C-6 STATISTICAL WATER QUALITY IMPACT ANALYSIS

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Introduction

Changes in timing and location of diversions have the potential to affect water quality conditions in the Delta. The water quality impacts and benefits analysis focuses on salinity (reported as electrical conductivity and chloride concentration) as an indicator of Delta water quality because salinity is the Delta water quality constituent most likely to be affected by shifts in the timing and location of pumping in the Delta. Salinity is also the constituent for which the most monitoring data and calibrated Delta modeling tools exist.

To assess the potential water quality impacts and benefits of the project alternatives, the results of CalSim II studies were input into the DSM2 water quality model for the Delta, and estimated Delta salinity concentrations were compared between each project alternative study and the relevant without project conditions under the existing or future level of development. Water quality analysis for these project alternatives was performed for the 16-year period from 1975 – 1991. The modeling results presented in this section have been updated to reflect the current modeling assumptions specified in Appendix C3.

It is important to note that not all of the differences in simulated salinity are necessarily due to changes in operations under the project alternatives. Model artifacts as discussed in Section 4.2.2 and project operations both contribute to potential water quality impacts. In order to determine if the changes in water quality posed potentially significant impacts, several statistical tests were used (Zar, 1999).

D1641 Water Quality Standards

Compliance with the D1641 water quality standards was assessed at the standard compliance locations in each of the model runs (without project and four alternatives). The compliance locations included Emmaton, Jersey Point, Brandt Bridge, Old River near Middle River, Old River near Tracy Bridge, and Old River at Rock Slough. The standards for each station are listed below in **Table C6-1.**

TABLE C6-1:
SUMMARY OF WATER QUALITY STANDARDS FOR SELECT LOCATIONS IN THE DELTA

Compliance Location	Description	Value
Sac River @ Emmaton	14 day running average of mean EC during the spring and summer months depending on water year type	0.45-2.78 (mmhos/cm) depending on water year type and time of year
San Joaquin River @ Jersey Pt	14 day running average of mean EC during the spring and summer months depending on water year type	.45 -2.20 (mmhos/cm) depending on water year type and time of year
San Joaquin River @ Brandt Bridge	Maximum 30 day running average of mean daily EC	Apr – Aug 0.7 (mmhos/cm) Sep – Mar 1.0 (mmhos/cm)
Old River near Middle River	Maximum 30 day running average of mean daily EC	Apr – Aug 0.7 (mmhos/cm) Sep – Mar 1.0 (mmhos/cm)
Old River @ Tracy Bridge	Maximum 30 day running average of mean daily EC	Apr – Aug 0.7 (mmhos/cm) Sep – Mar 1.0 (mmhos/cm)
Old River @ Rock Slough	Maximum mean daily Cl	250 Cl

Potential standards violations were found in all model runs, including the existing and future without project runs. In reality, water system operators manage the system so that water quality standard violations are avoided. However, a recognized issue in using CalSim II inputs to DSM2 is that the estimation of Delta water quality is approached differently by the two models. This sometimes leads to a condition in which the CalSim II model estimates the amount of outflow required to avoid causing a Delta water quality violation, but the subsequent DSM2 estimate of Delta salinity shows that the standard was exceeded. This model mismatch is responsible for water quality standard violations in the existing condition model run but also contributes to the number of violations under the project alternatives.

If the project alternative operations caused a significant impact to water quality standards, the frequency of standards violations in the without project case and alternatives would be significantly different. Specifically, if project operations caused a water quality impact, the frequency of violations for that project would be significantly greater than the frequency of violations for the without project operation. The occurrence of standards violations under the without project conditions were compared to the occurrence under the various alternative conditions. A contingency table (χ^2) was used to determine if the occurrence of standards violations under the project alternatives were significantly different (more or less frequent) than the occurrence under the without project condition. The χ^2 was calculated using the Yates correction for continuity. The following example demonstrates the calculation used (**Table C6-2**).

TABLE C6-2:
EXAMPLE OF 2-BY-2 CONTINGENCY TABLE

	Days With Violation	**Days Without Violation**	**Total**
Without Project	a	b	a+b
Alternative	c	d	c+d
Total	a+c	b+d	a+b+c+d = N

$$\chi^2 = \frac{N(ad - bc - \frac{N}{2})^2}{(a+b)(c+d)(b+d)(a+c)}$$

The p-values were calculated using the EXCEL function CHIDIST for one degree of freedom. At the 95% confidence interval, a significant result is a calculated p-value less than 0.05. If there was a significant difference between the without project violations and alternatives, it was assumed that the changes in operations cause a significant impact to water quality. **Table C6-3** through **Table C6-5** present the contingency tables and the results for each alternative.

At all locations and scenarios there were no significant differences between the frequency of water standards violations in the without project and alternatives conditions. Therefore, we conclude that there were no significant impacts.

Protection of Beneficial Uses

In addition to assessing project compliance with enforceable water quality standards, water quality changes were analyzed elsewhere in the Delta to ensure that the project alternatives did not affect beneficial uses. Unlike the standards violation analysis described above, the analysis of potential impacts to beneficial uses involved a direct comparison of water quality in the without project conditions and water quality with each of the project alternatives. Small differences, described in more detail below, were eliminated from further consideration and water quality changes that could be large enough to cause a change in beneficial use were further investigated. Changes in water quality were analyzed at existing and planned Delta drinking water intakes: Jones Pumping Plant, Clifton Court Forebay, Barker Slough, Cache Slough, San Joaquin River at Antioch and San Joaquin River at Empire Tract.

A sizeable increase in salinity was defined as a salinity difference between a project alternative and the without project condition greater than 5% and greater than 5 mg/l Cl. A sizeable decrease in salinity was defined as a salinity difference between a project alternative and the without project condition that is less than -5% and greater than -5 mg/l Cl.

If there was no statistically significant difference in the number of increases compared to decreases, then the changes found in the alternatives runs were attributed to threshold sensitivity and it was assumed that there would be no significant impact to beneficial uses. If there was a statistically significant difference, then it was assumed that project operations have to potential impact beneficial uses and was investigated further.

A one-tailed binomial test was used to determine if the likelihood of water quality degradation was significantly greater than the likelihood of a water quality improvement for a given alternative. The p-values were calculated using the EXCEL function BINOMDIST which required the following input: the number of improvements, total number of improvements plus degradations, an expected probability of 0.5, and a flag to indicate the functional form (“false” returns the probability mass function). At the 95% confidence interval, a significant result is a calculated p-value less than 0.05. **Table C6-6** through **Table C6-8** present the data used and the results.

There were no statistically significant sizable increases or decreases to water quality under any of the alternatives for both levels of development compared to the without project conditions. There would be no significant impacts to water quality and no significant impacts to beneficial uses based on the modeling results.

TABLE C6-3: CHI-SQUARED AND P-VALUES FOR WATER QUALITY STANDARDS VIOLATIONS IN ALTERNATIVE 1 AND WITHOUT PROJECT CONDITIONS

	Emmaton				**Jersey Point**				**Brandt Bridge**				**Old River near Middle River**				**Old River near Tracy Bridge**				**Old River at Rock Slough**			
	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value
2030 Level of Development																								
Future Without Project	149	5695			358	5486			94	5750			93	5751			150	5694			272	5572		
Alternative 1	149	5695	0.003	0.953	362	5482	0.01	0.91	94	5750	0.005	0.941	93	5751	0.01	0.94	150	5694	0.00	0.95	254	5590	0.58	0.45
2005 Level of Development																								
Existing Condition	203	5641			369	5475			175	5669			171	5673			258	5586			294	5550		
Alternative 1	201	5643	0.003	0.960	370	5474	0.00	1.00	175	5669	0.003	0.957	171	5673	0.00	0.96	255	5589	0.01	0.93	270	5574	0.99	0.32

TABLE C6-4: CHI-SQUARED AND P-VALUES FOR WATER QUALITY STANDARDS VIOLATIONS IN ALTERNATIVE 2 AND WITHOUT PROJECT CONDITIONS

	Emmaton				**Jersey Point**				**Brandt Bridge**				**Old River near Middle River**				**Old River near Tracy Bridge**				**Old River at Rock Slough**			
	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value
2030 Level of Development																								
Future Without Project	149	5695			358	5486			94	5750			93	5751			150	5694			272	5572		
Alternative 2	149	5695	0.003	0.953	362	5482	0.01	0.91	94	5750	0.005	0.941	93	5751	0.01	0.94	150	5694	0.00	0.95	254	5590	0.58	0.45
2005 Level of Development																								
Existing Condition	203	5641			369	5475			175	5669			171	5673			258	5586			294	5550		
Alternative 2	198	5646	0.041	0.839	369	5475	0.00	0.97	175	5669	0.003	0.957	171	5673	0.00	0.96	255	5589	0.01	0.93	269	5575	1.07	0.30

TABLE C6-5: CHI-SQUARED AND P-VALUES FOR WATER QUALITY STANDARDS VIOLATIONS IN ALTERNATIVE 4 AND WITHOUT PROJECT CONDITIONS

	Emmaton				**Jersey Point**				**Brandt Bridge**				**Old River near Middle River**				**Old River near Tracy Bridge**				**Old River at Rock Slough**			
	# of days **with** Water Quality Violation	# of days **without** Water Quality Violatio n	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value	# of days **with** Water Quality Violation	# of days **without** Water Quality Violation	χ^2	p-value
2030 Level of Development																								
Future Without Project	149	5695			358	5486			94	5750			93	5751			150	5694			272	5572		
Alternative 4	149	5695	0.003	0.953	355	5489	0.01	0.94	94	5750	0.01	0.94	93	5751	0.01	0.94	151	5693	0.00	1.00	230	5614	3.50	0.06
2005 Level of Development																								
Existing Condition	203	5641			369	5475			175	5669			171	5673			258	5586			294	5550		
Alternative 4	201	5643	0.003	0.960	366	5478	0.01	0.94	175	5669	0.00	0.96	171	5673	0.00	0.96	260	5584	0.00	0.96	265	5579	1.47	0.22

TABLE C6-6: BINOMIAL DISTRIBUTION TEST FOR POTENTIAL IMPACTS TO BENEFICIAL USES IN ALTERNATIVE 1

	Jones Pumping (CVP)				West Canal at Clifton Ct Forebay (SWP)				Barker Slough (NBA)				Cache Slough (City of Vallejo)				San Joaquin River at Empire Tract (City of Stockton DWSP)				San Joaquin River at Antioch (City of Antioch)			
	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value
2030 Level of Development	0	0	0	1.00	0	1	1	1.00	0	0	0	1.00	0	0	0	1.00	0	0	0	1.00	1	0	1	0.50
2005 Level of Development	0	0	0	1.00	0	0	0	1.00	0	0	0	1.00	0	0	0	1.00	0	0	0	1.00	2	4	6	0.89

TABLE C6-7: BINOMIAL DISTRIBUTION TEST FOR POTENTIAL IMPACTS TO BENEFICIAL USES IN ALTERNATIVE 2

	Jones Pumping (CVP)				West Canal at Clifton Ct Forebay (SWP)				Barker Slough (NBA)				Cache Slough (City of Vallejo)				San Joaquin River at Empire Tract (City of Stockton DWSP)				San Joaquin River at Antioch (City of Antioch)			
	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value
2030 Level of Development	0	0	0	1.00	0	0	0	1.00	0	0	0	1.00	0	0	0	1.00	0	0	0	1.00	3	0	3	0.13
2005 Level of Development	0	0	0	1.00	0	0	0	1.00	0	0	0	1.00	0	0	0	1.00	0	0	0	1.00	4	2	6	0.34

TABLE C6-8: BINOMIAL DISTRIBUTION TEST FOR POTENTIAL IMPACTS TO BENEFICIAL USES IN ALTERNATIVE 4

	Jones Pumping (CVP)				West Canal at Clifton Ct Forebay (SWP)				Barker Slough (NBA)				Cache Slough (City of Vallejo)				San Joaquin River at Empire Tract (City of Stockton DWSP)				San Joaquin River at Antioch (City of Antioch)			
	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value	Sizeable Salinity Increase	Sizeable Salinity Decrease	Sum	p-value
2030 Level of Development	0	1	1	1.00	0	2	2	1.00	0	0	0	1.00	0	0	0	1.00	0	1	1	1.00	2	0	2	0.25
2005 Level of Development	1	2	3	0.88	3	5	8	0.86	0	0	0	1.00	0	1	1	1.00	2	3	5	0.81	2	7	9	0.98

C-7 FISHERY ANALYSIS

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Introduction

Appendix C-7 provides a description of the methods used for evaluating the fisheries effects that were discussed in the updated Chapter 4.3, which is provided in Volume 4 of the Final EIS/EIR. Supporting detailed results and analysis are also included. The possible direct effects on Delta fish include changes in the numbers of fish salvaged at the SWP and CVP export facilities as a result of changes in water project operations, as well as possible changes in the vulnerability of various species and life stages of fish to entrainment (e.g., small planktonic fish eggs and larvae passing through the intake screen into the diversion) at the Rock Slough, Old River, and AIP intakes and the proposed new Los Vaqueros Delta Intake. Possible indirect effects on Delta fisheries include alterations in hydrodynamic conditions affecting fishery habitat within the Delta.

The methods used in this portion of the fishery analysis for examining potential effects of the project on Delta fishery resources are as follows:

1. **Entrainment Indices from Salvage Data.** Comparison of entrainment indices for juvenile and adult salmonids, based on CalSim II modeling of the project alternatives and average fish density as determined by salvage data;

2. **Particle Tracking Analysis**. Estimates of potential entrainment and changes in Delta hydrodynamics based on results of the particle tracking model (PTM) and fish surveys of fish density;

3. **Hydrologic Effects of Operations**. Evaluation of changes in Delta flows based on CalSim II modeling of the project alternatives; and

4. **Old and Middle River Flow Evaluation Based on DSM2 Model Studies**. Evaluation of changes in flows in Old and Middle Rivers (OMR) based on DSM2 hydrodynamic modeling of the project alternatives.

The CalSim II and DSM2 studies described in the updated Chapter 4.2 and updated Appendices C-2 and C-3 were used in performing these fishery impact analyses. Additional studies were run for the PTM analyses, as described within this chapter.

Entrainment Indices from Salvage Data

Alternatives 1, 2 and 4 could affect fish populations in the Delta by changing levels of entrainment at the Rock Slough, Old River, and AIP Intakes, and, in Alternatives 1 and 2, the proposed new Los Vaqueros Delta intake (new Delta Intake), as well as at the SWP and CVP export pumps and their associated fish salvage facilities. To evaluate potential impacts of the project alternatives, entrainment estimates for winter-run, spring-run, fall-run, and late fall-run chinook salmon and Central Valley steelhead were developed. Historical salmonid salvage data and modeled diversions from the CalSim II model were integrated to produce fish entrainment estimates that account for the spatial and temporal distribution of specific salmonid populations, and reflect the effects on these fish populations of changes in the timing, magnitude and location of pumping modifications. The salmonid entrainment estimates are represented as index values because they represent an estimate of average potential entrainment based on averages of available fish density data from CVP and SWP fish salvage operations. The entrainment index values should be considered as relative indicators of entrainment, and not as precise numerical estimates of future fish entrainment. Insufficient salvage data are available for green sturgeon to have included this species in this analysis; possible effects of the project alternatives on green sturgeon are evaluated in the discussion of particle fate analysis below. Effects on species that occur in the Delta as larvae are also considered in the particle fate analysis.

In this analysis based on salvage data, fish entrainment is assumed to vary in direct proportion to the seasonal density of fish in the immediate vicinity of an intake, the exclusion efficiency of any screens (which varies by fish length), and the diversion rate associated with the intake. The entrainment indices were developed through a two-step process as described below. First, average monthly densities were determined from salvage at the SWP and CVP export pumps. Then, the average monthly densities were multiplied by diversion values for the without project conditions and for the project alternatives from CalSim II output modeled monthly over a period representing 82 years of historical hydrology (see Appendix C). The results were summed across all intakes and averaged across the modeling period to produce the entrainment indices, which are given in numbers of fish entrained per year. To gauge the effects of the project alternatives, the entrainment indices developed from without project conditions were compared to the entrainment indices for each of the project alternatives.

Determination of Fish Densities

Methodology

This section describes the method used to calculate fish densities from salvage data. The general approach is described, including a discussion of the available data, followed by a detailed description of the procedure used to produce the salvage-based densities.

Density Determination Based on Salvage Facility Data

Estimates of fish occurrence in the Delta that reflect the seasonal and geographic distribution of each of the selected fish species were calculated from salvage of the selected species at the SWP and CVP export facilities. The data were converted to fish densities (number of fish per acre-foot

(AF) of water). This section discusses the procedure that was used to determine densities of each of the selected fish species from the salvage data. Fish salvage and loss estimates are only available from these facilities for fish greater than 20 mm in length.

For this analysis, salvage data was used for the period from 1995 to 2008, which spans both non-POD and POD years, and the 2008 modified flow regime, as well as a range of water year types. Salvage data at the SWP and CVP facilities are reported daily.

Expanded salvage numbers are used to calculate the steelhead densities. For chinook salmon, estimated loss numbers derived from salvage data are available from CDFG and are used to determine densities for all four runs of salmon. Estimated loss is calculated by CDFG from raw salvage data and takes into account factors including predation, louver efficiencies and includes consideration of release and potential survival from the salvage process. Because of the consideration of other sources of losses other than salvage, estimated losses are higher than raw salvage numbers for salmonids. A representative salmonid loss estimate for each month of the year is calculated by averaging monthly loss estimates obtained from the CDFG database from 1995 through 2008. Average monthly densities are then estimated by dividing the total number of salmonids in each species category in each month by the total volume of water exported at each facility in that month (available in the same CDFG data set). The average monthly densities of salmonid are calculated separately for the SWP and CVP export facilities. As a conservative estimate, the maximum salmonid loss density between these two sites is selected to represent the salvage-based density used in the entrainment index calculations.

Salmonids at all Intakes

The densities calculated using the salvage data are shown in **Figure C7-1**. Since spatially-distributed salmonid data are not available from survey sampling within the Delta, the densities based on loss estimates (for the chinook salmon) and expanded salvage estimates (for steelhead) reported at the CDFG salvage data site for the SWP and CVP export facilities are assumed to be representative of the seasonal densities of juvenile chinook salmon and steelhead at all intake locations included in this analysis. Loss estimates take into consideration the pre-louver predation loss, salmonids that went through the louvers, and salmonids that were returned alive to the Delta after the salvage process, as estimated by CDFG.

The reported juvenile chinook salmon densities at the SWP export facility tend to be higher than corresponding densities at the CVP facility, while the reverse is true for steelhead densities. The higher of the SWP or CVP density estimates were used in the analysis to represent the density of juvenile chinook salmon and steelhead at the Rock Slough, Old River, AIP and new Delta Intake locations. As the salmonids reported in the SWP and CVP salvage are all juveniles greater than 20 mm in length, we conservatively assumed 99.5% exclusion efficiency (see **Table C7-1**) at the screened intakes (Old River, AIP, Rock Slough, and new Delta intakes), and 100% entrainment at the other intakes (Rock Slough Intake in Existing Conditions, and SWP and CVP export pumps).

Chinook Salmon and Steelhead Densities

Fish Densities (1995-2008) in units of Average Number / AF

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Winter Run Salmon												
SWP Skinner Salvage	1.0E-02	6.6E-03	9.0E-03	3.2E-03	7.7E-05	0	0	0	0	0	0	2.1E-03
CVP Tracy Salvage	1.3E-03	1.0E-03	1.5E-03	1.7E-03	2.5E-05	0	0	0	0	0	0	2.8E-04
max density	**1.0E-02**	**6.6E-03**	**9.0E-03**	**3.2E-03**	**7.7E-05**	**0**	**0**	**0**	**0**	**0**	**0**	**2.1E-03**
Spring Run Salmon												
SWP Skinner Salvage	9.9E-06	2.0E-04	1.1E-02	1.3E-01	6.5E-02	8.9E-04	0	0	5.1E-06	1.1E-05	0	0
CVP Tracy Salvage	1.3E-05	7.4E-05	8.9E-03	5.4E-02	2.0E-02	4.0E-04	0	0	0	0	0	0
max density	**1.3E-05**	**2.0E-04**	**1.1E-02**	**1.3E-01**	**6.5E-02**	**8.9E-04**	**0**	**0**	**5.1E-06**	**1.1E-05**	**0**	**0**
Fall Run Salmon												
SWP Skinner Salvage	7.6E-04	1.5E-02	7.0E-03	5.1E-02	2.2E-01	2.6E-02	4.5E-04	5.6E-05	5.1E-04	2.0E-04	1.5E-04	1.6E-05
CVP Tracy Salvage	1.0E-02	2.5E-02	7.5E-03	1.9E-02	6.0E-02	1.6E-02	8.8E-05	1.9E-05	7.5E-05	1.0E-04	1.2E-04	1.3E-05
max density	**1.0E-02**	**2.5E-02**	**7.5E-03**	**5.1E-02**	**2.2E-01**	**2.6E-02**	**4.5E-04**	**5.6E-05**	**5.1E-04**	**2.0E-04**	**1.5E-04**	**1.6E-05**
Late Fall Run Salmon												
SWP Skinner Salvage	3.9E-03	3.6E-04	5.4E-05	2.0E-05	0	0	0	6.5E-06	6.7E-06	3.2E-05	7.6E-05	9.7E-04
CVP Tracy Salvage	3.7E-04	4.0E-05	0	8.0E-06	0	1.7E-05	0	0	0	1.9E-06	3.9E-05	2.3E-04
max density	**3.9E-03**	**3.6E-04**	**5.4E-05**	**2.0E-05**	**0**	**1.7E-05**	**0**	**6.5E-06**	**6.7E-06**	**3.2E-05**	**7.6E-05**	**9.7E-04**
Steelhead												
SWP Skinner Salvage	2.5E-03	4.9E-03	6.6E-03	1.6E-03	7.7E-04	1.2E-04	2.0E-05	1.2E-06	0	2.3E-05	3.3E-05	1.7E-04
CVP Tracy Salvage	3.2E-03	6.1E-03	8.3E-03	4.8E-03	1.3E-03	3.0E-04	8.2E-05	0	0	0	1.7E-05	6.4E-05
max density	**3.2E-03**	**6.1E-03**	**8.3E-03**	**4.8E-03**	**1.3E-03**	**3.0E-04**	**8.2E-05**	**1.2E-06**	**0**	**2.3E-05**	**3.3E-05**	**1.7E-04**

Figure C7-1: Average monthly density of juvenile chinook salmon and Central Valley steelhead calculated from SWP and CVP salvage.

Average Fish Densities

The average monthly salmonid fish density estimates calculated from salvage data are shown in **Figure C7-2**. As shown in the figure, the period from January through July is the general period when salmonid densities are higher in the vicinity of the intakes (although there is significant variation among the species within that period), while the months of August through December represent a period of the year when densities are relatively low.

As shown in Table C7-1**,** the effectiveness of a positive barrier fish screen with a 1.75 mm mesh in reducing the densities of larval and juvenile fish vulnerable to entrainment into a water diversion ranges from 76.9% for 5-7mm larval fish to 100% for adults (Weisberg, et al., 1987).

TABLE C7-1: EXCLUSION EFFICIENCY OF FISH SCREEN AT ROCK SLOUGH, OLD RIVER, AIP, AND NEW DELTA INTAKE.[1]

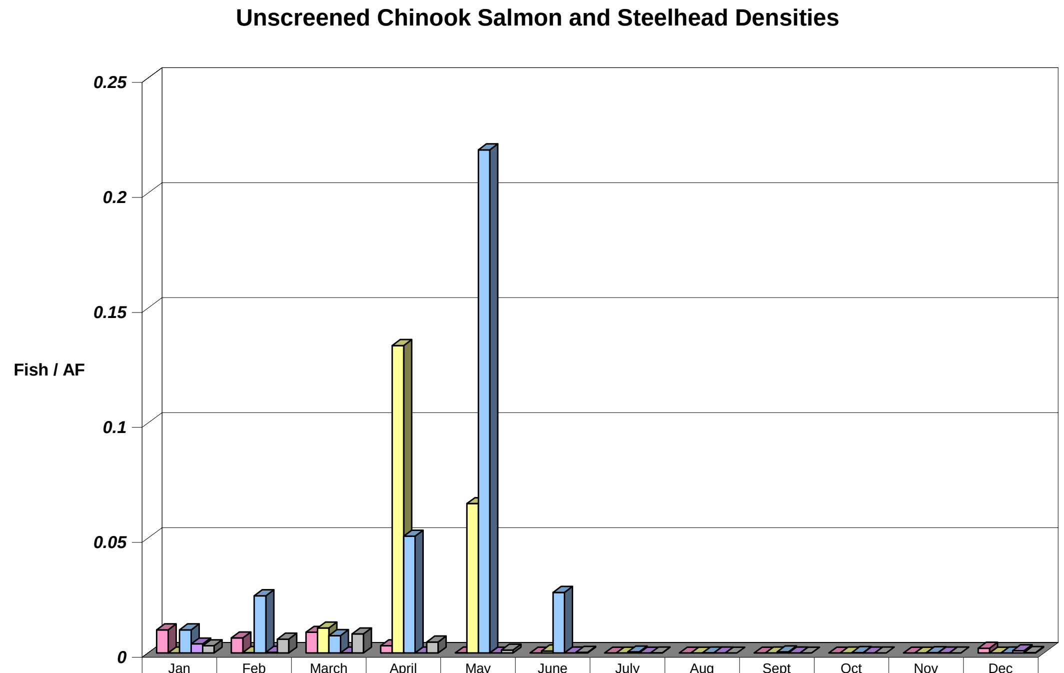
Size Class	Exclusion Efficiency (Percentage)
5-7 mm	0.769
8-10 mm	0.776
11-14 mm	0.951
>= 15 mm	0.995
>= 45 mm	1.000

These screen efficiencies were assumed in this analysis for the Old River Intake, AIP, Rock Slough, and new Delta Intake. A fish screen was not included in the analysis for the Rock Slough Intake in the Existing Conditions case, as described in updated Sections 4.2 and 4.3 of the Final EIS/EIR. The actual effectiveness of the fish screens at these intakes is likely to be even higher than those determined by the study, as conditions used by the study included impingement losses from higher approach velocities towards the fish screens, in contrast to the Old River, AIP, and new Delta intakes, where the water is pumped perpendicular to the direction of river flow at a low approach velocity. This results in a relatively high sweep velocity past the screened intake relative to the slow approach velocity towards the screen, which results in a low incidence of impingement. However, even the conservative application of the fish screen effectiveness estimates used here indicates that shifting water diversions from the SWP and CVP intakes to intakes with positive barrier fish screens can reduce the direct entrainment losses of larval and early juvenile lifestages of fish such as delta and longfin smelt associated with those shifted diversions. Diversions at intakes with positive barrier fish screens nearly completely prevent direct entrainment losses of adult smelt and juvenile chinook salmon, steelhead, sturgeon and striped bass.

