CHAPTER 2 | VAMP HYDROLOGIC PLANNING AND IMPLEMENTATION

This section documents the planning and implementation undertaken by the Hydrology Group of the San Joaquin River Technical Committee (SJRTC) for the 2002 VAMP investigations. Implementation of VAMP is guided by the framework provided in the SJRA and anticipated hydrologic conditions within the watershed.

The Hydrology Group was established for the purpose of forecasting hydrologic conditions and for planning, coordinating, scheduling and implementing the flows required to meet the test flow target in the San Joaquin River near Vernalis. The Hydrology Group is also charged with exchanging information relevant to the forecasted flows, and coordinating with others in the SJRTC, in particular the Biology Group, responsible for planning and implementing the salmon smolt survival study.

Participation in the Hydrology Group is open to all interested parties, with the core membership consisting of the designees of the agencies responsible for the water project operations that would be contributing flow to meet the target flow. In 2002, the agencies belonging to the Hydrology Group included: Merced Irrigation District (Merced), Turlock Irrigation District (TID), Modesto Irrigation District (MID), Oakdale Irrigation District (OID), South San Joaquin Irrigation District (SSJID), San Joaquin River Exchange Contractors (Exchange Contractors), and the U.S. Bureau of Reclamation (USBR). Though not a water provider, the California Department of Water Resources (DWR) was closely involved with the coordination of operations relating to the installation of the HORB and the planning of delta exports consistent with the VAMP.

VAMP FLOW AND SWP/CVP EXPORTS

The VAMP investigations are designed to collect data and information on the relationship between San Joaquin River flow and Delta exports (SWP and CVP pumping at the Tracy and Banks pumping plants) on the survival rates of juvenile Chinook salmon emigrating from the San Joaquin River system. The VAMP provides for a 31-day pulse flow (target flow) at the Vernalis gage during the months of April and May, along with a corresponding reduction in SWP/CVP exports, as shown in Table 2-1. The magnitude of the pulse flow is based on San Joaquin River flow that would occur during the pulse period absent the VAMP, referred to as the existing flow.

As part of the development of the VAMP experimental design, the VAMP Hydrology and Biology Groups jointly identified a level of variation in San Joaquin River flow and SWP/CVP export rate thought to be within an acceptable range for specific VAMP test conditions. In developing the criteria, the VAMP Hydrology and Biology Groups examined both the ability to effectively monitor and manage flows and exports within various ranges (e.g., the ability to accurately manage and regulate export rates is substantially greater than the ability to manage San Joaquin River flows) and the flow and export differences among VAMP targets (Table 2-1). Through these discussions, the technical committees agreed that SWP/CVP export rates would be managed to a level of plus or minus 2.5% of a given export rate target. Furthermore, the technical committees agreed that, to the extent possible, it would be desirable that exports be allocated approximately evenly between SWP and CVP diversion facilities.

The ability to manage and regulate San Joaquin River flows was more difficult due to variation in unregulated flows, uncertainty in real-time flows due to changing channel conditions, lags and delays in transit time, and a variety of other factors. Concern was expressed that variation in San Joaquin River flow on the order of plus or minus 10% would potentially result in overlapping flow conditions between two VAMP targets. To minimize the probability of overlapping flow conditions among VAMP targets, the technical committees explored an operational guideline of plus or minus 5% flow variation at the Vernalis gage, however, system operators expressed concern about the ability to maintain flows within this range. As a result of these discussions and analysis, the

TABLE 2–1

VAMP Vernalis Flow and Delta Export Targets

EXISTING FLOW (CFS)	VAMP TARGET FLOW (CFS)	DELTA EXPORT TARGET RATES (CFS)
0 to 1,999	2,000	
2,000 to 3,199	3,200	1,500
3,200 to 4,449	4,450	1,500
4,500 to 5,699	5,700	2,250
5,700 to 7,000	7,000	1,500 or 3,000
Greater than 7,000	Provide stable flow to the extent possible	

joint Hydrology and Biology Groups agreed to a target range variation of plus or minus 7% of the Vernalis flow target as a guideline for evaluating the VAMP experimental conditions. It was recognized by the Hydrology and Biology Groups that these guidelines were not absolute conditions, but was to be used by the VAMP hydrology fisheries workgroups to evaluate experimental test conditions and the potential effect of flow and export variation in our ability to detect and assess variation in juvenile Chinook salmon survival rates among VAMP test conditions.

Under the SJRA, the following SJRGA agencies have agreed to provide the supplemental water, limited to a maximum of 110,000 acre-feet, needed to achieve the VAMP target flows shown in Table 2-1: Merced, OID, SSJID, Exchange Contractors, MID and TID.

The 2,000 cfs VAMP target flow shown in Table 2-1 does not represent a VAMP experiment data point but is used to define the supplemental water volume to be provided by the SJRGA agencies. In preparation of the conceptual framework for the VAMP it was recognized that in extremely dry conditions the San Joaquin River flow and associated exports would be determined in accordance with the existing biological opinions under the Endangered Species Act and the 1994 Bay-Delta Accord. In consideration of these factors, when the existing flow is less than 2000 cfs, the USBR, in accordance with the SJRA, shall act to purchase additional water from willing sellers to fulfill the requirements of existing biological opinions.

