Appendix Z Hydrodynamic Effects of the Temporary Barriers Project and the South Delta Improvements Program Stage 1

Study 1:

Old and Middle River Flow Comparison between the No Barrier Condition and the Temporary Barrier Condition

Study 2:

Changes in Old and Middle River Flows Implementing Permanent Operable Gates versus Temporary Barriers

Study 3:

Particle Tracking Analysis of Studies 7.0 and 7.1 for the Month of June

Study 1: Old and Middle River Flow Comparison between the No Barrier Condition and the Temporary Barrier Condition

The Temporary Barriers Program (TBP) has been active since the late 1980s. The temporary barriers are made of gated culverts and rock piled in South Delta channels. Temporary barriers are installed at the Head of Old River, in Old River near the Jones (Tracy) pumping plant, in Grantline Canal near Tracy Road, and in Middle River just upstream of Victoria Canal. The Head of Old River barrier is a fish control barrier that is installed between April 15th and May 15th each year to prevent out migrating San Joaquin River salmon smolts from entering the south Delta via Old River. Because of construction constraints, the temporary Head of Old River barrier is assumed to be installed April 15th and removed May 15th in each year when the San Joaquin River flow is less than 5,000 cfs. Although, in the computer modeling analysis presented here, the Head of Old River barrier is installed each year without regard to San Joaquin River flows.

In 2000, permits were needed to continue constructing and operating the temporary barriers for several more years. At the time, the Department of Water Resources was seeking to use the temporary flow control barriers (or agricultural barriers) from March through fall. Since then, the temporary flow control barriers are permitted to operate after the temporary Head of Old River barrier is constructed or later in June if the HOR barrier is not constructed in the spring. The temporary Head of Old River (HOR) barrier was still to be installed during the Vernalis Adaptive Management Program (VAMP) period of April 15th through May 15th.

Old and Middle River (OMR) flows near Bacon Island are used in this analysis as a surrogate for potential impacts of the temporary barriers on Delta smelt movements in the Delta. The information is found in “Mitigated Negative Declaration and Initial Study Temporary Barriers Project 2001 – 2007” (DWR 2000).

Figure 1 shows the OMR Flows in cubic feet per second for both the No Barriers condition (None) and with the Temporary Barriers Project (TBP) for a dry year type, 1989. In these results, the OMR flow reverses once the Head of Old River Barrier is installed in the middle of April. In the middle of May, the Head of Old River Barrier is removed, but the use of the temporary flow control barriers (agricultural barriers) continues to impede some of the flow. Following May, the two cases differ by about 800 cfs. This is due to the effect of the flow-control barriers.

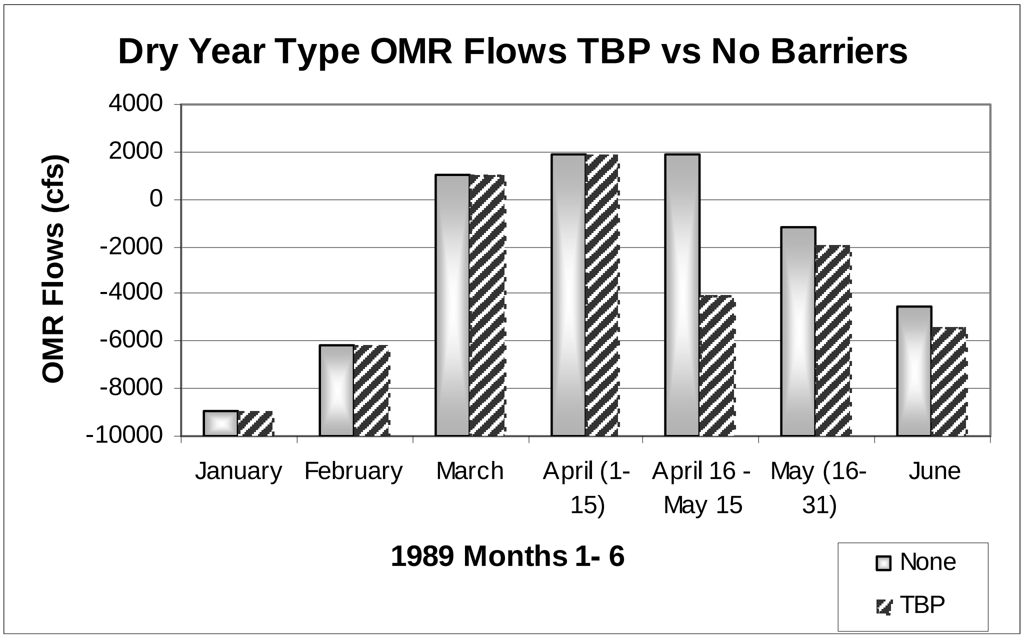

Figure 1 Dry Year Type OMR Flows – Temporary Barriers Project vs No Barriers

In Figure 2 1984, a wet year type, shows a response similar to the TBP plot in Figure 1. The OMR flows for each case are the same until the installation of the Head of Old River Barrier in mid-April. The OMR flows then diverge until the Head of Old River barrier is removed in mid-May. Following May, the two cases differ by about 700 cfs. This is due to the effect of the flow-control barriers. The change in flow will depend on how much water is flowing into the Head of Old River, the agricultural consumption in the South Delta and the level of exports.

In conclusion, the temporary barriers have a negative impact on OMR flows beginning with the installation of the HOR barrier in mid-April and continuing after the spring HOR barrier is removed and until the barriers are removed in the fall. The HOR barrier has a more significant impact on negative OMR flows because it restricts San Joaquin River water from entering Old River. Whereas the temporary flow control barriers have less of an impact on negative OMR flows because they allow downstream flow during high tide cycles.

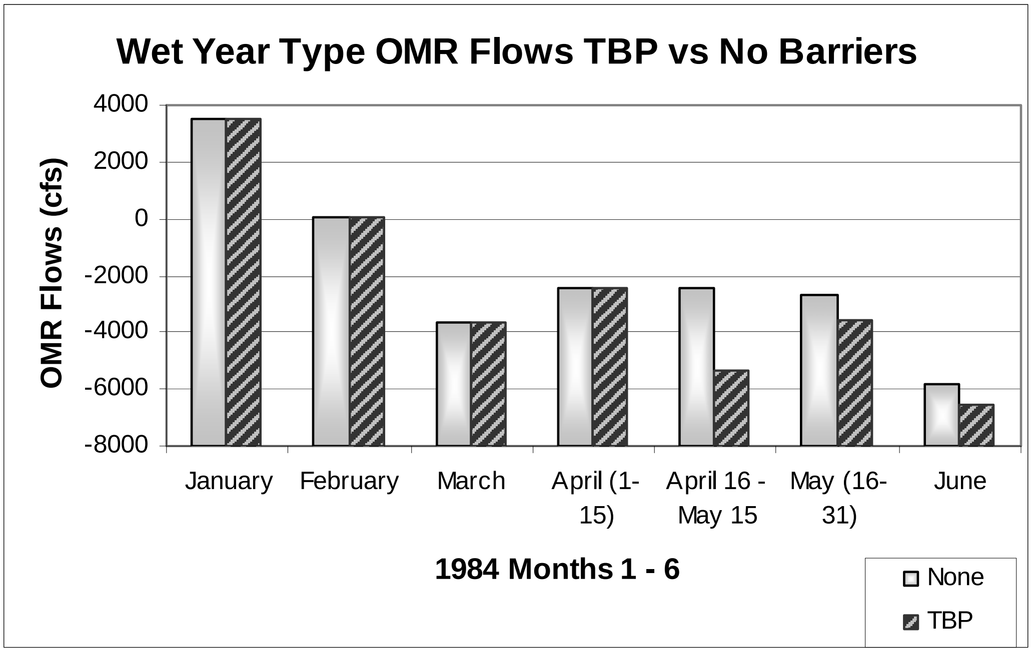

Figure 2 Wet Year Type OMR Flows Temporary Barriers vs No Barriers

Study 2: Changes in Old and Middle River Flows Implementing Permanent Operable Gates versus Temporary Barriers

In the South Delta Improvements Program EIR/EIS, operations of the Proposed SDIP gates are compared to the baseline condition of installing the temporary barriers which has been the case since the late 1980s.

The temporary barriers are made of rock and gated culverts. The Head of Old River barrier is a fish control barrier that is installed between April 15th and May 15th each year to prevent out migrating San Joaquin River salmon smolts from entering the south Delta via Old River. In the computer modeling analysis presented here, the temporary Head of Old River barrier is assumed to be installed April 15th and removed May 15th in each year when the San Joaquin River flow is less than 5,000 cfs. In those years when the flows are greater than 5000 cfs, the barrier is not in place. This is consistent with the practice of construction of this barrier. While the barrier is also installed in the fall months, this spring operation is the operational change that is most significant to Delta hydrodynamics as they affect Delta smelt and salmon smolts.

The temporary agricultural barriers (also referred to as flow control barriers) are installed after the Head of Old River barrier is installed and removed at the end of the agricultural season when the fall Head of Old River barrier is removed (November 30th). In the computer modeling analysis presented here, the temporary flow barriers are assumed to be installed April 15th and removed November 30th in each year. The temporary flow control barriers act as weirs, protecting the upstream stage of south Delta channels, but providing very little water quality benefit.