Figure C7-2 shows the pre-screened densities at each of the intakes used in this analysis. An average "effective" fish density accounts for fish screen efficiency at the Old River, AIP, Rock

[1]Weisberg, et al., 1987. "Reductions in Ichthyoplankton Entrainment with Fine, Mesh, Wedge-Wire Screens," North American Journal of Fisheries Management 7:386-393, 1987. Exclusion efficiency assumes a 1.75 mm fish screen mesh slot opening.

Slough, and new Delta intakes. To calculate the average effective densities, the average fish densities are multiplied by the quantity (1.0 minus the screen efficiency). This gives the fish densities that would be expected to be entrained (pass through) the intake screen mesh and be lost from the Delta per acre-foot of diversion. In the case of juvenile salmonids, which occur in the Delta at sizes greater than 20 mm in length based on 20mm survey data, a conservative screen efficiency of 99.5% is assumed; thus, only 0.5% of the salmonids are expected to be entrained through the screened intakes. The effective fish densities estimated for the Existing Condition Rock Slough intake and the SWP and CVP intakes remain unchanged.



	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Winter Run	1.0E-02	6.6E-03	9.0E-03	3.2E-03	7.7E-05	0	0	0	0	0	0	2.1E-03
Spring Run	1.3E-05	2.0E-04	1.1E-02	1.3E-01	6.5E-02	8.9E-04	0	0	5.1E-06	1.1E-05	0	0
Fall Run	1.0E-02	2.5E-02	7.5E-03	5.1E-02	2.2E-01	2.6E-02	4.5E-04	5.6E-05	5.1E-04	2.0E-04	1.5E-04	1.6E-05
Late Fall Run	3.9E-03	3.6E-04	5.4E-05	2.0E-05	0	1.7E-05	0	6.5E-06	6.7E-06	3.2E-05	7.6E-05	9.7E-04
Steelhead	3.2E-03	6.1E-03	8.3E-03	4.8E-03	1.3E-03	3.0E-04	8.2E-05	1.2E-06	0	2.3E-05	3.3E-05	1.7E-04

Figure C7-2: Average unscreened monthly chinook salmon and Central Valley steelhead densities.

Development of Entrainment Index at Each Intake

Once the monthly average salmonid densities and monthly pumping flow rates were determined, the entrainment indices were calculated. This section presents the methodology used to calculate the entrainment indices, and analysis of the indices.

Methodology

For the SWP and CVP export facilities, and for the Rock Slough intake in the Existing Condition case, it is assumed that 100% of the fish density in the volume of water diverted is entrained into the facility and lost from the Delta. As noted above, CDFG loss estimates were used to estimate densities for chinook salmon and Central Valley steelhead at the CVP and SWP facilities, so these values include an estimate of salvage survival. For screened intakes (Old River, AIP, new Delta intakes, and Rock Slough in all other scenarios), estimated average monthly salmonid densities were classified by size (length class), so that the number of each selected fish species entrained through the fish screens (accounting for size-specific fish exclusion by the fish screens) could be estimated. The fish density for each size class is multiplied by the intake flow rate, as determined in the CalSim II runs, and by (1.0 minus the screen efficiency) to estimate the number of each species entrained for each size class. The resultant numbers of entrained fish for each size class are then summed to determine the total number of entrained fish at a screened intake.

Flows are based on results of CalSim II simulations for each simulated month as summarized below:

- 2005 Level of Development (Existing Condition and three alternatives)
- 2030 Level of Development (Future Without Project conditions and three alternatives)

Salmonid densities, as discussed in the methodology section, are derived from loss estimates developed from salvage data and are assumed to be the same at all the intakes included in this impact analysis. As the intakes in reality vary in location, this assumption of uniform densities represents an order-of-magnitude approximation of the salmonid densities at the intakes. The data presented in the results tables are carried out to two significant figures due to the higher precision of the loss estimates. The chinook salmon sub-species considered in this analysis are the winter run, spring run, fall run, and late fall-run sub-species. Central Valley steelhead are also included in this analysis.

Results of Entrainment Index Calculations

This section presents the results of the salmonid entrainment index calculations. The total estimated entrainment index and percent change for each species of fish are shown in **Table C7-2** for the 2005 level of development and in **Table C7-3** for the 2030 level of development. For each of the alternatives shown in the tables, the shaded numbers represent improvements (a reduction in estimated entrainment losses) in salmonid entrainment numbers when compared to the Existing Condition.

2005 Level of Development. As shown in Table C7-2, Alternatives 1 and 2 show some reductions in entrainment losses for all salmonid species (ranging from 4% to about 10%) relative to the Existing Condition. Alternative 4 shows either no change or more modest reductions of about 2% to 3%.

TABLE C7-2: ESTIMATED SALMONID ENTRAINMENT INDEX FOR 2005 LEVEL OF DEVELOPMENT

2005 Level of Development

	Winter Run Salmon		Spring Run Salmon		Fall Run Salmon		Late Fall Run Salmon		Steelhead	
	total fish entrained / year	% change compared to new base	total fish entrained / year	% change compared to new base	total fish entrained / year	% change compared to new base	total fish entrained / year	% change compared to new base	total fish entrained / year	% change compared to new base
Base	12,000		30,000		62,000		2,400		8,300	
Alt1	12,000	0.0%	27,000	-10.0%	58,000	-6.5%	2,300	-4.2%	8,000	-3.6%
Alt2	12,000	0.0%	27,000	-10.0%	58,000	-6.5%	2,300	-4.2%	8,000	-3.6%
Alt4	12,000	0.0%	29,000	-3.3%	61,000	-1.6%	2,400	0.0%	8,200	-1.2%

2030 Level of Development. Table C7-3 presents estimated entrainment indices and percent changes for the 2030 level of development.

As with the 2005 level of development, Alternatives 1 and 2 show some reductions in entrainment losses for all salmonid species (ranging from about 4% to about 7%). Alternative 4 shows no change compared to the Future Without Project case.

TABLE C7-3: ESTIMATED SALMONID ENTRAINMENT INDEX FOR 2030 LEVEL OF DEVELOPMENT

2030 Level of Development

	Winter Run Salmon		Spring Run Salmon		Fall Run Salmon		Late Fall Run Salmon		Steelhead	
	total fish entrained / year	% change compared to new base	total fish entrained / year	% change compared to new base	total fish entrained / year	% change compared to new base	total fish entrained / year	% change compared to new base	total fish entrained / year	% change compared to new base
Base	12,000		31,000		62,000		2,400		8,300	
Alt1	12,000	0.0%	29,000	-6.5%	58,000	-6.5%	2,300	-4.2%	8,100	-2.4%
Alt2	12,000	0.0%	29,000	-6.5%	58,000	-6.5%	2,300	-4.2%	8,100	-2.4%
Alt4	12,000	0.0%	31,000	0.0%	62,000	0.0%	2,400	0.0%	8,300	0.0%

Discussion

The results of the entrainment index calculations are interpreted and discussed with respect to impact analysis in Chapter 4, Section 4.3. In general, Alternatives 1 and 2 show some reductions in estimated entrainment losses for all species under both 2005 and 2030 levels of development and under both severe and moderate fisheries restrictions. This is largely because delivery of CVP and SWP water supply to the South Bay water agencies is shifted to occur through the expanded Los Vaqueros Reservoir and South Bay Connection, and thus is being diverted at the efficiently screened Old River, AIP, Rock Slough, and new Delta intakes, instead of passing through the existing SWP and CVP export pump intakes. The improved screening provided by the shift in delivery results in a decrease in potential entrainment of 2 percent to 8 percent for the chinook salmon and Central Valley steelhead, which are large enough to experience completely effective screen efficiency at the Old River, AIP, Rock Slough, and new Delta intakes. These comparisons are relative to the without project condition, in which Delta water supply for the South Bay water agencies is delivered through the CVP and SWP export facilities.

Alternative 4 shows mild benefits to no change in estimated entrainment losses for all species under the 2005 level of development, and no change in estimated entrainment losses for all species under the 2030 level of development. The reductions in potential fish entrainment in Alternative 4 are smaller than in Alternatives 1 and 2, and are made possible by improved fish screening at CCWD intakes and the increased storage capacity of Los Vaqueros Reservoir, since there would be an increased number of years in which the No Diversion Period would apply due to increased storage, particularly in dry periods.

Particle Tracking Analysis

Methodology

The particle tracking model (PTM) simulates the transport and fate of neutrally buoyant particles in the Delta channels and estimates the probability that a parcel of water starting at one location will arrive at another location in a given time frame.

PTM uses velocity, flow, and water elevation information from DSM2-Hydro to simulate the movement of virtual particles in the Delta on a 15-minute time-step throughout the simulation period. If a particle leaves the Delta system by way of an export or diversion or through any other model boundary, this information is recorded for latter analysis and termed the “fate” of the particle. Additionally, the percentage of particles remaining within channels in each geographic region is tabulated and analyzed.

Use of PTM for fishery analysis has gained popularity over the last decade; however, the PTM tool has a number of limitations in application to fishery analysis. Chiefly, since the particles simulated in the model are neutrally buoyant (and therefore have no swimming behavior or other independent movement), results of these analyses are most relevant to the planktonic early larval stages of various organisms that do not move independently in the water column. The particles are not considered to reflect movements of juvenile or adult fish within the Delta, or of larvae that are able to move independently in the water column (for example, by varying their buoyancy).

PTM was used in this EIS/EIR to assess the effect of hydrodynamic changes on Delta hydrodynamics and entrainment. Delta hydrodynamics and general entrainment changes were assessed through a straightforward Particle Fate Analysis (PFA), while a more detailed survey-weighted Potential Entrainment Index (PEI) was developed and applied to the spring seasonal period (March through June) to evaluate effects on specific sensitive species. Additional assumptions and limitations of the analysis are described below.

Particle Release Locations

Particles were released in the model at various locations within the Delta that are either known to represent important fish habitat or areas where entrainment risk could change under the operation of the project alternatives. For the PFA, the biological relevance of each release location (shown in **Table C7-4** and **Figure C7-3**) varies significantly depending on the aquatic species and the season. For instance, adult delta smelt generally move upstream into the Delta in the winter prior to spawning. Although PTM cannot simulate this swimming behavior of the adults, PTM may be a useful tool to predict the movement of delta smelt larvae after they hatch in the spring. For the PEI, particle insertion nodes were selected to represent a subset of stations in the CDFG 20mm survey (**Figure C7-4**) from Suisun Bay eastward. These stations encompass the geographical extent of delta smelt distribution during the spring, and also cover the area of potential influence of water diversions in the Delta. **Table C7-5** presents the 20mm stations, the associated DSM2 nodes and surface areas which are used in the PEI calculation.

To evaluate hydrologic and operational variability, particle releases were simulated at the start of each month for water years 1976 through 1991. One thousand particles were released over a period of 26 hours (to encompass a full tidal cycle), starting at 11:00 pm on the second day of each month.

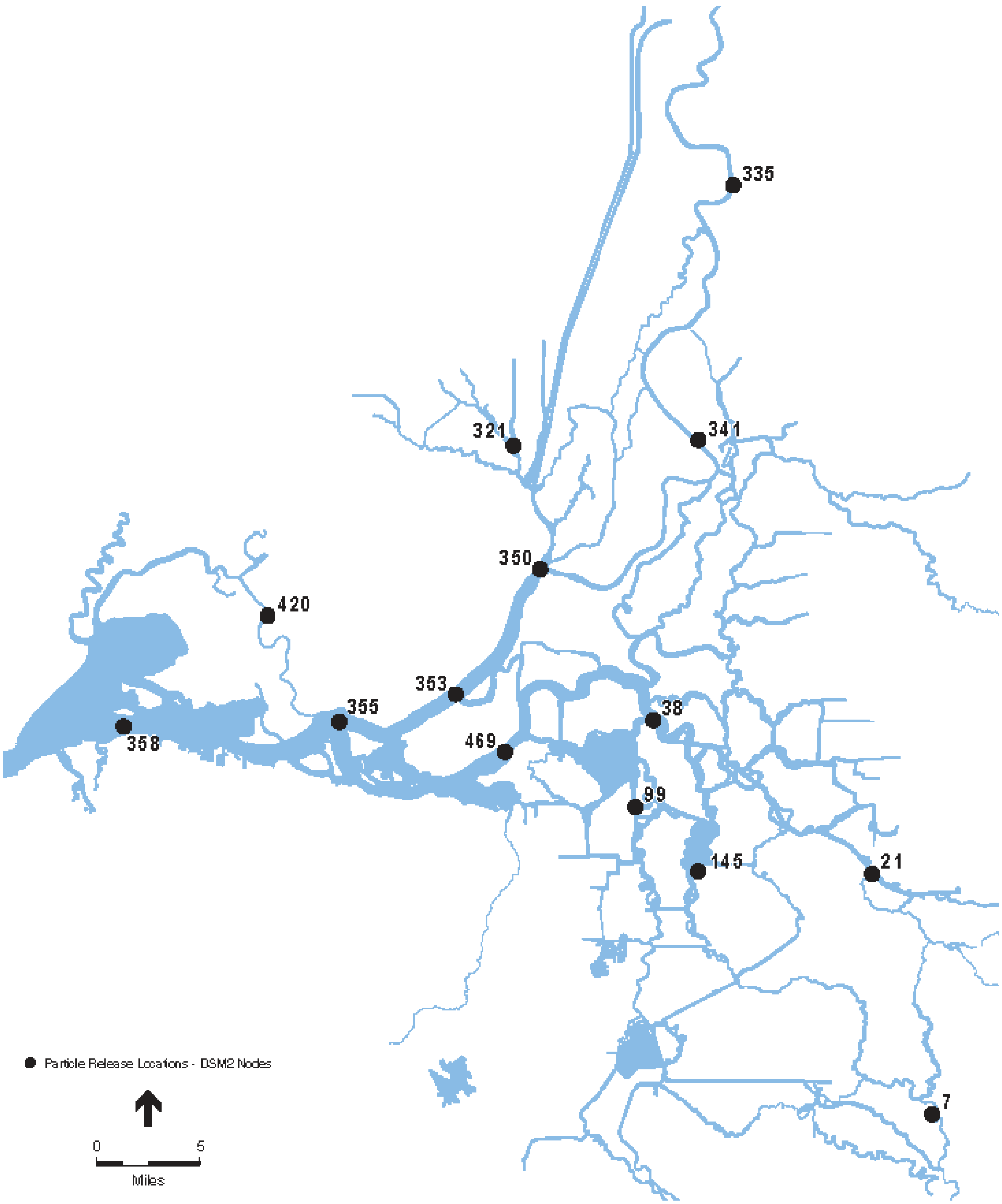


Figure C7-3: PTM Particle Release Locations for Particle Fate Analysis

TABLE C7-4: PARTICLE RELEASE LOCATIONS FOR PARTICLE FATE ANALYSIS IDENTIFIED BY DSM2 NODE NUMBER

DSM2 Node	Description
335	Sacramento River at Freeport
341	Sacramento River above Delta Cross Channel
321	Cache Slough
350	Sacramento River at Rio Vista
353	Sacramento River at Emmaton
355	Sacramento River at Collinsville
469	San Joaquin River at Jersey Island
38	San Joaquin River at mouth of Old River
99	Old River at Holland Tract
145	Middle River at Empire Tract
21	San Joaquin River west of Rough and Ready Island
7	San Joaquin River at Mossdale
358	Suisun Bay at Port Chicago
420	Montezuma Slough

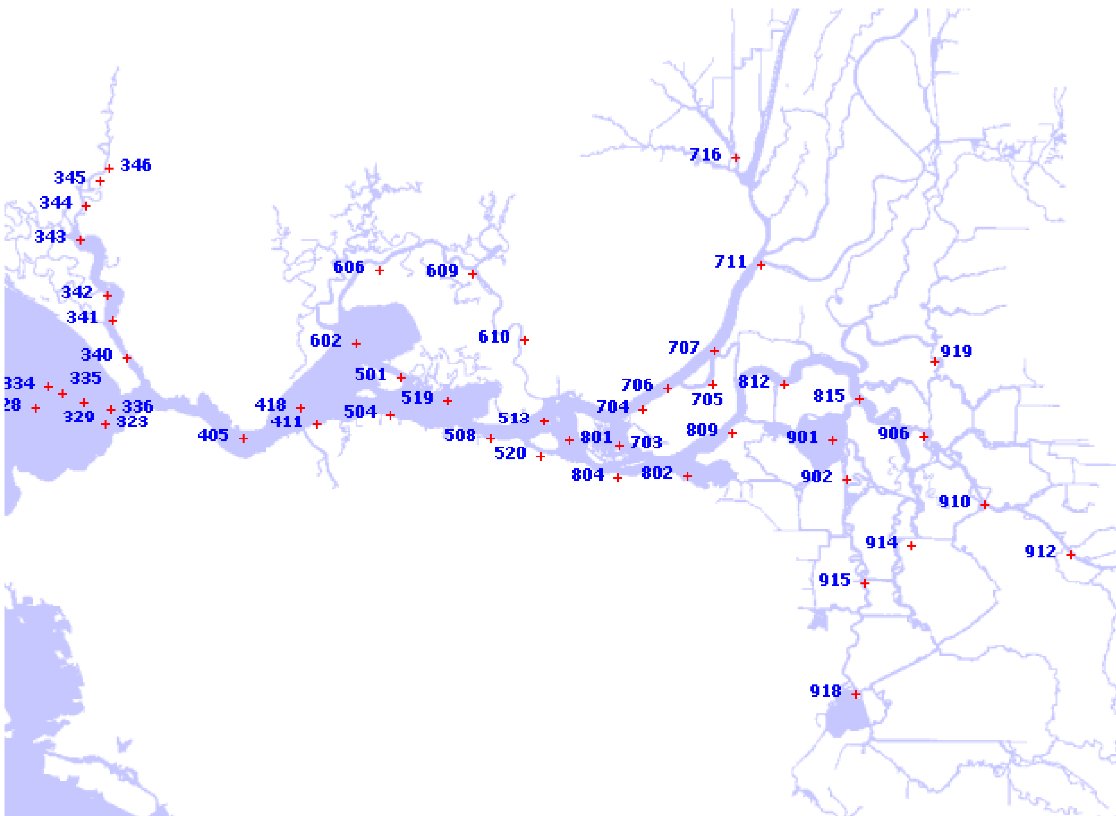


Figure C7-4: 20mm Survey Stations

TABLE C7-5: PARTICLE RELEASE LOCATIONS FOR PEI BY 20MM STATION AND ASSOCIATED DSM2 NODE NUMBER

20mm Station	DSM2 Node	Description	Surface Area (Acres)
411	359	Suisun Bay West of Point Edith	2,119
418	367	Suisun Bay near Mothball Fleet	2,756
501	238	Suisun Bay between Roe and Ryer Islands	3,692
504	358*	Suisun Bay at Port Chicago	2,403
508	356	Suisun Bay off Chipps Island	2,296
513	465	Sacramento River near Van Sickle Island	1,703
519	227	Honker Bay	4,101
520	463	New York Slough	438
602	365	Grizzly Bay Northeast of Suisun Slough	7,361
606	428	Montezuma Slough off of Joice Island	1,332
609	421	Montezuma Slough at Nurse Island	727
610	418	Montezuma Slough near Birds Landing	259
703	459	Sherman Lake	2,091
704	354	Sacramento River near Sherman Lake	605
705	352	Horseshoe Bend	277
706	353*	Sacramento River at Emmaton	931
707	352	Sacramento River at 3 Mile Slough	1,859
711	350*	Sacramento River at Rio Vista	1,000
716	321*	Cache Slough	6,219
719	314	Sacramento Deep Water Ship Channel	1,454
724	344	Sacramento River near Georgiana Slough	994
801	462	San Joaquin River near Mouth	2,226
804	46	San Joaquin River near West Island	1,195
809	469*	San Joaquin River at Jersey Island	1,392
812	42	San Joaquin River at Bradford Island	1,767
815	39	San Joaquin River at Potato Slough	4,023
901	232	Franks Tract	3,822
902	99*	Old River at Holland Cut	1,744
906	34	San Joaquin River at Medford Island	1,780
910	26	San Joaquin River between Hog and Turner Cut	1,925
912	21*	San Joaquin River west of Rough and Ready Island	1,225
914	145	Middle River at Empire Cut	1,554
915	86	Old River at Railroad Bridge	1,146
918	75	Old River near Coney Island	1,601
919	249	Little Potato Slough	2,043

*DSM2 node also included in the PFA

Model Output

Particle movement was tracked for 120 days; particle location is reported at 28 days and 120 days, using the metrics shown in **Figure C7-5** and **Table C7-6**, classified as flux past a specific location, potential entrainment at water intakes, or the percent remaining in channels in specific regions of the Delta and Suisun Bay and Marsh.

TABLE C7-6: PTM OUTPUT LOCATIONS

Name	Description
Flux Past Specific Location	
Past Chipps Island	Particles that pass Chipps Island
Past Martinez	Particles that pass Martinez
Past SMSCG	Particles that enter Montezuma Slough past the Suisun Marsh Salinity Control Gates
Potential Entrainment at Intakes	
Exports	Potential entrainment at Banks and Jones Pumping Plants combined
Agricultural Diversions	Potential entrainment at combined Agricultural Diversions in the Delta and Suisun Bay and Marsh
Old River	Potential entrainment at CCWD's existing intake on Old River (all alternatives) and the proposed new Delta intake on Old River (Alternatives 1 and 2 only) combined
Rock Slough	Potential entrainment at CCWD's existing intake on Rock Slough
AIP	Potential entrainment at the AIP on Victoria Canal
Remaining in Channel Regions	
South-Eastern Delta	Southeast of Victoria Canal and Trapper Slough. Includes Head of Old and Middle Rivers and San Joaquin River south of Rindge Tract
South-Central Delta	Centered on Old and Middle Rivers. Includes Franks Tract, Mildred Island and the channels around Los Vaqueros intakes and export locations
Eastern Delta	Encompassing Georgiana Slough, Snodgrass Slough, and all channels to the east. Includes San Joaquin River from Mokelumne River to Fourteen Mile Slough
Northern Delta	Sacramento River and tributaries above Rio Vista
Western Delta	Centered on Sherman Island. Includes western portion of San Joaquin and Sacramento Rivers and Three Mile Slough
Suisun Bay and Marsh	Region encompassing Suisun Bay and Marsh

PTM output locations and defined geographic regions are listed in Table C7-6 and illustrated in Figure C7-5. For the PFA, these output locations were selected because they are considered representative of major classes of particle fate. "Past Chipps Island" represents the percentage of particles that travel past Chipps Island at the western boundary of the Delta and into Suisun Bay. "Past SMSCG" represents the percentage of particles that enter Suisun Marsh past the Suisun Marsh Salinity Control Gates (SMSCG) on Montezuma Slough. "Past Martinez" represents the percentage of particles that travel past Martinez, the downstream boundary of the DSM2 model grid; once particles travel past Martinez, they cannot reenter the model domain on the subsequent tide. "Exports" represents the combined percentage of particles that were potentially entrained at the SWP Banks Pumping Plant and the CVP Jones Pumping Plant. "Old River" represents the combined percentage of particles that were potentially entrained at the Old River Intake (for all alternatives) and the new Delta Intake (Alternatives 1 and 2 only). "Rock Slough" and "AIP" represent potential entrainment at those respective Delta intakes. "Agricultural Diversions" represents the combined percentage of particles that were entrained in agricultural diversions located throughout the Delta and Suisun Bay and Marsh. The six regions defined under "Remaining in Channel Regions" represent the percentage of particles that remain within the Delta regions at the end of the simulation. The region boundaries are defined to group similar hydrodynamic, biological, water quality and/or water management characteristics.

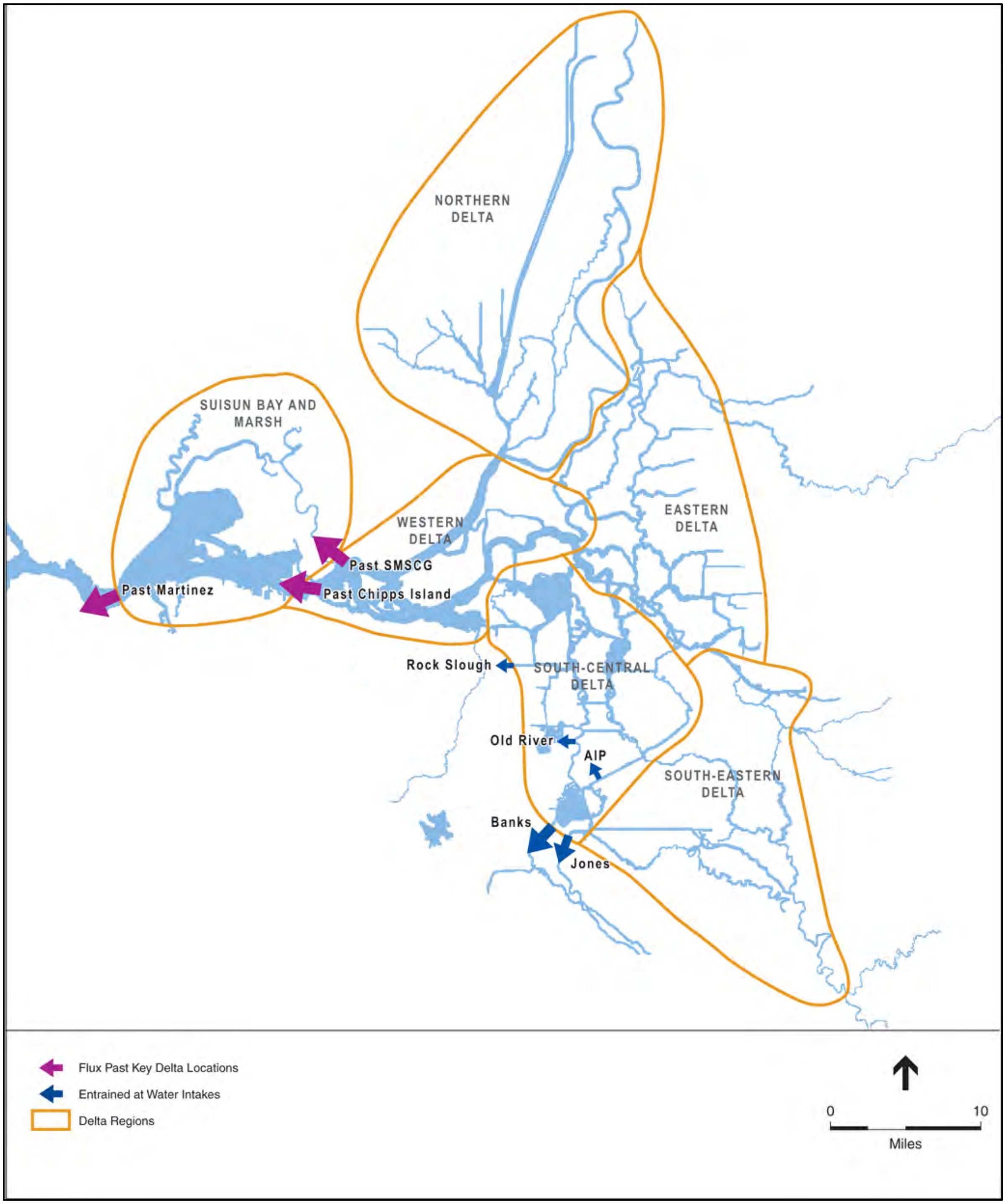


Figure C7-5: PTM Output Locations

Assumptions and Limitations

The application of DSM2-PTM to aquatic resources is limited by several factors, and requires consideration of the lifestage of the fish, the efficiency of fish screens at the intake with respect to size-specific exclusion of fish from entrainment, and modeling artifacts. The interpretation of these factors for this project analysis is described below.

