant	Daily
18	Index	Date	Day	Days	Units 1-3	Units 1-3	Unit 4	Unit 4	Flow	Head	Units 1-3	Unit 4	Units 1-3	Unit 4	Power	Generation
19					Count	CFS		CFS	CFS	FT	%	%	kW	kW	kW	kWh
20	1970.10	10/1/1970	T	31	3	679	0	0	2037	495.0	77.2%	0.0%	65,942	0	65,942	1,582,609
21	1970.10	10/2/1970	F	31	3	429	0	0	1288	498.2	65.2%	0.0%	35,423	0	35,423	850,156
22	1970.10	10/3/1970	S	31	3	403	0	0	1209	498.3	63.9%	0.0%	32,602	0	32,602	782,449
23	1970.10	10/4/1970	S	31	3	573	0	0	1718	496.0	73.4%	0.0%	53,001	0	53,001	1,272,019
24	1970.10	10/5/1970	M	31	3	459	0	0	1378	497.3	67.8%	0.0%	39,381	0	39,381	945,135
25	1970.10	10/6/1970	T	31	3	501	0	0	1502	496.5	70.3%	0.0%	44,432	0	44,432	1,066,359
26	1970.10	10/7/1970	W	31	3	441	0	0	1322	497.1	67.0%	0.0%	37,296	0	37,296	895,105
27	1970.10	10/8/1970	T	31	2	364	0	0	728	499.0	60.0%	0.0%	18,467	0	18,467	443,214
28	1970.10	10/9/1970	F	31	3	276	0	0	827	498.5	60.0%	0.0%	20,971	0	20,971	503,311
29	1970.10	10/10/1970	S	31	3	299	0	0	898	498.3	60.0%	0.0%	22,759	0	22,759	546,222

Figure 2.3-1. Project power computational procedure.

A validation of the computational process was made by comparing Model-produced generation to historically reported generation. Table 2.3-1 shows a comparison between computed and reported generation for a 2002 – 2009 period of record. The results show that Project generation is well depicted with the computational procedures, with minimal annual differences. This period of record includes a dry (reduced reservoir and releases) to wet (full reservoir and large releases) range of hydrologic conditions. Figure 2.3-2 illustrates the comparison of Model-produced daily generation and historically reported generation for calendar year 2003, which had a range of reservoir storage and release conditions.

Table 2.3-1. Modeled and reported Project power.

Reported Generation (MWh)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2002	5,079	4,259	38,044	61,819	54,412	54,341	66,448	52,811	28,790	18,760	6,073	7,005	397,840
2003	5,395	11,275	25,076	39,599	51,964	68,313	75,800	61,667	32,692	33,135	8,343	6,261	419,520
2004	7,509	12,122	62,985	72,157	58,301	58,788	68,904	54,145	25,452	23,118	4,565	4,402	452,449
2005	12,339	48,759	98,233	137,057	143,777	137,291	122,689	84,793	43,861	22,203	9,831	33,044	893,877
2006	111,669	72,155	125,741	110,498	131,217	124,759	97,387	80,643	46,356	26,152	11,631	8,204	946,413
2007	12,597	15,207	45,088	48,189	54,255	57,216	64,531	53,546	22,957	15,461	7,032	3,780	399,859
2008	3,184	5,562	37,289	43,158	58,312	45,852	54,811	46,690	22,417	11,467	4,647	6,114	339,501
2009	4,912	5,326	21,733	41,084	55,267	56,222	67,625	53,082	28,388	18,051	7,781	5,495	364,965
Average	20,335	21,833	56,774	69,195	75,938	75,348	77,274	60,922	31,364	21,043	7,488	9,288	526,803
Ann Dist	4%	4%	11%	13%	14%	14%	15%	12%	6%	4%	1%	2%	100%

Modeled Generation (MWh)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2002	4,692	4,343	36,119	63,521	54,701	56,249	69,864	53,614	27,334	17,457	5,765	6,422	400,081
2003	5,104	10,231	23,762	39,691	51,839	67,021	80,295	64,791	31,953	31,070	7,742	5,434	418,932
2004	6,696	11,128	62,972	75,770	60,036	59,137	70,224	55,786	24,403	21,785	5,131	4,488	457,555
2005	13,839	50,180	109,404	139,619	146,930	147,343	132,278	89,284	44,552	21,561	10,306	35,026	940,321
2006	102,499	71,293	130,498	108,499	113,092	111,410	102,790	82,253	45,051	24,484	11,237	7,320	910,425
2007	11,023	13,343	43,437	47,548	54,298	59,601	67,647	56,301	22,600	14,898	6,724	4,165	401,585
2008	3,820	5,733	37,688	43,469	59,007	45,476	56,320	49,154	21,603	10,833	4,542	6,150	343,795
2009	4,985	5,740	21,720	40,985	55,636	58,102	72,166	56,015	28,577	16,255	7,465	5,421	373,066
Average	19,082	21,499	58,200	69,888	74,443	75,542	81,448	63,400	30,759	19,793	7,364	9,303	530,720
Generation	4%	4%	11%	13%	14%	14%	15%	12%	6%	4%	1%	2%	100%