Based upon hydrologic conditions, the target flow in a given year could either be increased to the next highest value ("double-step") or the supplemental water requirement could be eliminated entirely. A numerical procedure has been established in the SJRA to determine the target flow. The SWRCB San Joaquin Valley Water Year Hydrologic Classification ("60-20-20" classification) is given a numerical indicator as shown in Table 2-2.

TABLE 2–2

San Joaquin Valley Water Year Hydrologic Year Classifications Used in VAMP

60-20-20 WATER YEAR CLASSIFICATION	VAMP NUMERICAL INDICATOR
Wet	5
Above Normal	4
Below Normal	3
Dry	2
Critical	1

"Double-step" flow years occur when the sum of last year's numerical indicator and the 90 percent exceedence forecast of the current year's numerical indicator is seven (7) or greater.

If the sum of the two previous years' numerical indicators and the 90 percent exceedence forecast of the current year's numerical indicator is four (4) or less, indicative of an extended dry period, no VAMP supplemental water will be provided. The USBR, however, has a continuing obligation to meet San Joaquin River flows pursuant to the March 6, 1995 Delta Smelt Biological Opinion.

Under the SJRA, the maximum amount of supplemental water to be provided to meet VAMP target flows in any given year is 110,000 acre-feet. Based on the targets outlined in Table 2-1, in a double-step year up to 157,000 acre-feet of supplemental water may be required. If the VAMP target flow requires more than 110,000 acre-feet of supplemental water, then additional water may be acquired on a willing seller basis.

HYDROLOGIC PLANNING

Hydrology Group Meetings

Beginning in February 2002, and continuing until early April, the Hydrology Group held five planning and coordination meetings (February 13, March 13, March 28, April 3 and April 10). At these meetings, forecasts of hydrologic and operational conditions on the San Joaquin River and its tributaries were discussed and refined.

Monthly Operation Forecasts

As part of the early planning efforts, monthly operation forecasts were developed by the Hydrology Group to estimate the existing flow at Vernalis. Inflows to the tributary reservoirs used in these forecasts were based on DWR Bulletin 120 runoff forecasts. The monthly operation forecasts used the 90 percent and 50 percent probability of exceedence runoff forecasts. The initial monthly operation forecast was prepared in early February and presented at the February 13 Hydrology Group meeting. The 90 percent exceedence forecast called for a VAMP target flow of 3,200 cfs with a need for about 30,000 acre-feet of supplemental water; the 50 percent exceedence forecast called for a VAMP target flow of 4,450 cfs with a need for about 76,000 acre-feet of supplemental water. Hydrologic projections and planning were subsequently refined as additional information became available in March and April.

Daily Operation Plan

Starting in mid-March, the Hydrology Group began development of a daily operation plan, updating it as hydrologic conditions and operational requirements changed. The daily operation plan calculated an estimated mean daily flow at Vernalis based on estimates

of the daily flow at the major tributary control points, estimates of ungaged flow between those control points and Vernalis, and estimates of flow in the San Joaquin River above the major tributaries. The following key assumptions were used in the development of the daily operation plan:

(1) The travel times for flows from the tributary control points and upper San Joaquin River to the Vernalis gauge are assumed as follows:

a. Merced River at Cressey to Vernalis — 3 days

b. San Joaquin River above Merced River to Vernalis — 2 days

c. Tuolumne River at LaGrange to Vernalis — 2 days

d. Stanislaus River below Goodwin Dam to Vernalis — 2 days

(2) Based upon a review of the historical flow record, the ungauged flow at Vernalis was assumed to be constant throughout the VAMP period and equal to the trending value entering the period. By definition, the ungauged flow is that unmeasured flow entering the system between Vernalis and the upstream measuring points and is calculated as follows:

Vernalis Ungauged =

VNS - GDWlag - LGNlag - CRSlag - USJRlag

where:

VNS = San Joaquin River near Vernalis

GDWlag = Stanislaus River below Goodwin Dam lagged 2 days

LGNlag = Tuolumne River below LaGrange Dam lagged 2 days

CRSlag = Merced River at Cressey lagged 3 days

USJRlag = San Joaquin River above Merced River lagged 2 days (USJR is not a gauged flow but is the calculated difference between the gauged flows at the San Joaquin River at Newman (NEW) and the Merced River near Stevinson (MST)).

A disagreement occurred between members of the Hydrology Group on how to compute the existing flow for the Stanislaus River. It was agreed that the existing flow would be the flow set by the New Melones Interim Operations Plan (IOP); however, there was disagreement on what level of exceedence forecast should be used when applying the IOP. The USBR uses a 90% exceedence forecast for developing water supply allocations. The U.S. Fish and Wildlife Service (USFWS) however, has suggested that since the IOP was developed based on a long-term planning model which used a set of known (perfect foresight) inflows, the 50% exceedence data set would best match what was used in the long-term modeling. At this time, the USBR and the USFWS are working to reach a common understanding on this issue.

By definition, the VAMP 31-day pulse flow period can occur anytime between April 1 and May 31. Until the VAMP flow period is specifically defined, it is assumed for the purposes of planning to be April 15 through May 15. Flexibility of the VAMP flow period exists so that it can coincide with the period of peak salmon out-migration. Other factors, including installation of HORB, availability of juvenile salmon at the hatchery, and manpower and equipment availability for salmon releases and recapture need to be considered in determining the timing of the VAMP period.