Movement of aquatic organisms. PTM studies estimate the influence of modeled Delta hydrodynamics on neutrally buoyant particles. As such, the studies are only appropriate to represent the influence of Delta hydrodynamics on organic material and planktonic organisms (such as phytoplankton and zooplankton) that would behave as passively drifting particles. The interpretation is often extended to apply to the larval stages of some fish species rearing in the Delta, which may be advected (i.e., transported) by Delta tidal flows prior to developing the ability to swim and control their position in the water column. The particles are not considered to reflect movements of juvenile or adult fish within the Delta.

Biological interpretation of particle release timing and location. The PFA is set up as a comprehensive analysis, with particle releases occurring at fourteen locations, every month of each year for the 16-year planning study (water years 1976 to 1991). In considering specific aquatic organisms, the seasonal timing and location in which particle releases are simulated should be interpreted appropriately. As discussed above, a practical application of PTM results for specific fish species must be limited to use for larval stages of Delta fish. It follows that this application of PTM should only be used at times and locations when larval stages are likely to occur (e.g. particle release locations in early spring on the lower Sacramento River may be interpreted to represent Delta smelt spawning locations, from which passively drifting larvae would be expected to emerge). Therefore, to facilitate interpretation for various aquatic organisms, the PFA results are summarized by release location and the season of release (winter, spring, and fall). The PEI provides a more comprehensive biological interpretation of the PTM results for delta smelt, longfin smelt and striped bass.

Positive barrier fish screens. The PTM simulation assumes that particles are entrained at water intakes (removing particles from the channels) based on the flow split between the channel and the water diversion, without regard for any fish protection facilities. Therefore, PTM results must be further interpreted to account for the efficiency of positive barrier fish screens. Both delta smelt and longfin smelt larvae hatch at sizes (approximately 5 mm) that would be partially excluded from entrainment by positive barrier screens (see Table C7-1), making the use of screen efficiency assumptions appropriate for these species at screened water intakes.

Larvae evaluated with PTM studies are assumed to be 5 mm for the PFA; or to fall within one of three size bins (5-7mm, 8-10mm and 11-14mm) determined from the 20mm field surveys for the PEI analysis. No larval growth is assumed during the simulation periods. Since screen efficiencies increase with fish size, this results in the application of conservatively lower screen efficiencies to all particles at screened intakes, independent of growth since release (or "hatch") in the Delta.

The potential entrainment at water intakes with positive barrier fish screens (Rock Slough except in Existing Condition, Old River and AIP intakes) is reduced according to the screen exclusion efficiency as follows:

Potential entrainment = (PTM entrainment estimate) multiplied by
(1.0 minus the screen exclusion efficiency)

This method determines the potential entrainment through positive barrier fish screens, but does not determine the ultimate fate of the larvae that are protected from entrainment by the screens. In other words, since the screen efficiency is applied post simulation, the screened out particles have already been removed from the simulation and their fate is left unresolved in the PTM study. To account for this, an approximation was made of the fate of the screened out particles. This was accomplished by inserting particles near each screened intake, tracking particle fate with respect to entrainment or flux out of the Delta, and applying the proportional fate to the screened out particles (i.e. adding back in the screened out particles as entrainment or flux at the indicated locations). For simplification, re-entrainment was not considered at the immediate intake being evaluated. Although this treatment is not as ideal as including particle screening capability directly in the model, it does provide a reasonable estimate of the ultimate fate of a screened out particle, so the effects of screening are estimated in the final results.

Geometry of Water Intakes. Because DSM2 is a one-dimensional model, it does not recognize the difference between an intake at the end of a channel and an intake on the side of a channel. Particles are entrained at water intakes in a PTM simulation based on advection and dispersion calculations made where the intake boundary intersects the one-dimensional arc that represents the Delta channel. This does not reflect the strong influence of longitudinal flow in the actual three-dimensional river, which tends to sweep neutral particles past side-of-channel intakes that have low approach velocities (Old River and AIP intakes have been designed to achieve an approach velocity of 0.2 ft/sec for the protection of delta smelt and other fish species; the new Delta Intake on Old River would be designed with similar criteria). This issue is not reflected in the larval fish entrainment analysis performed using PTM for this project, and could contribute to an over-estimate of larval entrainment at side-of-channel intakes.

Dispersion of particles. As discussed in Kimmerer and Nobriga (2008), PTM has limitations regarding the dispersion of particles, including the simplistic assumed velocity profiles that do not adjust for channel geometry or bottom roughness and the mixing of particles at channel nodes. These factors may have a significant effect on particle dispersion, especially in the near-field. Dispersion issues in the near-field are amplified in the central and south Delta due to the DSM2 channel grid, where nodes are very close together. Additionally, because agricultural diversions are simulated at almost every DSM2 node in the central and south Delta, simulated particle releases in this region are likely to contain errors in the estimation of agricultural entrainment that are due to the near-field dispersion issue.

Agricultural intakes. When particles are released in close proximity to simulated agricultural diversions, the particle tracking results are sensitive to small changes in hydrodynamics, such that minor changes in flows create relatively large changes in the percent of particles potentially entrained at nearby agricultural intakes. This is partly due to the underestimation of particle dispersion, addressed above, and the density of particles at the release location. When particles are released in the model, they are in a dense grouping until dispersion mixes the particles. When nodes are close together, dispersion does not have a sufficient time to act before particles are entrained at nearby simulated agricultural intakes.

Since the agricultural diversions are not altered between PTM simulations of project alternatives and PTM simulations of without project conditions, comparative changes in particle entrainment in the agricultural diversions appears to be an artifact of the modeling, and does not directly result from the operation of the project alternatives, or provide biologically meaningful information about the effects of the project alternatives on Delta fish.

Open water areas. The open water areas of the Delta (e.g. Franks Tract and Mildred Island) are not well represented in the particle tracking analysis. The model assumes these regions are completely mixed environments, such that a particle that enters on one side of the flooded lake has the possibility of exiting on the other side of the lake in a short time period. In reality, these environments have complicated dynamics that effectively “trap” particles within the regions or can move them in ways that the model does not capture.

20mm survey densities. Historical 20mm survey results from 1995-2009 are used to determine the initial spatial patterns of abundance for the PEI analysis. Future distribution patterns and timing may deviate from the historical averages. The PEI includes two stations (719 and 724) that have been sampled only since 2008, but are thought to be representative of important delta smelt habitat near the Cache Slough complex. In general, it is expected that under the flow regime specified under the OCAP BOs, fish densities would be lower in the central and south Delta during the spring, which would tend to lower entrainment across the board. This effect is difficult to confirm using the available 20mm survey data, because implementation of the OCAP BOs began in 2008, meaning less than 2 years of survey data under these new operations are available for comparison to historical operations at the time of this analysis. In addition, survey densities in the south Delta may also be underestimated when low hydraulic residence times occur in the south Delta. The March through June timeframe in the PEI covers the timing for the larval stage of delta smelt most completely. The PEI covers the window for larval stage longfin smelt and striped bass less ideally (longfin smelt larvae are present from January through March-April, while striped bass larvae span the period from April through July). Nonetheless, the PEI includes use of the data from the 20mm survey data, which is the most appropriate and complete data source for larval stage assessment of these three species.

Potential Entrainment Index (PEI) Calculation

This section describes the procedure used for determining the Potential Entrainment Index (PEI). The PEI method was used to combine the PTM analysis of Delta flows with survey results of fish distribution, abundance and timing patterns. The PEI method accounts for some of the spatial and temporal variation in the location and density of specific species and provides a biological interpretation of PTM analysis. It was originally developed by DWR to evaluate the effect of operations on potential entrainment and for use in planning real time operations to minimize salvage (Nam, 2009). In this application for the analysis of the Los Vaqueros Reservoir Expansion Project, PEI results from with- and without-project model simulations are compared, to determine the relative effect of the project alternatives.

In the PEI method, PTM results are weighted according to the relative abundance of larval stage fish present (as determined by the 20mm survey) near the initial particle release locations to determine the percent of population entrained. Analysis of the percentage of population entrained has been cited as a valid metric for evaluation of effects to delta smelt (USFWS, 2008). The PEI was calculated for the March through June time period. The steps used to calculate the PEI are summarized below:

1) <u>Determine fish densities at each 20mm survey location.</u> The 20mm survey database was obtained from DFG. The entire historical record (1995-2009) was used. The monthly average Catch per Unit Effort (CPUE) was calculated for each station by size class and converted to density in term of number of fish per acre-foot of water sampled (# fish/AF). Only fish below 15mm were included in the analysis as beyond that size, the fish begin to acquire swimming behavior and behave less like neutrally buoyant particles. The CPUE was sorted by three size classes (5-7mm, 8-10mm and 11-14mm) as these corresponded to the size categories used to classify screen efficiencies.

2) <u>Determine the monthly fish abundance at each station.</u> Monthly average densities by size class for each station were multiplied by the associated surface area (Table C7-4) and by a constant depth. Surface areas were determined by DWR using engineering judgment aided by the use of a Voronoi diagram which allowed an unbiased method for apportioning areas among stations.

3) <u>Determine monthly PTM entrainment percentage from each 20mm survey location.</u> As described above, 1000 particles were released at DSM2 nodes corresponding to the 20mm survey locations (Table C7-5 and Figure C7-4) and the percent of particles potentially entrained at each intake within 28 days was determined (subject to reduction by screen efficiency factors). The intakes that were included in the PEI analysis were the Exports (Banks and Jones) and the Rock Slough, Old River and AIP, and the New Delta Intakes. The 28 day period was selected as it corresponds to the approximate period for when the behavior of larval delta smelt most closely represents neutrally buoyant particles.

4) <u>Determine monthly weighted entrainment and cumulative weighted entrainment (March-June) at each intake.</u> For each intake, the percentage of PTM entrainment from a given station (see step 3 above) for a given month was multiplied by the abundance from that station (see steps 1 and 2 above) for the same month and then the total from all stations was summed to determine monthly weighted entrainment . The monthly weighted entrainment for each intake was then summed across the months of March through June to obtain the cumulative weighted entrainment.

5) <u>Divide cumulative weighted entrainment by the cumulative population to obtain percentage of population entrained for each intake.</u> The cumulative population was considered to be fish

abundance (determined in Step 2) summed across all 20mm stations included in the PEI summed across the months of March through June. The cumulative weighted entrainment determined in Step 4 was divided by the cumulative population to obtain the PEI, which is expressed as the percentage of cumulative population entrained. PEI was determined for the individual intakes and also for the combined set of intakes.

The strength of the PEI analysis is that it attempts to explicitly account for the spatial and temporal variation in the fish species of concern. The PTM results are made more meaningful when particle fate from a given location is related to relative abundance at that location through the PEI method. A similar approach has been used (Kimmerer, 2008) and cited in the USFWS OCAP BO as a valid tool for estimating the effect of operations on delta smelt abundance. The PEI is relevant for evaluating effects on abundance, as the metric provided is percent of population entrained. The March through June PEI is most relevant for delta smelt because this is the period when most Delta smelt larvae occur in the Delta. The PEI analysis is useful for identifying effects on larval stages of striped bass and longfin smelt, which are also present in the Central and South Delta during the same time period.

The PEI method as applied in this analysis has two limitations that must be considered along with the results of the analysis. One of these is the averaging of fish survey results into monthly density values for each station over the period of record. This averaging could remove from the PEI results some of the effects of variability in fish density that are driven by changes in hydrology from year to year. This would limit the benefit of the spatial and temporal fish information used for the method, by applying the same density values over wet and dry years. An improvement to the method would be to develop fish density values for specific Sacramento Valley water year types, or to otherwise capture the effects of hydrology in the fish density values used. An attempt was made to do so for this analysis, but the 20mm survey data were not available for sufficient years of each water year type to allow useful averages to be developed.

The second factor that can affect use of the PEI method as applied in this analysis is the effectiveness of fish sampling in the south Delta, due to relatively short hydraulic residence time in this area under historical water export operations, which may underestimate fish densities in this area. This represents a potential limitation in the 20mm survey data used in this PEI analysis. Future research into the effectiveness of sampling throughout the Delta region, and development of correction factors for differences if needed, will help address this potential limitation.

The PEI uses a subset of all the 20mm stations. The other stations located west and downstream of Suisun Bay register very little entrainment. Thus, the PEI is expected to be conservative since the PEI would likely be even lower when accounting for the fish that are present in these regions.

Figure C7-6, **Figure C7-7**, and **Figure C7-8** show the density patterns for delta smelt, longfin smelt and striped bass.

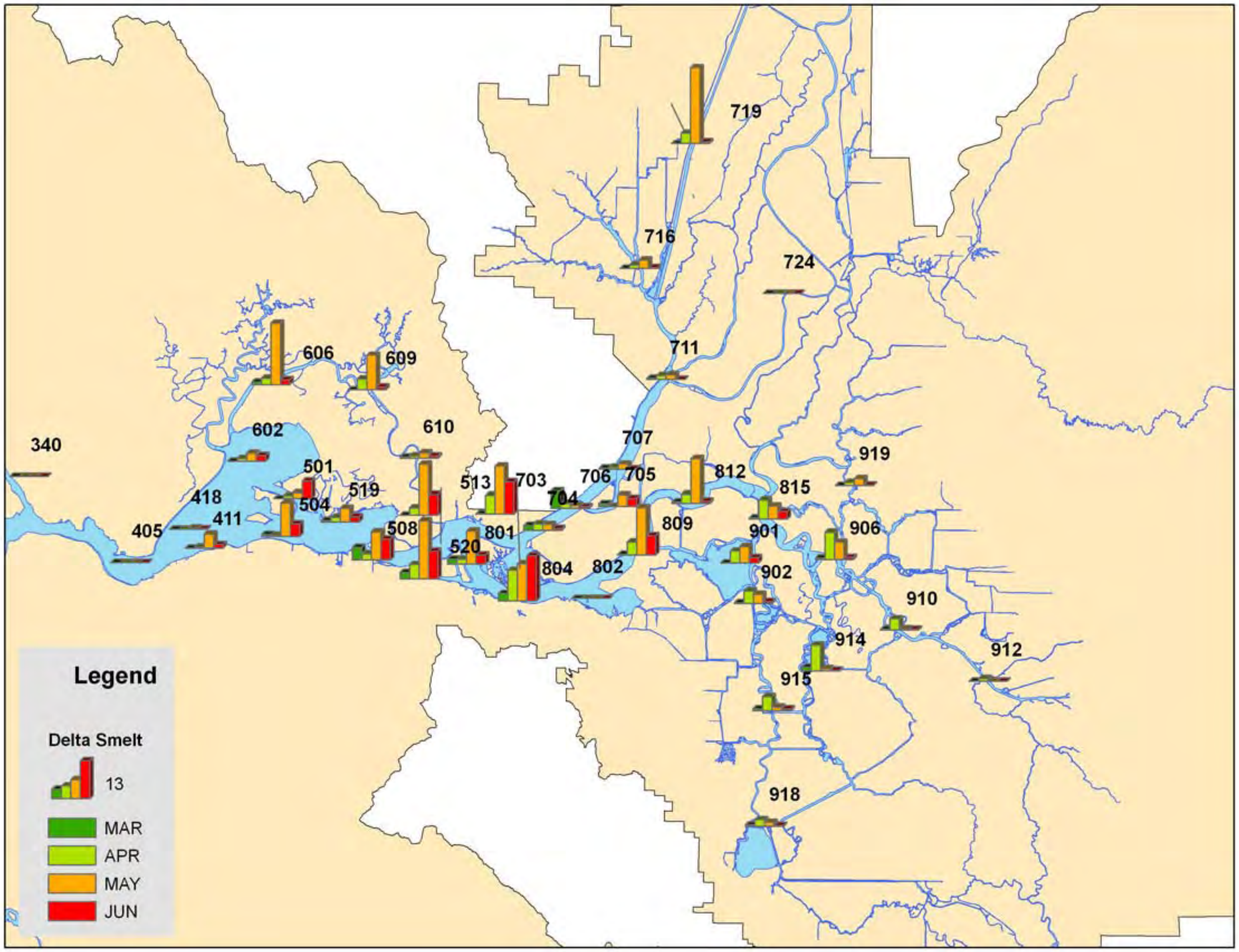


Figure C7-6: Delta Smelt Average Densities (1995-2009) used for PEI

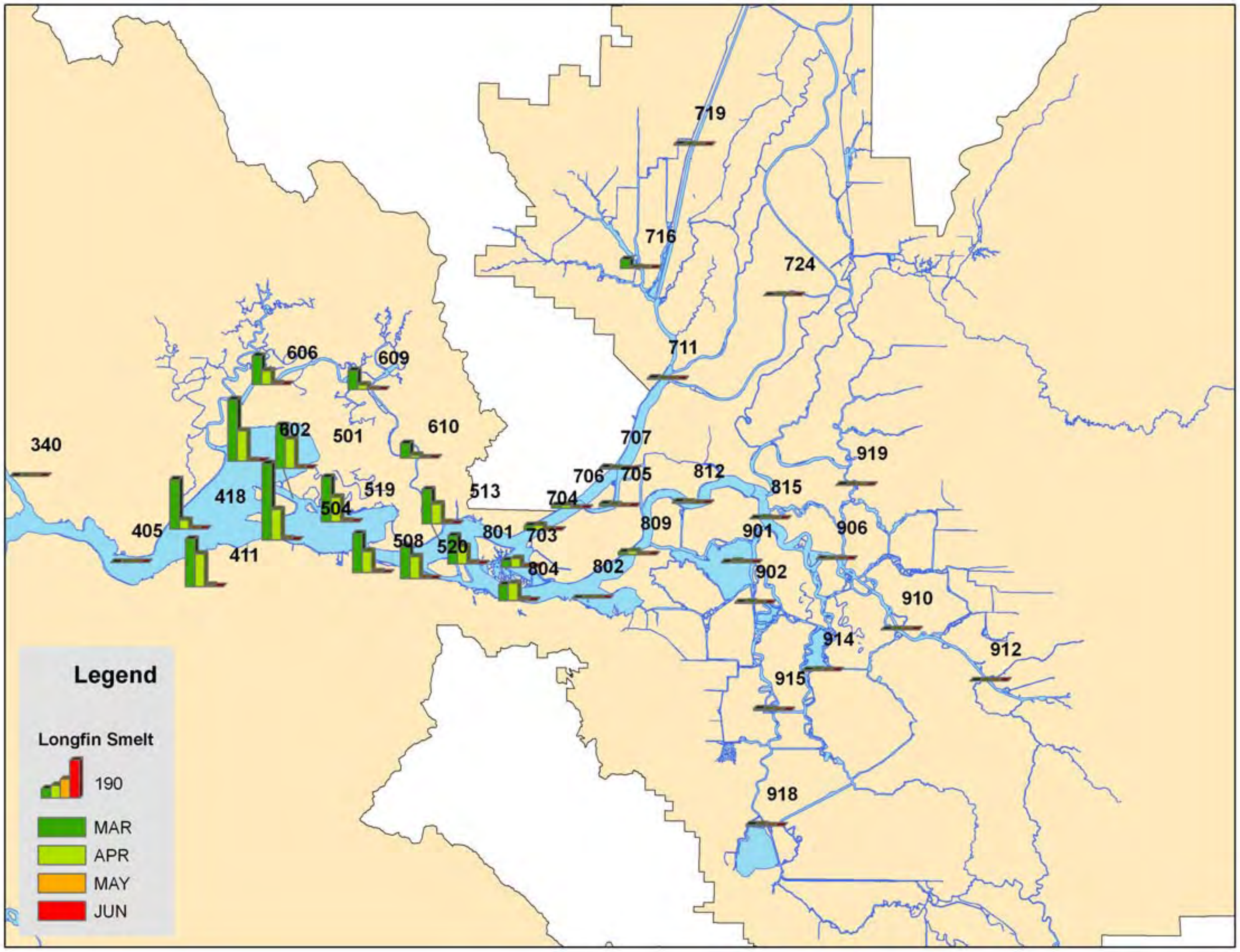


Figure C7-7: Longfin Smelt Average Densities (1995-2009) used for PEI

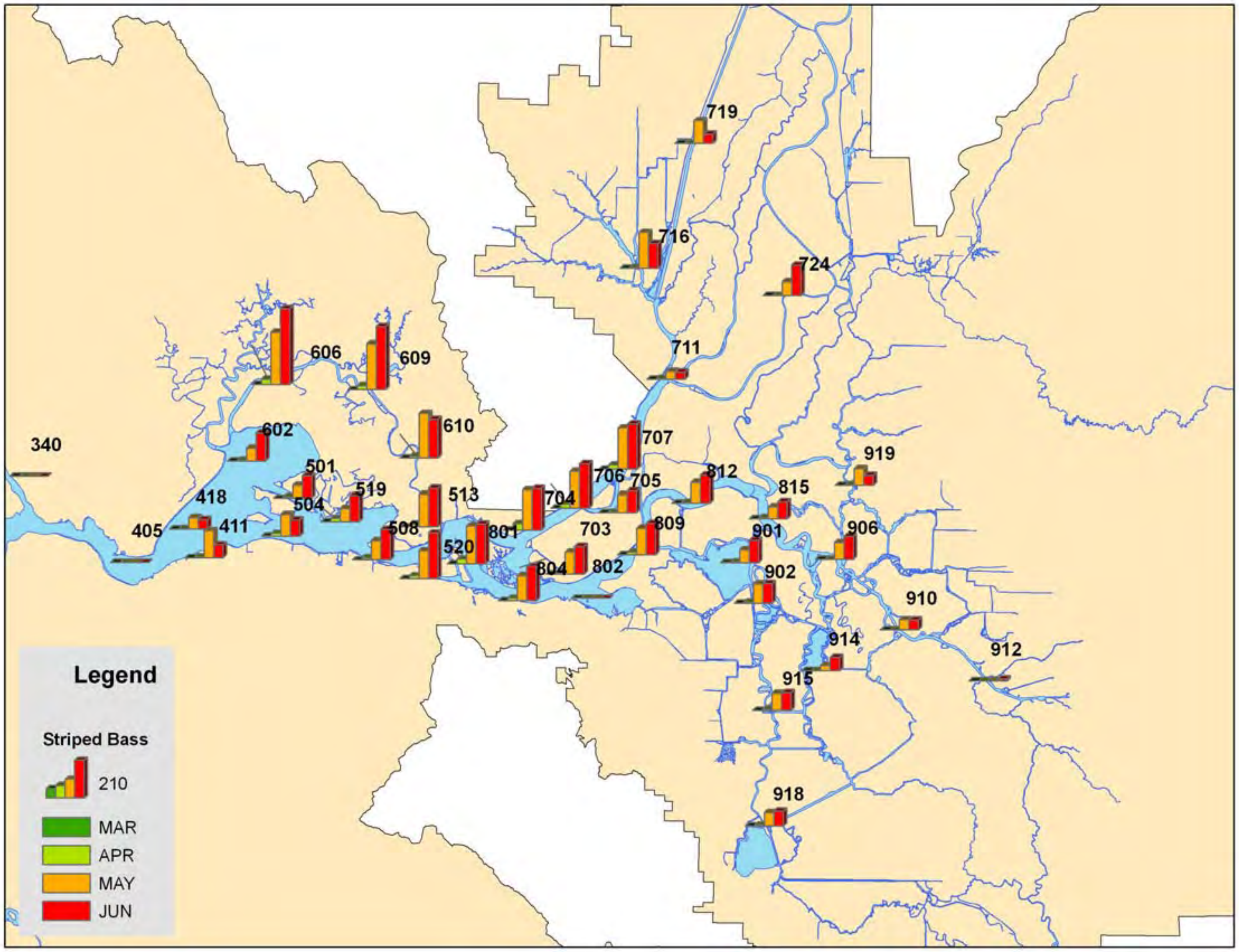


Figure C7-8: Striped Bass Average Densities (1995-2009) used for PEI

Results

For the Los Vaqueros Reservoir Expansion Project, the PTM tool is used to evaluate the direct and indirect effects of operation of each of the project alternatives. Direct effects are due to changes in potential entrainment of fish at water intakes. Indirect effects are due to changes in Delta hydrodynamics, which may affect aquatic habitat. The assessment relies on a comparative analysis of conditions within the estuary under without project conditions and with the proposed project under the 2005 and 2030 levels of development.

A summary of percent particle fate for particles originating on the San Joaquin River at Jersey Island for the 2030 level of development is shown below. Results are summarized by the season during which the particles are released (e.g. Winter ("W") averages the results for particles released during December, January, and February). The release location on the San Joaquin River at Jersey Island is presented as an example of the PTM results to illustrate the choice of simulation period. Results for all release locations are evaluated for changes in Delta hydrodynamics and potential entrainment at water intakes, as shown in subsequent sections below.