% Deviation ((Reported-Actual)/Actual)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2002	-8%	2%	-5%	3%	1%	4%	5%	2%	-5%	-7%	-5%	-8%	1%
2003	-5%	-9%	-5%	0%	0%	-2%	6%	5%	-2%	-6%	-7%	-13%	0%
2004	-11%	-8%	0%	5%	3%	1%	2%	3%	-4%	-6%	12%	2%	1%
2005	12%	3%	11%	2%	2%	7%	8%	5%	2%	-3%	5%	6%	5%
2006	-8%	-1%	4%	-2%	-14%	-11%	6%	2%	-3%	-6%	-3%	-11%	-4%
2007	-12%	-12%	-4%	-1%	0%	4%	5%	5%	-2%	-4%	-4%	10%	0%
2008	20%	3%	1%	1%	1%	-1%	3%	5%	-4%	-6%	-2%	1%	1%
2009	1%	8%	0%	0%	1%	3%	7%	6%	1%	-10%	-4%	-1%	2%
Average	-6%	-2%	3%	1%	-2%	0%	5%	4%	-2%	-6%	-2%	0%	1%

Modeled generation includes assumptions for historical outages of units.

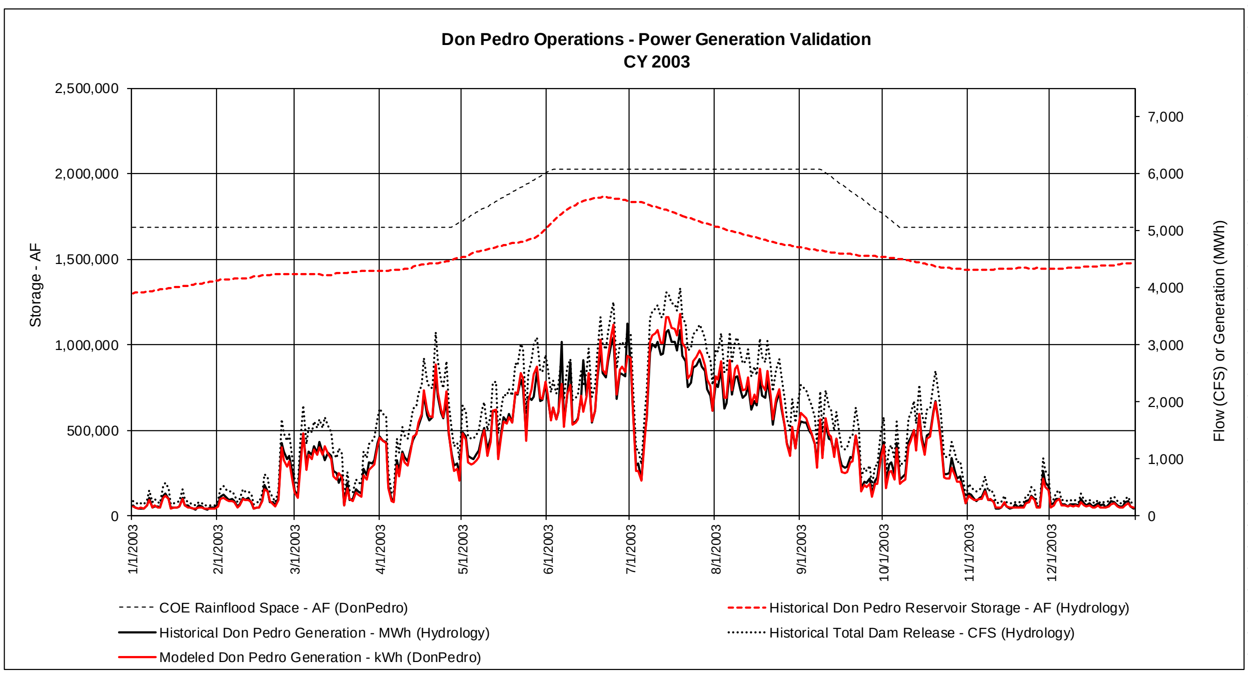


Figure 2.3-2. Project power daily generation.

3.0 INPUT AND HYDROLOGY MODIFICATIONS

Several changes to underlying hydrology and data assumptions have been implemented in the Model (Version 2.0).

3.1 Unimpaired Runoff

User's Guide reference: Section 5.22: "Hydrology" Worksheet

Concern was raised regarding the sometimes erratic daily pattern of computed unimpaired runoff for various components of the historical record, and the occassional computation of a "negative" value of flow. Although the use of the historically computed data are known to not adversely affect Model results, the Districts forwarded an approach to developing a hybrid gauge summation/gage proration hydrologic record for Tuolumne River unimpaired flow that would provide a "smoother" hydrograph. At a Workshop on March 27, 2013, RPs and the Districts worked through the approach and came to a consensus on an acceptable record of unimpaired flow for the Tuolumne River. It was clearly stated that the Districts and CCSF will not change their historical methods for calculating their respective water supplies from the Tuolumne River or the historical record of water bank operations. This modified data set will only be used to estimate unimpaired flow for the FERC relicensing.