The 60-20-20 classification for water year 2001 was "dry", giving it a VAMP numerical indicator of 2. There was no possibility of a dry period offramp (numerical indicator of previous two plus current year total of 4 or less) because the classification for water year 2000 was "above normal" with a numerical indicator of 4. In order to trigger the "double-step" criteria, the April 1 90 percent exceedence forecast for water year 2002 would need to be for a "wet" year, with a VAMP numerical indicator of 5. The early 90% exceedence forecasts (Jan., Feb. and Mar.) were indicating a "dry" or "critical" year, making it very unlikely that 2002 would be a "double-step" year; therefore, planning efforts concentrated on the "single step" criteria. In fact, the 90 percent exceedence forecast on April 1 for the San Joaquin Valley was for a "dry" year, resulting in the 2002 VAMP following the "single step" criteria.

The initial Daily Operation Plan was prepared on March 13, and was modified as hydrologic conditions and operational requirements changed. Table 2-3 summarizes the various iterations of and demonstrates the evolutionary nature of the daily operation plan. Copies of the daily operation plans are provided in Appendix A.

In early March DWR announced that the HORB would be completed by April 15, therefore the period of April 15 through May 15 was designated as the target flow period. Due to regulatory and operational constraints, Merced needs approximately 7 days of lead time to effect a flow change at Vernalis (48 hours regulatory notice on operation change and approximately 5 days travel time from New Exchequer Dam to Vernalis), therefore the target flow needed to be defined by April 8. Based on the available data the Hydrology Group set the target flow at 3,200 cfs at its meeting on April 8.

TABLE 2–3

Summary of 2002 VAMP Daily Operation Plans Prepared During Planning Phase

VAMP FORECAST DATE	PULSE PERIOD	ASSUMED UNGAUGED FLOW AT VERNALIS (CFS)	EXISTING FLOW (CFS)	VAMP TARGET FLOW (CFS)	SUPPLEMENTAL WATER NEEDED TO MEET TARGET FLOW (1,000 AF)
March 13	April 15–May 15	400	2,150	3,200	64.30
		800	3,130	3,200	4.12
March 22	April 15–May 15	400	2,450	3,200	46.16
		600	2,880	3,200	19.47
March 28	April 15–May 15	400	2,531	3,200	41.16
		600	3,525	4,450	56.91
April 08	April 15–May 15	400	2,842	3,200	22.04
April 09	April 15–May 15	400	2,742	3,200	28.19

TABLE 2–4

Summary of USGS Flow Measurements at the San Joaquin River Near Vernalis Gage

DATE	RIVER STAGE (FT)	MEASURED FLOW (CFS)	CDEC REPORTED REAL-TIME FLOW (CFS)	PERCENT DIFFERENCE	RATING SHIFT
March 5 at 9:30	9.61	1,990	1,940	+2.6%	No
March 27 at 8:26	9.82	2,120	2,120	0.0%	No
April 3 at 9:59	9.30	1,670	1,696	-1.5%	No
April 10 at 9:17	9.48	1,810	1,838	-1.5%	No
April 17 at 8:53	10.75	2,990	2,973	+0.6%	No
April 24 at 10:52	11.00	3,220	3,219	0.0%	No
May 1 at 9:26	11.20	3,340	3,426	-2.6%	No
May 8 at 9:00	11.18	3,340	3,408	-2.0%	No

Normally, the USGS measures the flow at Vernalis to check the current rating shift on a monthly basis. The real-time flows reported by the USGS and CDEC are dependent on the most current rating shift, therefore a new measurement and shift can result in a sudden and significant change in the reported real-time flow. In order to minimize the potential for these sudden and significant changes, arrangements were made with the USGS to measure the flow at Vernalis on a weekly basis between March 27 and May 8. The results of these measurements are summarized in Table 2-4. As can be seen in Table 2-4, the Vernalis gage site was relatively stable and no rating shifts were applied during the target flow period.

IMPLEMENTATION

Operation Conference Calls

During implementation of the VAMP pulse flow, conference calls were conducted on a regular basis to discuss the status of the pulse flow and to make changes to the operation plan if needed. The calls were held at 6:30 a.m. so that potential operational changes could be implemented on that day. The conference calls were held every Monday, Wednesday and Friday, starting on April 12 and ending on May 10.

Operation Monitoring

The planning and implementation of the VAMP spring pulse flow operation was accomplished using the best available real-time data from the sources listed in Table 2-5. The CDEC real-time data has not been reviewed for accuracy or adjusted for rating shifts; the USGS real-time data has had some preliminary review and adjustment. During the VAMP flow period, the real-time flows at Vernalis and in the San Joaquin River tributaries were continuously monitored. Similarly, the computed ungaged flow at Vernalis and the flow in the San Joaquin River upstream of the Merced River were continuously updated. The monitoring was necessary to verify that supplemental water deliveries were adhering to tributary allocations contained in the SJRA to the extent possible, as well as to determine if changes in hydrologic conditions would require changes to the operation plan.

The daily operation plan was updated throughout the VAMP flow period. A summary of the updated daily operation plans is provided in Table 2-6. Copies of the updated daily operation plans are provided in Appendix A.