Table C7-7 presents results 28 days after particles were released; this time frame has both biological and operational relevance. For delta smelt larvae, swim bladders are nearly fully developed and fin-folds begin to appear 25 to 40 days post-hatch (Bennett 2005); at this stage, neutrally buoyant particles may no longer represent larval movement. Additionally, since the CalSim II model simulates operations at a monthly time-step, significant changes in river flows and export operations at the start of each month cause abrupt changes in the particle movement within the Delta and Suisun Bay. Thus, limiting particle simulations to approximately one month may be appropriate for immediate application to predictions of smelt larvae entrainment through effectively screened intakes.

TABLE C7-7:
SEASONAL PERCENT PARTICLE FATE 28 DAYS AFTER PARTICLES ARE RELEASED

Seasonal[1] Percent Particle Fate, Long-term Average (1976 to 1991)
28 Days after Particles are Released at
San Joaquin River at Jersey Island
2030 Level of Development

	Future Without Project			Change from Future Without Project (Alternative - Future Without Project)								
				Alt 1			Alt 2			Alt 4		
Monitoring Location	W	S	F	W	S	F	W	S	F	W	S	F
Potentially Entrained at Water Intakes												
Exports (Banks and Jones)	10	1	14	0	0	0	0	0	0	0	0	0
Agricultural Diversions	0	1	0	0	0	0	0	0	0	0	0	0
Rock Slough[2]	0	0	0	0	0	0	0	0	0	0	0	0
Old River[2]	0	0	0	0	0	0	0	0	0	0	0	0
AIP[2]	0	0	0	0	0	0	0	0	0	0	0	0
Remaining in Channel Regions												
South-Eastern Delta	0	0	0	0	0	0	0	0	0	0	0	0
South-Central Delta	8	5	10	0	0	0	0	0	0	0	0	0
Eastern Delta	4	3	6	0	0	0	0	0	0	0	0	0
Northern Delta	0	0	0	0	0	0	0	0	0	0	0	0
Western Delta	9	13	21	0	0	0	0	0	0	0	0	0
Suisun Bay and Marsh	13	16	19	0	1	0	0	0	0	0	0	0
Past Specific Locations												
Past Suisun Gates	6	5	5	0	0	0	0	0	0	0	0	0
Past Chipps Island	66	71	46	0	0	0	0	0	0	0	0	0
Past Martinez	59	62	32	0	0	0	0	0	0	0	0	0

1 Seasonal averages:
W is Winter (December through February), S is Spring (March through June), and F is Fall (September through November)
2 Output from the particle tracking model has been adjusted to account for fish screens at the Rock Slough, Old River and AIP intakes for the Future Without Project and for each alternative and the new Delta Intake for the Future Without Project and Alternatives 1 and 2, assuming the larvae are 5mm in length and do not grow after hatch.

At the end of 28 days, a percentage of particles are still remaining in Delta channels. Due to the uncertainty in the ultimate fate of particles that are still remaining within the channels 28 days after release, the simulations were continued through 120 days post-release (**Table C7-8**), when almost all particles have moved out of the Delta. Because the results are more conclusive with respect to ultimate particle fate, the analysis of impacts to aquatic resources relies on the results 120 days after particles are released. When applied to entrainment estimates, this approach using 120 days of simulation may conservatively over-estimate the number of smelt entrained through effectively screened intakes in the latter portion of each simulation.

TABLE C7-8: SEASONAL PERCENT PARTICLE FATE 120 DAYS AFTER PARTICLES ARE RELEASED

Seasonal[1] Percent Particle Fate, Long-term Average (1976 to 1991)
120 Days after Particles are Released at
San Joaquin River at Jersey Island
2030 Level of Development

Monitoring Location	Future Without Project			Change from Future Without Project (Alternative - Future Without Project)								
				Alt 1			Alt 2			Alt 4		
	W	S	F	W	S	F	W	S	F	W	S	F
Potentially Entrained at Water Intakes												
Exports (Banks and Jones)	16	7	27	0	0	0	0	0	0	0	0	0
Agricultural Diversions	0	2	0	0	0	0	0	0	0	0	0	0
Rock Slough[2]	0	0	0	0	0	0	0	0	0	0	0	0
Old River[2]	0	0	0	0	0	0	0	0	0	0	0	0
AIP[2]	0	0	0	0	0	0	0	0	0	0	0	0
Remaining in Channel Regions												
South-Eastern Delta	0	0	0	0	0	0	0	0	0	0	0	0
South-Central Delta	0	0	0	0	0	0	0	0	0	0	0	0
Eastern Delta	0	0	0	0	0	0	0	0	0	0	0	0
Northern Delta	0	0	0	0	0	0	0	0	0	0	0	0
Western Delta	0	0	0	0	0	0	0	0	0	0	0	0
Suisun Bay and Marsh	1	2	1	0	0	0	0	0	0	0	0	0
Past Specific Locations												
Past Suisun Gates	8	6	9	0	0	0	0	0	0	0	0	0
Past Chipps Island	75	83	63	0	0	0	0	0	0	0	0	0
Past Martinez	83	88	71	0	0	0	0	0	0	0	0	0

1 Seasonal averages:
W = Winter (December through February), S = Spring (March through June), and F = Fall (September through November)
2 Output from the particle tracking model has been adjusted to account for fish screens at the Rock Slough, Old River and AIP intakes for the Future Without Project and for each alternative and the new Delta Intake for the Future Without Project and Alternatives 1 and 2, assuming the larvae are 5mm in length and do not grow after hatch.

Particle Fate Analysis - Delta Hydrodynamics

To assess changes in Delta hydrodynamics due to each project alternative, the change in the percentage of particles that travel past Chipps Island, the western boundary of the Delta, relative to without project conditions, is analyzed below. This analysis, along with the analysis presented in the "Hydrologic Effects of Operations" and "Old and Middle River Flow Evaluation" sections within this appendix, supports the findings for Impact 4.3.6.

Table C7-9 and **Table C7-10** show the percentage of neutrally buoyant particles that have traveled past Chipps Island 120 days after the particles originated at the specified release locations for the 2005 level of development and 2030 level of development, respectively. The three leftmost numeric columns of each table show the average percentage of particles that pass Chipps Island for the without project alternative for particles released during Winter (December through February), Spring (March through June), and Fall (September through November). The remaining columns show the change from the without project condition in percentage of particles that have traveled past Chipps Island for each season. Negative fluxes occur for the Suisun Bay at Port Chicago and Montezuma Slough locations as these are downstream from Chipps Island.

The percentage of particles passing Chipps Island tends to be greatest for particles originating in the Western Delta or upstream on the Sacramento River. Particles originating in the central and southern Delta have a lower probability of passing Chipps Island, yet a notable percentage of the particles originating in the spring do pass Chipps Island within 120 days after release. For instance, without the project, for the 2005 level of development, 46 percent of particles originating in the spring on Old River at Holland Tract pass Chipps Island within 120 days after release, and 25 percent of particles originating in the spring at Middle River at Empire Cut pass Chipps Island within 120 days after release, as shown below in Table C7-9. Thus, averaged over the 16-year PTM study, there remains a reasonable probability that particles in the south-central Delta may avoid entrainment at South Delta salvage facilities and exit the Delta through advection, in the absence of behavior.

Changes in particle fate between the alternatives and the without project condition were assessed. Changes in the percent of particles passing Chipps Island were in the range of -1 to 2 percent; this is consistent with the small change in Delta outflow discussed in the "Hydrologic Effects of Operations" section. Additionally, this level of change is within the level of model noise in CalSim II (see section 4.2), which is used as input for the PTM model.

Overall, the particle tracking results presented in Table C7-9 and Table C7-10 indicate no significant changes in particle fate at key rearing areas of larval and juvenile delta smelt and longfin smelt within the Delta, or rearing areas for green sturgeon on the Sacramento River, between the without project conditions and each of the project alternatives. These results support the conclusion that the project alternatives do not create adverse impacts to delta smelt, longfin smelt and green sturgeon relative to without project conditions.

TABLE C7-9:
LONG-TERM, SEASONAL AVERAGE PERCENT OF PARTICLES TRAVELING PAST CHIPPS ISLAND 120 DAYS AFTER PARTICLES ARE RELEASED AT DESIGNATED LOCATIONS
2005 LEVEL OF DEVELOPMENT

	Existing Conditions			Change from Existing Conditions								
				Alt 1			Alt 2			Alt 4		
Release Location	W	S	F	W	S	F	W	S	F	W	S	F
Sacramento River at Freeport	69	70	45	1	0	0	0	1	0	0	0	0
Sacramento River above Delta Cross Channel	65	71	40	0	1	0	0	1	0	0	1	0
Cache Slough at Sac Ship Channel	28	7	11	0	0	0	0	0	0	0	0	0
Sacramento River at Rio Vista	79	82	65	0	0	0	0	0	0	0	0	0
Sacramento River at Emmaton	83	87	75	1	0	0	0	0	0	0	0	-1
Sacramento River at Collinsville	88	91	84	0	0	0	0	0	0	0	0	0
San Joaquin River at Jersey Island	75	83	63	0	0	-1	0	0	0	0	1	0
San Joaquin River at mouth of Old River	47	65	27	0	0	0	0	0	0	0	1	0
Old River at Holland Tract	22	46	5	1	2	0	1	2	0	1	2	1
Middle River at Empire Cut	9	25	0	0	1	0	0	1	0	0	1	0
San Joaquin River west of Rough and Ready Island	23	38	5	0	1	0	0	0	0	0	0	0
San Joaquin River at Mossdale	13	23	3	0	0	0	0	0	0	0	0	0
Suisun Bay at Port Chicago	-2	-1	-3	0	0	0	0	0	0	0	0	0
Montezuma Slough	-1	0	4	0	0	0	0	0	0	0	0	0

1 Seasonal averages:
W is Winter (December through February), S is Spring (March through June), and F is Fall (September through November)
2 Output from the particle tracking model has been adjusted to account for fish screens at the Rock Slough, Old River and AIP intakes for the Future Without Project and for each alternative and the new Delta Intake for the Future Without Project and Alternatives 1 and 2, assuming the larvae are 5mm in length and do not grow after hatch.

TABLE C7-10:
LONG-TERM, SEASONAL AVERAGE PERCENT OF PARTICLES TRAVELING PAST CHIPPS ISLAND 120 DAYS AFTER PARTICLES ARE RELEASED AT DESIGNATED LOCATIONS
2030 LEVEL OF DEVELOPMENT

	Future Without Project			Change from Future Without Project								
				Alt 1			Alt 2			Alt 4		
Release Location	**W**	**S**	**F**	**W**	**S**	**F**	**W**	**S**	**F**	**W**	**S**	**F**
Sacramento River at Freeport	71	71	46	0	0	0	0	0	0	0	0	0
Sacramento River above Delta Cross Channel	66	72	42	0	0	0	0	0	0	0	0	0
Cache Slough at Sac Ship Channel	31	6	10	0	0	0	0	0	0	0	0	0
Sacramento River at Rio Vista	79	82	65	2	2	2	0	0	0	0	0	0
Sacramento River at Emmaton	84	87	75	0	0	0	0	0	0	0	0	1
Sacramento River at Collinsville	89	91	84	0	0	0	0	0	0	0	0	0
San Joaquin River at Jersey Island	75	83	63	0	0	0	0	0	0	0	0	0
San Joaquin River at mouth of Old River	48	66	28	0	0	0	0	0	0	0	0	0
Old River at Holland Tract	24	49	7	0	0	0	0	0	0	0	-1	0
Middle River at Empire Cut	12	28	0	0	0	0	0	0	0	0	0	0
San Joaquin River west of Rough and Ready Island	24	40	6	0	0	0	0	0	0	0	0	0
San Joaquin River at Mossdale	13	25	3	0	0	0	0	0	0	0	-1	0
Suisun Bay at Port Chicago	-1	-1	-3	0	0	0	0	0	0	0	0	0
Montezuma Slough	-1	0	4	0	0	0	0	0	0	0	0	0

1 Seasonal averages:
W is Winter (December through February), S is Spring (March through June), and F is Fall (September through November)
2 Output from the particle tracking model has been adjusted to account for fish screens at the Rock Slough, Old River and AIP intakes for the Future Without Project and for each alternative and the new Delta Intake for the Future Without Project and Alternatives 1 and 2, assuming the larvae are 5mm in length and do not grow after hatch.

Particle Fate Analysis - Potential Entrainment

To assess changes in potential entrainment, the change in the total percentage of particles potentially entrained at any water intake is analyzed below. This analysis, along with the analysis presented in the "Entrainment Indices from Field Surveys" section within this appendix, supports the findings for Impact 4.3.7.

Table C7-11 and **Table C7-12** show the total percentage of particles potentially entrained at the any of the water intakes, including intakes on Old River, Victoria Canal, and Rock Slough; the SWP Banks Pumping Plant; the CVP Jones Pumping Plant; and the agricultural intakes. The three leftmost numeric columns of each table show the average percentage of particles entrained for the without project alternative for particles released during Winter (December through February), Spring (March through June), and Fall (September through November). The remaining columns show the change from the without project condition in percentage of particles that are entrained at any of the water intakes (listed above) for each season.

In general, PTM results indicate the project alternatives do not significantly increase the number of particles "pulled" into the south Delta, as is evident in the results for particle releases along the Sacramento River (near delta smelt spawning habitat) and on the San Joaquin River at Jersey Point.

In Alternatives 1 and 2, there are generally small reductions in the percentage of particles entrained, which reflects a benefit of reduced potential for fish entrainment in these alternatives. Some of these benefits are related to the relocation of some South Bay water agencies' Delta diversions to the expanded Los Vaqueros system, which provides improved fish screening relative to the SWP and CVP facilities. The benefit for larval fish as determined by PTM is not as substantial as the reductions for individual salmonid species evaluated with the fish indices (see "Entrainment Indices from Salvage Data"), in part because the PTM analysis assumes larvae are neutrally buoyant particles, 5mm in length, with no growth assumed during the study period. Nonetheless, since the positive barrier fish screens are less than 100% efficient for the smaller size classes (e.g. planktonic larvae less than approximately 15 mm), this assumption results in a conservative estimate for the number of larval fish protected by positive barrier fish screens.

PTM results for Alternative 4 show no significant change from the without project condition, as all changes remain below 2 percent, which is within the noise of the CalSim II model (see updated Section 4.2) and also relatively low when compared to the seasonal variability.

These results support the conclusion that the project alternatives do not create adverse impacts to delta smelt, longfin smelt and green sturgeon relative to without project conditions.

TABLE C7-11:
LONG-TERM, SEASONAL AVERAGE PERCENT OF PARTICLES POTENTIALLY ENTRAINED 120 DAYS AFTER PARTICLES ARE RELEASED AT DESIGNATED LOCATIONS 2005 LEVEL OF DEVELOPMENT

	Existing Conditions			Change from Existing Conditions								
				Alt 1			Alt 2			Alt 4		
Release Location	W	S	F	W	S	F	W	S	F	W	S	F
Sacramento River at Freeport	22	22	45	-1	-1	-1	-1	-1	0	0	0	0
Sacramento River above Delta Cross Channel	28	22	53	-1	-1	-1	-1	-1	-1	0	0	0
Cache Slough at Sac Ship Channel	18	65	34	0	0	0	0	0	0	0	0	0
Sacramento River at Rio Vista	12	10	25	0	0	0	0	0	0	0	0	0
Sacramento River at Emmaton	6	5	14	0	0	0	0	0	0	0	0	0
Sacramento River at Collinsville	2	2	6	0	0	0	0	0	0	0	0	0
San Joaquin River at Jersey Island	17	10	27	0	0	0	0	0	0	0	0	0
San Joaquin River at mouth of Old River	48	29	68	-1	-1	-1	-1	-1	-1	0	-1	0
Old River at Holland Tract	75	49	93	-3	-3	-2	-3	-2	-2	-1	-2	-1
Middle River at Empire Cut	89	72	98	-3	-2	-3	-3	-2	-3	0	0	0
San Joaquin River west of Rough and Ready Island	72	58	92	-2	-1	-2	-2	-1	-2	0	0	0
San Joaquin River at Mossdale	85	74	95	-1	-1	-2	-1	-1	-1	0	0	0
Suisun Bay at Port Chicago	0	0	1	0	0	0	0	0	0	0	0	0
Montezuma Slough	0	0	1	0	0	0	0	0	0	0	0	0

1 Seasonal averages:
W is Winter (December through February), S is Spring (March through June), and F is Fall (September through November)
2 Output from the particle tracking model has been adjusted to account for fish screens at the Rock Slough, Old River and AIP intakes for the Future Without Project and for each alternative and the new Delta Intake for the Future Without Project and Alternatives 1 and 2, assuming the larvae are 5mm in length and do not grow after hatch.

TABLE C7-12:
LONG-TERM, SEASONAL AVERAGE PERCENT OF PARTICLES POTENTIALLY ENTRAINED 120 DAYS AFTER PARTICLES ARE RELEASED AT DESIGNATED LOCATIONS 2030 LEVEL OF DEVELOPMENT

	Future Without Project			Change from Future Without Project								
				Alt 1			Alt 2			Alt 4		
Release Location	W	S	F	W	S	F	W	S	F	W	S	F
Sacramento River at Freeport	21	22	44	0	0	0	0	0	0	0	0	0
Sacramento River above Delta Cross Channel	27	21	52	0	0	0	0	0	0	0	0	0
Cache Slough at Sac Ship Channel	18	64	33	0	0	0	0	0	0	0	0	0
Sacramento River at Rio Vista	12	10	25	-1	-2	-1	0	0	0	0	0	0
Sacramento River at Emmaton	6	5	14	0	0	0	0	0	0	0	0	0
Sacramento River at Collinsville	2	2	5	0	0	0	0	0	0	0	0	0
San Joaquin River at Jersey Island	16	10	28	0	0	0	0	0	0	0	0	0
San Joaquin River at mouth of Old River	47	28	67	0	0	0	0	0	0	0	0	0
Old River at Holland Tract	73	47	92	0	0	0	0	0	0	0	1	0
Middle River at Empire Cut	88	71	100	0	-1	0	0	-1	0	0	1	0
San Joaquin River west of Rough and Ready Island	72	57	92	-1	-1	0	0	-1	0	-1	0	0
San Joaquin River at Mossdale	84	73	95	0	0	0	0	0	0	0	1	0
Suisun Bay at Port Chicago	0	0	1	0	0	0	0	0	0	0	0	0
Montezuma Slough	0	0	0	0	0	0	0	0	0	0	0	0

1 Seasonal averages:
W is Winter (December through February), S is Spring (March through June), and F is Fall (September through November)
2 Output from the particle tracking model has been adjusted to account for fish screens at the Rock Slough, Old River and AIP intakes for the Future Without Project and for each alternative and the new Delta Intake for the Future Without Project and Alternatives 1 and 2, assuming the larvae are 5mm in length and do not grow after hatch.

Potential Entrainment Index

The results of the PEI analysis are shown below in **Table C7-13.** The results are considered in light of the strengths and limitations of the PEI method, described on page C7-20. In comparing the Alternatives to the Existing Condition, there are net benefits indicated for delta smelt and striped bass, while there are no impacts to longfin smelt. Under the 2030 Level of Development, there are benefits indicated to striped bass for Alternatives 1 and 2 and no impacts to delta smelt or longfin smelt. Some of the demonstrated benefits are related to the relocation of some South Bay water agencies' Delta diversions to the expanded Los Vaqueros system, which provides improved fish screening relative to the Banks Pumping Plant and Jones Pumping Plant facilities. In general, delta smelt and striped bass show more changes because their proportional representation in the Central and South Delta tends to be higher than longfin smelt in the March-June timeframe (see Figure C7-6, Figure C7-7, and Figure C7-8).

The results of the PEI indicate that the hydrodynamic changes induced by the alternatives do not produce impacts and in some cases provide benefits when timing and distribution of the fish are taken into account.

TABLE C7-13:
CHANGES IN POTENTIAL ENTRAINMENT INDEX DURING THE SPRING FOR COMBINED DELTA WATER SUPPLY DIVERSIONS (BANKS AND JONES PUMPING PLANTS AND CCWD INTAKES)

2005 Level of Development				
		Change in PEI from Existing Condition		
Species	**Existing Condition**	**Alt 1**	**Alt 2**	**Alt 4**
Delta Smelt	2.3%	-0.3%	-0.3%	-0.3%
Longfin Smelt	0.3%	0.0%	0.0%	0.0%
Striped Bass	5.3%	-0.4%	-0.4%	-0.5%
2030 Level of Development				
		Change in PEI from Future Without Project		
Species	**Future Without Project**	**Alt 1**	**Alt 2**	**Alt 4**
Delta Smelt	1.9%	0.0%	0.0%	0.0%
Longfin Smelt	0.3%	0.0%	0.0%	0.0%
Striped Bass	5.0%	-0.1%	-0.1%	0.0%

The results are shown further broken down by intake (CCWD Intakes, Banks Pumping Plant, and Jones Pumping Plant) in **Table C7-14**.

TABLE C7-14:
CHANGES IN POTENTIAL ENTRAINMENT INDEX DURING THE SPRING CATEGORIZED BY WATER SUPPLY DIVERSION LOCATION

CCWD intakes				
2005 Level of Development				
Species	**Existing Condition**	**Change in PEI from Existing Condition**		
		Alt 1	**Alt 2**	**Alt 4**
Delta Smelt	0.3%	-0.2%	-0.2%	-0.2%
Longfin Smelt	0.0%	0.0%	0.0%	0.0%
Striped Bass	0.4%	-0.3%	-0.3%	-0.3%
2030 Level of Development				
Species	**Future Without Project**	**Change in PEI from Future Without Project**		
		Alt 1	**Alt 2**	**Alt 4**
Delta Smelt	0.1%	0.0%	0.0%	0.0%
Longfin Smelt	0.0%	0.0%	0.0%	0.0%
Striped Bass	0.2%	0.0%	0.0%	0.0%
Banks Pumping Plant				
2005 Level of Development				
Species	**Existing Condition**	**Change in PEI from Existing Condition**		
		Alt 1	**Alt 2**	**Alt 4**
Delta Smelt	1.2%	-0.1%	-0.1%	0.0%
Longfin Smelt	0.2%	0.0%	0.0%	0.0%
Striped Bass	2.7%	-0.2%	-0.2%	-0.1%
2030 Level of Development				
Species	**Future Without Project**	**Change in PEI from Future Without Project**		
		Alt 1	**Alt 2**	**Alt 4**
Delta Smelt	1.1%	-0.1%	-0.1%	0.0%
Longfin Smelt	0.2%	0.0%	0.0%	0.0%
Striped Bass	2.7%	-0.2%	-0.2%	0.0%
Jones Pumping Plant				
2005 Level of Development				
Species	**Existing Condition**	**Change in PEI from Existing Condition**		
		Alt 1	**Alt 2**	**Alt 4**
Delta Smelt	0.8%	0.0%	0.0%	0.0%
Longfin Smelt	0.1%	0.0%	0.0%	0.0%
Striped Bass	2.2%	0.0%	0.0%	0.0%
2030 Level of Development				
Species	**Future Without Project**	**Change in PEI from Future Without Project**		
		Alt 1	**Alt 2**	**Alt 4**
Delta Smelt	0.7%	0.0%	0.0%	0.0%
Longfin Smelt	0.1%	0.0%	0.0%	0.0%
Striped Bass	2.1%	0.0%	0.0%	0.0%

CCWD Intakes. In the 2005 Level of Development, there are fisheries benefits to delta smelt and striped bass, and no impacts on longfin smelt. In the 2030 Level of Development, there are no impacts to any species.

Banks Pumping Plant. Under both 2005 and 2030 level of development, Alternatives 1 and 2 indicate benefits for both delta smelt and striped bass and no impacts to longfin smelt. Some of these benefits are related to the relocation of some South Bay water agencies' Delta diversions to the expanded Los Vaqueros system, which provides improved fish screening relative to the SWP and CVP facilities. There are no impacts to longfin smelt.

Jones Pumping Plant. There are no significant changes to the PEI at Jones Pumping Plant.

Potential Effects of Project Alternatives on Fishery Habitat within the Delta due to Changes in Hydrology

The proposed project and alternatives would alter the location and timing of water diversions from the Delta. The following analysis addresses the potential for these changes to adversely or beneficially affect Delta fish populations or the quality and quantity of aquatic habitat within the Bay-Delta estuary. Potential effects of proposed project Alternatives on fishery habitat within upstream tributaries and the mainstem Sacramento River are not addressed in this analysis.

Methodology

Effects on fish populations were analyzed using a number of different parameters that have been shown to be, or are thought to be, significant factors that affect habitat conditions and the reproduction of various fish and macroinvertebrate species inhabiting the Bay-Delta estuary. These habitat parameters are grouped into the following three categories:

- those that indicate flows upstream of the Delta, including
    - total Delta inflow (**Table C7-17** and **Table C7-18**),
    - Sacramento River flow at Freeport (**Table C7-19** and **Table C7-20**), and
    - San Joaquin River flow at Vernalis (**Table C7-21** and **Table C7-22**);
- those that are currently regulated by SWRCB D-1641 for fish and wildlife beneficial use, including
    - net Delta outflow (**Table C7-23** and **Table C7-24**),
    - the location of X2 (**Table C7-25** and **Table C7-26**), and
    - the Export-to-Inflow Ratio (**Table C7-27** and **Table C7-28**); and
- those that indicate hydrodynamics within the Delta, including
    - particle tracking analysis (see “Particle Tracking Analysis” section above),
    - net flow on the lower San Joaquin River (Qwest) (**Table C7-29** and **Table C7-30**), and
    - net flow in Old and Middle rivers (see “Old and Middle River Flow Evaluation” section below).

The biological relevance for each of these parameters is discussed in Section 4.3, with a discussion of the potential significance of any changes due to the operation of the project alternatives.

The assessment relies on a comparative analysis of operational and resulting environmental conditions within the estuary between without project conditions and each of the project alternatives. The changes in these parameters for each alternative are obtained from the hydrologic modeling results, which describe water diversion operations over a range of environmental and hydrologic conditions (see Appendix C-3). Hydrologic modeling results provide the technical foundation for assessing adverse effects of project diversions and CVP and SWP export operations on fish species and their habitat within the Bay-Delta estuary.