Modified sub-basin hydrology was implemented for Hetch Hetchy Reservoir inflow, Cherry/Eleanor inflow, and the unregulated inflow to Don Pedro Reservoir. With only one month of exception, the historically computed monthly volumes of total runoff above La Grange were maintained in the modified data set. However, the daily shaping of the sub-basin runoff was modified, and on occasion rebalanced between the sub-basins to rectify historically computed negative volumes. Figure 3.1-1 illustrates the location and an example of the modified hydrology implemented in the "Hydrology" Worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1			1		Hydrology								
2			2		CFS	CFS	CFS	CFS	CFS		CFS	CFS	CFS
3			3		Unimpaire	Unimpaire	Unimpaire	Revised Ur	Unregulated Inflow tc		Dry Creek	Total LTR Ac	Modesto to
6					Read by	Read by	Read by		Read by		Read by	Read by	Read by
7					Model	Model	Model		Model		Model	Model	Model
12											LTR Accretions		
13					March 26, 2013 Prorated Hydrology						Nov 2012	Nov 2012	
14											Dry Creek	Lower	Modesto
15					1,934,193	762,930	487,867		683,396		Flow @	Tuolumne	to
16					Unimpaired Flow			Computed Flow			Modesto	River	Confluence
17	Month					Hetch	Cherry/		Unregul		HDR est.	Acc abv	
18	Index	Date	Day		La Grange	Hetchy	Eleanor		blw SF			Modesto	
19					CFS	CFS	CFS		CFS		CFS	CFS	CFS
20	1970.10	10/1/1970	T		125	4	14		107		30	80	32
21	1970.10	10/2/1970	F		130	4	14		111		30	80	32
22	1970.10	10/3/1970	S		129	4	14		111		30	80	32
23	1970.10	10/4/1970	S		133	4	15		115		30	80	32
24	1970.10	10/5/1970	M		135	4	15		117		30	80	32
25	1970.10	10/6/1970	T		137	4	15		118		30	80	32
26	1970.10	10/7/1970	W		139	4	15		119		30	80	32
27	1970.10	10/8/1970	T		142	4	15		122		30	80	32
28	1970.10	10/9/1970	F		144	4	15		124		30	80	32
29	1970.10	10/10/1970	S		149	4	16		130		30	80	32

Figure 3.1-1. Unimpaired runoff data set.

3.2 District Canal Operation Assumptions

User's Guide reference: Section 5.18: "DailyCanalsCompute" Worksheet, Section 5.18.3 Daily Canal Operation Assumptions

The "DailyCanalsCompute" Worksheet performs the computation of the daily canal demands of the MID and TID. The computation of canal demands incorporate the PDAW and canal operations practices of the Districts. Canal operation assumptions include regulating reservoir operation, seepage and losses, nominal groundwater pumping and canal operational spills. Since the initial development of data for the Model, a recent review of the Districts' operation records associated with the Districts' preparation and filing of their 5-year Agricultural Water Management Plans has led to the refinement of certain canal operations assumptions. Model (Version 2.0) assumptions for each District are shown Figure 3.2-1.

Modesto Irrigation District

Month	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Modesto Res	Intercepted Flows	Nominal MID GW Pumping	Modesto Res and Upper Canal Losses/Div	Municipal Delivery from Modesto Res	Modesto Res Target Storage	Modesto Res Target Storage Change
	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0	2.0
February	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0	1.0
March	65.0	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0	0.0
April	70.0	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0	1.0
May	85.0	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0	1.0
June	85.0	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0	0.0
July	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0	1.0
August	70.0	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0	1.0
September	65.0	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0	-2.0
October	40.0	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0	-3.0
November	30.0	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0	-2.0
December	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0	0.0
Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5		

MID March TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	65.0
9.9	65.0
13.2	65.0
20.0	65.0
9999.0	65.0

TID March TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	65.0
19.8	65.0
27.5	65.0
40.0	65.0
9999.0	65.0

MID April TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	70.0
10.0	70.0
17.5	70.0
25.0	80.0
9999.0	80.0

TID April TO Factor

Factor Break Pnt (PDAW-TAF)	Factor %
0.0	57.5
20.0	57.5
35.0	70.0
50.0	80.0
9999.0	80.0

Turlock Irrigation District

Month	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Turlock Lk	Intercepted and Other Flows	Nominal TID GW Pumping	Turlock Lk and Upper Canal Losses	Other Delivery from Turlock Lk	Turlock Lk Target Storage	Turlock Lk Target Storage Change
	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0	5.0
February	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0	7.0
March	65.0	1.2	3.0	3.0	4.5	0.5	4.1	1.0	0.0	30.0	5.0
April	57.5	2.4	5.1	6.3	4.5	1.0	8.0	6.6	0.0	30.0	0.0
May	85.0	3.6	4.6	6.7	4.5	1.3	10.3	7.7	0.0	32.0	2.0
June	92.5	5.2	4.2	6.7	4.5	1.3	12.4	8.2	0.0	32.0	0.0
July	75.0	6.4	4.2	6.7	4.5	1.5	14.6	8.7	0.0	32.0	0.0
August	65.0	6.2	4.0	7.3	4.5	1.5	13.3	9.0	0.0	30.0	-2.0
September	67.5	3.9	3.2	7.3	4.5	1.0	9.1	5.0	0.0	27.0	-3.0
October	40.0	2.4	2.3	7.3	4.5	0.5	5.3	2.0	0.0	13.0	-14.0
November	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
December	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
Total		31.3	38.6	59.3	39.2	8.5	77.1	52.2	0.0		

Figure 3.2-1. Districts' canal demand components.

The change that has occurred to the data set is the estimation of “intercepted and other flows” for the TID canal system. The change reflects the addition of a component of canal water supply that was previously not recognized in the data set. Also refined in the data set and computational process for both Districts were several of the monthly turnout delivery factors. The turnout delivery factors are unique to each District and represent a modeling mechanism to adjust the PDAW for irrigation practices that are not included in the estimation of the CUAW, such as irrigation that provides for groundwater recharge. Data identified in this worksheet are entered through the Control Worksheet.

