# CHAPTER 2

## VAMP Hydrologic Planning & Implementation



*This section documents the planning and implementation undertaken by the Hydrology Group of the San Joaquin River Technical Committee (SJRTC) for the 2004 VAMP investigations. Implementation of VAMP is guided by the framework provided in the San Joaquin River Agreement (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 2004, 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 (SJRECWA), 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 provides for a 31-day pulse flow (target flow) at the Vernalis gage on the San Joaquin River (Figure 2-1, inside front cover) during the months of April and May, along with a corresponding reduction in SWP/CVP Sacramento-San Joaquin Delta exports. The VAMP target flow and reduced Delta export are determined based on a forecast of the San Joaquin River flow absent the VAMP (Existing Flow) that would occur during the target flow period (Table 2-1). The Existing Flow is defined in the SJRA as "the forecasted flows in the San Joaquin River at Vernalis during the Pulse Flow Period that would exist absent the VAMP or water acquisitions," including such flows as minimum instream flows, water quality or scheduled fishery releases from New Melones Reservoir, flood control releases, uncontrolled reservoir spills, and/or local runoff. Achieving the target flow requires the coordinated operation of the three major San Joaquin River tributaries upstream of Vernalis: the Merced River, the Tuolumne River and the Stanislaus River.

**TABLE 2–1**
***VAMP Vernalis Flow & Delta Export Targets***

| Forecasted Existing Flow (cfs) | VAMP Target Flow (cfs) | Delta Export Target Rates (cfs) |
|---|---|---|
| 0 to 1,999 | 2,000 [a] | 1,500 [a] |
| 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 | |

[a] non-VAMP flow objectives

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 the San Joaquin River flow near Vernalis is difficult due to uncertainty and variation in unregulated flows, inaccuracy 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 Hydrology and Biology Groups agreed to a target range variation of plus or minus 7% of the Vernalis flow target. It was recognized by the Hydrology and Biology Groups that these guidelines are not absolute conditions, but are to be used by the VAMP hydrology and biology workgroups to evaluate experimental test conditions and the potential effect of flow and export variation on our ability to detect and assess variation in juvenile Chinook salmon survival rates among VAMP test conditions.

Under the SJRA, the following San Joaquin River Group Authority (SJRGA) agencies have agreed to provide the supplemental water needed to achieve the VAMP target flows, limited to a maximum of 110,000 acre-feet: Merced, OID, SSJID, SJRECWA, MID and TID. The Merced supplemental water would be provided on the Merced River from storage in Lake McClure and would be measured at the Merced River at Cressey gage. The OID and SSJID supplemental water would be provided on the Stanislaus River through diversion reductions and would be measured below Goodwin Dam. The SJRECWA supplemental water would be provided via Salt Slough, West Delta Drain, Boundary Drain and/or Orestimba Creek through system operation. The MID and TID supplemental water would be provided on the Tuolumne River from storage in New Don Pedro Reservoir

and would be measured at the Tuolumne River below LaGrange Dam gage.

The target flow of 2,000 cubic feet per second (cfs) shown in Table 2-1 does not represent a VAMP experiment target flow data point, but, rather, is used to define the SJRGA supplemental water obligation when Existing Flow is less than 2,000 cfs. 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 higher value (double-step) or the supplemental water requirement could be eliminated entirely (off-ramp). These potential adjustments to the target flow are dependent on the hydrologic year type as defined by the SWRCB San Joaquin Valley Water Year Hydrologic Classification (60-20-20 classification), which is given a numerical indicator as shown in Table 2-2 to make this determination. A double-step flow year occurs when the sum of the numerical indicators for the previous year's year type and current year's forecasted 90 percent exceedence year type is seven (7) or greater, a general recognition of either abundant reservoir storage levels or a high probability of abundant runoff. An off-ramp year occurs when the sum of the numerical indicators for the two previous years' year types and the current year's forecasted 90 percent exceedence year type is four (4) or less, an indication of extended drought conditions.

**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 |

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. 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 the USBR will attempt to acquire the needed additional water on a willing seller basis. The SJRGA will extend a "favored purchaser" offer to the USBR in accordance with the SJRA.

## HYDROLOGIC PLANNING

### *Hydrology Group Meetings*

Beginning in February 2004, and continuing until early April, the Hydrology Group held four planning and coordination meetings (February 19, March 17, March 30 and April 9). At these meetings, forecasts of hydrologic and operational conditions on the San Joaquin River and its tributaries were discussed and refined.

### *Monthly Operation Forecast*

As part of the initial planning efforts in February, a monthly operation forecast was 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 presented at the February 19 Hydrology Group meeting. The 90 percent exceedence forecast called for a VAMP target flow of 3,200 cfs and the 50 percent exceedence forecast called for a VAMP target flow of 5,700 cfs.

### *Daily Operation Plan Development*

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 calculates 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 travel times for flows from the tributary measurement points and upper San Joaquin River to the Vernalis gage are used in the development of the daily operation plan. The whole day increments are used because the daily operation plan is developed using mean daily flows.

## FLOW TRAVEL TIMES

a. Merced River at Cressey to Vernalis . . . . . 3 days

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

c. Tuolumne River below LaGrange Dam to Vernalis. . . . . 2 days

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

By definition, the ungaged flow at Vernalis is the unmeasured flow entering or leaving the system between the Vernalis gage and the upstream measuring points and is measured as follows:

**Ungaged flow at Vernalis =**

**$VNS - GDW_{lag} - LGN_{lag} - CRS_{lag} - USJR_{lag}$**

*where:*

VNS = San Joaquin River near Vernalis

$GDW_{lag}$ = Stanislaus River below Goodwin Dam lagged 2 days

$LGN_{lag}$ = Tuolumne River below LaGrange Dam lagged 2 days

$CRS_{lag}$ = Merced River at Cressey lagged 3 days

$USJR_{lag}$ = San Joaquin River above Merced River lagged 2 days (USJR is not a gaged flow but is the calculated difference between the gaged flows at the San Joaquin River at Newman (NEW) and the Merced River near Stevinson (MST)).

Of all of the assumptions required for the development of the daily operation plan, the ungaged flow estimation is the one assumption with the greatest degree of uncertainty. An extensive review of historical ungaged flows was made to determine if there were any correlations between the ungaged flow and the hydrologic conditions that could be used to reduce the uncertainty. Unfortunately, no significant correlations were found, but the review did indicate that a reasonable estimate of the ungaged flow for entering the target flow period could be projected. The daily operation plan is developed assuming a constant ungaged flow throughout the target flow period essentially equal to the value entering the period.