The proposed South Delta Improvements Program (SDIP) permanent operable gates would replace the function of the temporary barriers. The SDIP gates are bottom hinged lift gates which lay flat on the bottom of the channel when open and are lifted to a specified height when operated. The gates would be operated in two different manners, as detailed in the Project Description in Chapter 2, to protect stage only and to protect both stage and water quality. However, the proposed SDIP gate operations in the EIR/EIS included closing the Head of Old River Gate from April 1st to May 31st , which is one significant distinction between the modeling assumptions. In the OCAP modeling, the permanent Head of Old River (HOR) gate operations in spring are only from April 15th through May 15th. Another significant distinction is that the Permanent HOR gate is proposed to be operated April 15th through May 15th when the San Joaquin River is less than 10,000 cfs, whereas the Temporary HOR barrier is only installed if the San Joaquin River flow is less than 5000 cfs. Therefore there are seasons in which the Temporary HOR Barrier would not have been installed, but the Permanent HOR Gate is operated. Our modeling shows this occurrence on a few occasions.

In this analysis, the export rates remain the same throughout the two studies. Therefore, when changes are discerned through the modeling results those changes are due to the new proposed gates. The modeling was completed for the years of 1975 through 1991. These years were selected because they were indicative of the larger hydrologic period of record, yet the set was small enough to model with the Delta Simulation Model 2 (DSM2). Although this set of years is representative, it tends to be slightly dryer than the larger hydrologic period of record. The water year category for each year in the 1975-1991 period is shown in Table 1.

Table 1 Water Year Types for the Years Used in Computer Modeling

Year	Water Year Type	Year	Water Year Type
1975	Wet	1976	Critical
1977	Critical	1978	Above Normal
1979	Below Normal	1980	Above Normal
1981	Dry	1982	Wet
1983	Wet	1984	Wet
1985	Dry	1986	Wet
1987	Dry	1988	Critical
1989	Dry	1990	Critical
1991	Critical		

This analysis also concentrates on one primary surrogate for impacts to fish – negative Old and Middle River flows (OMR Flows). Significant negative OMR flows indicate the potential for Delta smelt to be moved to the State Water Project and Central Valley Project export facilities in the south Delta.

Figure 3, Figure 4, and Figure 5, contain three charts depicting the first six months of the years 1987, 1988, and 1989. These three years are dry and critically dry. In each of these years, there are slight changes in OMR flows prior to the onset of VAMP. During the months prior to VAMP (January – March), modeling assumptions have no temporary barriers or permanent gates operating. There is a slight difference in the flows which might be caused by the monthly tidal cycle effects on the presence of the structures and the dredging proposed in Middle River.

During the periods of April 1- April 15 and May 15-May 31, you see a separation of OMR flows between the two scenarios. These individual events, up to about 500 cfs increase in negative OMR flows, are caused by the simulation of the operation of the HOR gate for the first part of April and the end of May, which is above and beyond the use of the temporary barrier at the HOR. These changes in flow would not result from the current proposed operation of the SDIP HOR gate because the HOR gate operations will be restricted to April 15th through May 15th (VAMP) in the spring. During the VAMP period of mid-April to mid-May, the plots show the SDIP gates cause the OMR flows to be more negative. The effect ranges from 150 cfs to 600 cfs. These changes can be expected to occur as the HOR gate can completely block flows into Old River whereas the HOR temporary barrier allows flows into Old River via culverts. In real-time operation, the HOR gate could be operated to allow flow into Old River, which would reduce the estimated negative OMR flows.

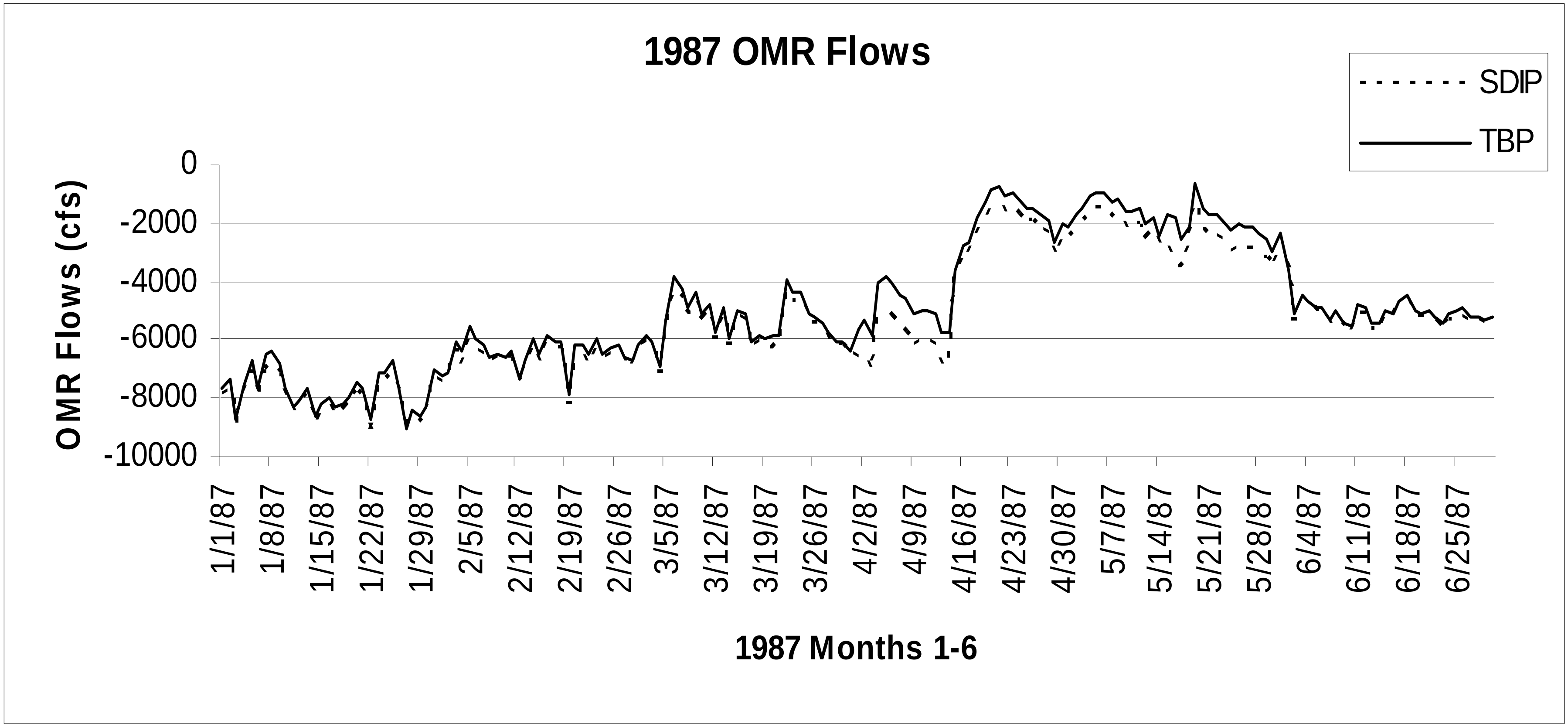

Figure 3 OMR Flows for 1987. Temporary Barriers vs South Delta Improvement Program Gates

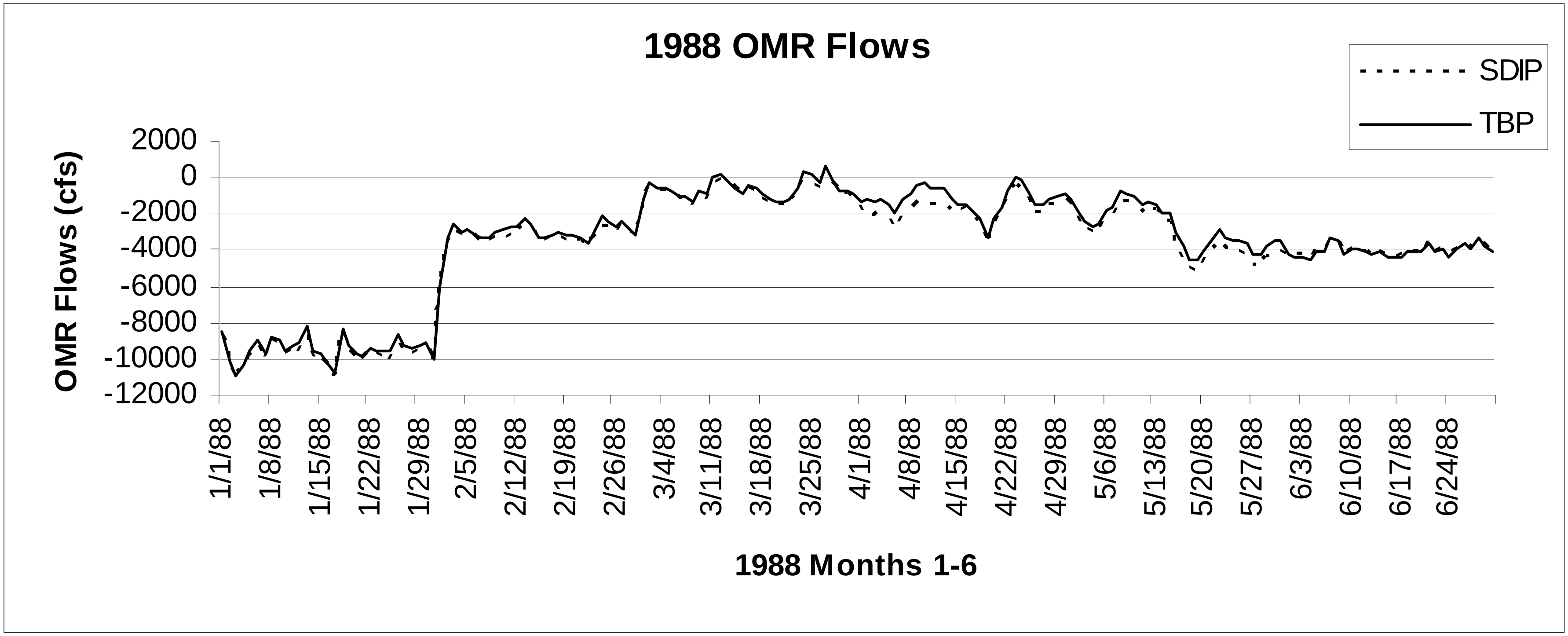

Figure 4 OMR Flows for 1988. Temporary Barriers vs South Delta Improvement Program Gates