3.3 Don Pedro Water Supply Factor

User’s Guide reference: Section 5.20: “DPWSF” Worksheet

The “DPSWF” Worksheet computes the Don Pedro Water Supply Factor (WSF). The premise of the WSF factor is to reduce the amount of water diverted to the canals during years when lack of carryover storage at Don Pedro Reservoir becomes a concern. The modeling mechanism used to reduce canal diversions is a factor applied to the PDAW of the canal demand. This mechanism results in a reduction to the amount of water “turned out” to the customers. Changes to estimated canal demands and underlying hydrology, in combination with the review of projected operations has led to a change in the WSF to be used for the Base Case. Figure 3.3-1 illustrates the Base Case WSF components in the Model (Version 2.0). The values are entered in the “Control” Worksheet.

Don Pedro Reservoir Inflow Forecast for Diversion of Water Supply

Reservoir Index Method - Active Matrix

	M/T NDP Stor + Infl Index	M/TID WS Factor	+1	+1
	kaf	%		
Enter	0	0.75	1090	0.75
Values	1090	0.75	1090	0.875
From	1090	0.875	1700	0.875
C1.90	1700	0.875	1700	1
	1700	1	2300	1
	2300	1	9999	1
	9999	1		

(W)ater (S)upply (F)actor is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir.

Forecast begins for February:
EO-January storage + Feb-July UF - Feb-July US adj - Feb-Mar minimum river
March Forecast:
EO-February storage + Mar-July UF - Mar-July US adj - Mar minimum river
April Forecast: (final)
EO-March storage + Apr-July UF - Apr-July US adj

Factor Table is April Forecast based
February and March Forecasts act as adjustments to estimate April 1 state.

Figure 3.3-1. Don Pedro water supply forecast factors.

3.5 Lower Tuolumne River Accretions below Modesto

The Model (Version 1.0) incorporated a synthesized data set for lower Tuolumne River accretions above the “Modesto” gage and estimated flow from Dry Creek. These data sets inform the Model of flow that could influence Don Pedro Reservoir releases during flood control operations. Recent, actual field measurements for flow in the Tuolumne River and for Dry Creek have confirmed general assumptions of the data sets. Also acquired during these field measurements has been flow data for the reach of the lower Tuolumne River below the “Modesto” gage and above the confluence with the San Joaquin River. Based on these measurements, an accretion of 32 cfs has been assumed to occur below the USGS “Modesto” gage. This data set has been added to the “Hydrology” Worksheet, Column M (“Modesto to Confluence”), incorporated into computations of river flow in the “DonPedro” Worksheet,

Column CP ("TR at Confluence"), and the projected flow at the confluence is reported in the "Output" Worksheet, Column AR ("Flow-Confluence").

3.5 Miscellaneous Reference Case Data Revisions

As the result of defining a Base Case in the Model (Version 2.0), several data sets required update or revision to facilitate automated comparisons between the Base Case results and alternative scenario results. Changes to Base Case reference values occurred in table values or time series sets for:

"UserInput" Worksheet

- Existing FERC Flow Requirements at La Grange Bridge Gage
- Base Case MID Canal Diversion
- Base Case TID Canal Diversion
- Base Case Supplemental Releases

"WaterBankRel" Worksheet

- Water Bank Supplemental Release (Column T)

"DonPedro" Worksheet

- Base Case Full Diversion Demand (Column I – Column L)

"SFWaterBankRel" Worksheet

- Water Bank Supplemental Release (Column AN)

"DailyCanalsCompute" Worksheet

- DP Water Supply Factor Base Case (Column F)

"DailyCanals" Worksheet

- Base MID Canal Diversion (Column L)
- Base TID Canal Diversion (Column N)

4.0 MODEL EXECUTION

To aid in the execution, completion and recording of an alternative operation scenario, several "macro" tools have been incorporated into the Model.

4.1 Water Bank Supplemental Release Macro

A variation from Base Case Don Pedro Reservoir operation assumptions will normally cause a change in results to the CCSF Water Bank Account Balance. If needing revision from Base Case conditions (e.g., revised supplemental releases to maintain a positive Water Bank Account Balance) supplemental releases can be automatically computed by use of a macro implemented for the "WaterBankRel" Worksheet. This macro will replicate the manual action of the user to provide the day-by-day supplemental release exactly needed to maintain no less than a zero Water Bank Balance.

Figure 4.1-1 illustrates the location of the macro button in the "WaterBankRel" Worksheet. To "run" the macro the user simply "clicks" on the button identified by the label "Supplemental Release". By invoking the macro, values will be automatically placed into Column T to maintain a positive Water Bank Account Balance. The macro will iterate computations up to 24 times to complete the process. It is advised to initialize Column T with zeroes prior to invoking the macro. It is also advised to set the Excel worksheet "Options" to a manual calculation mode prior to invoking the macro.