By definition, the VAMP 31-day pulse flow period can occur anytime between April 1 and May 31. Factors that are considered in the determination of the timing of the VAMP target flow period include installation of HORB, availability of juvenile salmon at the MRFF, and manpower and equipment availability for salmon releases and recapture. Until a specific start date is defined, a default target flow period of April 15 to May 15 is used for the VAMP operation planning. For 2004 the conditions were such that there was no apparent advantage to a different start date, therefore the target flow period was designated to be April 15 through May 15.

As part of the daily operation plan development, the determination must be made on whether the current year is likely to fall into the "off-ramp" or "double-step" category. The 60-20-20 water year classification for 2002 was "dry" (VAMP numerical indicator of two) and for 2003 was "below normal" (VAMP numerical indicator of three). Under these conditions the possibility of 2004 being an off-ramp year was eliminated since the off-ramp criterion (sum of VAMP numerical indicators for previous two plus current year equal to or less than four) was already exceeded without including the current year's numerical indicator. Conversely, 2004 would be a "double-step" year if the 90% probability of exceedence forecast called for a 60-20-20 water year classification of "above normal" (VAMP numerical indicator of four) or "wet" (VAMP numerical indicator of five). The final determination of the current year's VAMP numerical indicator is based on the April 1 runoff forecast, but the hydrologic conditions and forecasts prior to April are monitored so that the VAMP planning can proceed based on the most likely conditions. This year the January, February and March 90% probability of exceedence forecasts were placing 2004 in the "critical" and "dry" classifications, making the possibility of a "double-step" year remote. A drier than average March all but assured that 2004 would not be a "double-step" year. As it turned out, the April 1 90% probability of exceedence forecast classification for 2004 was "dry" (VAMP numerical indicator of two), making 2004 a normal, or single-step, VAMP year.

The initial daily operation plan was prepared on March 17, and was modified as hydrologic conditions and operational requirements changed. Table 2-3 summarizes the various iterations, and demonstrates the evolutionary nature, of the daily operation plan during the VAMP planning phase. The daily operation plans prepared during the VAMP planning phase are provided in Appendix A-1.

### *Tributary Flow Coordination*

Although the primary goal of the VAMP operation is to provide a stable target flow in the San Joaquin River near Vernalis, an

**TABLE 2–3**

*Summary of 2004 VAMP Daily Operation Plans*

| Phase | VAMP Forecast Date | VAMP Target Flow Period | Assumed Ungaged Flow at Vernalis (cfs) | Existing Flow (cfs) | VAMP Target Flow (cfs) | Supplemental Water needed to meet Target Flow (1,000 AF) |
|---|---|---|---|---|---|---|
| | March 17 | April 15–May 15 | 300<br>800 | 2,185<br>3,779 | 3,200<br>4,450 | 62,400<br>41,280 |
| Planning | March 30 | April 15–May 15 | 300<br>500 | 2,135<br>3,778 | 3,200<br>4,450 | 65,460<br>41,290 |
| | April 09 | April 15–May 15 | 500 | 2,353 | 3,200 | 52,070 |
| | April 13 | April 15–May 15 | 500 | 2,352 | 3,200 | 52,170 |
| Implementation | April 20 | April 15–May 15 | 365 | 2,213 | 3,200 | 59,780 |
| | May 03 | April 15–May 15 | 281 | 2,137 | 3,200 | 63,620 |

**TABLE 2–4**

*Real-time Flow Data and Sources*

| Measurement Location | Real-time Data Source |
|---|---|
| San Joaquin River near Vernalis | USGS, station 11303500 (http://waterdata.usgs.gov/ca/nwis/dv?format=pre&period=31&site_no=11303500) |
| Stanislaus River below Goodwin Dam | USBR, Goodwin Dam Daily Operation Report (http://www.usbr.gov/mp/cvo/vungvari/gdwdop.pdf) |
| Tuolumne River below LaGrange Dam | USGS, station 11289650 (http://waterdata.usgs.gov/ca/nwis/dv?format=pre&period=31&site_no=11289650) |
| Merced River at Cressey | CDEC, station CRS (http://cdec.water.ca.gov/cgi-progs/queryDgroups?s=fw2) |
| Merced River near Stevinson | CDEC, station MST (http://cdec.water.ca.gov/cgi-progs/queryDgroups?s=fw2) |
| San Joaquin River at Newman | USGS, station 11274000 (http://waterdata.usgs.gov/ca/nwis/dv?format=pre&period=31&site_no=11274000) |

important consideration in the planning and operation is that the flows that are scheduled on the Merced, Tuolumne and Stanislaus Rivers to achieve this goal are beneficial and do not conflict with studies or flow requirements on those rivers. During the development of the daily operation plan, the Hydrology Group consults with DFG and the tributary biological teams to determine periods when pulse flows and stable flows are desirable on the tributaries, what flow rates are desired, what rates of change are acceptable, and what minimum and maximum flows are acceptable. The periods of desired stable flow are highlighted with bold outlines in the daily operation plans in Appendix A.

For the 2004 VAMP operation the April 9 daily operation plan called for staggered single pulse flow periods on each of the tributaries (Figure 2-2), starting on the Tuolumne River with a nine day flow of about 1,400 cfs, followed by the Stanislaus River with a ten day flow of about 1,250 cfs, and concluding on the Merced River with a ten day flow of about 1,300 cfs. Plots of the individual tributary flows during the VAMP operation are provided in Appendix A-3.

## IMPLEMENTATION

### *Operation Conference Calls*

During implementation of the VAMP pulse flow, conference calls were conducted every Monday, Wednesday and Friday between April 16 and May 10 at 6:30 A.M. to discuss the status of the pulse flow and to make operational changes if needed. The calls were held at 6:30 A.M. so that if operational changes were called for they could be implemented on that day.