TABLE 2–5

Real-time Flow Data and Sources

MEASUREMENT LOCATION	REAL-TIME DATA SOURCE
San Joaquin River near Vernalis	USGS
Stanislaus River below Goodwin Dam	USBR Goodwin Dam daily operation report
Tuolumne River below LaGrange Dam (LGN)	USGS
Merced River at Cressey (CRS)	CDEC
Merced River near Stevinson (MST)	CDEC
San Joaquin River at Newman (NEW)	USGS

RESULTS OF OPERATIONS

The final accounting for the VAMP operation is accomplished using provisional mean daily flow data available from USGS and DWR. The provisional data has been reviewed and adjusted for rating shifts but is still considered preliminary and subject to change. Plots of the real-time and provisional flows at the primary measuring points are provided in Appendix A to illustrate the differences between the real-time and the provisional data.

The mean daily flow at the Vernalis gage averaged 3,300 cfs during the VAMP test flow period, with a maximum of 3,610 cfs and a minimum of 2,840 cfs. The average flow for the test flow

TABLE 2–6

Summary of 2002 VAMP Daily Operation Plans Prepared During Implementation Phase

VAMP FORECAST DATE	VAMP PERIOD	ASSUMED UNGAUGED FLOW AT VERNALIS (CFS)	EXISTING FLOW (CFS)	VAMP TARGET FLOW (CFS)	SUPPLEMENTAL WATER NEEDED TO MEET TARGET FLOW (1,000 AF)
April 16	April 15–May 15	300	2,645	3,200	34.10
April 19	April 15–May 15	300	2,623	3,200	35.49
April 25	April 15–May 15	300	2,636	3,200	34.68
May 09	April 15–May 15	450	2,747	3,200	27.88