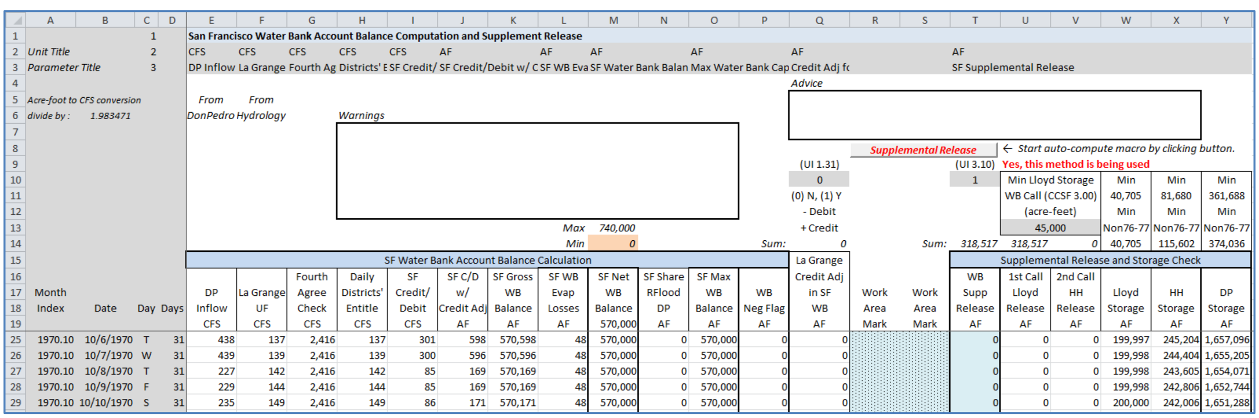


Figure 4.1-1. Water bank supplemental release macro.

4.2 Copy Output Worksheet Macro

The "Output" Worksheet provides an interface between Model computations and summary and analysis tools. It also provides a formatted set of information usable for exchange into an HEC-DSS database file. Results provided in the worksheet are directly linked to the computational and input worksheets of the Model. As such, any change to model assumptions or data which causes a recalculation by the Model will automatically update the values in the worksheet. To preserve or store the results of a particular study a copy of the worksheet should be created with a unique tab name and its contents converted to values. The user can either use Excel keystroke or menu commands to create the worksheet copy, or can invoke a macro. Figure 4.2-1 illustrates the location of the macro button in the "Output" Worksheet. To "run" the macro the user simply "clicks" on the button identified by the label "Copy Sheet / Values". By invoking the macro, the worksheet will be "copied" as "values" into an adjacent worksheet and given a name identified by Switch UI 1.00 in the "UserInput" Worksheet. The user must save the entire workbook to not lose the new worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	1	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE
2	2	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO
3	3	FLOW- LAGRANGE UNIMP	FLOW- HHUNIMP	FLOW- LLOYDUNI MP	FLOW- ELEANORU NIMP	FLOW- UNREGUNI MP	FLOW- TOTINFLO W	FLOW- SUP1INFLO WLL	FLOW- SUP2INFLO WHH	FLOW- INFLOWHH	FLOW- INFLOWLL	FLOW- INFLOWEL	STORAGE
4	4	2	3	4	5	6	7	8	9	10	11	12	13
5	5	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY
6	6	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case	Base_Case
7	*Save study results* 7	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70
8	*as unique* 8	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
9	*worksheet by* 9	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09
10	*clicking button* 10	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
11	↓ 11	CFS	CFS	CFS	CFS	CFS	CFS	AF	AF	CFS	CFS	CFS	AF
12	*Copy Sheet / Values*	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER
13	10/1/1970	125	4	10	4	107	427	0	0	90	220	10	1,667,564
14	10/2/1970	130	4	10	4	111	431	0	0	90	220	10	1,665,724
15	10/3/1970	129	4	10	4	111	431	0	0	90	220	10	1,664,041
16	10/4/1970	133	4	10	5	115	435	0	0	90	220	10	1,661,355
17	10/5/1970	135	4	10	5	117	437	0	0	90	220	10	1,659,348
18	10/6/1970	137	4	10	5	118	438	0	0	90	220	10	1,657,096
19	10/7/1970	139	4	10	5	119	439	0	0	90	220	10	1,655,205
20	10/8/1970	142	4	10	5	122	227	0	0	90	5	10	1,654,071
21	10/9/1970	144	4	10	5	124	229	0	0	90	5	10	1,652,744
22	10/10/1970	149	4	11	5	130	235	0	0	90	5	10	1,651,288

Figure 4.2-1. "Output" Worksheet copy values macro.

Enclosure B

FOR HDR USE ONLY	
Run #	

DRAFT SCENARIO SHEET
Operations Model Run Request

Originator: Date Requested:
Relicensing Participant Group: Needed By:

Instructions: Complete this entire form, including a brief narrative description of your request. The narrative description should include specific questions you think this model run will answer and/or be specific how flow requirements should be modified. Empty scenario values will be assumed to be equal to Base Case.

Decription:____

____

____

____

Section 1—Minimum Flow Requirements at La Grange Bridge	
☐ Existing 1995 FERC Requirement ☐ Alternative, provided as daily time series___________ ☐ Alternative, provided as Year Type Schedule___________ ☐ Alternative, previous Run #___________ ☐ Shared CCSF/Districts Responsibility	*Instructions: Attach alternative flow requirements or provide location of file containing alternative flow requirements*
Section 2—Canal Diversions of Modesto Irrigation District and Turlock Irrigation District	
☐ Base Case Diversions ☐ Alternative diversions, volume by month ☐ Alternative, previous Run #___________	*Instructions: Attach alternative diversions or provide location of file containing alternative diversions*
Section 3—Supplemental Releases to Water Bank from San Francisco	
☐ "WaterBankRel" Worksheet ☐ Alternative releases, volume by month, add to Base Case ☐ Alternative releases, volume by month, replace Base Case ☐ Alternative, previous Run #___________	*Instructions: Attach alternative diversion, worksheet, or provide location of file containing alternative diversions*
Section 4—San Joaquin Pipeline Diversions of San Francisco	
☐ Base Case San Joaquin Pipeline Diversions ☐ Alternative diversions, volume by month ☐ Alternative, previous Run #___________	*Instructions: Attach alternative diversions or provide location of file containing alternative diversions*
Section 5—Additional Operational Objectives	