### *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 2-4. The real-time flow data used during the implementation of the VAMP flow have varying degrees of quality. The CDEC real-time data has not been reviewed for accuracy or adjusted for rating shifts, whereas 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 are continuously monitored. Similarly, the computed ungaged flow at Vernalis and the flow in the San Joaquin River upstream of the Merced River are continuously updated. The monitoring is done to assure that



FIGURE 2-2

*April 9 Forecast of San Joaquin River Basin 2004 VAMP Operation*

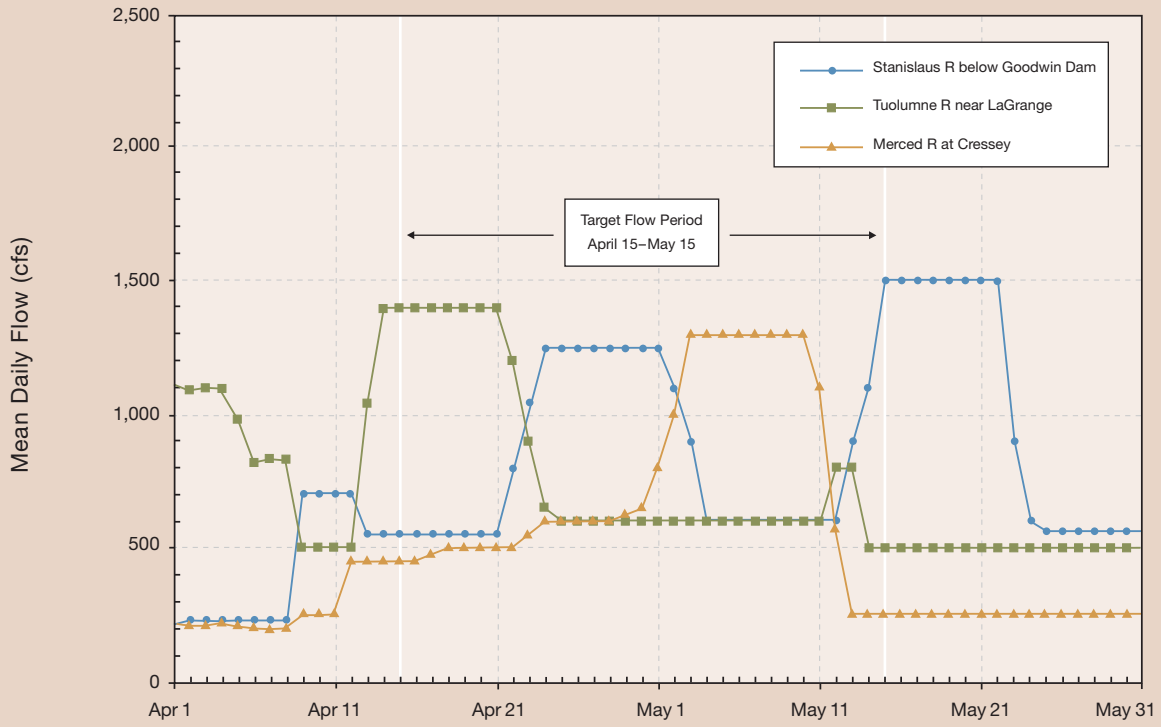


**TABLE 2-5**

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

| Date | Gage Height | Measured Flow (cfs) | Current Rating Shift Flow (cfs) | Percent Difference | Rating Shift |
|---|---|---|---|---|---|
| 3/19/04 (15:10) | 12.13 | 4,330 | 4,240 | 2.1% | No |
| 4/06/04 (09:50) | 10.46 | 2,640 | 2,720 | -3.0% | No |
| 4/14/04 (10:20) | 9.64 | 2,050 | 2,030 | 1.0% | No |
| 4/20/04 (09:48) | 10.85 | 3,130 | 3,070 | 1.9% | No |
| 4/27/04 (10:48) | 11.11 | 3,190 | 3,320 | -4.1% | No |
| 5/04/04 (10:15) | 11.11 | 3,350 | 3,320 | 0.9% | No |
| 5/11/04 (09:50) | 11.12 | 3,310 | 3,320 | -0.3% | No |



the supplemental water deliveries are adhering to the tributary allocations contained in the SJRGA Division Agreement to the extent possible, as well as to determine if adjustments need to be made to the operation plan.

Normally, the USGS makes monthly measurements of the flow at Vernalis to check the current rating shift. 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 April 6 and May 11. The results of these measurements are summarized in Table 2-5. There were no rating shifts during the 2004 VAMP operation period.

The daily operation plan was updated twice during the VAMP flow period (Table 2-3). In each update the estimation of VAMP supplemental flow was adjusted to compensate for a decline in the ungaged flow. The daily operation plans prepared during the VAMP implementation phase are provided in Appendix A-1 in the April 20 and May 3 plans. Final accounting of the supplemental VAMP water contribution is provided in Appendix A-2.

## RESULTS OF OPERATIONS

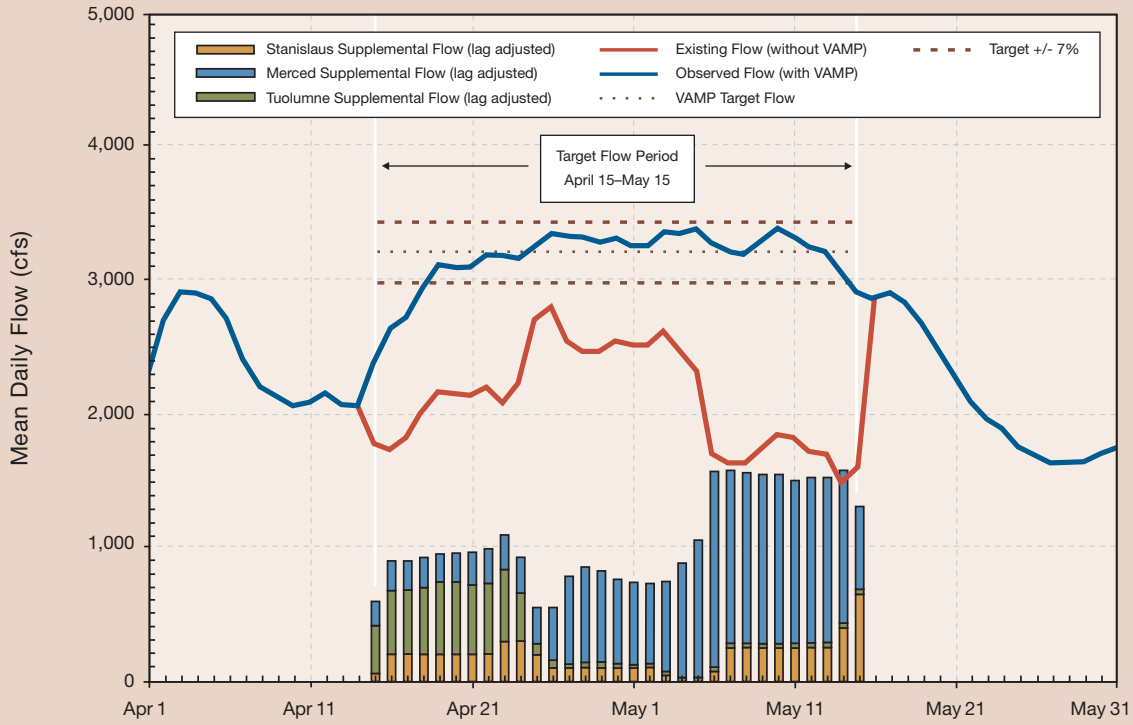
The final accounting for the VAMP operation was accomplished using provisional mean daily flow data available from USGS and DWR as of July 2, 2004. Provisional data is data that has been reviewed and adjusted for rating shifts but is still considered preliminary and subject to change. Plots of the real-time and provisional flows at the primary measuring points are provided in Appendix A-3 to illustrate the differences between the real-time and the provisional data.