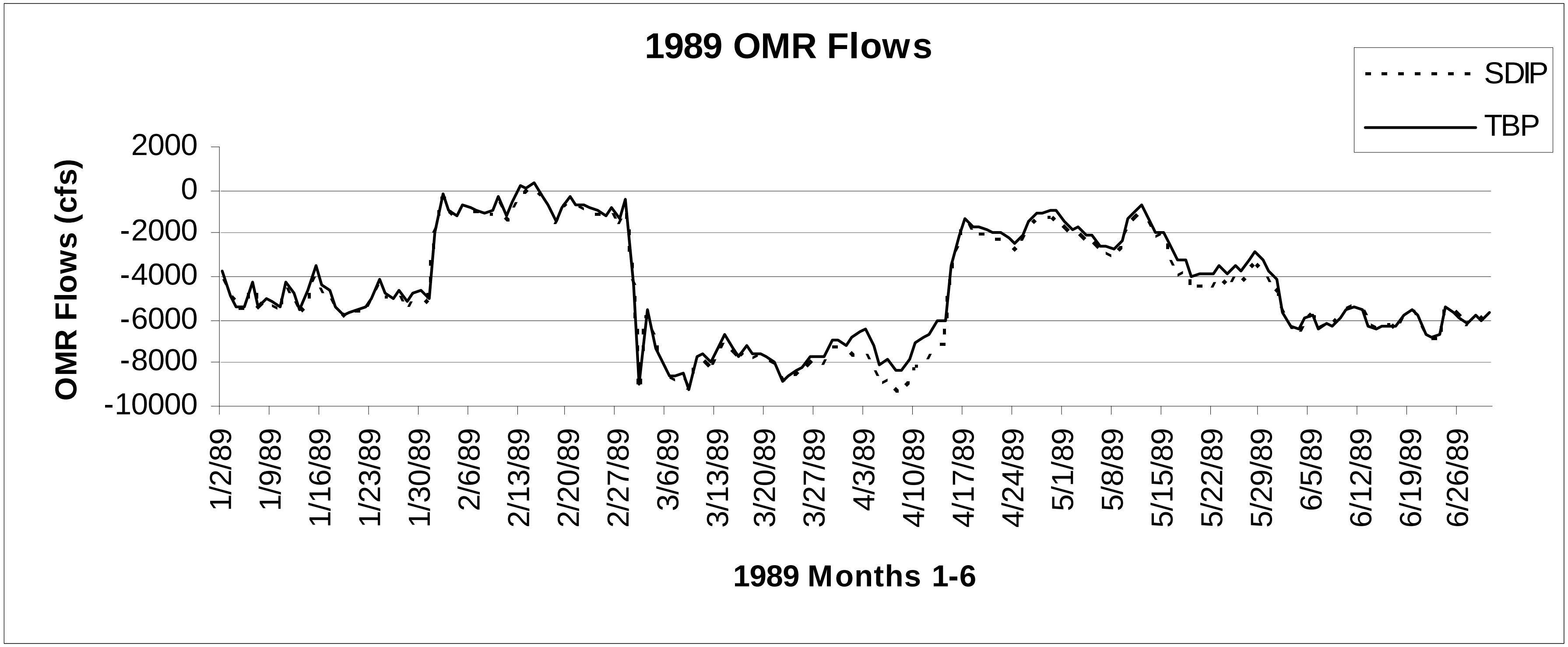

Figure 5 OMR Flows for 1989. Temporary Barriers vs South Delta Improvement Program Gates

Following the month of May, both the SDIP and Temporary Barriers scenarios return to the same levels during the month of June. In June, the level of barrier use is typically only to protect water stage, so the proposed permanent operable gates operate as though they are weirs, which is very similar to the temporary barriers.

Computer modeling results for other year types, such as the wet year type in Figure 6, are different depending on the presence of the temporary HOR barrier. Again, the Permanent HOR gate is proposed to be operated April 15th through May 15th when the San Joaquin River is less than 10,000 cfs and the temporary Head of Old River barrier is assumed to be installed April 15th and removed May 15th in each year when the San Joaquin River flow is less than 5,000 cfs. Therefore there are seasons in which the Temporary HOR Barrier would not have been installed, but the Permanent HOR Gate is installed. The results of modeling for the years 1975, 1979, 1980, 1981, 1984 and 1986 show this happening. During these events there is a separation between the SDIP and TBP OMR flows during all of VAMP, indicating that the Temporary Head of Old River barrier was not installed in the TBP run. After May, the OMR flows go back to the same levels as they were with the temporary barriers program.

In conclusion, in wetter years, the operation of the permanent HOR gate can have a negative influence on the Old and Middle River flows when compared to the temporary HOR barrier because the gate can be operated during periods when the temporary HOR barrier can not be installed. The negative impact shown on these plots at the beginning of April and end of May will not be the case because the OCAP project description confines the HOR gate operations to the mid April to mid May period in the spring operations

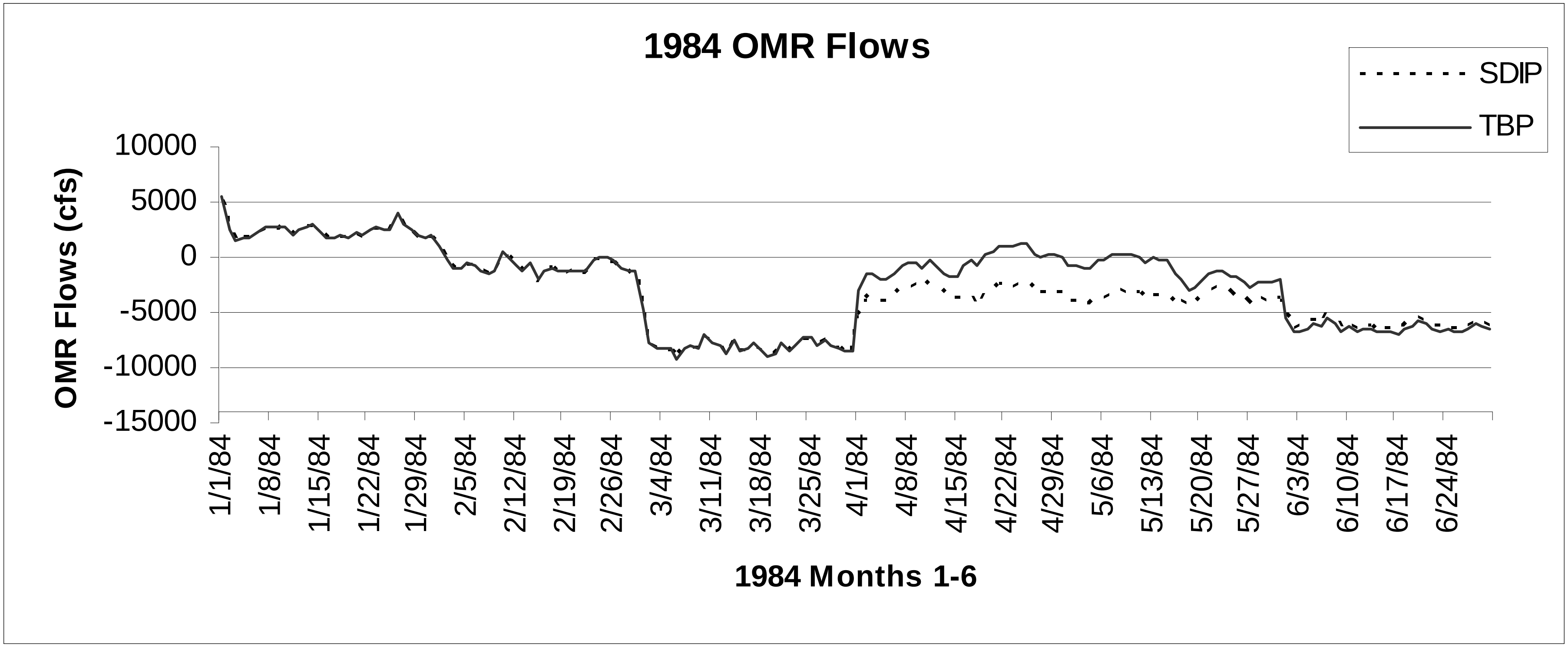

Figure 6 Wet Year Type Differences in OMR Flows between Temporary Barriers and SDIP Gate Operations - 1984

Study 3: Particle Tracking Analysis of Studies 7.0 and 7.1 for the month of June

The purpose of this Appendix is to examine the effect of South Delta Improvement Project - Operable Gates for the OCAP-BA. Since a specific study was not conducted to investigate the effect of the operable gates on the Delta hydrodynamics the two existing conditions CALSIM studies were used. Study 7.0 and Study 7.1 were selected for this analysis because the demands and level of development are consistent between the studies. In the DSM2 analysis these two studies incorporate the Temporary Barriers Project (TBP) in Study 7.0 and South Delta Improvements Project (SDIP) with operable gates in Study 7.1.