Changes to each of the parameters are evaluated on a monthly basis, for each month of the modeling simulation for both the 2005 level of development and the 2030 level of development. For the purpose of evaluating the potential effect of each project alternative, the incremental changes for each alternative are averaged by water year type, resulting in a long-term monthly average for each water year type (e.g. long-term average incremental change in January of wet water years).

Results

Each parameter is averaged by month, for each water year type, in the following sections.

Total Pumping at SWP Banks Pumping Plant and CVP Jones Pumping Plant

TABLE C7-15: TOTAL COMBINED PUMPING (CFS) AT BANKS AND JONES UNDER 2005 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Existing Condition		6,353	6,604	8,529	6,776	7,274	6,688	1,991	2,175	4,813	10,117	9,349	9,034
	Change from Existing Condition	Alt 1	-3.3%	-2.9%	-3.1%	-2.8%	-2.9%	-1.1%	-7.6%	-7.8%	-2.4%	-2.5%	-2.5%	-2.9%
		Alt 2	-3.2%	-2.6%	-3.0%	-2.6%	-2.8%	-0.6%	-7.5%	-7.7%	-2.0%	-2.9%	-2.5%	-2.8%
		Alt 4	0.2%	0.2%	-0.2%	0.8%	0.6%	0.2%	0.0%	0.0%	3.3%	-0.2%	-0.4%	-0.2%
Wet	Existing Condition		6,965	7,610	8,354	7,904	9,646	9,469	2,961	3,536	7,515	11,162	11,072	10,604
	Percent Change from Existing Condition	Alt 1	-4.0%	-2.8%	-3.2%	-3.1%	-2.5%	-1.7%	-7.5%	-6.5%	-3.5%	-3.0%	-3.1%	-3.4%
		Alt 2	-3.8%	-2.3%	-2.9%	-2.7%	-2.3%	-1.0%	-7.2%	-6.2%	-2.8%	-3.0%	-3.1%	-3.3%
		Alt 4	-0.4%	0.8%	0.2%	0.6%	0.8%	0.1%	0.0%	0.0%	1.4%	0.0%	0.2%	0.3%
Above Normal	Existing Condition		6,314	6,079	8,868	6,565	7,557	8,055	1,763	1,670	5,832	10,249	11,036	10,812
	Percent Change from Existing Condition	Alt 1	-3.5%	-2.2%	-1.9%	-3.2%	-2.6%	-0.3%	-9.7%	-12.0%	-2.1%	-3.5%	-2.8%	-3.8%
		Alt 2	-2.8%	-2.1%	-1.8%	-3.3%	-2.5%	-0.1%	-9.7%	-12.0%	-2.0%	-3.5%	-2.8%	-3.8%
		Alt 4	-0.6%	0.2%	0.3%	0.3%	0.7%	0.5%	0.0%	0.0%	3.8%	0.0%	0.1%	-0.6%
Below Normal	Existing Condition		6,433	7,045	9,494	6,337	6,724	6,845	1,608	1,618	4,123	10,966	9,610	9,548
	Percent Change from Existing Condition	Alt 1	-2.0%	-3.1%	-5.0%	-3.3%	-3.6%	-0.6%	-9.8%	-11.1%	-2.1%	-2.9%	-0.5%	-0.4%
		Alt 2	-2.0%	-2.7%	-4.9%	-3.3%	-3.5%	-0.3%	-9.8%	-11.1%	-2.2%	-2.9%	-0.5%	-0.4%
		Alt 4	0.8%	0.4%	-0.6%	0.5%	0.2%	-0.1%	0.0%	0.0%	5.6%	-0.1%	-0.2%	0.8%
Dry	Existing Condition		5,835	6,092	8,989	6,388	5,832	4,121	1,457	1,497	2,897	10,543	9,243	7,934
	Percent Change from Existing Condition	Alt 1	-4.0%	-3.3%	-2.7%	-1.7%	-3.3%	-1.6%	-6.9%	-8.4%	0.1%	-1.3%	-2.3%	-3.6%
		Alt 2	-3.9%	-3.1%	-2.6%	-1.7%	-3.2%	-0.6%	-7.3%	-8.4%	0.2%	-1.2%	-2.4%	-3.5%
		Alt 4	0.4%	-0.4%	-0.3%	0.8%	0.7%	0.6%	-0.1%	0.1%	6.4%	-0.5%	-0.6%	-1.7%
Critical	Existing Condition		5,751	5,202	6,753	5,638	4,658	2,965	1,367	1,401	1,616	6,090	3,783	4,901
	Percent Change from Existing Condition	Alt 1	-2.5%	-3.3%	-2.4%	-2.5%	-3.6%	0.4%	-3.0%	-4.6%	-0.5%	-1.1%	-4.8%	-2.3%
		Alt 2	-2.5%	-3.2%	-2.4%	-2.0%	-3.6%	0.4%	-3.0%	-4.6%	-0.5%	-5.4%	-3.4%	-2.4%
		Alt 4	1.2%	-0.4%	-1.0%	2.3%	0.2%	0.4%	0.0%	-0.4%	5.1%	-0.3%	-4.6%	-0.1%

TABLE C7-16: TOTAL COMBINED PUMPING (CFS) AT BANKS AND JONES UNDER 2030 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Future Without Project		6,155	6,672	8,494	6,828	7,187	6,915	2,182	2,185	4,928	10,009	9,341	8,979
	Change from Future Without Project	Alt 1	-3.4%	-2.2%	-2.6%	-2.4%	-2.6%	-1.3%	-9.6%	-9.2%	-3.3%	-2.5%	-2.2%	-2.6%
		Alt 2	-3.3%	-1.9%	-3.0%	-2.3%	-2.6%	-0.7%	-9.5%	-9.0%	-2.9%	-2.5%	-2.2%	-2.5%
		Alt 4	0.1%	-0.1%	0.6%	0.2%	0.1%	-0.1%	0.1%	0.0%	2.8%	-0.2%	-0.4%	-0.2%
Wet	Future Without Project		6,873	7,770	8,162	8,050	9,549	9,754	3,369	3,541	7,669	11,161	11,148	10,684
	Percent Change from Future Without Project	Alt 1	-4.1%	-2.1%	-3.7%	-3.0%	-2.9%	-1.8%	-9.1%	-7.3%	-3.3%	-2.9%	-2.8%	-3.5%
		Alt 2	-3.9%	-1.7%	-3.4%	-2.9%	-2.8%	-1.3%	-8.8%	-6.9%	-2.6%	-2.8%	-2.8%	-3.3%
		Alt 4	0.1%	-0.3%	-0.3%	0.1%	0.4%	-0.2%	0.0%	0.0%	1.4%	0.0%	0.0%	-0.2%
Above Normal	Future Without Project		6,027	6,334	8,860	6,592	7,228	8,275	1,905	1,713	6,050	10,176	11,242	10,872
	Percent Change from Future Without Project	Alt 1	-4.3%	-0.9%	-2.2%	-2.3%	-2.6%	-0.7%	-13.7%	-14.3%	-3.2%	-3.4%	-2.3%	-2.9%
		Alt 2	-4.3%	0.3%	-2.2%	-2.3%	-2.5%	-0.4%	-13.7%	-14.3%	-3.1%	-3.5%	-2.3%	-2.6%
		Alt 4	-1.7%	1.2%	0.2%	-0.1%	0.1%	0.2%	0.0%	0.0%	2.7%	0.0%	-0.1%	-0.1%
Below Normal	Future Without Project		6,156	7,259	9,531	6,388	6,679	6,999	1,777	1,614	4,195	10,978	9,865	9,505
	Percent Change from Future Without Project	Alt 1	-1.5%	-3.4%	-1.7%	-2.5%	-2.4%	-1.1%	-12.5%	-13.5%	-3.7%	-2.4%	-0.9%	-0.7%
		Alt 2	-1.4%	-3.2%	-4.2%	-2.5%	-2.4%	-0.1%	-12.4%	-13.5%	-3.8%	-2.4%	-0.9%	-0.7%
		Alt 4	1.0%	0.5%	0.7%	0.1%	0.1%	-0.5%	-0.1%	0.0%	3.8%	0.0%	-0.5%	0.3%
Dry	Future Without Project		5,543	6,042	8,528	6,511	5,851	4,382	1,510	1,500	2,982	10,085	8,976	7,683
	Percent Change from Future Without Project	Alt 1	-4.1%	-2.1%	-2.2%	-2.0%	-2.5%	-1.0%	-8.9%	-10.4%	-3.3%	-1.7%	-2.5%	-3.0%
		Alt 2	-4.1%	-2.1%	-2.2%	-2.0%	-2.6%	-0.5%	-9.0%	-10.4%	-3.2%	-1.7%	-2.5%	-3.1%
		Alt 4	0.1%	-1.3%	2.8%	0.0%	-0.3%	0.2%	0.6%	0.0%	7.3%	-0.8%	-1.3%	-1.1%
Critical	Future Without Project		5,645	4,894	7,587	5,408	4,624	3,110	1,368	1,411	1,646	6,102	3,461	4,723
	Percent Change from Future Without Project	Alt 1	-1.8%	-2.5%	-2.7%	-0.6%	-1.9%	0.2%	-3.4%	-5.5%	-2.2%	-1.6%	-1.2%	-1.3%
		Alt 2	-1.7%	-2.5%	-2.6%	-0.7%	-1.9%	0.2%	-3.4%	-5.5%	-2.2%	-1.7%	-1.1%	-1.3%
		Alt 4	0.7%	0.6%	-1.0%	1.4%	-0.2%	0.2%	-0.1%	0.0%	3.0%	0.1%	-0.2%	0.4%

Delta Inflow

TABLE C7-17: DELTA INFLOW (CFS) UNDER 2005 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Existing Condition		14,747	18,597	32,636	47,195	58,182	49,100	33,193	27,131	21,719	22,461	18,111	19,072
	Change from Existing Condition	Alt 1	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.3%	0.0%	-0.1%	-0.1%
		Alt 2	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.3%	-0.1%	-0.1%	-0.1%
		Alt 4	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.2%	0.0%	-0.1%	0.0%
Wet	Existing Condition		17,155	25,171	55,833	88,215	103,510	87,014	57,740	46,830	34,584	26,779	22,665	28,691
	Percent Change from Existing Condition	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.1%	-0.1%	0.1%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.1%	0.0%	0.1%	0.1%
		Alt 4	-0.1%	0.3%	0.0%	-0.1%	0.0%	0.0%	-0.1%	0.1%	0.1%	0.0%	0.2%	0.2%
Above Normal	Existing Condition		13,930	19,121	29,540	52,291	65,625	59,382	34,774	28,576	21,822	24,492	20,857	22,022
	Percent Change from Existing Condition	Alt 1	-0.1%	0.1%	0.2%	0.0%	0.0%	0.0%	-0.2%	0.0%	0.3%	0.0%	0.1%	-0.2%
		Alt 2	0.2%	0.2%	0.2%	0.0%	0.0%	0.0%	-0.2%	0.1%	0.3%	0.0%	0.1%	-0.2%
		Alt 4	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	-0.2%	0.0%	0.3%	0.1%	0.3%	-0.1%
Below Normal	Existing Condition		14,514	16,105	23,637	27,687	42,147	30,123	24,656	20,517	16,778	22,673	16,677	14,782
	Percent Change from Existing Condition	Alt 1	0.2%	-0.8%	-0.5%	0.0%	-0.1%	0.1%	0.0%	0.0%	0.2%	0.1%	0.1%	0.7%
		Alt 2	0.2%	-0.8%	-0.5%	0.0%	-0.1%	0.1%	0.0%	-0.1%	0.2%	0.1%	0.1%	0.7%
		Alt 4	0.0%	-0.5%	-0.4%	0.0%	0.0%	0.1%	0.0%	0.0%	0.2%	0.1%	0.0%	0.9%
Dry	Existing Condition		13,536	15,121	20,640	20,318	27,073	24,482	17,102	14,403	14,071	20,082	15,843	12,836
	Percent Change from Existing Condition	Alt 1	0.0%	-0.2%	0.3%	0.0%	0.0%	0.1%	0.0%	0.1%	0.9%	0.0%	-0.5%	-0.9%
		Alt 2	0.0%	-0.3%	0.3%	0.0%	0.0%	0.1%	0.0%	0.1%	0.9%	0.0%	-0.5%	-0.9%
		Alt 4	0.2%	-0.5%	0.4%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	-0.2%	-0.3%	-1.1%
Critical	Existing Condition		12,434	11,950	13,967	16,294	17,898	15,739	12,522	9,810	10,981	14,399	10,572	9,641
	Percent Change from Existing Condition	Alt 1	-0.2%	-0.1%	-0.1%	0.5%	0.0%	-0.1%	0.0%	0.0%	0.3%	0.2%	-0.8%	-0.2%
		Alt 2	-0.2%	0.0%	-0.1%	0.5%	0.0%	-0.1%	0.1%	0.0%	0.3%	-1.6%	-0.7%	-0.2%
		Alt 4	-0.1%	-0.2%	0.0%	0.0%	-0.1%	-0.1%	0.1%	-0.1%	0.3%	-0.1%	-1.3%	-0.3%

TABLE C7-18: DELTA INFLOW (CFS) UNDER 2030 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Future Without Project		14,650	18,851	32,765	47,421	58,078	49,685	34,427	27,073	21,825	22,365	18,160	19,014
	Change from Future Without Project	Alt 1	0.1%	0.0%	-0.1%	0.0%	0.1%	0.1%	-0.1%	0.1%	0.1%	-0.1%	-0.2%	-0.1%
		Alt 2	0.2%	0.0%	-0.1%	0.0%	0.1%	0.1%	-0.1%	0.0%	0.1%	-0.1%	-0.2%	-0.1%
		Alt 4	0.1%	0.0%	-0.1%	0.0%	0.1%	0.0%	-0.1%	0.0%	0.1%	0.0%	-0.2%	0.0%
Wet	Future Without Project		17,084	25,599	55,620	88,249	103,121	87,645	59,304	46,652	34,614	26,909	22,756	28,747
	Percent Change from Future Without Project	Alt 1	0.2%	-0.2%	-0.1%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.1%	-0.1%	0.1%	0.0%
		Alt 2	0.2%	-0.2%	-0.1%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.1%	-0.1%	0.1%	0.0%
		Alt 4	0.2%	-0.2%	-0.1%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.1%	0.0%	0.1%	0.0%
Above Normal	Future Without Project		13,974	19,408	29,566	52,091	65,946	59,905	36,006	28,931	22,113	24,511	21,167	22,167
	Percent Change from Future Without Project	Alt 1	-0.5%	0.2%	-0.1%	0.0%	0.0%	0.3%	-0.2%	0.1%	0.0%	0.0%	0.1%	-0.1%
		Alt 2	-0.5%	0.5%	-0.1%	0.0%	0.0%	0.3%	-0.2%	-0.1%	-0.1%	0.0%	0.1%	0.0%
		Alt 4	-0.5%	0.2%	-0.2%	0.0%	0.0%	0.1%	-0.1%	0.1%	0.0%	0.1%	0.2%	0.1%
Below Normal	Future Without Project		14,279	16,523	24,002	28,046	41,872	30,793	26,136	20,245	16,823	22,642	16,915	14,660
	Percent Change from Future Without Project	Alt 1	0.6%	-0.3%	0.0%	0.0%	-0.1%	-0.1%	-0.2%	0.2%	0.0%	0.1%	-0.2%	0.3%
		Alt 2	0.6%	-0.3%	0.0%	0.0%	-0.1%	-0.1%	-0.2%	0.2%	0.1%	0.1%	-0.2%	0.3%
		Alt 4	0.6%	0.3%	0.1%	0.0%	-0.4%	-0.1%	-0.2%	0.2%	0.0%	0.2%	-0.3%	0.4%
Dry	Future Without Project		13,424	15,100	20,809	20,620	27,169	25,090	18,382	14,396	14,163	19,441	15,662	12,659
	Percent Change from Future Without Project	Alt 1	0.0%	0.1%	-0.1%	0.0%	1.2%	0.1%	0.0%	0.0%	0.5%	-0.2%	-1.1%	-0.7%
		Alt 2	0.0%	0.1%	-0.1%	0.0%	1.2%	0.1%	0.0%	0.0%	0.5%	-0.2%	-1.2%	-0.7%
		Alt 4	0.0%	-0.1%	-0.1%	0.0%	1.2%	0.1%	0.0%	0.0%	0.5%	-0.3%	-1.1%	-0.4%
Critical	Future Without Project		12,327	12,017	14,605	17,094	17,890	16,151	12,686	9,773	11,157	14,437	10,398	9,388
	Percent Change from Future Without Project	Alt 1	0.3%	0.5%	-0.4%	-0.5%	0.1%	0.0%	0.0%	0.0%	-0.2%	-0.3%	-0.1%	0.1%
		Alt 2	0.3%	0.4%	-0.4%	-0.5%	0.1%	0.0%	0.0%	0.0%	-0.2%	-0.3%	-0.1%	0.1%
		Alt 4	0.2%	0.5%	-0.6%	-0.8%	0.0%	-0.1%	0.0%	0.0%	-0.2%	0.1%	-0.3%	0.3%

Sacramento River Inflow

TABLE C7-19: SACRAMENTO RIVER INFLOW (CFS) UNDER 2005 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Existing Condition		11,691	15,199	26,085	32,870	38,988	33,566	23,345	19,211	16,465	19,131	15,813	16,487
	Change from Existing Condition	Alt 1	0.0%	-0.2%	-0.1%	0.1%	0.0%	0.0%	-0.1%	0.0%	0.4%	0.0%	-0.1%	-0.1%
		Alt 2	0.0%	-0.2%	-0.1%	0.1%	0.0%	0.0%	-0.1%	0.1%	0.3%	-0.2%	-0.1%	-0.1%
		Alt 4	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.1%	0.3%	0.0%	-0.1%	0.0%
Wet	Existing Condition		13,535	20,480	43,095	53,807	60,864	51,713	38,959	32,398	23,859	19,754	18,867	24,810
	Percent Change from Existing Condition	Alt 1	0.0%	0.0%	-0.2%	0.1%	0.0%	0.0%	-0.1%	0.1%	0.1%	-0.1%	0.1%	0.1%
		Alt 2	0.0%	0.0%	-0.2%	0.1%	0.0%	0.0%	-0.1%	0.1%	0.1%	0.0%	0.1%	0.1%
		Alt 4	-0.1%	0.3%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.1%	0.2%	0.0%	0.2%	0.2%
Above Normal	Existing Condition		11,307	15,997	23,802	41,576	48,064	46,277	25,836	21,213	16,063	21,577	18,630	19,474
	Percent Change from Existing Condition	Alt 1	-0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	-0.2%	0.0%	0.5%	0.0%	0.2%	-0.3%
		Alt 2	0.3%	0.2%	0.1%	0.0%	0.0%	0.1%	-0.2%	0.1%	0.4%	0.0%	0.2%	-0.3%
		Alt 4	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	-0.2%	0.0%	0.5%	0.1%	0.3%	-0.1%
Below Normal	Existing Condition		11,581	13,132	19,332	22,778	32,592	23,327	17,310	14,164	13,826	20,862	14,679	12,494
	Percent Change from Existing Condition	Alt 1	0.3%	-1.0%	-0.6%	0.0%	-0.1%	0.1%	0.0%	-0.1%	0.2%	0.1%	0.2%	0.8%
		Alt 2	0.3%	-1.0%	-0.6%	0.0%	-0.1%	0.1%	0.0%	-0.1%	0.2%	0.1%	0.2%	0.8%
		Alt 4	0.0%	-0.6%	-0.5%	0.0%	0.0%	0.1%	0.0%	0.0%	0.3%	0.1%	0.0%	1.1%
Dry	Existing Condition		10,493	12,290	17,756	17,246	22,380	20,473	12,599	10,507	12,441	18,901	14,540	11,038
	Percent Change from Existing Condition	Alt 1	-0.1%	-0.3%	0.3%	0.0%	0.0%	0.1%	0.0%	0.1%	1.0%	0.0%	-0.5%	-1.0%
		Alt 2	0.0%	-0.3%	0.3%	0.0%	0.1%	0.1%	0.0%	0.1%	1.0%	0.0%	-0.6%	-1.0%
		Alt 4	0.3%	-0.7%	0.5%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	-0.2%	-0.4%	-1.2%
Critical	Existing Condition		10,002	9,737	11,888	14,009	14,887	13,124	10,182	7,585	9,965	13,662	9,615	8,297
	Percent Change from Existing Condition	Alt 1	-0.2%	-0.1%	-0.1%	0.5%	0.0%	-0.1%	0.0%	0.0%	0.4%	0.3%	-0.9%	-0.3%
		Alt 2	-0.2%	0.0%	-0.1%	0.5%	0.0%	-0.1%	0.1%	0.0%	0.4%	-1.7%	-0.8%	-0.3%
		Alt 4	-0.1%	-0.3%	0.0%	0.0%	-0.1%	-0.2%	0.1%	-0.2%	0.3%	-0.1%	-1.5%	-0.3%

TABLE C7-20: SACRAMENTO RIVER INFLOW (CFS) UNDER 2030 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Future Without Project		11,526	15,255	26,165	33,094	39,068	33,694	23,423	19,057	16,454	19,018	15,845	16,386
	Change from Future Without Project	Alt 1	0.2%	0.0%	-0.1%	0.0%	0.2%	0.1%	-0.1%	0.1%	0.2%	-0.1%	-0.3%	-0.1%
		Alt 2	0.2%	0.0%	-0.1%	0.0%	0.2%	0.1%	-0.1%	0.0%	0.2%	-0.1%	-0.2%	-0.1%
		Alt 4	0.2%	0.0%	-0.1%	0.0%	0.1%	0.1%	-0.1%	0.1%	0.2%	0.0%	-0.2%	0.1%
Wet	Future Without Project		13,422	20,688	42,896	54,024	60,889	51,882	39,128	32,139	23,615	19,702	18,842	24,779
	Percent Change from Future Without Project	Alt 1	0.2%	-0.2%	-0.1%	0.1%	0.0%	0.1%	-0.1%	0.0%	0.2%	-0.1%	0.1%	0.0%
		Alt 2	0.2%	-0.2%	-0.1%	0.1%	0.0%	0.1%	-0.1%	0.0%	0.2%	-0.1%	0.1%	0.0%
		Alt 4	0.3%	-0.2%	-0.1%	0.1%	0.0%	0.1%	-0.1%	0.0%	0.2%	0.0%	0.1%	0.0%
Above Normal	Future Without Project		11,271	16,089	23,952	41,416	48,278	46,146	25,901	21,237	15,991	21,637	18,950	19,593
	Percent Change from Future Without Project	Alt 1	-0.6%	0.2%	0.1%	0.0%	0.0%	0.3%	-0.2%	0.1%	0.0%	0.0%	0.1%	-0.2%
		Alt 2	-0.6%	0.6%	0.1%	0.0%	0.0%	0.3%	-0.2%	-0.1%	-0.1%	0.0%	0.1%	0.0%
		Alt 4	-0.6%	0.2%	0.1%	0.0%	0.0%	0.2%	-0.2%	0.2%	0.0%	0.1%	0.2%	0.1%
Below Normal	Future Without Project		11,273	13,347	19,538	22,995	32,536	23,512	17,280	13,879	13,853	20,853	14,932	12,334
	Percent Change from Future Without Project	Alt 1	0.8%	-0.3%	0.0%	0.0%	-0.2%	-0.2%	-0.3%	0.3%	0.0%	0.1%	-0.3%	0.4%
		Alt 2	0.8%	-0.3%	0.0%	0.0%	-0.2%	-0.2%	-0.3%	0.3%	0.1%	0.1%	-0.3%	0.4%
		Alt 4	0.8%	0.4%	0.1%	0.0%	-0.5%	-0.2%	-0.3%	0.3%	0.0%	0.2%	-0.3%	0.5%
Dry	Future Without Project		10,294	12,084	17,793	17,438	22,505	20,636	12,782	10,440	12,591	18,374	14,409	10,857
	Percent Change from Future Without Project	Alt 1	0.1%	0.1%	-0.1%	0.0%	1.4%	0.2%	0.0%	0.0%	0.5%	-0.2%	-1.3%	-0.8%
		Alt 2	0.0%	0.1%	-0.1%	0.0%	1.4%	0.2%	0.0%	0.0%	0.5%	-0.2%	-1.3%	-0.9%
		Alt 4	0.0%	-0.1%	-0.1%	0.0%	1.4%	0.2%	0.1%	0.0%	0.5%	-0.3%	-1.1%	-0.4%
Critical	Future Without Project		9,816	9,632	12,415	14,687	15,045	13,303	10,044	7,498	10,233	13,738	9,466	8,016
	Percent Change from Future Without Project	Alt 1	0.4%	0.6%	-0.5%	-0.6%	0.1%	0.0%	0.0%	0.1%	-0.2%	-0.3%	-0.1%	0.1%
		Alt 2	0.4%	0.5%	-0.4%	-0.6%	0.2%	0.0%	0.0%	0.1%	-0.2%	-0.3%	-0.1%	0.1%
		Alt 4	0.2%	0.7%	-0.7%	-0.9%	0.1%	-0.1%	0.0%	0.0%	-0.2%	0.1%	-0.3%	0.4%

San Joaquin River Flow at Vernalis

TABLE C7-21: SAN JOAQUIN RIVER FLOW AT VERNALIS (CFS) UNDER 2005 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Existing Condition		2,815	2,484	3,246	4,704	6,285	6,547	6,399	6,418	4,601	3,194	2,052	2,299
	Change from Existing Condition	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wet	Existing Condition		3,221	3,211	5,124	9,130	11,173	12,729	10,983	11,343	9,160	6,467	3,130	3,230
	Percent Change from Existing Condition	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Above Normal	Existing Condition		2,478	2,039	2,953	4,246	6,021	6,022	6,240	5,836	5,060	2,813	2,018	2,297
	Percent Change from Existing Condition	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Below Normal	Existing Condition		2,779	2,254	2,743	2,915	5,709	4,789	5,479	5,320	2,522	1,781	1,836	2,083
	Percent Change from Existing Condition	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dry	Existing Condition		2,822	2,247	2,109	2,071	2,585	2,462	3,541	3,443	1,646	1,330	1,365	1,770
	Percent Change from Existing Condition	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Critical	Existing Condition		2,302	1,979	1,759	1,610	2,181	1,858	1,989	2,074	1,123	929	1,032	1,330
	Percent Change from Existing Condition	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