The mean daily flow at the Vernalis gage averaged 3,155 cfs during the April 15–May 15 VAMP target flow period, 1.4% below the target flow of 3,200 cfs. The maximum mean daily flow (Figure 2-3) during target flow period was 3,380 cfs on May 10 and the minimum was 2,370 cfs on April 15. The final Existing Flow was estimated to have averaged 2,088 cfs during the target flow period. The VAMP operation resulted in a 51% increase in flow at Vernalis during the target flow period and required 65,591 acre-feet of supplemental water. Figure 2-3 shows the flow at Vernalis with and without the VAMP supplemental water. Figure 2-4 shows the sources of the flow at Vernalis. Figures 2-5, 2-6 and 2-7 show the with and without VAMP flows at the tributary measurement points, Merced River at Cressey, Tuolumne River below LaGrange Dam and Stanislaus River below Goodwin Dam, respectively.

The initiation of the VAMP was based on the April 9 daily operation plan (see Appendix A-1) with a forecasted Existing Flow of 2,353 cfs and a supplemental water requirement of 52,070 acre-feet. During the target flow period the observed Existing Flow was substantially less than the forecasted Existing

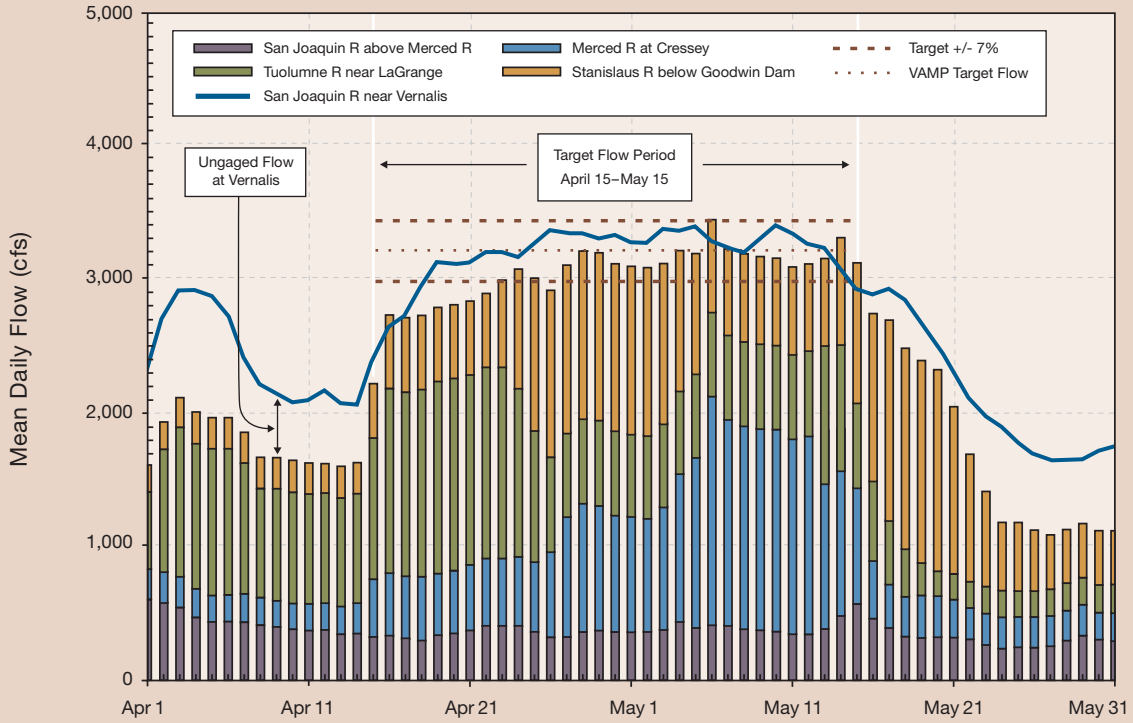
## FIGURE 2-3

*2004 VAMP–San Joaquin River Near Vernalis With and Without VAMP*



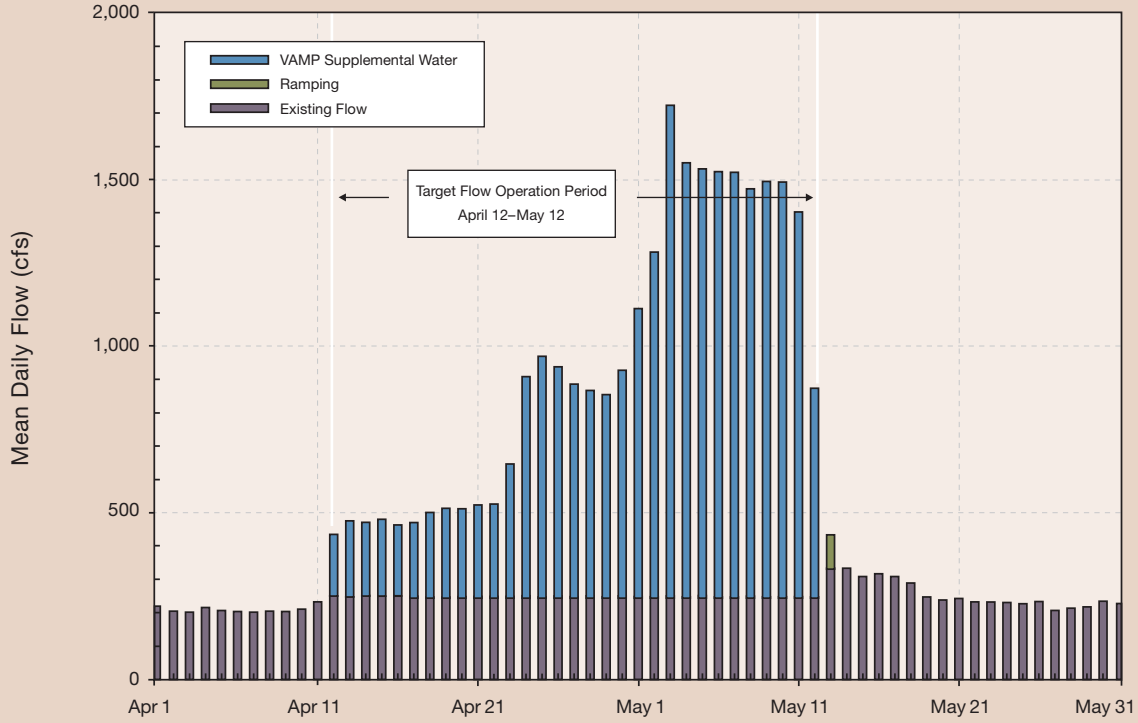

## FIGURE 2-4

*2004 VAMP San Joaquin River Near Vernalis With Lagged Contributions from Primary Sources*