However there are some significant differences between the studies as well. The most significant differences are the introduction of a limited EWA and Delta Mendota Canal – California Aqueduct Intertie in Study 7.1. The limited EWA tends to change the seasonal pumping pattern and the Intertie allows additional pumping at Jones Pumping Plant when local agricultural demands are low.

To mitigate for these differences and tease out the effect of the operable gates, the month of June was selected for the analysis. In June, the hydrodynamics are very similar and the temporary barriers are in place (Study 7.0) or the SDIP flow-control gates are operating (Study 7.1). As shown in Figure 7 the average exports (Banks Pumping Plant and Junes Pumping Plant) for June were very close, average combined exports for Study 7.0 and 7.1 were 5705 cfs and 5820 cfs respectively. The inflows into the Delta were also similar, where Study 7.0 and 7.1 on average had 22,577 cfs and 22,982 cfs respectively. In general Study 7.1 has slightly higher inflows as well as slightly higher exports. Figure 9 shows the comparison of exports and inflows for these two studies as box plots. Each box plot illustrates the maximum, 75 percentile, median, 25 percentile, and minimum export or inflow rate in cfs.

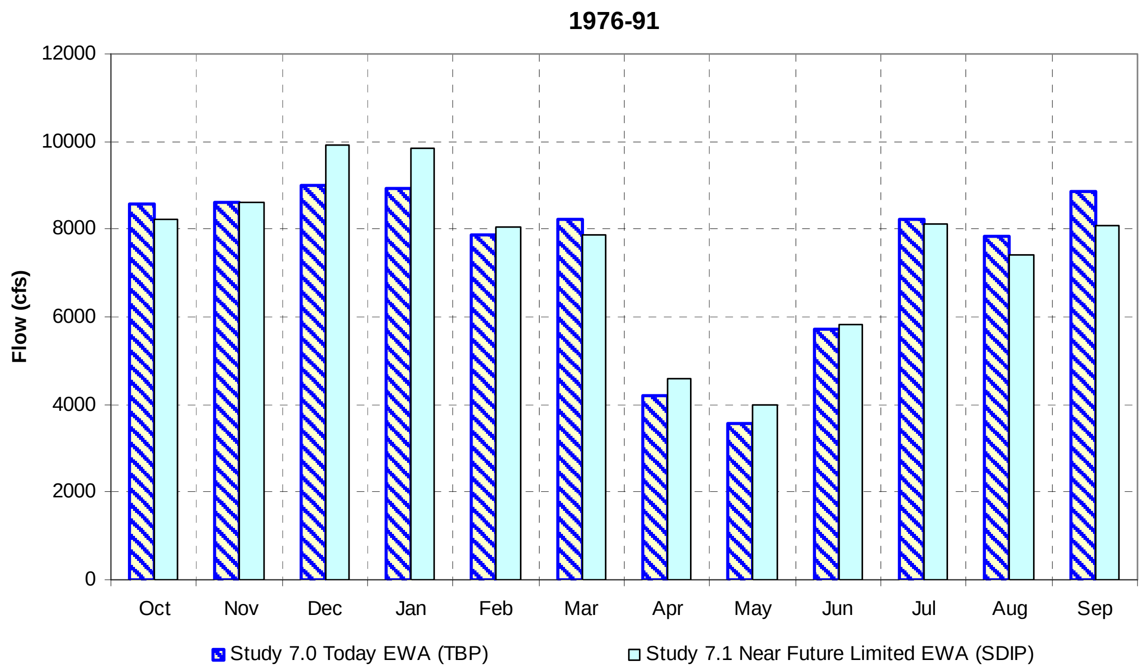

Figure 7 Combined monthly average SWP and CVP exports in cfs for water years 1976 to 1991.

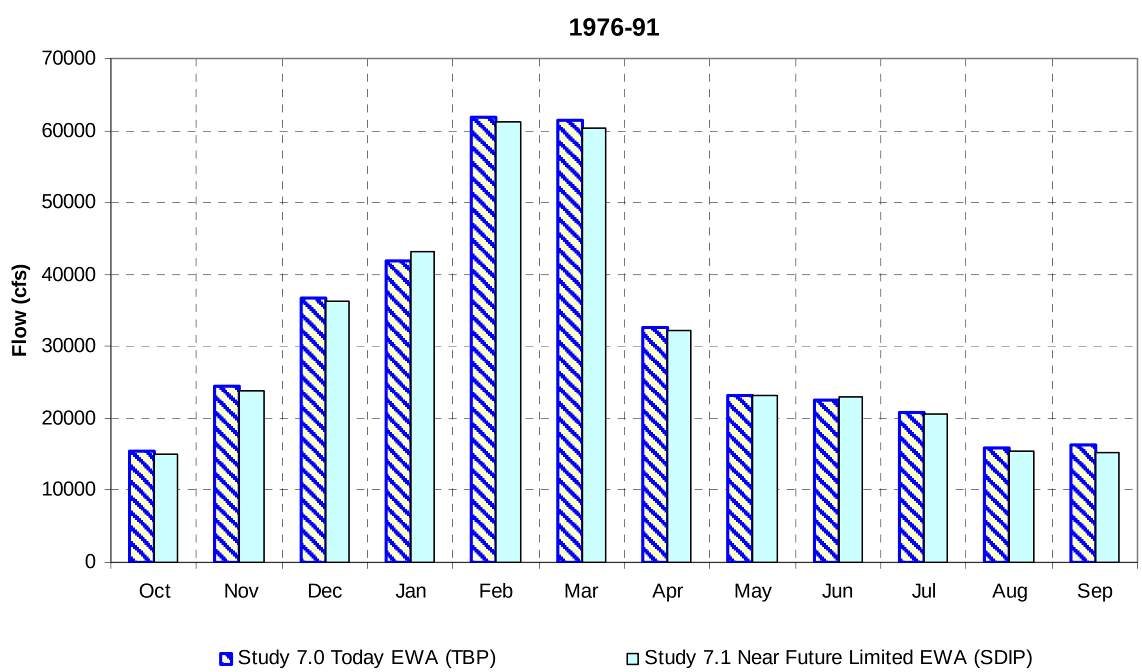

Figure 8 Average monthly Delta inflow in cfs for water years 1976 to 1991.

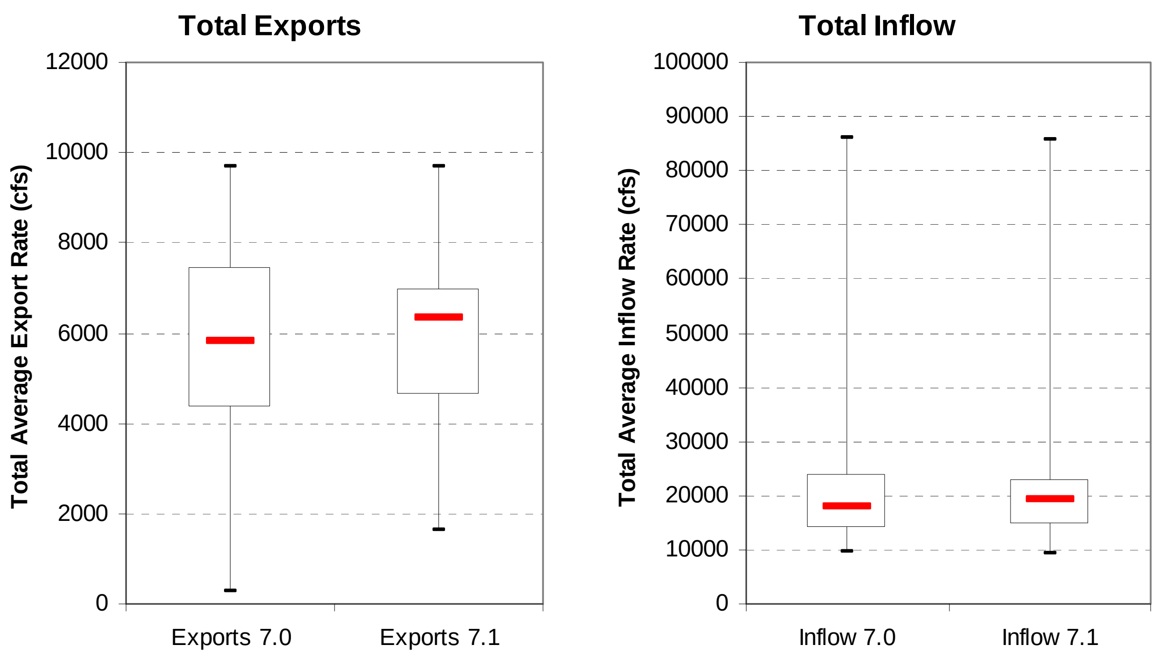

Figure 9 Box plots for total exports and total inflow show a good comparison for June between Study 7.0 and Study 7.1.