TABLE C7-22: SAN JOAQUIN RIVER FLOW AT VERNALIS (CFS) UNDER 2030 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Future Without Project		2,899	2,675	3,280	4,701	6,094	6,968	7,529	6,514	4,716	3,209	2,072	2,342
	Change from Future Without Project	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wet	Future Without Project		3,321	3,405	5,148	8,958	10,810	13,146	12,342	11,428	9,434	6,646	3,251	3,318
	Percent Change from Future Without Project	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Above Normal	Future Without Project		2,555	2,237	2,773	4,247	6,052	6,597	7,407	6,165	5,419	2,769	2,009	2,323
	Percent Change from Future Without Project	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Below Normal	Future Without Project		2,846	2,453	2,862	3,017	5,457	5,258	6,910	5,329	2,536	1,756	1,823	2,120
	Percent Change from Future Without Project	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dry	Future Without Project		2,906	2,431	2,199	2,161	2,536	2,885	4,635	3,500	1,584	1,214	1,313	1,773
	Percent Change from Future Without Project	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Critical	Future Without Project		2,377	2,153	1,849	1,705	1,997	2,077	2,288	2,117	1,028	887	1,006	1,358
	Percent Change from Future Without Project	Alt 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Alt 4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Delta Outflow

TABLE C7-23: DELTA OUTFLOW (CFS) UNDER 2005 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

Year Type			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Existing Condition		7,102	11,178	23,773	41,723	51,806	42,136	29,869	22,576	12,616	7,850	5,810	8,224
	Change from Existing Condition	Alt 1	-0.4%	-0.6%	0.1%	-0.2%	-0.1%	0.4%	-0.6%	-0.2%	0.1%	-0.6%	-0.1%	-0.2%
		Alt 2	-0.4%	-0.8%	0.1%	-0.2%	-0.1%	0.3%	-0.6%	-0.2%	0.0%	-0.5%	-0.2%	-0.2%
		Alt 4	-0.3%	-0.3%	0.1%	-0.2%	0.0%	0.2%	-0.5%	-0.1%	0.1%	-0.2%	0.0%	0.0%
Wet	Existing Condition		8,937	16,858	47,614	82,800	95,281	77,803	53,932	41,020	22,886	11,115	8,531	16,155
	Percent Change from Existing Condition	Alt 1	-0.3%	-0.6%	0.0%	-0.2%	0.0%	0.3%	-0.5%	-0.2%	0.2%	-1.1%	-0.3%	-0.3%
		Alt 2	-0.4%	-0.8%	0.0%	-0.2%	-0.1%	0.2%	-0.5%	-0.3%	0.1%	-0.9%	-0.4%	-0.3%
		Alt 4	-0.1%	-0.1%	0.0%	-0.1%	0.0%	0.1%	-0.4%	-0.1%	0.3%	-0.2%	0.0%	0.0%
Above Normal	Existing Condition		6,371	12,282	20,377	47,685	59,780	51,183	31,720	24,617	11,573	9,721	6,798	9,245
	Percent Change from Existing Condition	Alt 1	-0.3%	-0.2%	0.0%	-0.1%	-0.1%	0.2%	-0.7%	-0.2%	0.1%	-0.3%	0.2%	-0.1%
		Alt 2	-0.3%	-0.1%	-0.1%	-0.1%	-0.1%	0.2%	-0.7%	-0.1%	0.1%	-0.3%	0.2%	-0.1%
		Alt 4	0.2%	-0.2%	-0.1%	-0.1%	-0.1%	0.1%	-0.7%	-0.3%	0.1%	-0.4%	0.2%	-0.1%
Below Normal	Existing Condition		6,729	8,180	13,661	21,950	36,216	22,833	21,557	16,367	8,238	7,086	4,000	3,506
	Percent Change from Existing Condition	Alt 1	-1.0%	-1.4%	0.8%	-0.1%	-0.1%	0.5%	-0.6%	-0.4%	-0.4%	-0.1%	0.0%	0.5%
		Alt 2	-1.0%	-1.7%	0.8%	-0.1%	-0.1%	0.4%	-0.6%	-0.4%	-0.4%	-0.1%	0.0%	0.5%
		Alt 4	-0.8%	-1.3%	-0.3%	-0.1%	0.0%	0.4%	-0.6%	-0.4%	-0.2%	-0.1%	0.0%	0.8%
Dry	Existing Condition		6,388	8,152	11,108	14,386	21,537	19,809	14,090	10,472	6,751	5,041	3,825	3,240
	Percent Change from Existing Condition	Alt 1	0.0%	-0.9%	0.8%	-0.6%	-0.1%	0.9%	-0.9%	0.0%	-0.1%	0.0%	-0.8%	0.2%
		Alt 2	0.0%	-1.0%	0.8%	-0.6%	-0.1%	0.6%	-0.8%	0.0%	-0.1%	0.0%	-0.8%	0.2%
		Alt 4	-0.1%	-0.6%	1.0%	-0.3%	-0.1%	0.4%	-0.8%	0.0%	-0.2%	0.0%	-1.0%	0.0%
Critical	Existing Condition		5,360	5,804	6,305	10,833	13,230	11,823	9,248	5,970	5,316	4,009	4,019	3,000
	Percent Change from Existing Condition	Alt 1	-0.6%	-0.1%	-0.4%	0.7%	-0.1%	0.3%	-0.7%	0.0%	0.0%	0.0%	1.1%	0.0%
		Alt 2	-0.7%	-0.1%	-0.4%	0.4%	-0.1%	0.3%	-0.6%	0.0%	0.0%	0.0%	0.1%	0.0%
		Alt 4	-1.2%	-0.1%	1.0%	-1.0%	-0.1%	0.4%	-0.6%	0.1%	0.0%	-0.2%	0.7%	0.0%

TABLE C7-24: DELTA OUTFLOW (CFS) UNDER 2030 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

Year Type			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Future Without Project		7,142	11,334	23,912	41,921	51,793	42,484	30,921	22,479	12,549	7,917	5,847	8,199
	Change from Future Without Project	Alt 1	0.0%	-0.6%	-0.1%	-0.1%	0.2%	0.5%	-0.9%	-0.3%	0.3%	-0.5%	-0.5%	0.1%
		Alt 2	0.0%	-0.7%	0.0%	-0.1%	0.2%	0.4%	-0.9%	-0.3%	0.2%	-0.6%	-0.5%	0.0%
		Alt 4	0.1%	0.1%	-0.4%	0.0%	0.1%	0.3%	-0.8%	-0.3%	0.3%	-0.2%	-0.4%	0.2%
Wet	Future Without Project		8,876	17,093	47,578	82,693	94,969	78,124	55,098	40,804	22,695	11,154	8,439	16,064
	Percent Change from Future Without Project	Alt 1	0.1%	-1.0%	-0.1%	-0.1%	0.1%	0.4%	-0.6%	-0.3%	0.4%	-1.0%	-0.4%	-0.2%
		Alt 2	0.0%	-1.1%	-0.1%	-0.1%	0.0%	0.3%	-0.6%	-0.3%	0.3%	-1.1%	-0.4%	-0.2%
		Alt 4	0.2%	-0.1%	-0.1%	0.0%	0.0%	0.2%	-0.5%	-0.2%	0.4%	-0.3%	0.0%	0.0%
Above Normal	Future Without Project		6,644	12,270	20,387	47,496	60,429	51,468	32,806	24,894	11,583	9,743	6,804	9,264
	Percent Change from Future Without Project	Alt 1	0.0%	-0.4%	-0.2%	0.0%	0.0%	0.6%	-0.9%	-0.3%	0.2%	-0.2%	0.4%	-0.4%
		Alt 2	0.0%	-0.5%	-0.2%	0.0%	0.0%	0.6%	-0.9%	-0.5%	0.0%	-0.1%	0.4%	-0.4%
		Alt 4	0.0%	-0.4%	-0.3%	0.0%	0.0%	0.3%	-0.9%	-0.4%	0.2%	-0.1%	0.2%	-0.1%
Below Normal	Future Without Project		6,692	8,351	13,966	22,302	36,016	23,345	22,883	16,078	8,155	7,118	4,000	3,378
	Percent Change from Future Without Project	Alt 1	-0.3%	0.2%	-0.6%	0.0%	-0.2%	0.5%	-1.3%	-0.5%	0.4%	-0.4%	0.0%	2.6%
		Alt 2	-0.3%	0.0%	1.2%	0.0%	-0.2%	0.2%	-1.3%	-0.5%	0.5%	-0.4%	0.0%	2.6%
		Alt 4	0.4%	0.2%	-0.2%	0.0%	-0.4%	0.4%	-1.2%	-0.6%	0.4%	-0.4%	0.0%	1.6%
Dry	Future Without Project		6,515	8,161	11,706	14,589	21,623	20,151	15,340	10,426	6,708	5,168	3,971	3,310
	Percent Change from Future Without Project	Alt 1	0.3%	-1.0%	-0.1%	0.1%	1.7%	1.0%	-1.5%	-0.1%	0.2%	0.2%	-1.9%	0.3%
		Alt 2	0.3%	-1.0%	-0.1%	0.1%	1.7%	0.8%	-1.5%	-0.1%	0.2%	0.2%	-1.9%	0.3%
		Alt 4	0.1%	0.9%	-2.1%	0.2%	1.7%	0.7%	-1.5%	-0.1%	0.2%	0.2%	-2.4%	0.9%
Critical	Future Without Project		5,350	6,158	6,075	11,896	13,270	12,110	9,405	5,907	5,419	4,134	4,245	3,053
	Percent Change from Future Without Project	Alt 1	-0.4%	0.6%	0.2%	-1.3%	0.3%	0.5%	-0.8%	0.2%	0.0%	0.0%	-0.6%	0.5%
		Alt 2	-0.4%	0.6%	0.1%	-1.3%	0.3%	0.5%	-0.8%	0.2%	0.0%	0.0%	-0.6%	0.5%
		Alt 4	-0.3%	0.8%	0.2%	-1.6%	0.3%	0.5%	-0.8%	0.2%	-0.1%	0.0%	-0.5%	0.5%

X2 Location

TABLE C7-25: X2 LOCATION (PREVIOUS MONTH, KM) UNDER 2005 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Existing Condition		84	85	82	75	67	61	62	64	68	75	81	85
	Change from Existing Condition	Alt 1	0.0	0.0	0.1	0.0	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	0.0
		Alt 2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
		Alt 4	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Wet	Existing Condition		81	81	77	62	54	51	53	55	57	65	74	79
	Change from Existing Condition	Alt 1	0.1	0.0	0.1	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.1	0.1
		Alt 2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
		Alt 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Above Normal	Existing Condition		84	85	81	76	61	55	55	59	63	73	78	82
	Change from Existing Condition	Alt 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
		Alt 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
		Alt 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
Below Normal	Existing Condition		85	85	85	81	72	61	64	65	69	77	82	87
	Change from Existing Condition	Alt 1	0.0	0.1	0.2	-0.1	-0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.0
		Alt 2	0.0	0.1	0.2	-0.1	-0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.0
		Alt 4	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
Dry	Existing Condition		85	86	85	82	77	70	67	71	75	81	86	89
	Change from Existing Condition	Alt 1	0.0	0.0	0.1	-0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
		Alt 2	0.0	0.0	0.1	-0.1	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	0.0
		Alt 4	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	0.0
Critical	Existing Condition		89	89	89	88	82	77	75	78	83	86	89	91
	Change from Existing Condition	Alt 1	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.1	0.0	0.0	0.0	-0.1
		Alt 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Alt 4	0.0	0.1	0.1	0.0	0.1	0.1	-0.1	0.0	0.0	0.0	0.0	0.0

TABLE C7-26: X2 LOCATION (PREVIOUS MONTH, KM) UNDER 2030 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Future Without Project		84	84	82	75	67	61	61	64	68	75	81	85
	Change from Future Without Project	Alt 1	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.1	0.1	0.0	0.0	0.0
		Alt 2	0.0	0.0	0.1	0.0	0.0	-0.1	-0.1	0.1	0.1	0.0	0.0	0.0
		Alt 4	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	0.1	0.1	0.0	0.0	0.0
Wet	Future Without Project		81	81	77	62	54	51	53	55	57	65	74	79
	Change from Future Without Project	Alt 1	0.1	0.0	0.1	0.0	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	0.1
		Alt 2	0.1	0.0	0.1	0.0	0.0	0.0	-0.1	0.1	0.0	0.0	0.1	0.1
		Alt 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Above Normal	Future Without Project		84	84	81	75	61	55	55	59	63	73	78	82
	Change from Future Without Project	Alt 1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.1	0.0	0.0	0.0
		Alt 2	0.0	0.0	0.1	0.0	0.0	0.0	-0.1	0.1	0.1	0.0	0.0	0.0
		Alt 4	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.1	0.0	0.0	0.0
Below Normal	Future Without Project		85	85	84	81	71	61	64	64	69	77	82	87
	Change from Future Without Project	Alt 1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.0
		Alt 2	0.0	0.0	0.0	-0.2	-0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.0
		Alt 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0
Dry	Future Without Project		85	86	85	81	76	70	67	70	75	81	86	89
	Change from Future Without Project	Alt 1	0.0	0.0	0.0	0.1	0.0	-0.3	-0.3	0.1	0.1	0.0	0.0	0.1
		Alt 2	0.0	0.0	0.0	0.1	0.0	-0.3	-0.3	0.1	0.1	0.0	0.0	0.1
		Alt 4	0.0	0.0	-0.1	0.2	0.2	-0.3	-0.2	0.1	0.1	0.0	0.0	0.1
Critical	Future Without Project		88	89	89	88	81	76	75	77	83	86	89	90
	Change from Future Without Project	Alt 1	0.0	0.0	0.0	0.0	0.1	0.1	-0.1	0.0	0.0	0.0	0.0	0.0
		Alt 2	0.0	0.0	0.0	0.0	0.1	0.1	-0.1	0.0	0.0	0.0	0.0	0.0
		Alt 4	0.0	0.0	-0.1	-0.1	0.2	0.1	-0.1	0.0	0.0	0.0	0.0	0.0

E:I Ratio

TABLE C7-27: EXPORT-TO-INFLOW RATIO (%) UNDER 2005 LEVEL OF DEVELOPMENT

Export/Inflow Ratio (%) under 2005 Level of Development
Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Existing Condition		45	40	39	24	19	18	7	9	23	45	50	51
	Change from Existing Condition	Alt 1	0.1	0.2	-0.2	0.2	0.1	-0.2	0.0	0.0	1.0	0.1	-0.2	-0.1
		Alt 2	0.2	0.2	-0.2	0.2	0.1	-0.1	0.0	0.0	1.0	-0.1	-0.1	-0.1
		Alt 4	0.2	0.1	-0.2	0.3	0.1	0.1	0.0	0.0	0.9	-0.1	-0.3	-0.1
Wet	Existing Condition		42	36	22	12	12	15	6	7	24	43	49	37
	Change from Existing Condition	Alt 1	0.0	0.2	0.0	0.1	0.1	-0.3	0.0	0.1	0.4	0.3	0.2	0.2
		Alt 2	0.1	0.3	0.0	0.1	0.1	-0.2	0.0	0.1	0.4	0.3	0.2	0.2
		Alt 4	-0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.4	0.0	0.0	0.1
Above Normal	Existing Condition		46	36	40	17	13	15	6	6	28	42	53	49
	Change from Existing Condition	Alt 1	0.0	0.1	0.2	0.1	0.1	0.0	0.0	0.0	1.1	0.0	-0.1	-0.2
		Alt 2	0.3	0.1	0.2	0.1	0.1	0.0	0.0	0.0	1.1	0.0	-0.1	-0.2
		Alt 4	-0.2	0.1	0.2	0.0	0.1	0.1	0.0	0.0	1.1	0.0	-0.1	-0.2
Below Normal	Existing Condition		45	45	50	26	19	24	7	8	24	48	57	65
	Change from Existing Condition	Alt 1	0.7	0.3	-1.0	0.1	0.1	-0.1	0.0	0.0	1.4	0.0	-0.1	0.0
		Alt 2	0.7	0.5	-1.0	0.1	0.1	0.0	0.0	0.0	1.4	0.0	-0.1	0.0
		Alt 4	0.5	0.4	-0.3	0.1	0.1	0.0	0.0	0.0	1.3	-0.1	-0.1	-0.1
Dry	Existing Condition		45	41	48	35	26	20	9	11	21	52	57	61
	Change from Existing Condition	Alt 1	-0.2	0.2	-0.3	0.6	0.2	-0.4	0.0	0.0	1.8	-0.2	-0.3	-0.5
		Alt 2	-0.1	0.2	-0.3	0.6	0.2	-0.2	0.0	0.0	1.8	-0.2	-0.3	-0.5
		Alt 4	0.1	0.1	-0.4	0.3	0.2	0.1	0.0	0.0	1.3	-0.2	-0.2	-0.4
Critical	Existing Condition		47	45	47	36	28	20	11	15	15	39	32	50
	Change from Existing Condition	Alt 1	0.4	0.0	-0.1	-0.2	0.0	0.1	0.0	0.0	0.7	0.2	-0.7	0.0
		Alt 2	0.4	0.0	-0.1	0.1	0.0	0.1	0.0	0.0	0.7	-1.2	-0.3	0.0
		Alt 4	0.8	0.0	-0.8	1.0	0.1	0.1	0.0	0.0	0.7	0.0	-1.1	0.1

TABLE C7-28: EXPORT-TO-INFLOW RATIO (%) UNDER 2030 LEVEL OF DEVELOPMENT

Export/Inflow Ratio (%) under 2030 Level of Development
Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Future Without Project		43	39	39	23	19	19	8	9	23	45	50	50
	Change from Future Without Project	Alt 1	0.0	0.3	0.0	0.1	-0.2	-0.2	0.0	0.0	0.8	-0.1	0.0	-0.1
		Alt 2	0.1	0.4	-0.2	0.1	-0.2	-0.1	0.0	0.0	0.8	-0.1	0.0	-0.1
		Alt 4	0.0	0.0	0.2	0.1	-0.1	0.0	0.0	0.0	0.8	-0.1	0.0	-0.2
Wet	Future Without Project		42	35	22	12	12	15	6	7	25	43	49	37
	Change from Future Without Project	Alt 1	0.0	0.6	-0.2	0.0	0.0	-0.3	0.1	0.0	0.4	0.3	0.1	0.1
		Alt 2	0.1	0.7	-0.2	0.0	0.0	-0.2	0.1	0.1	0.4	0.3	0.1	0.1
		Alt 4	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.4	0.0	-0.1	-0.1
Above Normal	Future Without Project		43	37	40	17	13	16	6	7	28	42	53	49
	Change from Future Without Project	Alt 1	-0.4	0.5	0.2	0.0	0.0	-0.1	0.0	0.0	0.9	0.0	-0.1	0.0
		Alt 2	-0.3	0.8	0.2	0.0	0.0	-0.1	0.0	0.0	0.9	0.0	-0.1	0.1
		Alt 4	-0.6	0.5	0.1	-0.1	0.1	0.0	0.0	0.0	0.9	0.0	-0.1	-0.1
Below Normal	Future Without Project		45	45	50	26	19	24	7	8	25	49	58	65
	Change from Future Without Project	Alt 1	0.5	-0.3	0.4	0.0	0.0	-0.1	0.0	0.0	1.0	-0.1	-0.3	0.0
		Alt 2	0.5	-0.2	-0.8	0.0	0.0	0.1	0.0	0.0	1.0	-0.1	-0.3	0.0
		Alt 4	0.0	0.1	0.3	0.0	0.1	0.0	0.0	0.0	1.0	-0.1	-0.1	-0.1
Dry	Future Without Project		43	40	45	35	26	20	9	11	21	51	56	60
	Change from Future Without Project	Alt 1	-0.1	0.4	0.1	0.1	-0.7	-0.2	0.0	0.0	1.5	-0.4	-0.3	-0.5
		Alt 2	-0.1	0.4	0.2	0.1	-0.8	-0.1	0.0	0.0	1.5	-0.4	-0.3	-0.5
		Alt 4	0.2	-0.3	1.2	0.0	-0.7	0.0	0.1	0.0	1.5	-0.4	-0.2	-0.5
Critical	Future Without Project		46	42	51	33	28	20	11	15	15	40	29	50
	Change from Future Without Project	Alt 1	0.2	0.0	-0.3	0.6	-0.2	0.0	0.0	0.0	0.4	-0.4	0.4	-0.2
		Alt 2	0.2	0.0	-0.3	0.6	-0.2	0.0	0.0	0.0	0.4	-0.4	0.4	-0.2
		Alt 4	0.2	0.2	-0.4	0.8	-0.1	0.0	0.0	0.0	0.5	-0.1	0.4	0.0

Net Flow on Lower San Joaquin River (Qwest)

TABLE C7-29: NET FLOW (CFS) ON LOWER SAN JOAQUIN RIVER (QWEST) UNDER 2005 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Existing Condition		310	139	452	5,850	7,993	7,001	9,030	7,479	3,201	-2,094	-2,350	-1,662
	Change from Existing Condition	Alt 1	-21.9	-30.1	26.0	-66.3	-33.2	148.9	-151.4	-52.6	-33.3	-44.5	4.8	-4.4
		Alt 2	-25.6	-44.0	23.1	-78.1	-41.9	113.7	-154.4	-58.2	-41.1	-15.0	-2.9	-7.2
		Alt 4	-14.3	-3.9	18.2	-52.6	-21.7	67.1	-143.0	-41.4	-15.2	-14.2	6.9	0.6
Wet	Existing Condition		48	704	5,711	14,738	15,673	14,838	16,292	14,338	6,883	739	-1,813	-1,554
	Change from Existing Condition	Alt 1	-18.3	-90.5	-20.3	-124.1	-62.6	246.8	-203.7	-105.0	22.5	-106.6	-40.9	-57.2
		Alt 2	-28.7	-122.0	-24.3	-147.4	-83.0	182.0	-213.8	-124.5	-1.6	-100.2	-42.7	-66.7
		Alt 4	8.1	-71.5	-11.5	-57.3	-47.8	77.4	-175.8	-62.1	29.6	-23.4	-23.7	-36.1
Above Normal	Existing Condition		-8	205	-585	7,378	9,543	7,287	9,409	7,700	2,323	-1,955	-3,361	-1,802
	Change from Existing Condition	Alt 1	4.7	-40.4	-63.8	-42.0	-35.7	90.9	-171.3	-54.3	-43.8	-38.2	-8.7	21.3
		Alt 2	4.0	-30.9	-69.4	-41.8	-40.4	80.1	-172.4	-50.3	-44.5	-38.2	-9.0	23.6
		Alt 4	42.6	-27.8	-30.1	-42.2	-31.0	46.4	-181.0	-70.8	-44.4	-56.9	-32.0	2.5
Below Normal	Existing Condition		264	-730	-2,012	1,726	6,683	2,954	7,503	5,775	1,496	-4,065	-3,345	-2,641
	Change from Existing Condition	Alt 1	-61.2	81.3	199.7	-22.3	-18.0	103.3	-141.1	-62.6	-49.4	-13.0	-12.3	-57.0
		Alt 2	-60.2	59.0	197.9	-22.6	-21.9	84.3	-141.3	-62.6	-49.4	-13.1	-12.0	-56.7
		Alt 4	-35.1	50.0	43.3	-21.9	1.2	73.5	-144.0	-76.2	-47.1	-23.9	3.7	-65.9
Dry	Existing Condition		970	-99	-2,962	-333	1,678	2,443	4,275	3,007	1,029	-4,767	-3,421	-1,911
	Change from Existing Condition	Alt 1	2.2	-35.7	41.0	-84.7	-19.4	150.7	-125.1	-5.1	-98.4	3.9	24.1	82.7
		Alt 2	-1.7	-39.3	39.2	-84.8	-23.6	106.0	-124.3	-4.9	-98.4	2.7	25.6	81.3
		Alt 4	-23.4	56.8	38.1	-37.3	-15.6	63.3	-123.7	-3.3	-31.4	26.6	-1.3	94.1
Critical	Existing Condition		260	222	-1,911	-849	806	1,296	1,828	1,095	1,345	-2,061	264	-237
	Change from Existing Condition	Alt 1	-46.8	-10.7	-9.0	10.8	-5.3	45.5	-69.3	2.8	-27.5	-25.8	108.2	14.8
		Alt 2	-43.8	-14.9	-10.2	-19.1	-5.2	45.5	-68.0	3.0	-27.5	163.9	57.1	15.7
		Alt 4	-81.6	12.7	71.6	-111.8	8.5	63.5	-61.9	15.9	-21.8	-1.4	128.1	15.5

TABLE C7-30: NET FLOW (CFS) ON LOWER SAN JOAQUIN RIVER (QWEST) UNDER 2030 LEVEL OF DEVELOPMENT

Long-term Monthly Average by Water Year Type

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Water Years	Future Without Project		554	236	520	5,802	7,870	7,193	9,994	7,524	3,150	-1,937	-2,316	-1,631
	Change from Future Without Project	Alt 1	1.7	-63.7	-1.9	-35.0	29.5	188.7	-233.7	-72.9	16.8	-31.5	1.5	17.8
		Alt 2	-2.7	-80.1	38.5	-37.0	22.3	149.8	-237.8	-81.8	8.7	-34.0	1.3	11.5
		Alt 4	-4.1	1.3	-38.7	-1.9	28.8	113.9	-215.2	-72.9	18.4	-15.7	3.4	13.6
Wet	Future Without Project		205	738	5,905	14,418	15,376	14,977	17,289	14,365	6,888	843	-1,850	-1,600
	Change from Future Without Project	Alt 1	-22.5	-135.2	16.1	-74.4	18.9	291.6	-296.0	-116.9	47.5	-106.2	-43.0	-26.0
		Alt 2	-34.9	-150.4	13.2	-81.6	3.7	238.5	-308.4	-142.1	22.7	-117.7	-43.6	-36.0
		Alt 4	-28.8	10.5	16.1	2.5	4.7	135.6	-241.3	-90.0	55.3	-38.7	-15.6	-2.7
Above Normal	Future Without Project		378	79	-779	7,315	9,908	7,601	10,456	7,972	2,404	-1,956	-3,556	-1,845
	Change from Future Without Project	Alt 1	85.8	-81.5	-20.3	-10.4	10.1	172.4	-235.0	-96.1	17.1	-21.2	8.4	-10.7
		Alt 2	85.8	-141.9	-19.9	-10.5	2.1	140.4	-235.8	-102.5	12.8	-12.1	7.2	-34.6
		Alt 4	51.4	-68.7	-3.7	17.2	23.3	109.7	-248.7	-136.9	17.3	-21.8	-9.4	-21.6
Below Normal	Future Without Project		488	-754	-1,925	1,786	6,448	3,271	8,773	5,739	1,401	-4,019	-3,501	-2,660
	Change from Future Without Project	Alt 1	-52.7	71.4	-68.0	0.0	-5.2	151.9	-250.1	-113.9	27.0	-41.6	28.6	54.2
		Alt 2	-54.7	55.8	180.3	0.1	-11.7	80.5	-250.4	-114.0	28.9	-43.0	29.0	54.4
		Alt 4	-23.6	-84.0	-43.2	3.6	-9.3	121.8	-235.1	-132.6	27.7	-61.1	30.7	10.8
Dry	Future Without Project		1,314	83	-2,426	-359	1,589	2,599	5,360	3,020	876	-4,276	-3,182	-1,725
	Change from Future Without Project	Alt 1	40.5	-88.2	-5.8	5.5	91.0	161.2	-231.5	-15.5	-34.3	39.2	50.8	77.8
		Alt 2	39.9	-89.8	-6.6	5.5	91.0	137.5	-231.5	-15.3	-34.2	38.6	52.0	79.5
		Alt 4	10.7	106.2	-225.7	20.5	91.5	107.9	-228.4	-15.1	-34.2	51.4	21.5	66.2
Critical	Future Without Project		423	691	-2,574	-451	650	1,386	2,101	1,093	1,246	-2,002	593	-145
	Change from Future Without Project	Alt 1	-24.6	-11.7	60.5	-75.7	19.7	66.0	-81.4	7.6	14.6	25.5	-14.6	8.4
		Alt 2	-24.9	-10.3	53.7	-73.8	19.8	66.0	-81.4	7.6	14.7	27.5	-15.2	8.4
		Alt 4	-5.4	-6.1	93.5	-70.5	36.5	70.9	-81.9	11.1	7.5	-7.2	-1.6	8.4

Old and Middle River Flow Evaluation

Methodology

Estimates of net flow in Old and Middle rivers (OMR) were calculated from DSM2 studies and evaluated for the without project conditions and each of the project alternatives. This evaluation of net OMR flows was performed for the updated modeling analysis in the Final EIS/EIR.