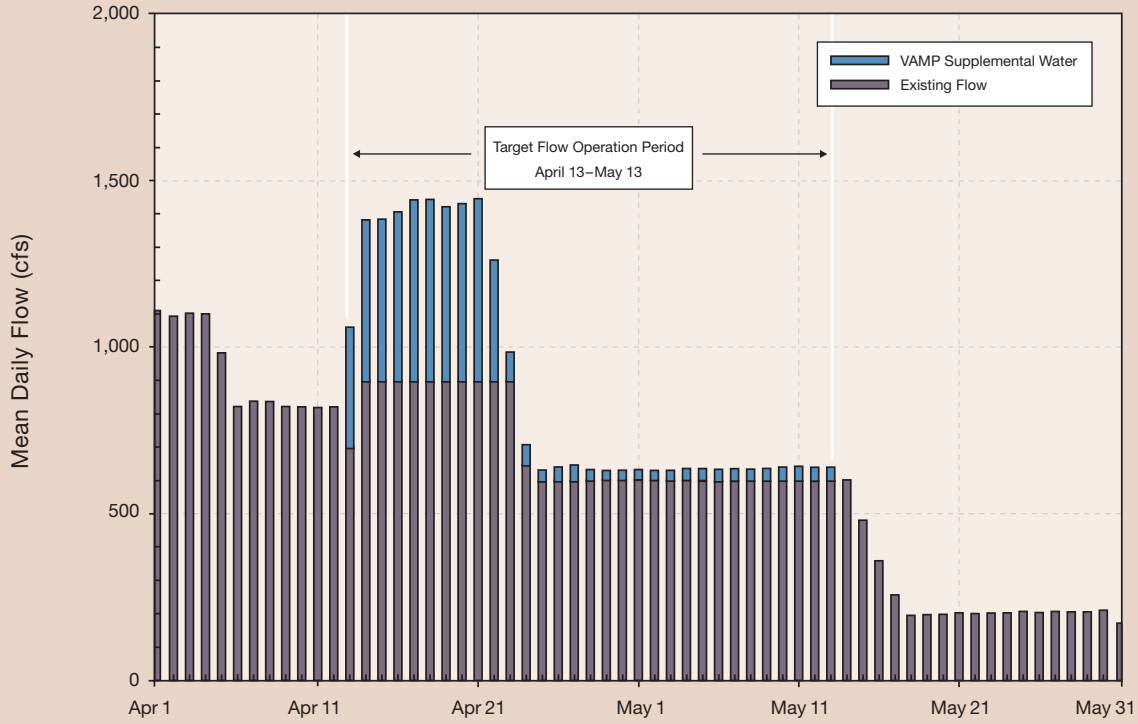
## FIGURE 2-5

*2004 VAMP–Merced River at Cressey*



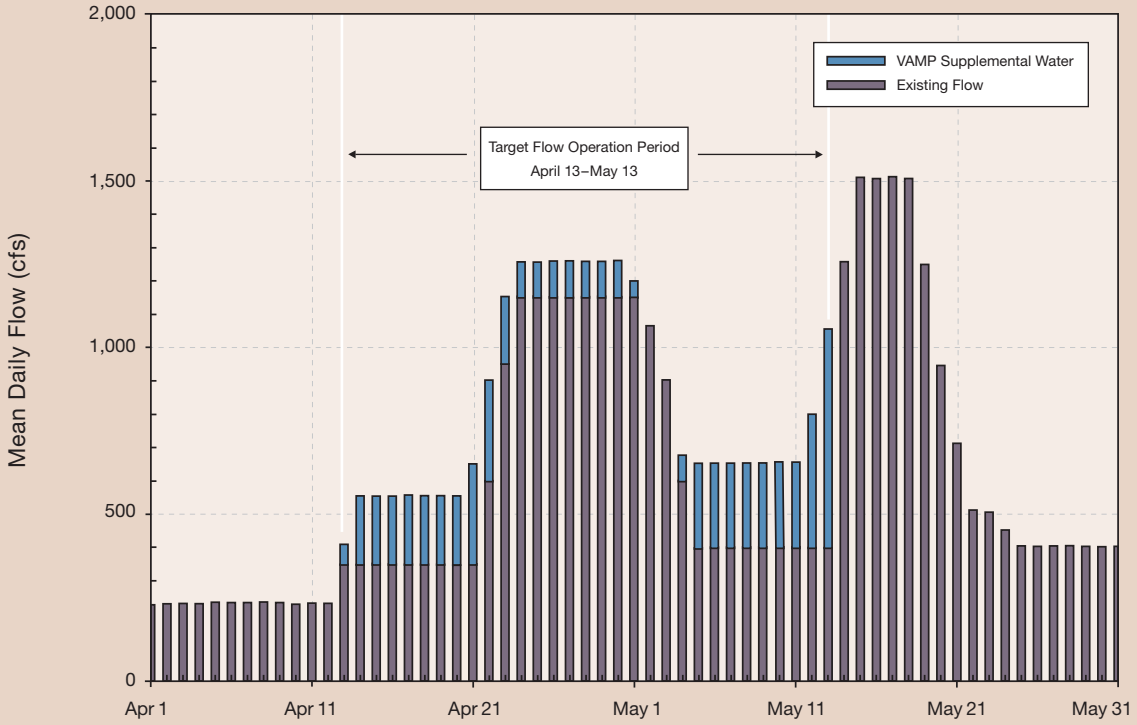

## FIGURE 2-6

*2004 VAMP–Tuolumne River Below LaGrange Dam*



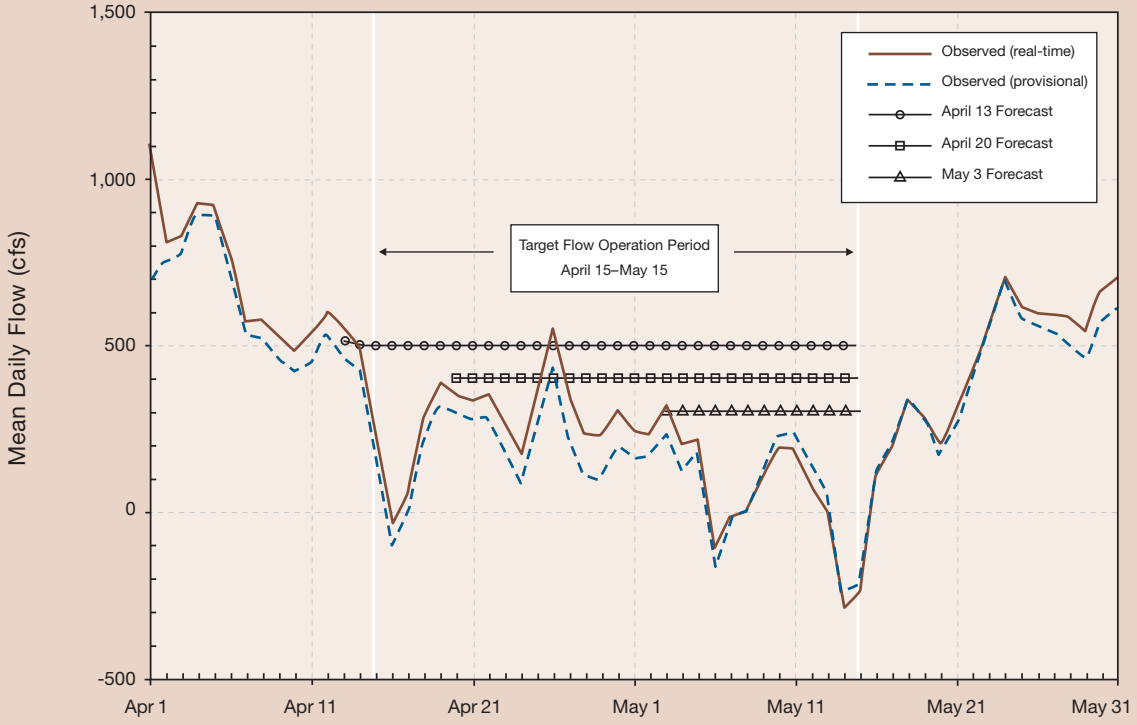
## FIGURE 2-7

*2004 VAMP–Stanislaus River Below Goodwin Dam*




## FIGURE 2-8

*2004 VAMP–Ungaged Flow in San Joaquin River at Vernalis*
*Comparison of Forecasted and Observed*



Flow, primarily due to a significant decline in the ungaged flows from that forecasted, causing the SJRGA to contribute an additional 13,521 acre-feet of supplemental water. During the target flow period, no adjustments were made to the New Melones Reservoir water quality or scheduled fishery flow releases, which are a component of the Existing Flow. Without further analysis it is unknown if any such adjustments would have been appropriate.

In planning for the VAMP operation the ungaged flow in the San Joaquin River 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, adjustments were made to the ungaged flow based not on day-to-day fluctuations but on evidence that the ungaged flow is trending away from the forecast. This is best illustrated in Figure 2-8, which shows in hindsight the observed ungaged flow along with that forecast prior to the test flow period on April 13 and the adjusted forecasts that were modified on an ongoing basis in an attempt to account for deviation from the existing forecast.