Even though the average export and inflow for June is very similar, there is still variability from year to year. Figure 10 and Figure 11 shows this variability when comparing individual years. However looking at Figure 12 it can be shown that for the most part, any increase or decrease in exports is matched by a similar increase or decrease in inflow.

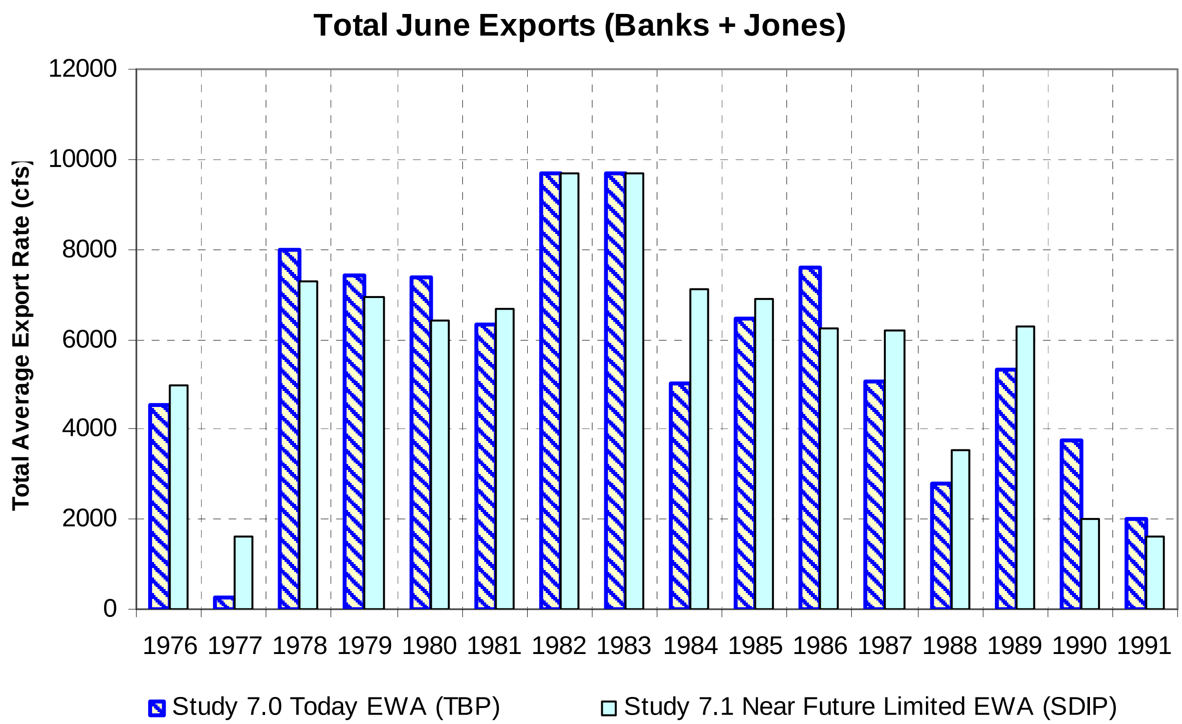

Figure 10 Comparison of June export rates in cfs.

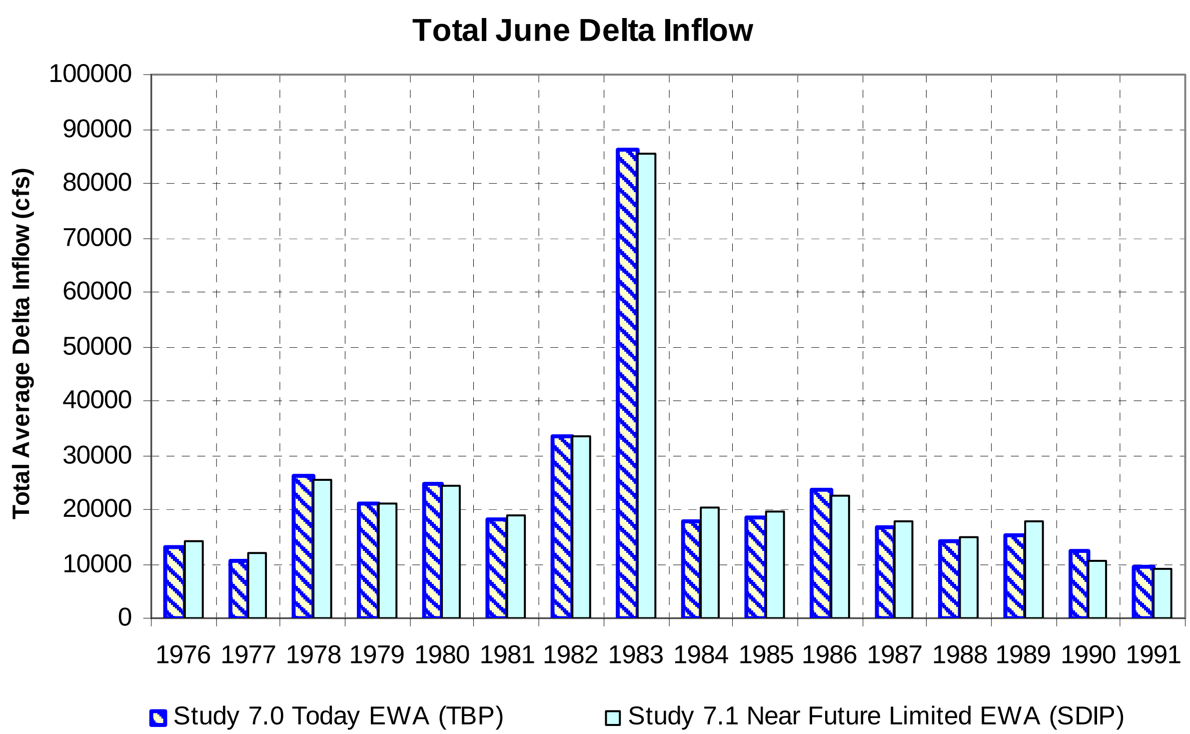

Figure 11 Comparison of June inflow rates in cfs.

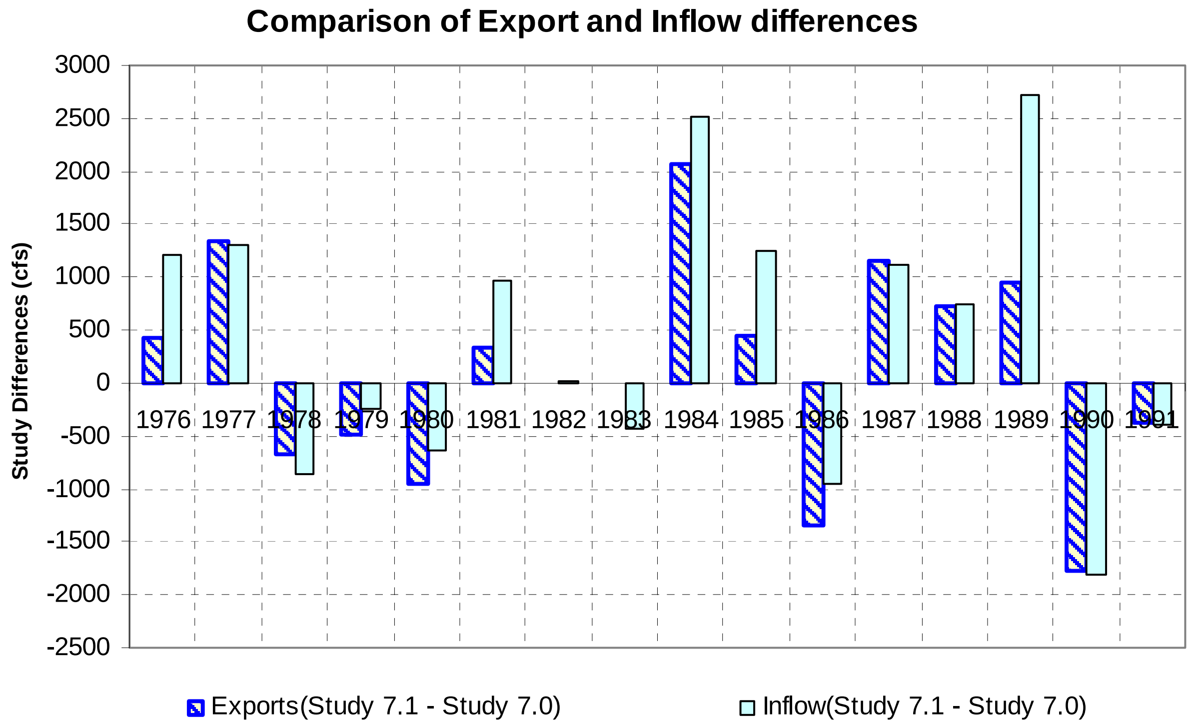

Figure 12 Comparison of differences between exports and inflow in cfs.