Attachment C

The Districts' October 4, 2013 response to CDFW's letter to FERC

October 4, 2013
E-Filing

Don Pedro Project
FERC No. 2299-075

Honorable Kimberly D Bose, Secretary
Federal Energy Regulatory Commission
Mail Code DHAC PJ-12.3
888 First Street NE
Washington DC 20426

Subject: Districts' Reply Comments to California Department of Fish and Wildlife Comments on the Meeting Notes of the June 4, 2013 W&AR-03 and W&AR-16 Consultation Workshop

Dear Secretary Bose:

On July 19, 2013, California Department of Fish and Wildlife ("CDFW") filed a letter with the Federal Energy Regulatory Commission ("FERC" or "Commission") providing comments on a Consultation Workshop held by Turlock Irrigation District and Modesto Irrigation District (collectively, the "Districts") on June 4, 2013. The Workshop conducted by the Districts on June 4, 2013 covered topics related to W&AR-03: Reservoir Temperature Model Study and W&AR-16: Lower Tuolumne River Temperature Model. CDFW's letter also provides comments related to the Districts' study W&AR-02: Tuolumne River Operations Model for which the Districts held Consultation Workshop No. 5 on May 30, 2013.

CDFW's July 19 letter provides comments primarily directed at the Districts' Tuolumne River Operations Model. CDFW expresses a concern over "a lack of validation comparing the Operations Model Base Case rules with current project operations." CDFW's July 19 letter also asserts that, according to the Districts' own statements, the Operations Model is "not intended to replicate actual water use and the recent past would not be appropriate for modeling purposes." Based on these statements attributed to the Districts, CDFW goes on to conclude that "the Operations Model Base Case does not attempt to represent current operations and is simply a starting point for future alternatives analyses."

These comments and conclusions by CDFW are simply incorrect. The Operations Model Base Case **does** depict the current demands, regulatory requirements, and operational policies of the Districts' and CCSF's Hetch Hetchy water storage and delivery systems. CDFW states in its July 19 letter that "the Districts maintain the Operations Model is not intended to **replicate actual water use**" [emphasis added]. Here, CDFW seriously mischaracterizes a statement made by the Districts. The actual statement made by the Districts, as reproduced in the Workshop meeting notes reviewed by CDFW and submitted to FERC, reads as follows: "the model is not intended to **replicate exact historical water use"** (see page 3 of the June 4th Workshop notes).

The Districts have explained on numerous occasions to all relicensing participants, including CDFW, that a daily operations model that involves irrigation and municipal water demand and supply could not possibly replicate or duplicate the **exact** patterns and magnitude of water use over time because those patterns and magnitudes occur by virtue of differing regulatory requirements, operating policies, maintenance needs, and the decisions of thousands of water users with different water demands making decisions in real time. In fact, no model has been or should be held to a standard of *duplicating* historical conditions and we doubt that CDFW would hold its own models to that standard. Consistent with FERC's long standing policy, the Tuolumne River Operations Model base case represents the "no action" alternative; that is, the continuation of Tuolumne River water system operations under current and authorized license terms and operating conditions. This is also consistent with SWRCB's request to use existing in- river conditions as the baseline for comparison of alternative operating scenarios.

CDFW also attributes to the Districts a statement to the effect that "the recent past would not be appropriate for modeling purposes." Here, CDFW must be referring to these same June 4th Workshop notes where the phrase "so the very recent past would not be appropriate for modeling purposes" is found. However, it is necessary to include the first part of that sentence to truly understand its meaning related to the Operations Model. The full sentence reads: **"CCSF has been implementing construction projects on their system, so the very recent past would not be appropriate for modeling purposes"** (page 3 of the June 4th Workshop notes). This fact about recent CCSF operations was fully explained in the W&AR-02 Operational Modeling Workshop held on May 30 and fully captured in those Workshop notes (see page 4 of the May 30th notes) where Ms. Ellen Levin, Deputy Manager of the Water Enterprise for CCSF, described that recent operations of CCSF's system include a number of "maintenance and construction-related shutdowns that have been occurring since 2005." These would not be expected to recur any time soon, so while these outages and changes may be reflective of actual recent conditions, it would be highly inappropriate for these conditions to be reflected in the Operations Model base case. This is but one example of why trying to duplicate the very recent past would not be appropriate for modeling purposes. We refer CDFW to the W&AR-02: Operations Model Base Case, Workshop No. 5 meeting notes for the full discussion of this issue.

Given that CDFW has apparently misinterpreted statements made by the Districts in the Workshops and mischaracterized portions of the Workshop notes, it follows that the conclusion arrived at by CDFW that the "Operations Model Base Case does not attempt to represent current operations" is also incorrect. The Districts' statement that the Operations Model does not "*replicate exact* historical water use" should not be interpreted by CDFW to infer that the Operations Model does not adequately *represent* current operations. To be clear, and contrary to CDFW's assertions, the Districts and CCSF have both stated for the record that the rules of operation contained in the Operations Model base case accurately represent the current water supply operations and current demands of their respective systems.