Another unknown in the forecast equation similar to the ungaged flow is the flow in the San Joaquin River upstream of the Merced River. This unknown tends not to be as variable as the ungaged flow, but like the ungaged flow, it may be adjusted if the observed flow warrants it. During the 2004 VAMP operation no modifications were made to the upper San Joaquin River flow forecast that was used in the April 13 daily operation plan. Figure 2-9 shows the observed and forecasted upper San Joaquin River flows.

The target combined CVP and SWP Delta export rate for the 2004 VAMP was 1,500 cfs. The observed export rate averaged 1,331 cfs during the VAMP target flow period. The daily SWP and CVP exports during the VAMP test period are shown in Figure 2-10.

The SJRGA member agencies have entered into an agreement, known as the Division Agreement, which allocates the responsibility of the member agencies for providing the VAMP supplemental water. The member agencies may also enter into additional agreements among themselves regarding delivery of the supplemental water. For the 2004 VAMP, Merced I.D. and the SJRECWA entered into an agreement whereby the SJRECWA supplemental water would be provided by Merced I.D. on the Merced River. The distribution of supplemental water for the 2004 VAMP operation, compared to the distribution called for under the Division Agreement, is summarized in Table 2-6.

### *Hydrologic Impacts*

The Merced VAMP supplemental water is provided from storage in Lake McClure on the Merced River and the MID/TID VAMP