FIGURE 2–1

2002 VAMP–San Joaquin River Near Vernalis–With and Without VAMP

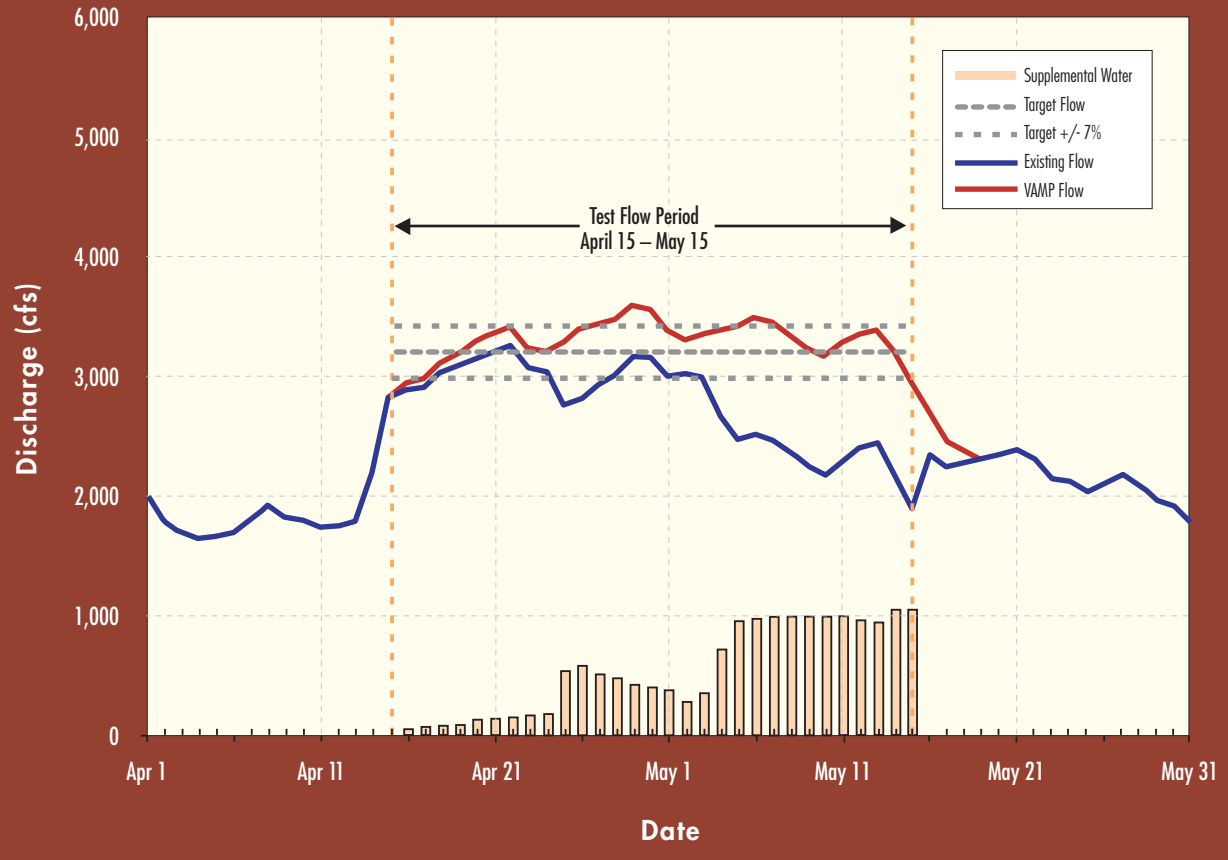


FIGURE 2–2

2002 VAMP–San Joaquin River Near Vernalis With Lagged Contributions From Primary Sources