The convention used in this analysis is that the positive direction of net flow in Old and Middle rivers is seaward flow, and that the negative direction of net flow in Old and Middle rivers is southward, towards the CVP and SWP export facilities. Hourly flow values were extracted from the DSM2 output at DSM2 channel 106 for Old River and DSM2 channels 144 and 145 for Middle River, which correspond to the current OMR flow measurement locations on Old and Middle Rivers per the USFWS and NMFS OCAP BOs. To determine net flow in Old and Middle rivers, the hourly flow values at these three locations are added[2] and then a Godin filter is applied to determine the tidally averaged flow (or the tidal residual).

Results

The assessment relies on a comparative analysis of net OMR flow for the water years 1976 through 1991 under without project conditions and with the proposed project for both 2005 level of development and 2030 level of development. Long-term average net OMR flow with and without each of the project alternatives for both the 2005 and 2030 level of development are presented in Section 4.3. Detailed results are presented below.

The tables and figures provided are described below in the sequence in which they appear for each set of conditions. Note that in some of the figures, net flow (i.e. the tidally filtered flow) is referred to as the tidal residual.

Tables of Old and Middle River Net Flow. The monthly average of the tidally filtered flow in Old and Middle rivers is presented for each month of the 16 year simulation, covering water years 1976 through 1991. At the bottom of the table, the long-term monthly averages are provided for the entire 16 year period, along with average monthly values for wetter water year types (wet, above normal and below normal water years), and for dryer water year types (dry and critical water years). The 16-year study period does not include sufficient years in each water year type category to present average values for each water year type (e.g. there is only one below normal water year from 1976 to 1991). Grouping the year types into wetter and dryer water year categories reduces the uneven weighting that would occur by taking long term averages over individual water year types.

A table is presented for the without project condition (Existing Condition for the 2005 level of development and Future Without Project for the 2030 level of development) and for each alternative. Following the same format, another table presents differences in the monthly averages

[2] Combined flow in Old and Middle rivers is equal to the flow in channel 106 plus the flow in channel 144 minus the flow in channel 145. The flow in channel 145 is subtracted because channel 145 is defined in the DSM2 model with positive flow to the south while channels 106 and 144 are defined with positive flow to the north.

of OMR net flow between the alternative and the without project conditions. In the table of differences, a positive value means that OMR net flow was increased in the seaward direction by the alternative, relative to the without project condition. For instance, if OMR net flow is positive (water is moving north towards the Bay on average) in the without project condition, a positive value in the difference table implies the net flow in Old and Middle rivers in the alternative is flowing that much more towards the Bay, while a negative value in the difference table in this case implies that the net seaward flow in Old and Middle rivers has decreased. Likewise, if OMR net flow is negative (water is moving south towards the SWP and CVP export pumps on average) in the without project condition, a positive value in the difference table implies that the net flow in Old and Middle rivers in the alternative, although likely still moving to the south, is moving less southward on average, while a negative value in the difference table implies the water is moving more towards the south..

Figures Comparing Each Alternative to the Without Project Condition. Four figures are provided for each project alternative to illustrate the change in OMR net flow compared to the without project condition.

- The first figure provides a direct comparison between the OMR tidal residuals (net flows) for the project alternative versus the without project condition for the months of January through June.
- The second figure plots time series of OMR tidal residual for the project alternative and without project condition; the changes between the alternative and without project condition (positive value indicates that OMR net flow seaward is increased by the alternative) are also shown.
- The third figure compares the long-term (16-year) monthly average OMR net flow for the without project condition and the project alternative.
- The forth figure shows the differences between the project alternative and the without project condition long term (16-year) monthly average OMR net flow. A positive value means that the alternative is increasing OMR net flow seaward.

2005 Level of Development

Existing Condition

Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

Existing Condition
2005 Level of Development

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	-7,045	-3,672	-9,274	-4,952	-4,907	-4,384	-359	-644	-2,136	-9,680	-6,895	-7,809
1977	-4,102	-4,469	-2,365	-4,780	-628	-659	-674	-640	-2,143	-1,973	-3,746	-3,998
1978	-1,827	-3,771	-5,113	-3,234	-5,040	-5,040	3,015	2,049	-4,686	-10,015	-10,259	-9,890
1979	-4,520	-5,578	-9,314	-5,080	-5,072	-4,291	1,195	1,299	-3,437	-10,922	-9,598	-8,359
1980	-7,874	-4,994	-9,538	-3,731	-928	-809	1,590	974	-4,294	-8,379	-9,718	-10,017
1981	-5,258	-4,409	-9,265	-4,908	-4,950	-2,673	284	-56	-3,544	-11,007	-10,548	-9,588
1982	-7,115	-9,672	-5,848	-4,511	-5,117	-1,334	7,256	4,720	-4,542	-7,919	-9,182	-7,220
1983	-7,036	-5,057	1,560	5,665	9,880	21,575	4,531	4,129	4,261	1,759	-6,905	-7,117
1984	-8,857	-2,514	8,104	-506	-4,067	-4,505	1,205	642	-3,470	-10,408	-10,213	-7,133
1985	-5,090	-9,283	-9,170	-4,957	-4,990	-3,674	256	-76	-3,526	-10,943	-9,673	-7,785
1986	-7,228	-6,998	-6,690	-2,812	-3,734	2,697	2,915	2,155	-4,099	-10,451	-8,121	-4,792
1987	-2,706	-3,489	-8,607	-4,867	-4,872	-2,737	-163	-240	-3,528	-10,858	-3,689	-4,896
1988	-4,409	-4,439	-5,485	-3,276	-86	-860	-443	-693	-2,234	-8,972	-3,299	-4,098
1989	-3,641	-5,636	-3,939	-4,937	-750	-1,154	-970	-1,347	-5,070	-11,115	-10,494	-7,401
1990	-6,600	-7,017	-4,142	-4,861	-3,461	-1,222	-965	-691	-2,387	-8,417	-4,832	-4,000
1991	-3,239	-3,985	-2,973	-852	-1,959	-904	-907	-1,171	-3,533	-9,457	-3,769	-3,929
Avg	-5,409	-5,312	-5,129	-3,288	-2,543	-623	1,110	651	-3,023	-8,672	-7,559	-6,752
W/AN/BN	-6,351	-5,512	-3,834	-2,030	-2,011	1,185	3,101	2,281	-2,895	-8,048	-9,142	-7,790
D/C	-4,677	-5,156	-6,136	-4,266	-2,956	-2,030	-438	-618	-3,122	-9,158	-6,327	-5,945

Alternative 1

Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

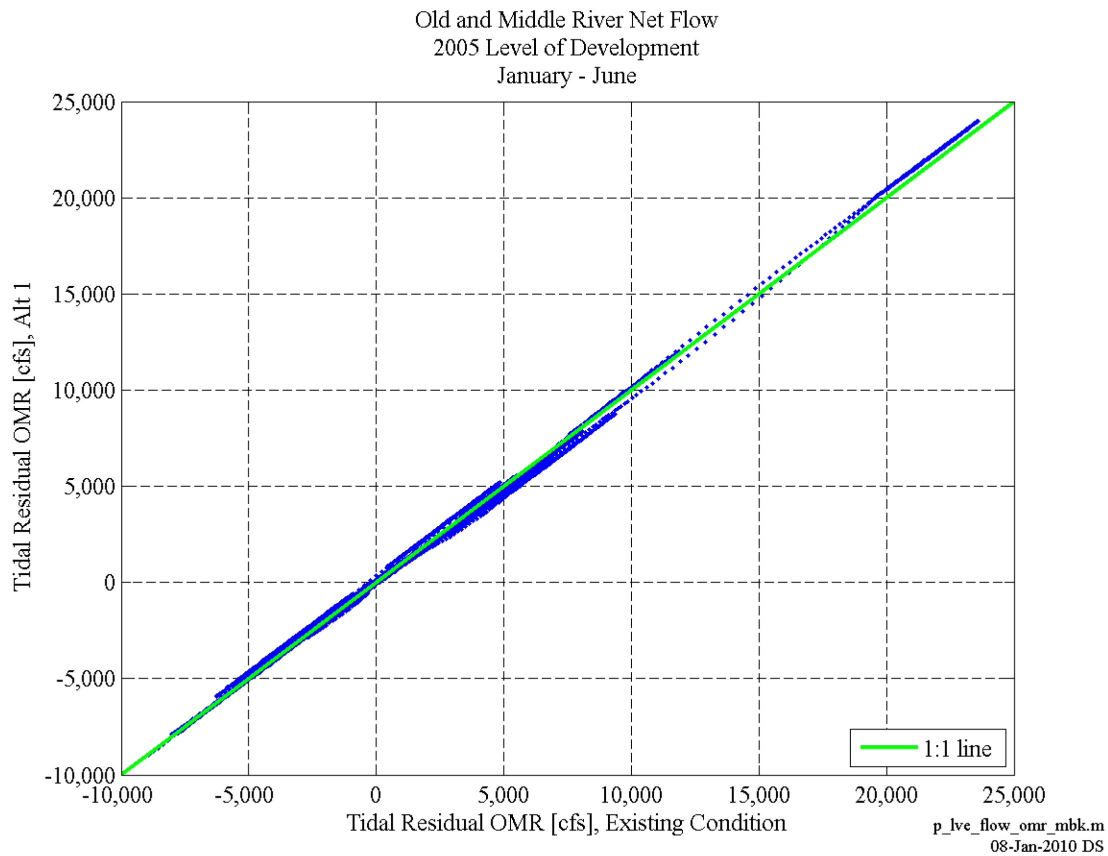
Alternative 1
2005 Level of Development

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	-6,979	-3,676	-9,277	-4,955	-4,909	-4,380	-370	-655	-2,137	-9,725	-6,804	-7,568
1977	-4,138	-4,412	-2,375	-4,780	-633	-657	-674	-643	-2,142	-1,973	-3,682	-3,998
1978	-1,830	-3,772	-5,112	-3,235	-5,040	-5,040	2,987	1,863	-4,686	-9,911	-10,382	-9,987
1979	-4,542	-5,706	-9,202	-5,085	-5,074	-4,286	1,095	1,289	-3,438	-10,940	-9,595	-8,374
1980	-7,883	-5,000	-9,566	-3,736	-870	-728	1,498	953	-4,211	-8,175	-9,719	-10,017
1981	-5,250	-4,411	-9,269	-4,912	-4,952	-2,669	264	-66	-3,542	-11,048	-10,554	-9,564
1982	-7,118	-9,729	-5,849	-4,515	-5,118	-1,204	6,658	4,531	-4,543	-7,817	-9,242	-7,836
1983	-7,666	-5,683	1,836	5,462	10,014	21,987	4,107	4,213	4,309	1,931	-6,959	-7,164
1984	-8,896	-2,544	8,179	-471	-3,975	-4,175	1,166	623	-3,466	-10,201	-10,209	-7,123
1985	-5,064	-9,807	-9,177	-4,961	-4,991	-3,325	251	-76	-3,531	-11,003	-9,308	-7,816
1986	-7,228	-7,002	-6,711	-2,821	-3,727	3,067	2,884	1,970	-3,803	-10,345	-8,239	-4,845
1987	-2,442	-3,482	-8,528	-4,870	-4,873	-2,583	-168	-245	-3,525	-11,033	-3,646	-4,925
1988	-4,412	-4,442	-5,499	-3,277	-90	-855	-449	-697	-2,236	-8,963	-3,206	-4,103
1989	-3,509	-5,611	-4,084	-4,940	-752	-1,152	-944	-1,222	-5,070	-11,007	-10,625	-7,809
1990	-6,607	-6,849	-4,142	-4,863	-3,457	-1,218	-887	-579	-2,385	-8,386	-4,585	-4,003
1991	-3,383	-3,985	-2,826	-764	-1,974	-904	-910	-1,086	-3,529	-8,979	-3,864	-3,930
Avg	-5,434	-5,382	-5,100	-3,295	-2,526	-508	1,032	636	-2,996	-8,599	-7,539	-6,816
W/AN/BN	-6,452	-5,634	-3,775	-2,057	-1,970	1,374	2,914	2,206	-2,834	-7,923	-9,192	-7,906
D/C	-4,643	-5,186	-6,131	-4,258	-2,959	-1,971	-432	-586	-3,122	-9,124	-6,253	-5,968

Change in Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

Alternative 1 - Existing Condition
2005 Level of Development

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	66	-3	-3	-2	-2	4	-11	-11	-1	-46	91	242
1977	-36	57	-9	-1	-5	2	0	-3	1	0	64	1
1978	-3	-1	2	-1	-1	0	-27	-186	0	104	-122	-97
1979	-23	-128	112	-5	-2	4	-100	-10	-1	-18	2	-15
1980	-9	-6	-28	-5	58	81	-92	-20	83	203	-1	0
1981	8	-2	-4	-4	-2	4	-20	-10	2	-41	-6	24
1982	-3	-58	-1	-3	-2	131	-598	-189	0	102	-60	-616
1983	-630	-626	275	-203	134	412	-424	83	48	172	-54	-47
1984	-39	-30	75	34	92	330	-39	-19	3	206	4	11
1985	26	-523	-7	-4	-1	349	-5	1	-5	-60	366	-32
1986	0	-4	-21	-9	7	370	-31	-184	296	106	-118	-53
1987	264	7	79	-3	-1	154	-5	-5	3	-176	43	-29
1988	-3	-3	-14	-2	-4	6	-6	-4	-2	9	93	-5
1989	132	25	-145	-3	-2	2	27	126	0	109	-131	-407
1990	-8	167	0	-2	4	4	78	111	2	31	247	-2
1991	-144	0	148	88	-15	0	-4	84	5	478	-95	-1
Avg	-25	-70	29	-8	16	116	-79	-15	27	74	20	-64
W/AN/BN	-101	-122	59	-27	41	190	-187	-75	61	125	-50	-117
D/C	34	-31	5	8	-3	58	6	32	1	34	75	-23


Old and Middle River Net Flow
2005 Level of Development
January - June
Tidal Residual OMR [cfs], Alt 1
Tidal Residual OMR [cfs], Existing Condition
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20,000
15,000
10,000
5,000
0
-5,000
-10,000
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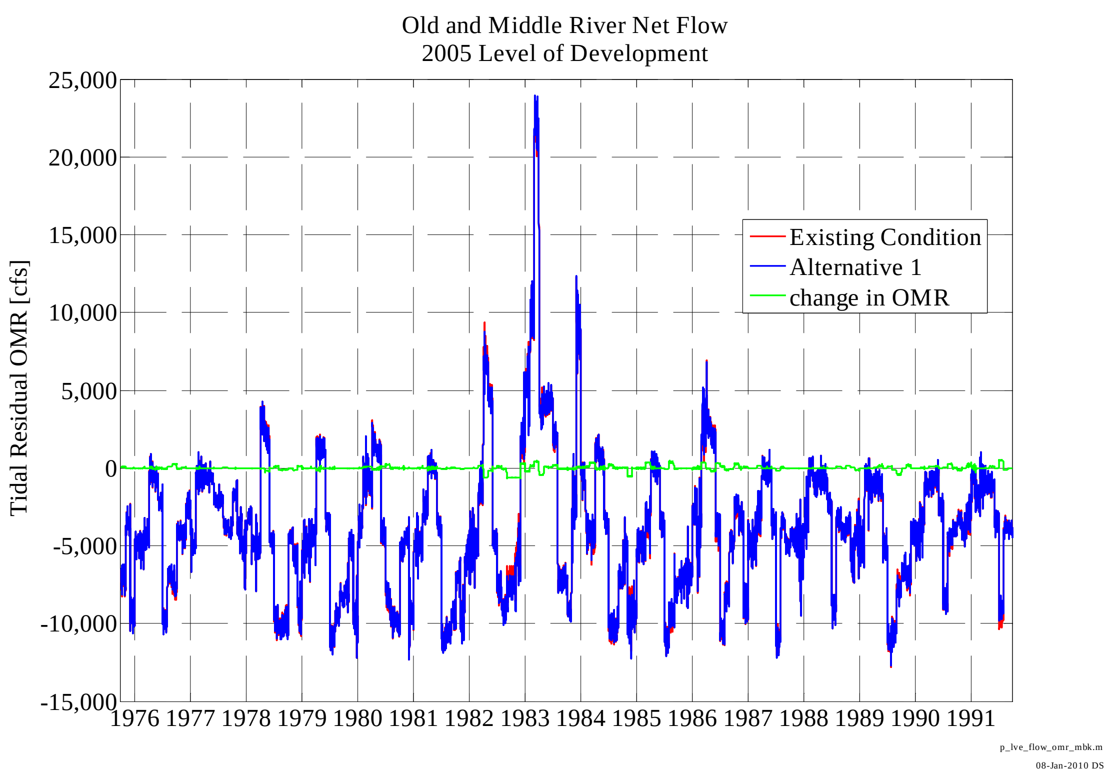
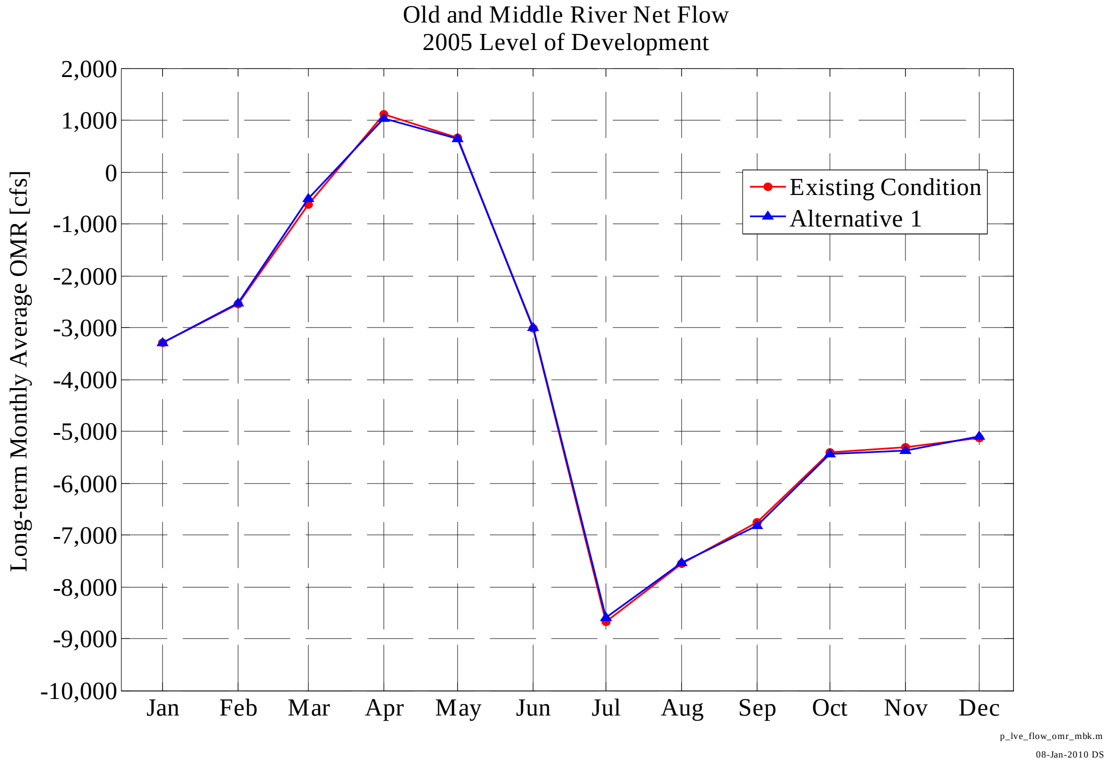
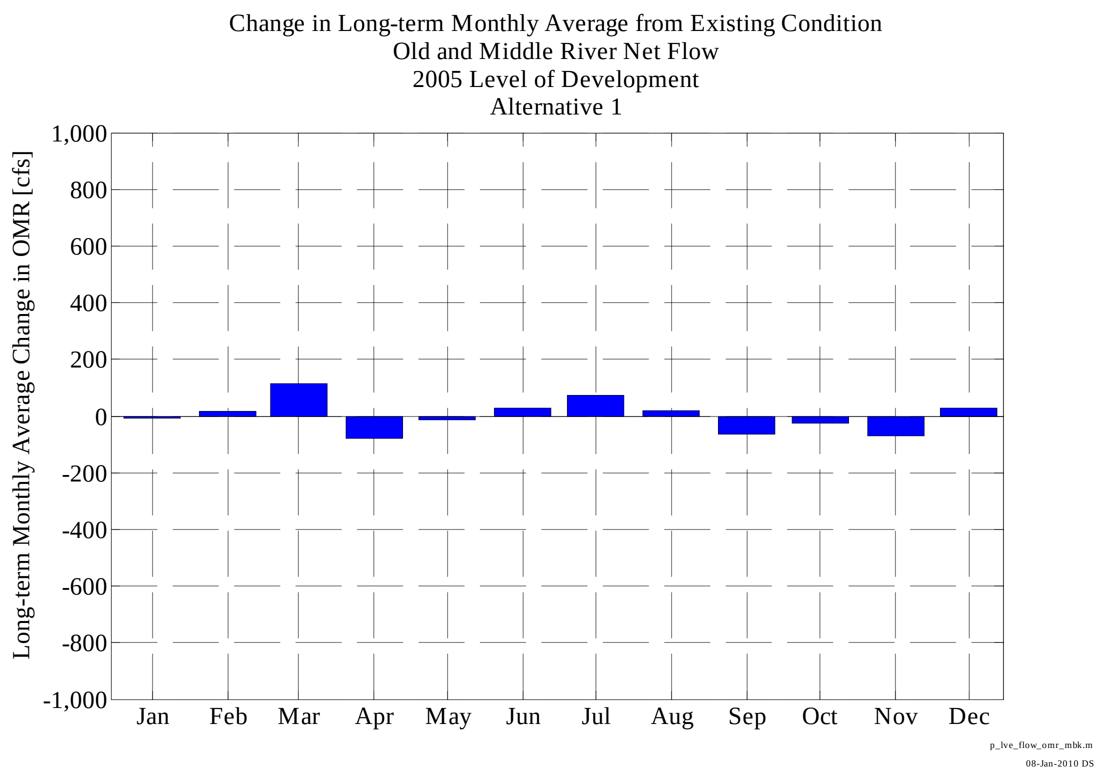
08-Jan-2010 DS


Old and Middle River Net Flow
2005 Level of Development
Tidal Residual OMR [cfs]
Existing Condition
Alternative 1
change in OMR
1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Old and Middle River Net Flow
2005 Level of Development
Long-term Monthly Average OMR [cfs]
2,000
1,000
0
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
-7,000
-8,000
-9,000
-10,000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Existing Condition
Alternative 1
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Change in Long-term Monthly Average from Existing Condition
Old and Middle River Net Flow
2005 Level of Development
Alternative 1
Long-term Monthly Average Change in OMR [cfs]
1,000
800
600
400
200
0
-200
-400
-600
-800
-1,000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
p_lve_flow_omr_mbk.m
08-Jan-2010 DS