To look at how the project influences water movement, the DSM2-PTM was used. Figure 13 shows the PTM injection nodes that were used for this analysis. Six nodes were used to characterize three general areas of the Delta. Nodes 7 and 21 were used to show the affect of the project on particles in the San Joaquin River or southern Delta, nodes 249 and 272 were used to show the affect of the project on particles in the Central Delta, and nodes 45 and 350 were used to show the affect of the project on particles in the North and Western Delta.

The results are shown as a series of box plots that describe the percent of particles that end up at the exports (Banks and Jones pumping plants). Each box plot illustrates the maximum, 75 percentile, median, 25 percentile, and minimum percent of particles after 21 days for the series of PTM simulations. The three plots presented show the results for June from all years (1976 to 1991), dry years which include years defined as dry and critical, and wet years which include years defined as below normal, above normal, and wet by the Sacramento Valley Water Year Index.

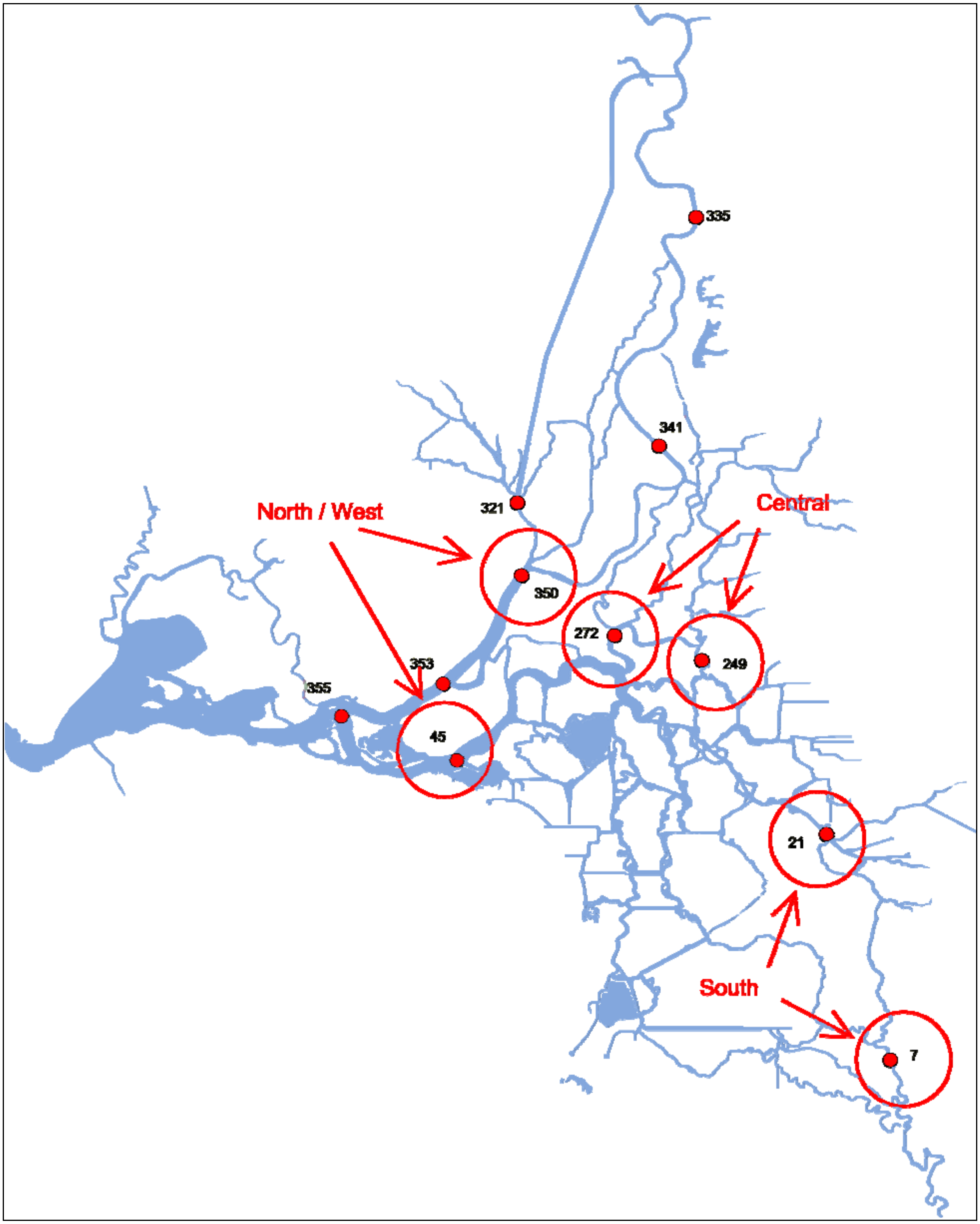

Figure 13 Particle injection nodes and locations used in this analysis.

Figure 14 shows the results for Node 7, which is located on the San Joaquin River just upstream of the Head of Old River. From the figure it can be shown that the median number of particles at the exports after 21 days increased by 260 particles out of 1000 with the SDIP, or 26 percent more particles at the exports for the SDIP study than the TBP study. During dry years this increase is more pronounced with wet years being slightly reduced.

In June, the flow-control gates are operated as weirs to protect water stage. In most June months, there is no need to operate the flow-control gates for water quality because the water quality in the area is sufficient. When the flow-control gates are operated as weirs, the height of the weirs is lower than the height of the temporary barriers, which are also weirs. Therefore, the flow-control gates allow more flow from the San Joaquin River than the temporary barriers allow in months when water quality is sufficient.

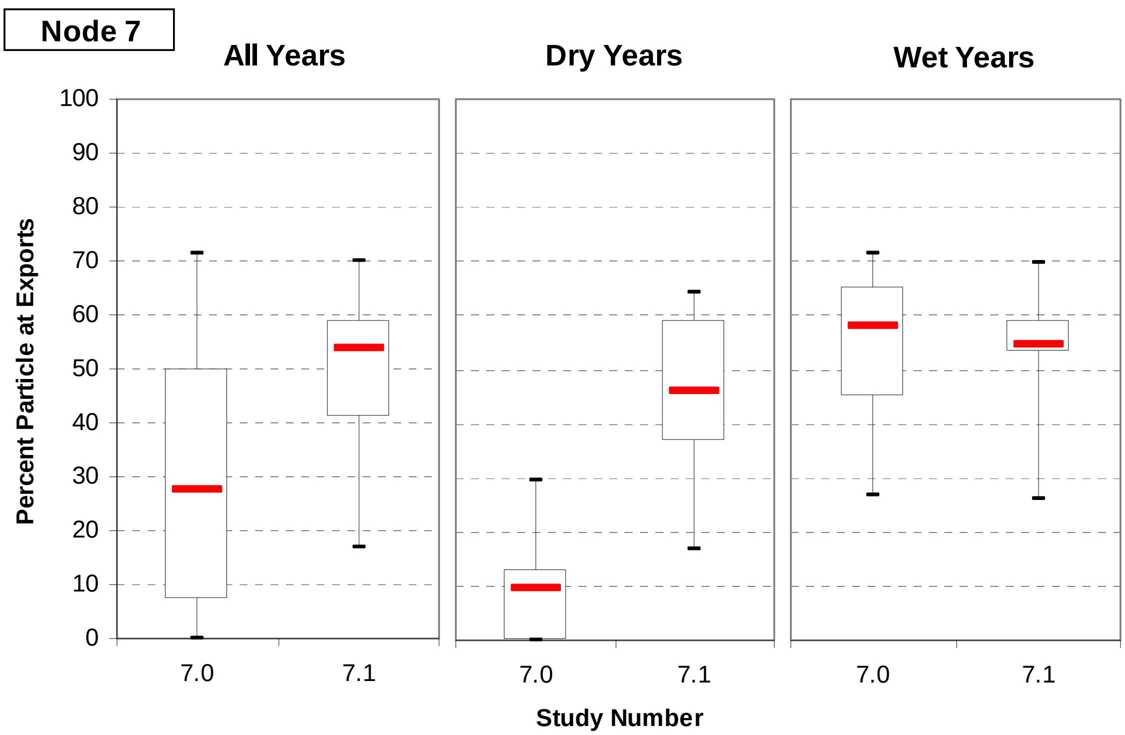

Figure 14 Percent of Particles found at Banks and Jones Pumping Plant after 21 days for particles injected at Node 7. Box plot shows the combined maximum, 75%, 50%, 25% and minimum percentage of particles at Banks and Jones Pumping Plants in June. "All Years" include water years 1976 to 1991, "Dry Years" include dry and critical years, and "Wet Years" include below normal, above normal and wet years as defined by the Sacramento Valley Water Year Index.

Figure 15 shows the results for Node 21, which is located on the San Joaquin River just downstream of Rough and Ready Island. From the figure it can be shown that the median number of particles at the exports after 21 days decreased by 240 particles out of 1000 with the SDIP, or 24 percent less particles at the exports for the SDIP study than the TBP study. During dry years this decrease is more pronounced with wet years also showing a reduction.