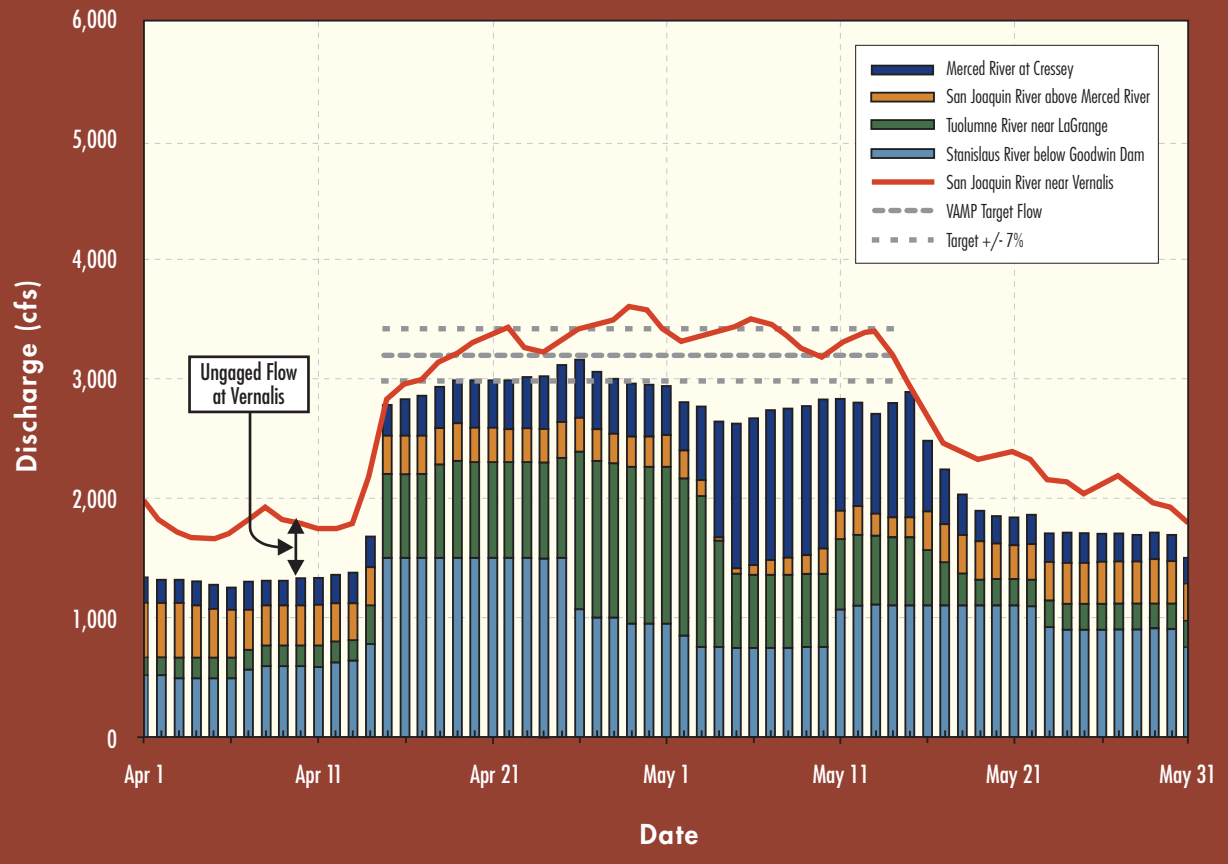


FIGURE 2–3

2002 VAMP–Ungaged Flow at Vernalis During Test Flow Period

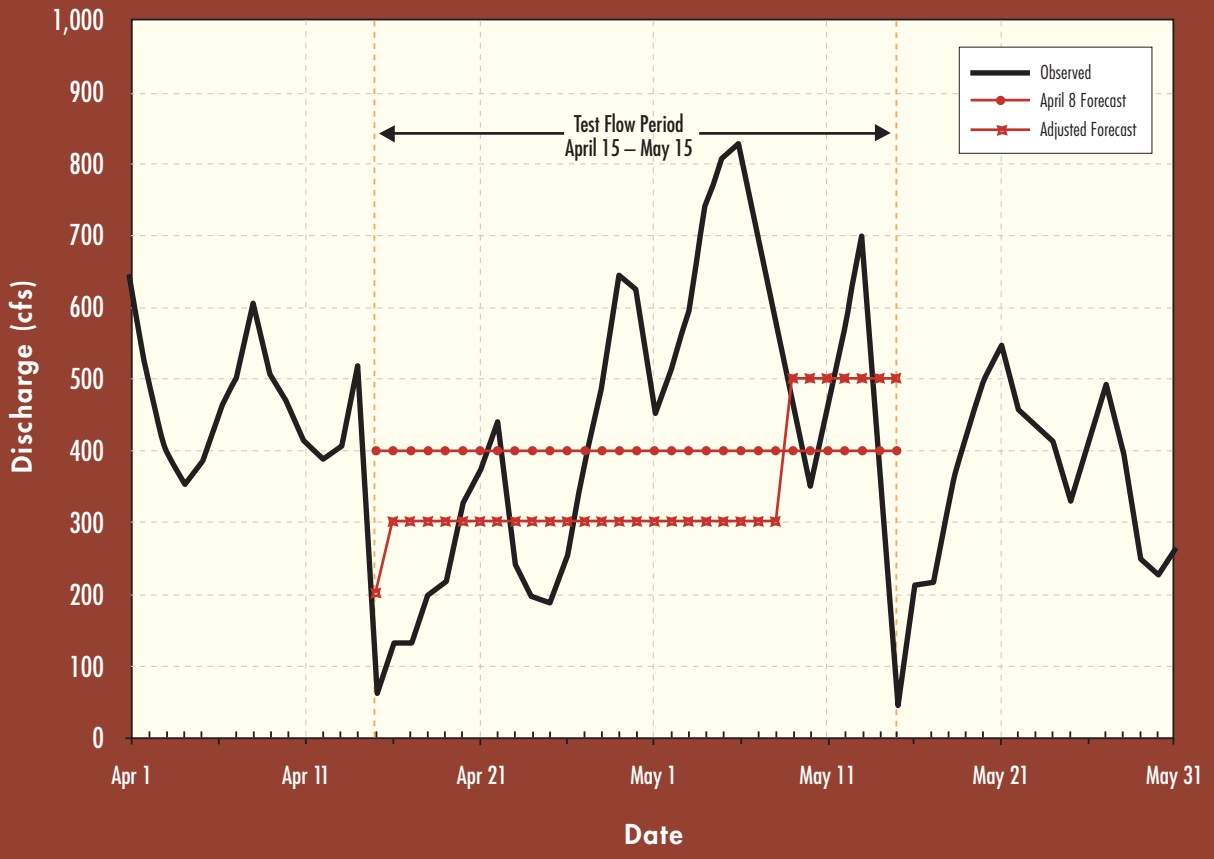


FIGURE 2–4

2002 VAMP–Federal and State Exports [Source: USBR Delta Operations Report]