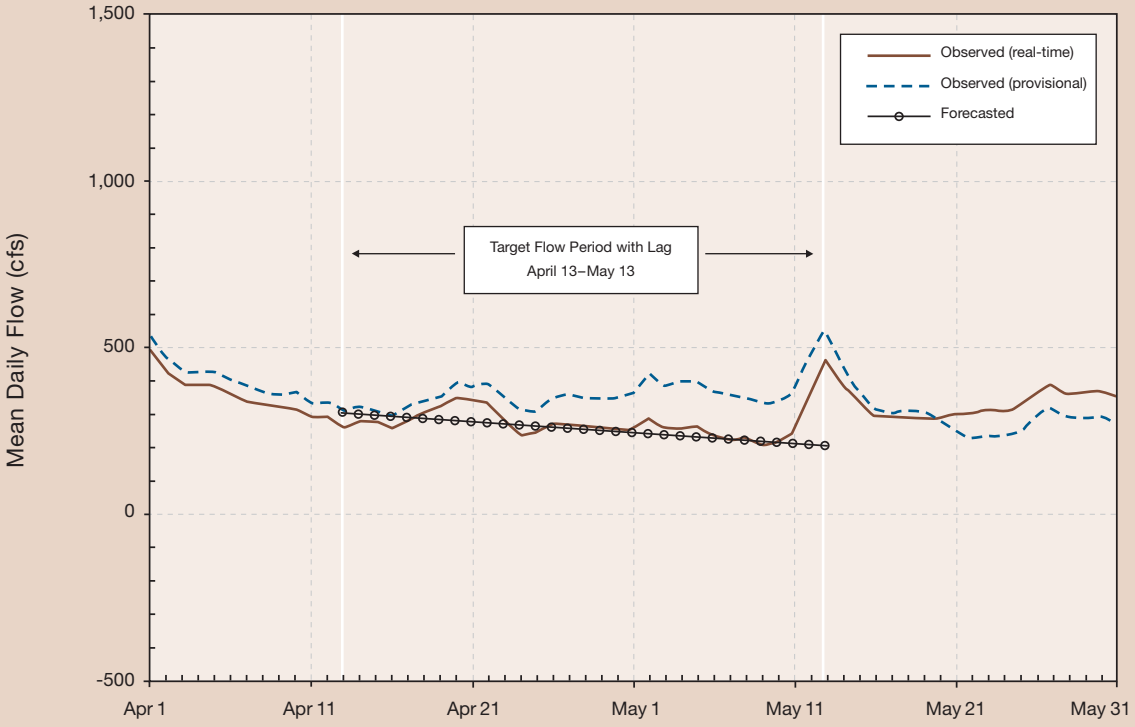
**TABLE 2-6**
*Distribution of Supplemental Water*

| Agency | Supplemental Water Provided (acre-feet) | Division Agreement Distribution (acre-feet) | Deviation from Division Agreement (acre-feet) |
|---|---|---|---|
| Merced I.D. | 37,680 | 36,500 | +1,180 |
| Oakdale I.D./South San Joaquin I.D. | 11,760 | 14,091 | -2,331 |
| Exchange Contractors | 5,000 [a] | 5,000 | 0 |
| Modesto I.D./Turlock I.D. | 11,151 | 10,000 | +1,151 |
| Total | 65,591 | 65,591 | 0 |

[a] The Exchange Contractors supplemental water was provided by Merced I.D.

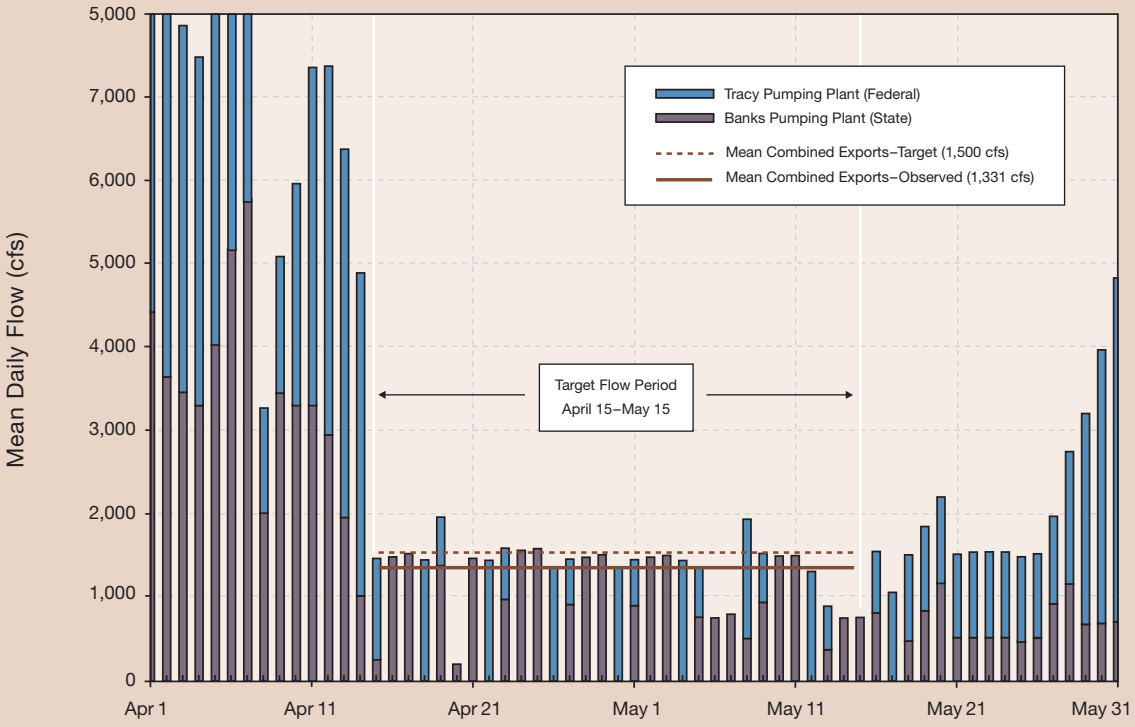
## FIGURE 2-9

*2004 VAMP–San Joaquin River Above Merced River*
*Comparison of Forecasted and Observed*




## FIGURE 2-10

*2004 VAMP–Federal and State Delta Exports*



supplemental water is provided from storage in New Don Pedro Reservoir. The OID/SSJID VAMP supplemental water is made available from their diversion entitlements and therefore there are no storage impacts in New Melones Reservoir on the Stanislaus River due to the SJRA. 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.

The current cumulative impact of the SJRA on the storage in Lake McClure would be 215,197 acre-feet (Table 2-7), if Merced I.D. diversions from the Merced River are assumed to have been the same for both without and with SJRA conditions. However, as a result of the SJRA, Merced I.D. has undertaken a number of conservation measures that have resulted in a reduced reliance on Merced River diversions. Any reductions in Merced River diversions would offset the storage deficit shown in Figure D-1 (Appendix D). The impact of the conservation measures on Merced River diversions is in the process of being quantified and was not available at the time of publication of this report. The conservation impacts will be incorporated into next year's annual report. It should be noted that even under the assumption that the storage deficit is equal to the supplemental water contribution the SJRA has resulted in no reductions in Merced River flow during the period of 2000 through 2004 as shown in Figure D-3.