Because more water is entering the south Delta via the Head of Old River, there is a net decrease in water entering the south Delta from the San Joaquin River near Stockton via Turner Cut. Therefore, particles injected in the San Joaquin River near Turner Cut are less likely to be directed to the export facilities.

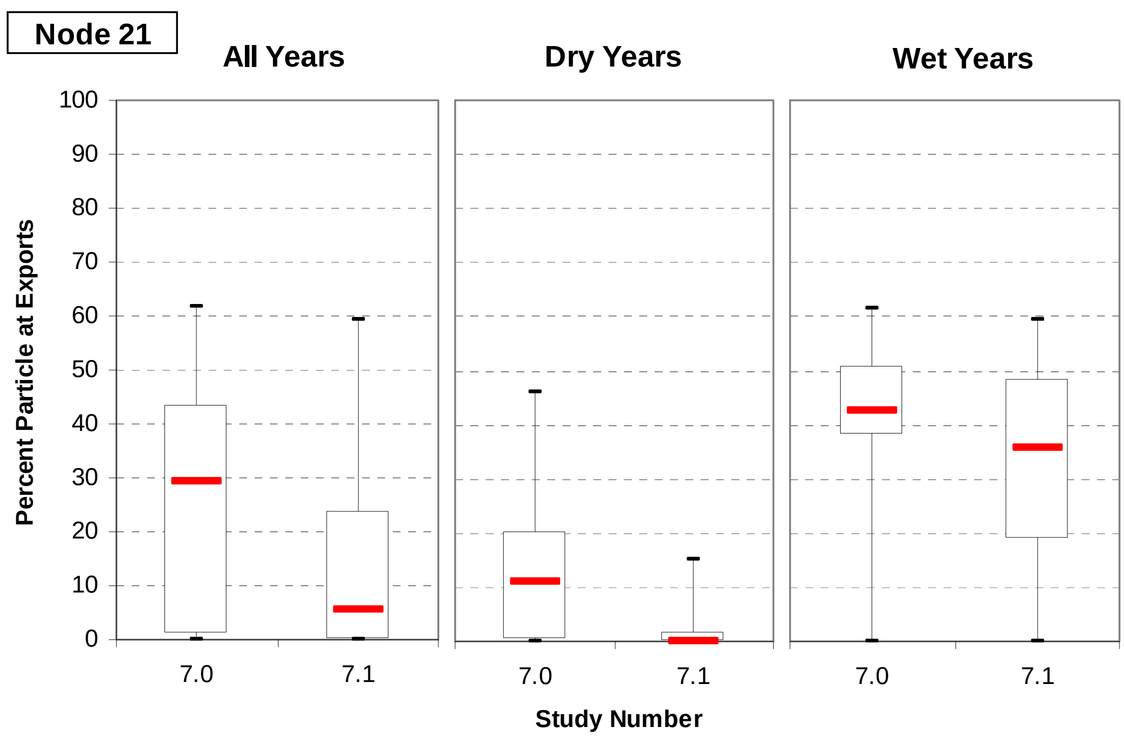

Figure 15 Percent of Particles found at Banks and Jones Pumping Plant after 21 days for particles injected at Node 21. Box plot shows the combined maximum, 75%, 50%, 25% and minimum percentage of particles at Banks and Jones Pumping Plants in June. "All Years" include water years 1976 to 1991, "Dry Years" include dry and critical years, and "Wet Years" include below normal, above normal and wet years as defined by the Sacramento Valley Water Year Index.

Node 249 and Node 272 can be used to describe the affect of the SDIP on particles in the Central Delta.

Figure 16 shows the results for Node 249, which is located on Little Potato Slough near the confluence with White Slough. From the figure it can be shown that the median number of particles at the exports after 21 days decreased slightly but by less than 50 particles out of 1000 with the SDIP, or less than 5 percent. During dry years there is a slight increase, but in wet years there is a decrease of about 70 particles out of 1000 in the amount of particles at the exports or a 7 percent decrease.

The export facilities influence on the central Delta particles is reduced, at times, for the same reasons associated with particles in the San Joaquin River near Stockton. San Joaquin River flows entering the south Delta via the Head of Old River reduces the flows from the central Delta.

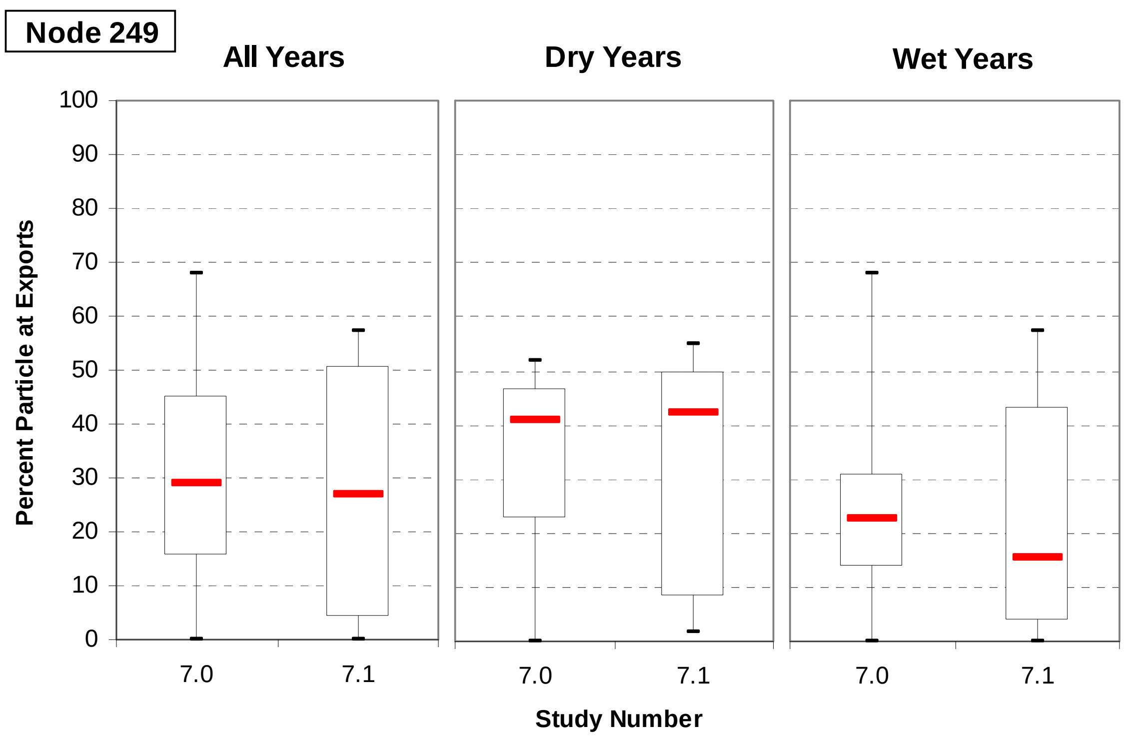

Figure 16 Percent of Particles found at Banks and Jones Pumping Plant after 21 days for particles injected at Node 249. Box plot shows the combined maximum, 75%, 50%, 25% and minimum percentage of particles at Banks and Jones Pumping Plants in June. "All Years" include water years 1976 to 1991, "Dry Years" include dry and critical years, and "Wet Years" include below normal, above normal and wet years as defined by the Sacramento Valley Water Year Index.

Figure 17 shows the results for Node 272, which is located on the Mokelumne River downstream of the confluence of Georgiana Slough and North and South Mokelumne rivers. From the figure it can be shown that the median number of particles at the exports after 21 days decreased slightly but by less than 50 particles out of 1000 with the SDIP, or less than 5 percent. During dry years there is a slight increase, and in wet years there is a slight decrease. It is important to note the change in magnitude of influence the export facilities have on Node 272 compared to Node 7 on the San Joaquin River.