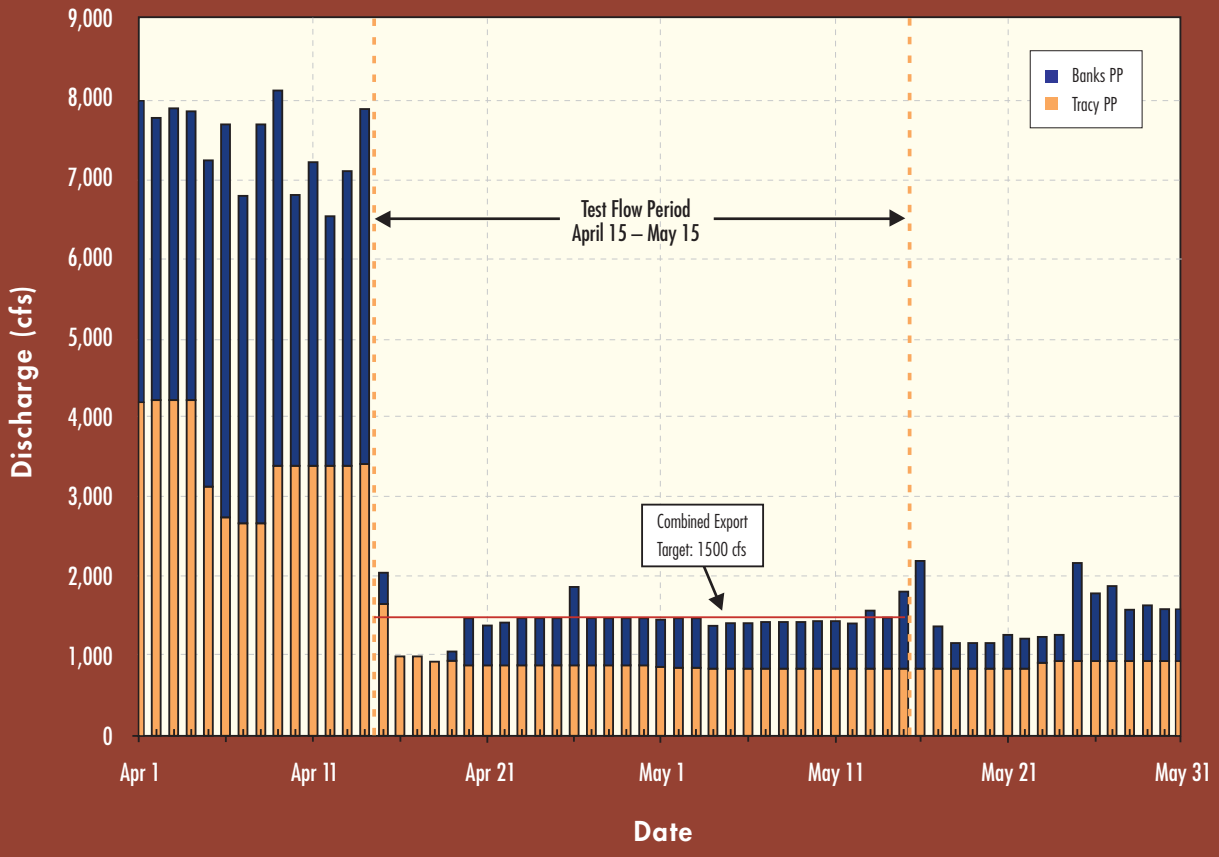


FIGURE 2–5

2002 VAMP–SJRA Storage Impacts–Lake McClure (Merced River), October 2001 through December 2002

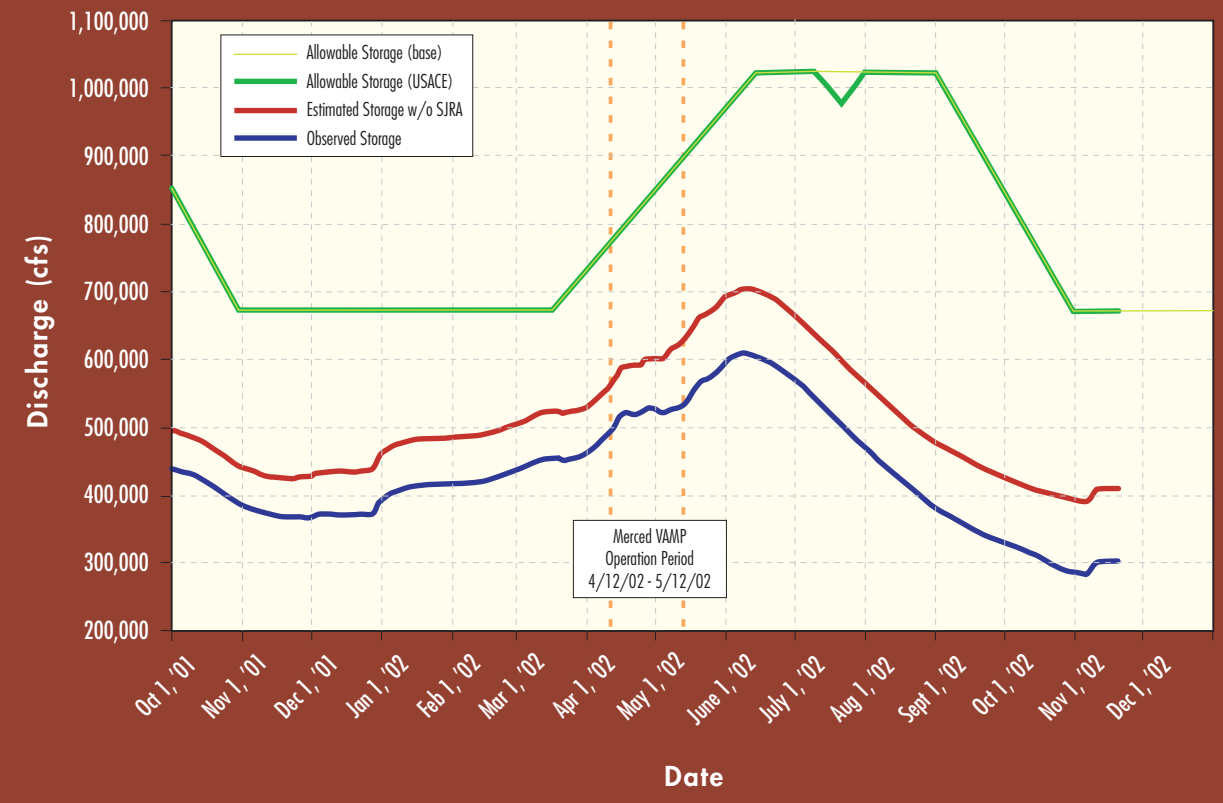
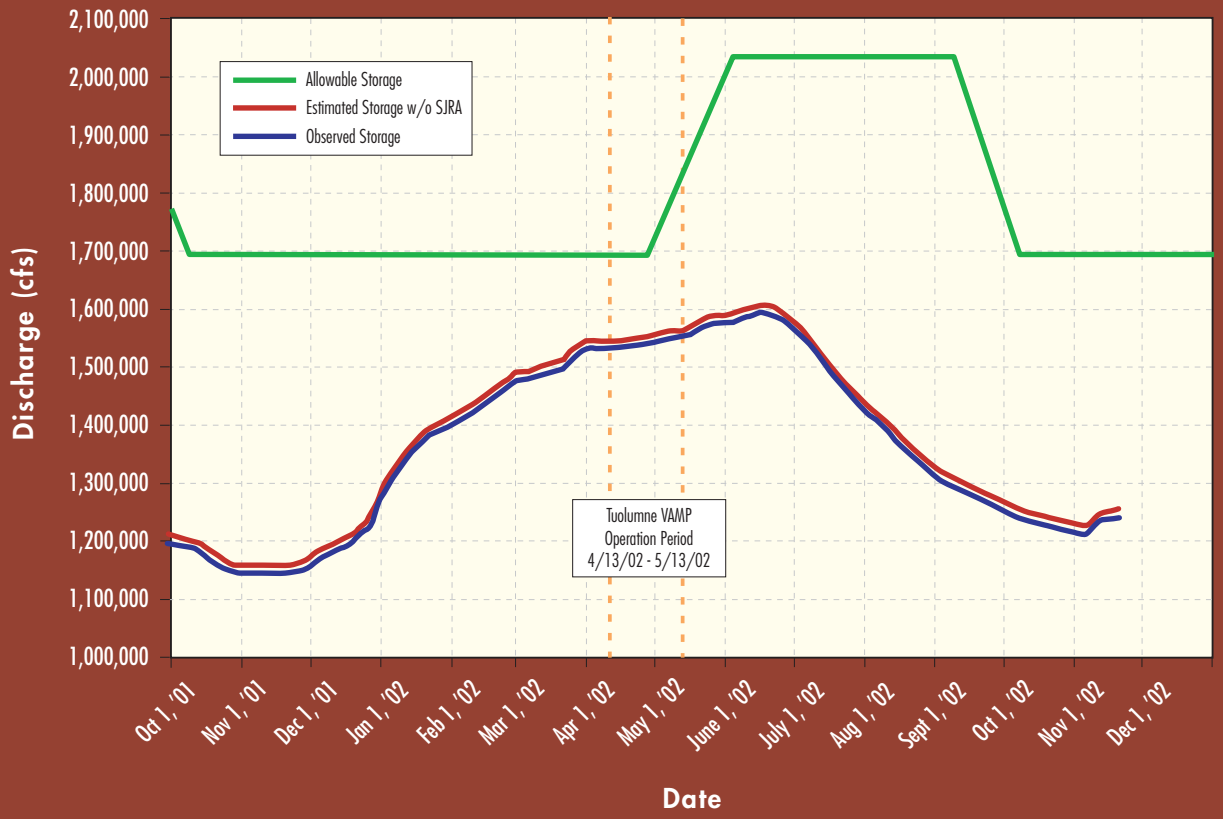