We review below the substantial efforts made by the Districts and CCSF to accurately describe and demonstrate the Operations Model to relicensing participants and thereby further rectify the several mischaracterizations contained in CDFW's July 19 letter.

The Districts held W&AR-02: Tuolumne River Operations Model Workshop No. 4 on December 7, 2012 which included considerable time devoted to describing the Operations Model Validation process and results. The Districts issued the full Draft Model Validation Report on January 17, 2013 as part of the Initial Study Report (ISR). Relicensing participants' comments on the report were required to be provided by March 11, 2013. Neither CDFW, nor any other participant, had any comments on the Draft Model Validation Report.

The July 19, 2013 CDFW letter does not raise any concerns about the January 17, 2013 Draft Model Validation Report. Instead, CDFW states that since that time, the Districts have made "several significant changes" to the Operations Model. None of the five changes identified by CDFW in its July 19 letter qualifies as constituting a significant change to the Operations Model rules of operations for either the Districts' or CCSF's systems. The overarching rules of operations contained in the Base Case are substantially the same as described in the January 2013 Validation Report. None of the five items identified by CDFW produce any change to seasonal water releases from the Districts' or CCSF's systems. Each of the items described by CDFW simply represent a refinement of the model to either reflect the latest information available, produce a more efficient model, or more closely reflect actual system operations. During the May 30, 2013 W&AR-02: Operations Model Workshop No. 5, the Districts and CCSF thoroughly described and discussed each of the model adjustments identified by CDFW.

To justify its request that the Districts validate the Base Case model to "recent historic operation of the project", CDFW identifies what it believes are five "significant changes" to the Operations Model subsequent to the December 2012 Workshop No. 4. CDFW's comments demonstrate a lack of understanding of what elements of hydrology and logic are of significance to the Model and the comparative analyses to be performed by the Model. Each of the cited "significant changes" is discussed below:

- **Item 1: New model logic regarding management of reservoir releases in early July.** As explained at Workshop No. 5, the Operation Model logic concerning reservoir release management during early-July was modified to refine the Model's representation of reservoir operation to better depict actual Don Pedro operations during a short period of a few days applicable to only a few years in the 39-year period-of-record when the reservoir should fill within the first couple of weeks of July rather than the previously modeled end-of-June time frame. This refinement made daily releases more representative of current operations and does not in any way affect seasonal release volumes. This change improves the model's simulation of actual practices during wet years.

- **Item 2: Differentiation between base flow and pulse flow releases to the lower Tuolumne River and representation of current October attraction flow requirements.** This item concerns modeling current fish flow requirements. The refined logic provides better construction of the daily hydrograph assumed for monthly flow requirements as set forth under the current FERC license terms. Previously, the Model did not provide a daily pulse component during October. The revised logic allows a user-specified pattern of release. Again, both of these refinements to Model logic simply depict current operations more closely and are consistent with CDFW's desire to "attempt to represent current operations."

- **Item 3: Inclusion of new hydrologic data to eliminate negative daily reservoir inflows.** This item refers to the revisions to model hydrology made to eliminate negative daily inflows to the Don Pedro Reservoir. This revised hydrologic data set was presented at the March 27, 2013 Hydrology Workshop held with CDFW and State Water Resources Control Board (SWRCB). The model hydrology was revised to respond to a specific request made by CDFW to eliminate the occurrence of negative daily inflows to Don Pedro Reservoir while still keeping the same monthly volumes in the model in order to maintain overall water balance consistent with conservation of mass requirements. This change has the full support of CDFW and SWRCB. The entire process of modifying the model hydrology was documented in the Districts' April 9, 2013 filing with FERC: *Response to Relicensing Participants Comments on the Initial Study Report.* Section III of this filing provides a full description of the consensus approach to the model hydrology and Appendix 2 provides the Workshop meeting notes which reflect that consensus was reached. The changes made to the original model hydrology to reflect the consensus approach amounted to a "smoothing" of the underlying unimpaired flow that occurs within the Tuolumne River basin upstream of Don Pedro Reservoir. As discussed on several occasions previously, the smoothing and occasional minor rebalancing of unimpaired flow volumes within the basin does not affect Don Pedro Reservoir operations and does not constitute a change in the model's representation of either Don Pedro or Hetch Hetchy operations.

- **Item 4: Refinements to canal diversions.** This item deals with the model's depiction of the Districts' canal diversions. As discussed on numerous occasions with relicensing participants, to represent the Districts' canal demands, a methodology utilizing estimates of recent agricultural land use within the Districts and current MID municipal and industrial water demands has been employed. This methodology was chosen because it is consistent with California's statewide water plan modeling practices. An initial comparison of the Model's results to history was illustrated in the December 2012 Workshop. CDFW's July 19, 2013 letter states that one of the "significant changes" made to the Model since the December Workshop was refinements to the Districts' canal operations, including the "addition of a component to canal water supply that was previously not recognized in the data set" and "refinement of monthly turnout delivery factors." CDFW extracts these statements from the

Districts' Attachment B (revised May 20, 2013) of the Operations Model Study Report (see Section 3.2, page 3-3). A full reading of that Section 3.2 explains the reason for the model refinement (see page 3-2). As clearly explained on page 3-2, subsequent to the December 7 Workshop, both TID and MID filed with the State of California their 2012 *Agricultural Water Management Plans* as required by state regulations. These water management plans provide more recent historical operational records which led to the refinement of Model logic that depicts current water demands and canal operations of the Districts. If CDFW's true concern is for the Operations Model to "represent current operations," then CDFW should be fully supportive of these Model refinements which use the latest information available to represent the Districts' practices.