The cumulative impact of the SJRA on storage in New Don Pedro Reservoir following the 2003 VAMP operation was 23,790 acre-feet. This storage deficit was erased as a result of flood control operations in March 2004. Therefore, as a result of the 2004 VAMP operation the current impact of the SJRA on New Don Pedro Reservoir storage is 11,151 acre-feet (see Table 2-8). The impacts of the SJRA on New Don Pedro Reservoir storage and on Tuolumne River flow for the period of 2000 through 2004 are shown in Appendix D, Figures D-2 and D-4.

## SUMMARY OF HISTORICAL VAMP OPERATIONS

2004 marks the fifth year of VAMP operation in compliance with SWRCB Decision 1641. A summary of the VAMP target flows for these first five years is provided in Table 2-9. A summary of the SJRGA supplemental water contributions is provided in Table 2-10. The Hydrology Group monitors the cumulative impact of the SJRA on reservoir storage and stream flows. Plots of storage and flow impacts throughout the five years of VAMP operation are provided in Appendix D.

Over the first five years of the program considerable variation has occurred in both the flow entering the system upstream of the Merced River and the ungaged flow within the system. With each update of the daily operation plan throughout the planning and implementation phases the upstream and ungaged flows would vary causing the SJRGA to reduce or increase the contribution of supplemental water in order to support the VAMP target flow. A table summarizing the differences between the forecasted and observed Existing Flows during the five years of VAMP implementation, along with the corresponding differences in the supplemental water requirements, is provided in Appendix D-5. An analysis of the variability in the upstream and ungaged flows and how these affect the computation of the Existing and supplemental flows is warranted.

## TABLE 2–7

*Storage Impact History, Lake McClure (Merced River)*

| Calendar Year | VAMP Supplemental Water (acre-feet)* | Fall Supplemental Water (acre-feet) | SJRA Storage Impact Replenishment (acre-feet) | End of Year Cumulative Storage Impact (acre-feet)** |
|---|---|---|---|---|
| 2000 | 46,750 | 12,500 | 46,750 (May 2000) | -12,500 |
| 2001 | 43,146 | 12,496 | 0 | -68,142 |
| 2002 | 27,120 | 12,470 | 0 | -107,732 |
| 2003 | 39,586 | 12,500 | 0 | -159,818 |
| 2004 | 42,879 | 12,500 | 0 | -215,197 |

* Includes ramping flows.

** End of Year storage impacts not adjusted for conservation actions implemented by district.

## TABLE 2–8

*Storage Impact History, New Don Pedro Reservoir (Tuolumne River)*

| Calendar Year | VAMP Supplemental Water (acre-feet) | SJRA Storage Impact Replenishment (acre-feet) | End of Year Cumulative Storage Impact (acre-feet) |
|---|---|---|---|
| 2000 | 22,651 | 14,955 (Sept–Oct 2000) | -7,696 |
| 2001 | 14,061 | 7,696 (Jan–Feb 2001) | -14,061 |
| 2002 | 0 | 0 | -14,061 |
| 2003 | 9,729 | 0 | -23,790 |
| 2004 | 11,151 | 23,790 (March 2004) | -11,151 |

CHAPTER 2

The SJRGA member agencies have entered into an agreement, known as the Division Agreement, which allocates the responsibility of the member agencies for providing the VAMP supplemental water.

## TABLE 2-9

*Summary of VAMP Flows, 2000-2004*

| Year | 60-20-20 Water Year Hydrologic Classification | VAMP Target Flow (cfs) | Observed VAMP Flow (cfs) | Existing Flow (cfs) | VAMP Suppl. Water (acre-ft) | Delta Export Target (cfs) | Observed Delta Exports (cfs) |
|---|---|---|---|---|---|---|---|
| 2000 | Above Normal | 5,700 | 5,869 | 4,800 | 77,680 | 2,250 | 2,155 |
| 2001 | Dry | 4,450 | 4,224 | 2,909 | 78,650 | 1,500 | 1,420 |
| 2002 | Dry | 3,200 | 3,301 | 2,757 | 33,430 | 1,500 | 1,430 |
| 2003 | Below Normal | 3,200 | 3,235 | 2,290 | 58,065 | 1,500 | 1,446 |
| 2004 | Dry | 3,200 | 3,155 | 2,088 | 65,591 | 1,500 | 1,331 |

## TABLE 2-10

*Summary of VAMP Supplemental Water Contributions, 2000-2004*

| Year | VAMP Supplemental Water (acre-ft) | | Supplemental Water (acre-ft) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Merced ID | OID | SSJID | SJRECWA | MID | TID |
| 2000 | 77,680 | Observed: | 46,750 | [a] | [b] | 8,280 | 15,200 | 7,450 |
| | | Division Agreement: | 45,160 | 7,300 | 7,300 | 7,300 | 16,920 | 8,300 |
| | | Deviation: | +1,590 | 0 | 0 | +980 | -1,720 | -850 |
| 2001 | 78,650 | Observed: | 42,120 | 7,365 | 7,365 | 7,740 | 7,030 | 7,030 |
| | | Division Agreement: | 42,150 | 7,300 | 7,300 | 7,300 | 7,300 | 7,300 |
| | | Deviation: | -30 | +65 | +65 | +440 | -270 | -270 |
| 2002 | 33,430 | Observed: | 25,840 | 3,795 | 3,795 | 0 | 0 | 0 |
| | | Division Agreement: | 25,000 | 4,215 | 4,215 | 0 | 0 | 0 |
| | | Deviation: | +840 | -420 | -420 | 0 | 0 | 0 |
| 2003 | 58,065 | Observed: | 38,257 | 5,039 | 5,039 | [c] | 4,864.5 | 4,864.5 |
| | | Division Agreement: | 38,065 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| | | Deviation: | +192 | +39 | +39 | 0 | -135.5 | -135.5 |
| 2004 | 65,591 | Observed: | 42,680 | 5,880 | 5,880 | [c] | 5,575.5 | 5,575.5 |
| | | Division Agreement: | 41,500 | 7,045.5 | 7,045.5 | 5,000 | 5,000 | 5,000 |
| | | Deviation: | +1,180 | -1,165.5 | -1,165.5 | 0 | +575.5 | +575.5 |

[a] Provided by Modesto ID
[b] Provided by Merced ID (54.55%), Oakdale ID (15.91%), Modesto ID (15.91%), Turlock (13.64%)
[c] Provided by Merced ID