FIGURE 2–6

SJRA Storage Impacts–New Don Pedro Reservoir (Tuolumne River), October 2001 through December 2002



period absent the VAMP supplemental water (existing flow) was estimated to be 2,760 cfs. The VAMP operation resulted in a 20 percent increase in flow at Vernalis during the target flow period. Figure 2-1 shows the flow at Vernalis with and without the VAMP pulse flow. Figure 2-2 shows the sources of the flow at Vernalis. A total of 33,430 acre-feet of supplemental water was provided during the VAMP test flow period. A daily summary of VAMP operations, along with supporting data, is provided in Appendix A.

In planning for the VAMP operation the ungaged flow at Vernalis is the most difficult factor to forecast for the test flow period. The Daily Operation Plan is developed assuming a steady ungaged flow during the test flow period, but in reality there will be day to day fluctuations due to a number of unpredictable factors including weather, pre-existing conditions, irrigation operations, as well as mathematical uncertainties introduced by using mean daily flows and assumed travel times rounded to the nearest day. During the implementation phase of the VAMP operation, the forecast ungaged flow will not necessarily be adjusted as a result of the day to day fluctuations, but will be adjusted if the general trend appears to be deviating from the existing forecast. This is all illustrated in Figure 2-3, which shows in hindsight the observed ungaged flow along with that forecast prior to the test flow period on April 8 and the adjusted forecast that was modified on an ongoing basis in an attempt to account for deviation from the existing forecast.

The combined CVP and SWP export rate averaged 1,430 cfs during the 31-day period, about 5 percent below the target of 1,500 cfs. The daily SWP and CVP exports during the VAMP test period are shown in Figure 2-4.

SJRG member agencies have entered into the Division Agreement, which allocates responsibility of the members for providing VAMP supplemental water. The distribution of supplemental water for the 2002 VAMP operation, compared to the distribution called for under the Division Agreement, is summarized in Table 2-7.

Hydrologic Impacts

The VAMP supplemental water contributions, with the exception of that provided by the Exchange Contractors and OID/SSJID, are supplied from reservoir storage: Lake McClure on the Merced River and New Don Pedro Reservoir on the Tuolumne River. Due to the extended nature of the VAMP, a 12-year plan, the storage impacts can potentially carry over from year to year. Reservoir storage impacts are reduced or eliminated when the reservoirs make flood control releases.

As noted in the 2001 Annual Technical Report, the storage impact in Lake McClure on the Merced River following the 2001 VAMP operation was 55,650 acre-feet. As per the SJRA, Merced provided 12,500 acre-feet of supplemental water in the Fall of 2001 (see Chapter 3), resulting in a total SJRA storage impact on Lake McClure at the end of 2001 of 68,150 acre-feet. There were no opportunities to make up for any of this impact during the winter, therefore the entire impact of 68,150 acre-feet carried over into the 2002 VAMP operation period. With the 25,840 acre-feet of supplemental water provided by Merced for the 2002 VAMP operation along with 1,270 acre-feet of operational ramp-down water, the current impact of the SJRA on Lake McClure storage is 95,260 acre-feet. Figure 2-5 shows Lake McClure storage for water year 2002 with and without the SJRA.

As noted in the 2001 Annual Technical Report, the storage impact in New Don Pedro Reservoir on the Tuolumne River following the 2001 VAMP operation was 14,060 acre-feet. There were no opportunities to make up for any of this impact during the winter, therefore the entire impact of 14,060 acre-feet carried over into the 2002 VAMP operation period. No supplemental water was provided from New Don Pedro Reservoir for the 2002 VAMP; therefore the current storage impact due to the SJRA remains at 14,060 acre-feet. Figure 2-6 shows New Don Pedro Reservoir storage for water year 2002 with and without the SJRA.

In the 2001 Annual Technical Report, a cumulative storage impact to New Melones of 54,210 acre-feet was identified. This statement was not correct. The water provided by OID/SSJID for both the VAMP pulse flow and the "additional" water is made available from their diversion entitlements. Thus, there are no storage impacts in New Melones due to either VAMP or the "additional" water purchase.

TABLE 2–7

2002 VAMP–Distribution of Supplemental Water

AGENCY	DIVISION AGREEMENT DISTRIBUTION (ACRE–FEET)	SUPPLEMENTAL WATER PROVIDED (ACRE–FEET)	DEVIATION FROM DIVISION AGREEMENT (ACRE–FEET)
Merced I.D.	25,000	25,840	+840
Oakdale I.D./ South San Joaquin I.D.	8,430	7,590	–840
Exchange Contractors	0	0	0
Modesto I.D./ Turlock I.D.	0	0	0