- **Item 5: Changes to the water supply factor based on changes to estimated canal demands and underlying hydrology and a review of projected operations**. During development of the Operations Model Base Case, additional effort was focused on development of a reservoir management plan for drought to be used for Model simulation purposes. Recent operations of the Districts coincide well with the Model's assumptions; however, a recent long-duration drought to use for validation purposes has fortunately not occurred. However, this limits the confirmation of the Model's overall operation during drought. Comparing the current Model results to the operations that occurred over 20 years ago during the last significant drought (1987 – 1992) would be inappropriate because of the many changes in both CCSF's and Districts' operations. For non-drought years, the Operation Model's Base Case depiction of canal diversions was specifically refined to depict recent operations, with professional judgment used to best fit the many components affecting the annually-varying projected canal diversions.

As summarized above and discussed in detail in the March 27, 2013 Hydrology Workshop, the April 9, 2013 response to comments on the ISR, the May 30, 2013 Operations Model Workshop, and the June 4, 2013 Reservoir and River Temperature Modeling Workshop, each of the five items identified by CDFW represent minor refinements to the Operations Model in an effort to use the most recent water use data and the consensus on hydrology reached on March 27, 2013 with CCSF, CDFW, SWRCB, and the Districts. Additionally, using this most recent information, the Model's logic was refined to better fit actual recorded and estimated data concerning recent canal operations, and the data are consistent with reports submitted to the State of California. Concerning the Model's assumptions for reservoir management during drought (inferred by the "water supply factor"), as also discussed above, there is no metric to validate. The operating rules incorporated into the Model produce an operation during drought that is viable when using historical hydrology as the template for future events.

One additional item raised by CDFW in its July 19 letter is a curious reference to the recently released HEC-5Q model for the San Joaquin River system. CDFW states that it is "interested in a set of modeling tools that will allow interested parties to start with water temperature objectives and explore subsequent impacts to project operations." CDFW states that the HEC-5Q basin-wide model allows a "bottom-up" analysis, while implying that the suite of site-specific Tuolumne River modeling tools developed by the Districts under the approved FERC study plans do not. The Districts are currently reviewing the HEC-5Q and SALSIM models released by CDFW, and at this point we limit our comments to two general observations:

- As a starting point, the HEC-5Q model is inherently incapable of exploring "impacts to *project* operations" simply because it does not even attempt to model the affects of temperature-driven releases on the City and County of San Francisco's "project operations." This is a serious limitation and essentially prevents the HEC-5Q model from informing overall water supply project impacts on the Tuolumne River. Given CDFW's deep concerns about a model being able to adequately represent "current operations", ignoring even the existence of CCSF and the potential impacts to CCSF water supply operations should be a serious concern to CDFW.

- At best the HEC-5Q model is a flow rate calculator based on an assumed starting outflow temperature from Don Pedro Reservoir. The HEC-5Q model neither represents current operations of the Districts (nor CCSF) nor can it predict changes in reservoir outflow temperature under conditions of deep drawdowns during drought events due to its over-simplified representation of the thermal structure of the Don Pedro Reservoir. Therefore, any results obtained by using the basin-wide HEC-5Q model would have to be completely re-analyzed by evaluating the same scenario with the river- and project-specific Tuolumne River Operations Model and the Don Pedro Reservoir Temperature Model.

- The scope of the HEC-5Q model – the entire San Joaquin river basin – is inherently broad. FERC directed the Districts to perform studies based upon their capacity to identify and isolate effects associated with existing project operations, thereby demonstrating a capability to inform potential license requirements for the project. As a result, the Districts have prepared a variety of studies, models and analyses that are specific to conditions on the Tuolumne River and in the Don Pedro Reservoir, including bathymetry data, a three-dimensional reservoir temperature model, a river-specific downstream temperature model, and a fully transparent Tuolumne River operations model inclusive of CCSF Hetch Hetchy water supply operations. While the Districts acknowledge that the HEC-5Q model has been used in a variety of efforts concerning regional conditions within the San Joaquin River basin, its broad scope and lack of site-specific detail prevents it from being used to isolate project effects on the Tuolumne River, particularly in light of the Tuolumne and project specific models and studies that have been prepared and conducted.

Use of the HEC-5Q model is unlikely to inform potential license conditions for the Don Pedro Project. The Districts intend to provide further comments on the HEC-5Q and SALSIM models once its reviews are complete.

The Districts remain concerned that CDFW's July 19 letter seriously mischaracterizes direct statements made by the Districts in Workshops and in subsequent Workshop meeting notes that have been previously reviewed by relicensing participants. Conclusions based on statements taken out of context are not helpful to the extensive and thorough consultation process undertaken by the Districts and relicensing participants in support of the cooperative development of the Tuolumne River Operations Model. The Districts continue to maintain that in the context of this FERC proceeding and the comparative analyses being performed, the Operations Model represents a reasonable depiction of current operations across the overall 1971-2009 modeling period. Both the Districts and CCSF have stated for the record that the base case rules of operation track closely with actual operations, and believe the Model is fit.

The Districts have recently decided to expand the model period-of-record through 2012 as we approach the filing of the Draft and Final License Application. As such, the Districts are extending both the base case model and model validation through 2012. The Districts will provide both the expanded base case and model validation to relicensing participants in the near future.

Sincerely,

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