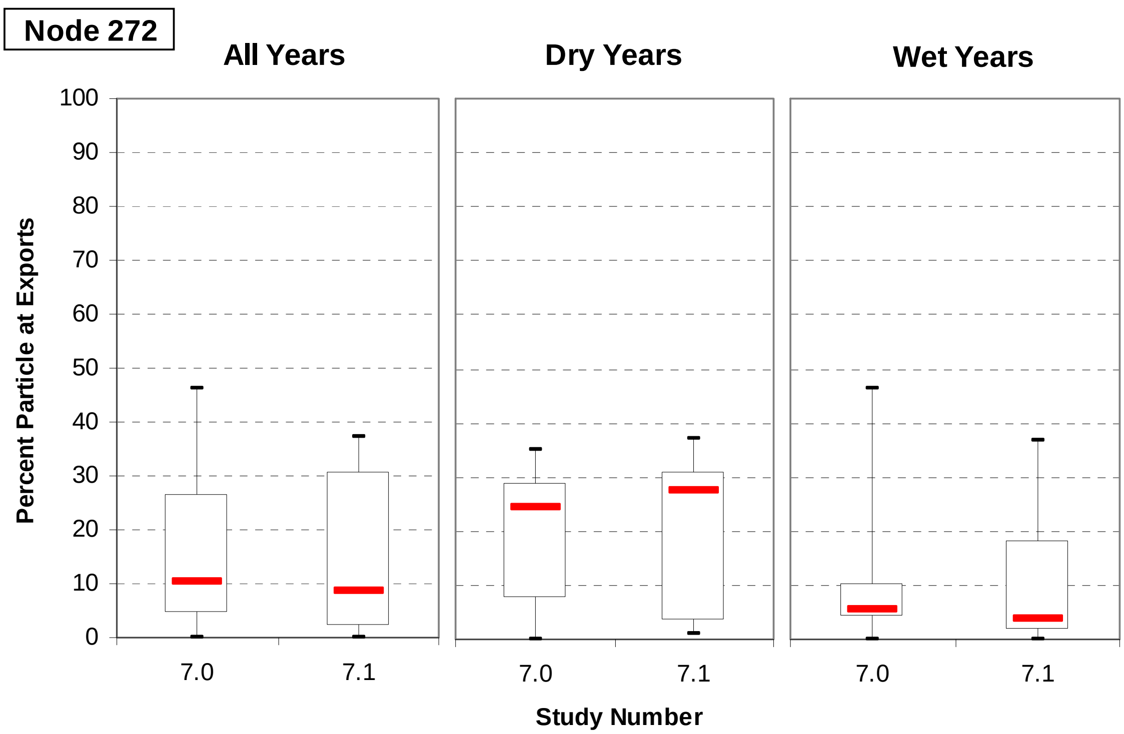

Figure 17 Percent of Particles found at Banks and Jones Pumping Plant after 21 days for particles injected at Node 272. Box plot shows the combined maximum, 75%, 50%, 25% and minimum percentage of particles at Banks and Jones Pumping Plants in June. "All Years" include water years 1976 to 1991, "Dry Years" include dry and critical years, and "Wet Years" include below normal, above normal and wet years as defined by the Sacramento Valley Water Year Index.

Figure 18 shows the results for Node 350, which is located on the Sacramento River at the confluence with Cache Slough and Steamboat Slough. From the figure it is difficult to distinguish any significant difference in particles at the exports after 21 days. Both the TBP and SDIP studies show less than 50 out of 1000 particles or less than 5 percent of particle at the exports. This is consistent when looking at the dry years and wet years separately.

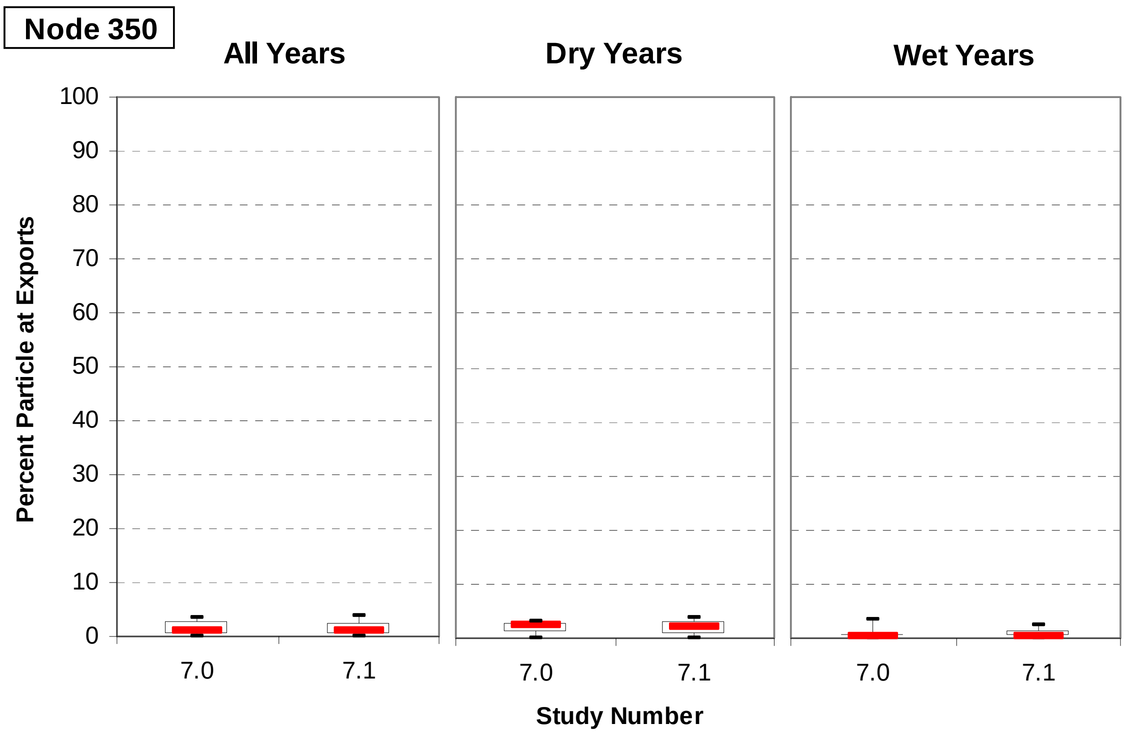

Figure 18 Percent of Particles found at Banks and Jones Pumping Plant after 21 days for particles injected at Node 350. Box plot shows the combined maximum, 75%, 50%, 25% and minimum percentage of particles at Banks and Jones Pumping Plants in June. “All Years” include water years 1976 to 1991, “Dry Years” include dry and critical years, and “Wet Years” include below normal, above normal and wet years as defined by the Sacramento Valley Water Year Index.

Figure 19 shows the results for Node 45, which is located on the San Joaquin River near Big Break. From the figure it is difficult to distinguish any significant difference in particles at the exports after 21 days. Both the TBP and SDIP studies show less than 50 out of 1000 particles or less than 5 percent of particle at the exports. This is consistent when looking at the dry years and wet years separately.

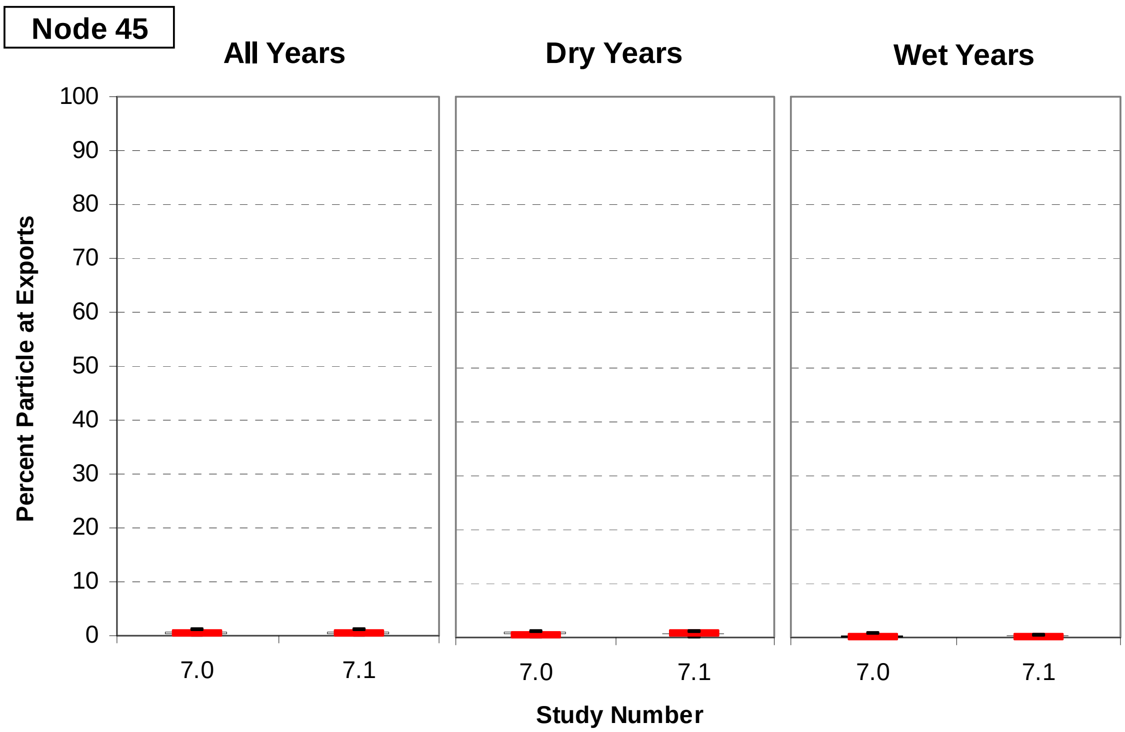

Figure 19 Percent of Particles found at Banks and Jones Pumping Plant after 21 days for particles injected at Node 45. Box plot shows the combined maximum, 75%, 50%, 25% and minimum percentage of particles at Banks and Jones Pumping Plants in June. "All Years" include water years 1976 to 1991, "Dry Years" include dry and critical years, and "Wet Years" include below normal, above normal and wet years as defined by the Sacramento Valley Water Year Index.

Conclusions

From this analysis, it can be concluded that the SDIP flow-control gates have a positive affect in June by reducing the amount of particles at the exports, with the exception of Node 7. However, the increase of particles at the exports for Node 7 could be mitigated by additional operation of the gate at the head of Old River to reduce the flow towards the export facilities during periods when particles of concern are present. It should be noted that the proposed SDIP operable gates do not have to be used as completely open or completely closed. The gates can also be used as weirs to regulate flow.