Alternative 2

Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

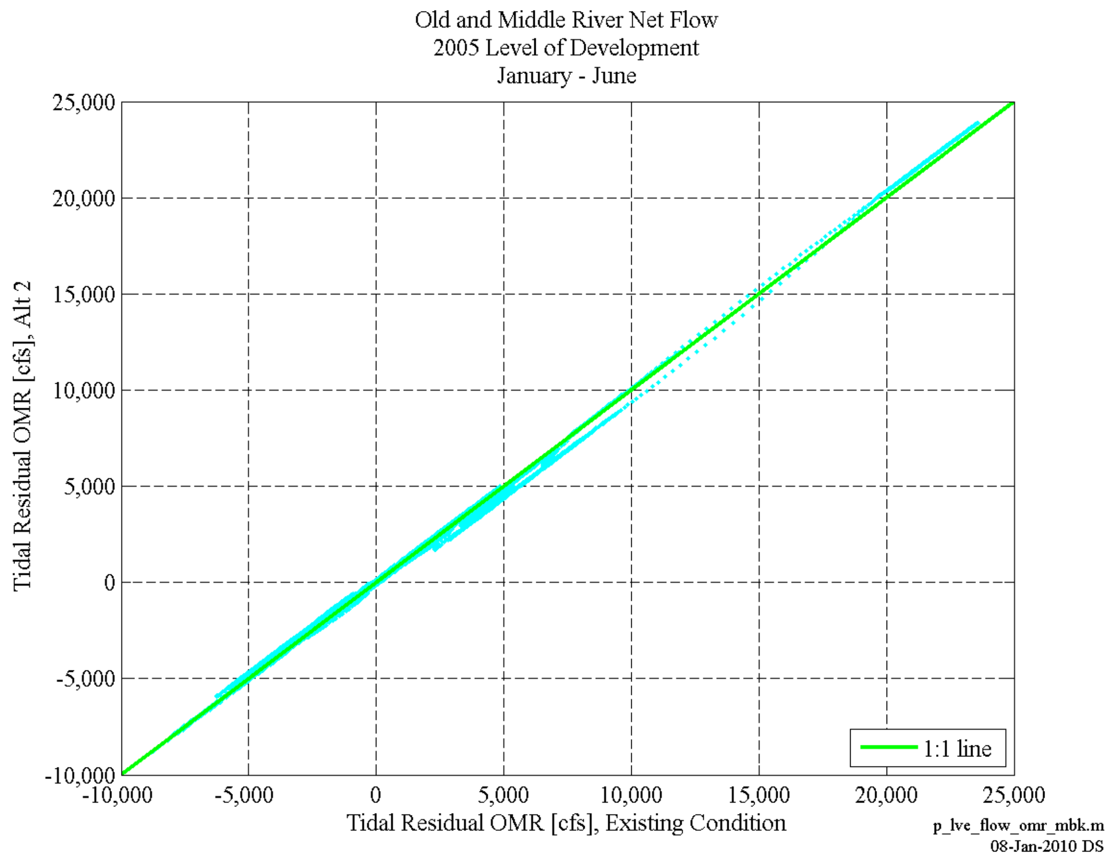
Alternative 2
2005 Level of Development

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	-6,930	-3,675	-9,277	-4,955	-4,909	-4,380	-370	-655	-2,137	-9,724	-6,802	-7,559
1977	-4,139	-4,431	-2,398	-4,781	-633	-656	-674	-643	-2,142	-1,973	-3,706	-3,998
1978	-1,830	-3,772	-5,115	-3,235	-5,040	-5,040	2,987	1,863	-4,686	-9,911	-10,382	-9,987
1979	-4,542	-5,707	-9,202	-5,085	-5,074	-4,286	1,095	1,289	-3,438	-10,940	-9,596	-8,371
1980	-7,880	-4,999	-9,566	-3,736	-918	-728	1,496	953	-4,211	-8,175	-9,719	-10,017
1981	-5,250	-4,411	-9,269	-4,912	-4,952	-2,669	264	-66	-3,542	-11,048	-10,554	-9,564
1982	-7,118	-9,853	-5,851	-4,515	-5,118	-1,204	6,633	4,530	-4,543	-7,818	-9,243	-7,835
1983	-7,666	-5,683	1,835	5,089	9,948	21,912	3,911	3,777	4,180	1,908	-6,974	-7,377
1984	-9,157	-2,741	8,176	-616	-4,035	-4,181	1,166	623	-3,466	-10,202	-10,209	-7,123
1985	-5,064	-9,906	-9,178	-4,960	-4,991	-3,354	251	-76	-3,531	-11,006	-9,308	-7,815
1986	-7,228	-7,002	-6,711	-2,820	-3,771	2,849	2,883	1,970	-3,803	-10,345	-8,239	-4,844
1987	-2,498	-3,484	-8,528	-4,870	-4,873	-2,734	-170	-245	-3,525	-11,032	-3,632	-4,922
1988	-4,412	-4,442	-5,497	-3,277	-90	-855	-449	-697	-2,236	-8,932	-3,180	-4,103
1989	-3,539	-5,590	-4,111	-4,941	-752	-1,152	-944	-1,222	-5,070	-11,010	-10,629	-7,820
1990	-6,607	-6,840	-4,142	-4,863	-3,457	-1,218	-887	-579	-2,385	-8,389	-4,577	-4,002
1991	-3,388	-3,985	-2,819	-764	-1,974	-904	-910	-1,086	-3,529	-8,997	-3,858	-3,930
Avg	-5,453	-5,408	-5,103	-3,328	-2,540	-538	1,018	609	-3,004	-8,600	-7,538	-6,829
W/AN/BN	-6,489	-5,680	-3,776	-2,131	-2,001	1,332	2,881	2,144	-2,852	-7,926	-9,195	-7,936
D/C	-4,647	-5,196	-6,136	-4,258	-2,959	-1,991	-432	-586	-3,122	-9,123	-6,250	-5,968

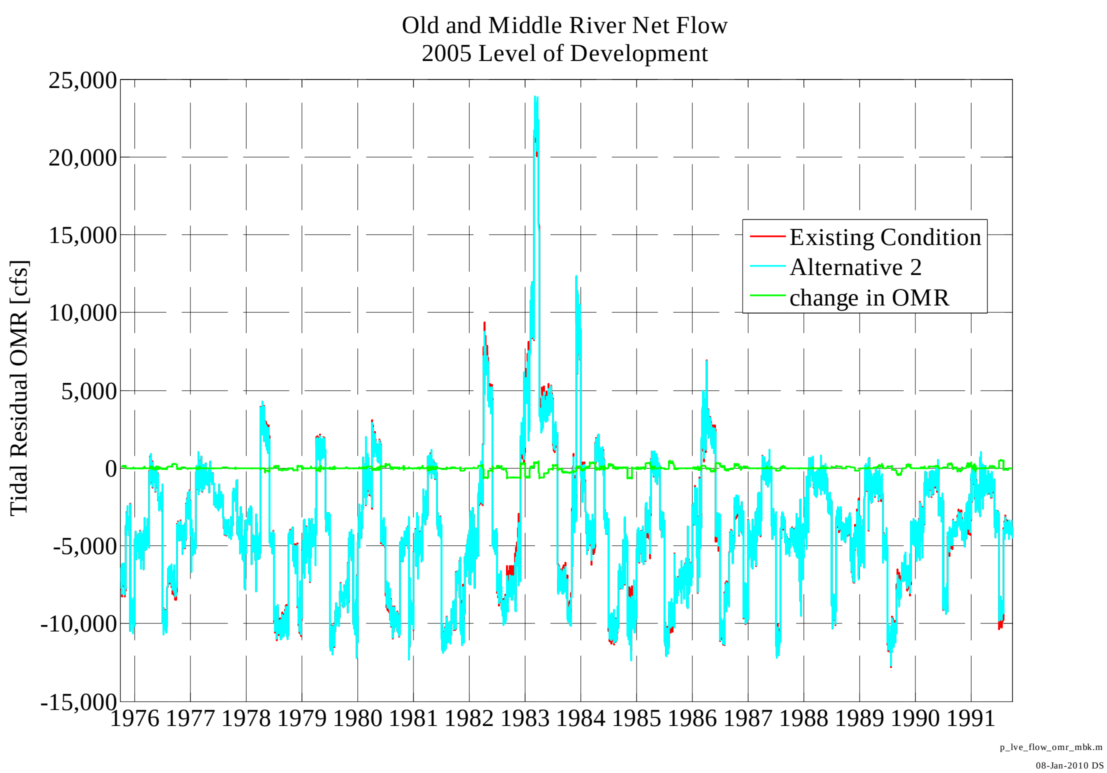
Change in Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

Alternative 2 - Existing Condition
2005 Level of Development

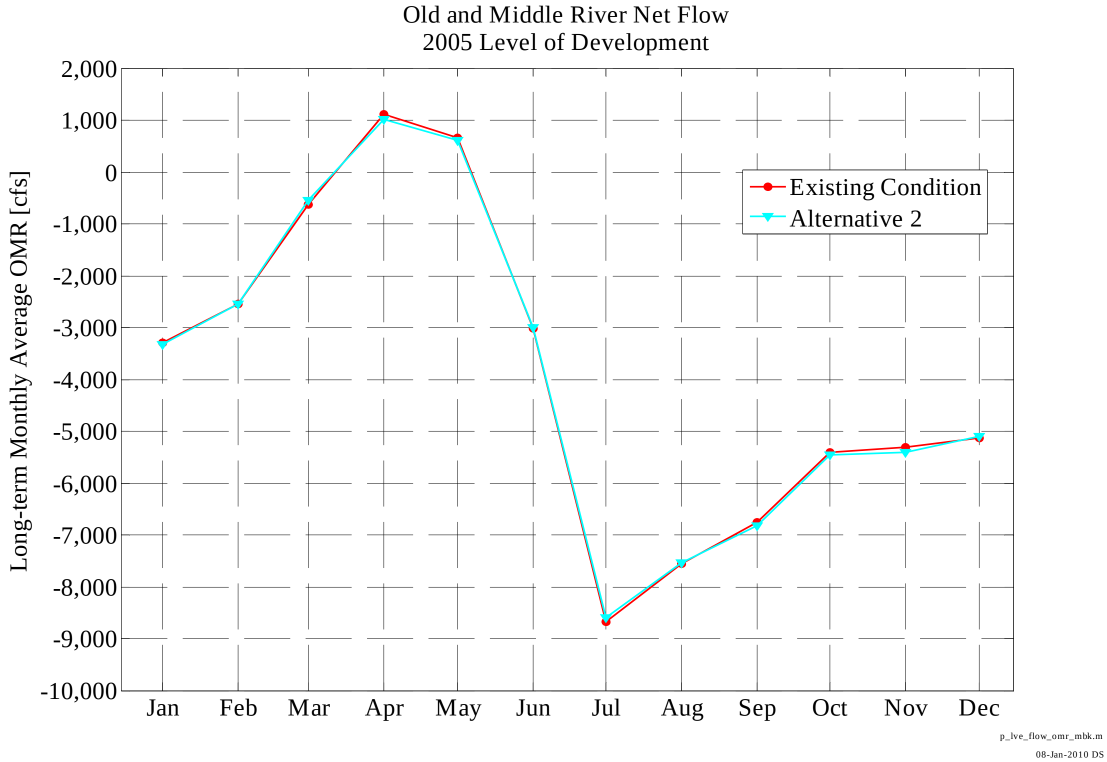
Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	115	-3	-3	-2	-2	4	-11	-11	-1	-45	93	250
1977	-37	38	-33	-1	-5	2	0	-3	1	0	40	1
1978	-3	-1	-1	-1	-1	0	-27	-186	0	104	-122	-97
1979	-23	-129	112	-5	-2	4	-101	-10	-1	-18	2	-13
1980	-5	-5	-28	-5	10	81	-94	-20	83	203	-1	0
1981	9	-2	-4	-4	-2	4	-20	-10	2	-41	-6	24
1982	-3	-182	-3	-3	-2	131	-623	-189	0	101	-61	-615
1983	-630	-626	275	-576	68	337	-620	-352	-81	149	-69	-260
1984	-300	-227	72	-110	32	324	-39	-19	4	205	4	11
1985	26	-623	-7	-3	-1	320	-6	1	-5	-63	365	-30
1986	0	-4	-21	-8	-37	151	-33	-184	296	106	-118	-52
1987	208	6	78	-3	-1	3	-7	-5	3	-174	57	-26
1988	-3	-3	-12	-2	-4	5	-6	-4	-2	40	120	-5
1989	101	46	-172	-4	-2	2	27	126	0	105	-135	-418
1990	-8	176	0	-2	4	4	78	111	2	29	255	-2
1991	-149	0	154	88	-15	0	-4	84	5	460	-89	-1
Avg	-44	-96	25	-40	2	86	-93	-42	19	73	21	-77
W/AN/BN	-138	-168	58	-101	10	147	-220	-137	43	122	-52	-147
D/C	29	-40	0	8	-3	38	6	32	1	35	78	-23

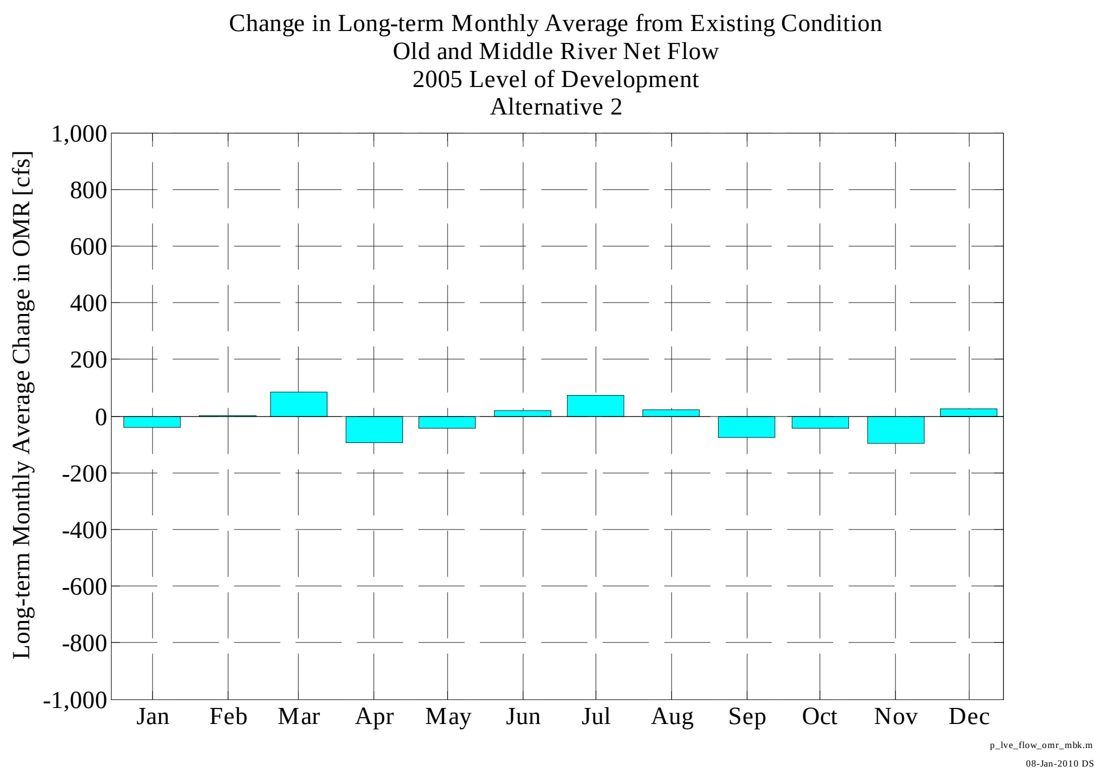


Old and Middle River Net Flow
2005 Level of Development
January - June
Tidal Residual OMR [cfs], Alt 2
Tidal Residual OMR [cfs], Existing Condition
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
1:1 line
p_lve_flow_omr_mbk.m
08-Jan-2010 DS



Old and Middle River Net Flow
2005 Level of Development
Tidal Residual OMR [cfs]
Existing Condition
Alternative 2
change in OMR
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Old and Middle River Net Flow
2005 Level of Development
Long-term Monthly Average OMR [cfs]
2,000
1,000
0
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
-7,000
-8,000
-9,000
-10,000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Existing Condition
Alternative 2
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Change in Long-term Monthly Average from Existing Condition
Old and Middle River Net Flow
2005 Level of Development
Alternative 2
Long-term Monthly Average Change in OMR [cfs]
1,000
800
600
400
200
0
-200
-400
-600
-800
-1,000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
p_lve_flow_omr_mbk.m
08-Jan-2010 DS

Alternative 4

Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

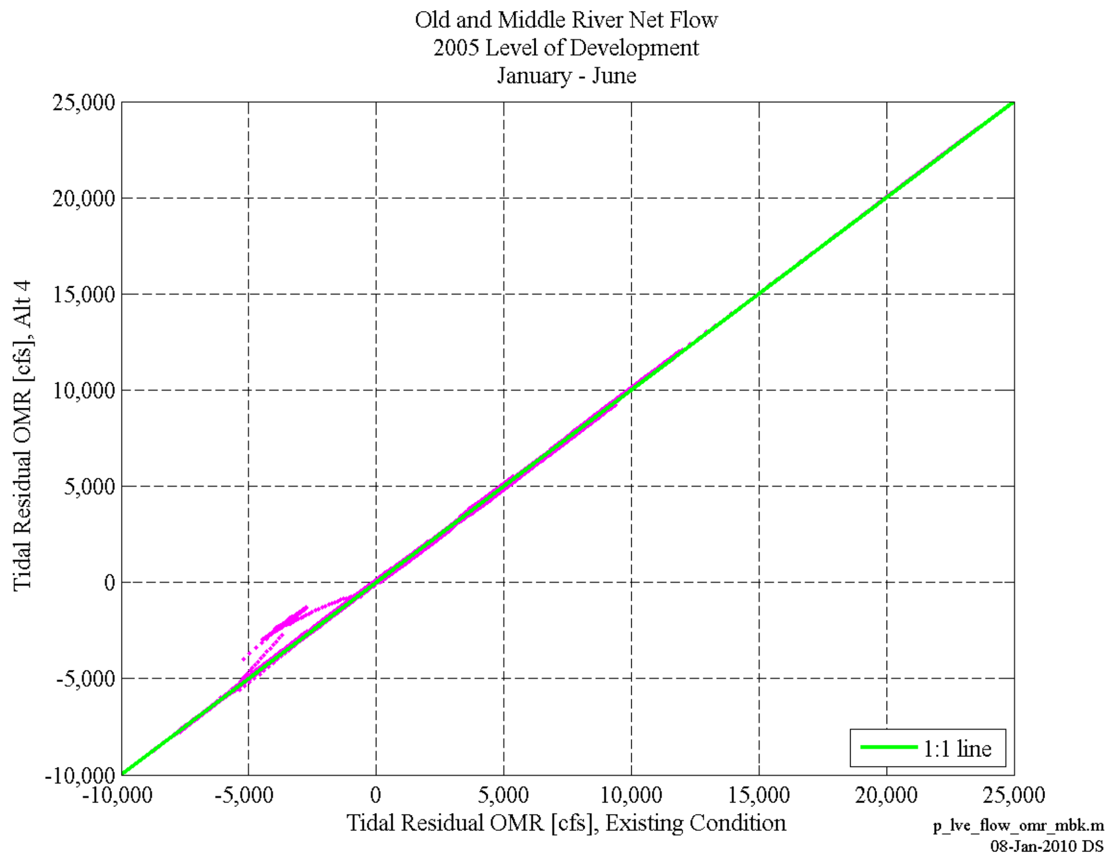
Alternative 4
2005 Level of Development

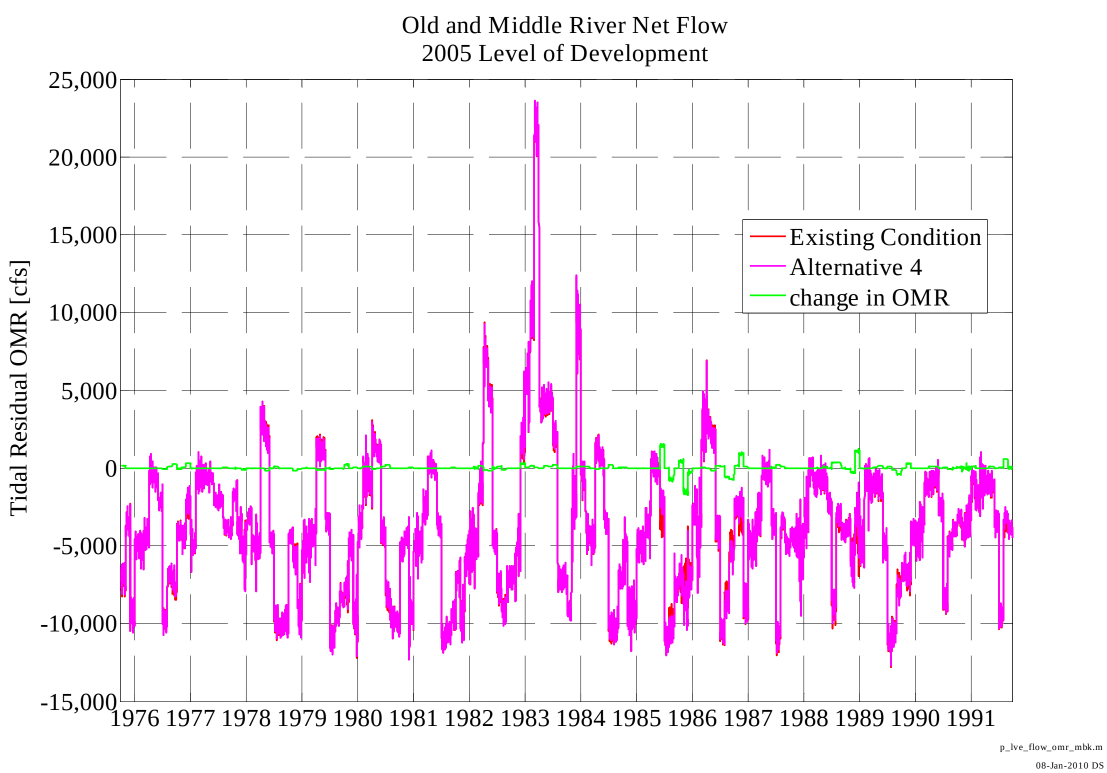
Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	-6,918	-3,681	-9,274	-4,953	-4,907	-4,382	-362	-644	-2,136	-9,723	-6,801	-7,562
1977	-4,138	-4,431	-2,075	-4,776	-624	-659	-672	-641	-2,143	-1,973	-3,712	-3,998
1978	-1,826	-3,771	-5,206	-3,236	-5,040	-5,041	2,988	1,890	-4,690	-9,908	-10,259	-9,890
1979	-4,539	-5,764	-9,383	-5,081	-5,072	-4,290	1,057	1,159	-3,437	-10,975	-9,595	-8,389
1980	-7,662	-4,999	-9,475	-3,733	-852	-710	1,503	958	-4,215	-8,180	-9,721	-10,020
1981	-5,256	-4,410	-9,235	-4,908	-4,950	-2,672	281	-69	-3,542	-11,009	-10,563	-9,569
1982	-7,118	-9,684	-5,847	-4,513	-5,121	-1,203	7,120	4,560	-4,545	-7,814	-9,312	-7,223
1983	-7,037	-5,057	1,844	5,708	10,004	21,605	4,528	4,265	4,344	1,956	-6,908	-7,119
1984	-8,858	-2,513	8,181	-431	-3,980	-4,503	1,156	626	-3,469	-10,221	-10,216	-7,120
1985	-5,071	-9,283	-9,170	-4,958	-4,992	-3,673	252	-76	-2,097	-10,924	-10,407	-7,811
1986	-6,817	-8,484	-6,986	-2,816	-3,725	2,733	2,883	1,995	-3,967	-10,346	-8,696	-5,516
1987	-2,556	-2,573	-8,520	-4,867	-4,873	-2,735	-166	-240	-3,525	-10,671	-3,599	-4,896
1988	-4,410	-4,438	-5,490	-3,276	-85	-859	-446	-635	-2,231	-8,628	-2,955	-4,097
1989	-3,694	-5,914	-2,866	-4,923	-772	-1,154	-937	-1,212	-5,066	-11,014	-10,599	-7,797
1990	-6,609	-6,747	-4,138	-4,862	-3,458	-1,222	-886	-576	-2,385	-8,375	-4,884	-4,006
1991	-3,181	-3,990	-2,979	-744	-1,958	-904	-906	-1,080	-3,533	-9,421	-3,204	-3,908
Avg	-5,356	-5,359	-5,039	-3,273	-2,525	-604	1,087	643	-2,915	-8,577	-7,590	-6,808
W/AN/BN	-6,265	-5,753	-3,839	-2,014	-1,969	1,227	3,033	2,208	-2,854	-7,927	-9,244	-7,897
D/C	-4,648	-5,052	-5,972	-4,252	-2,957	-2,029	-427	-575	-2,962	-9,082	-6,303	-5,960

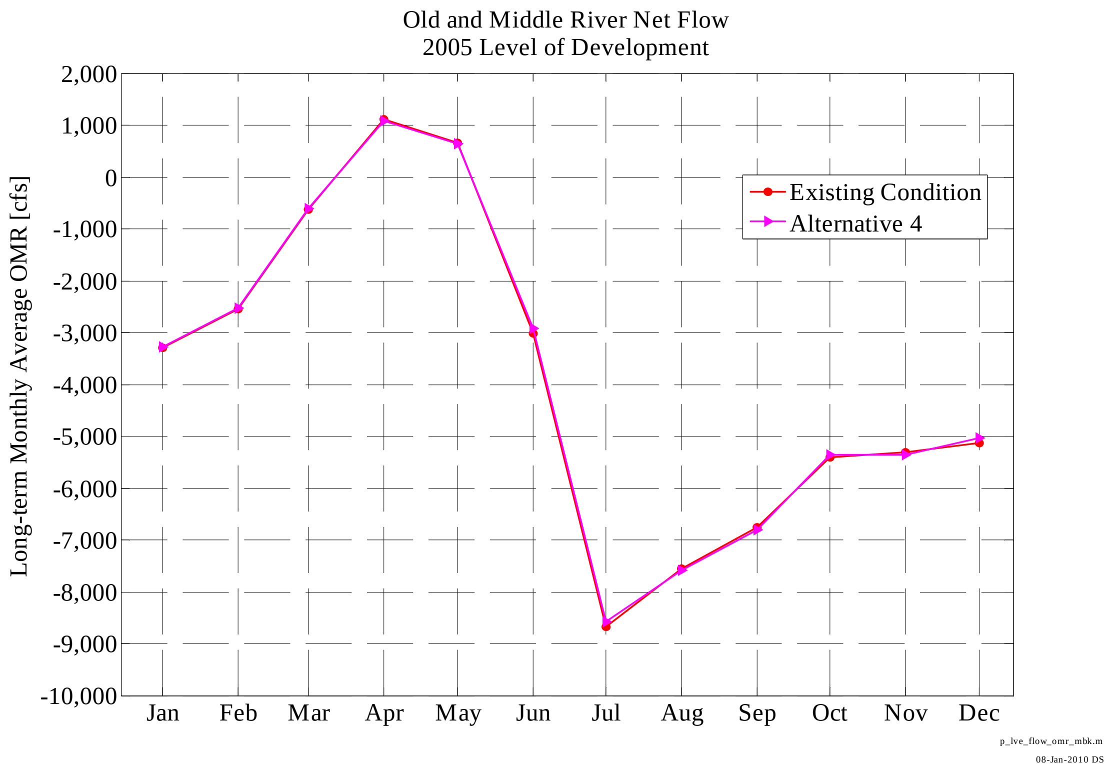
Change in Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

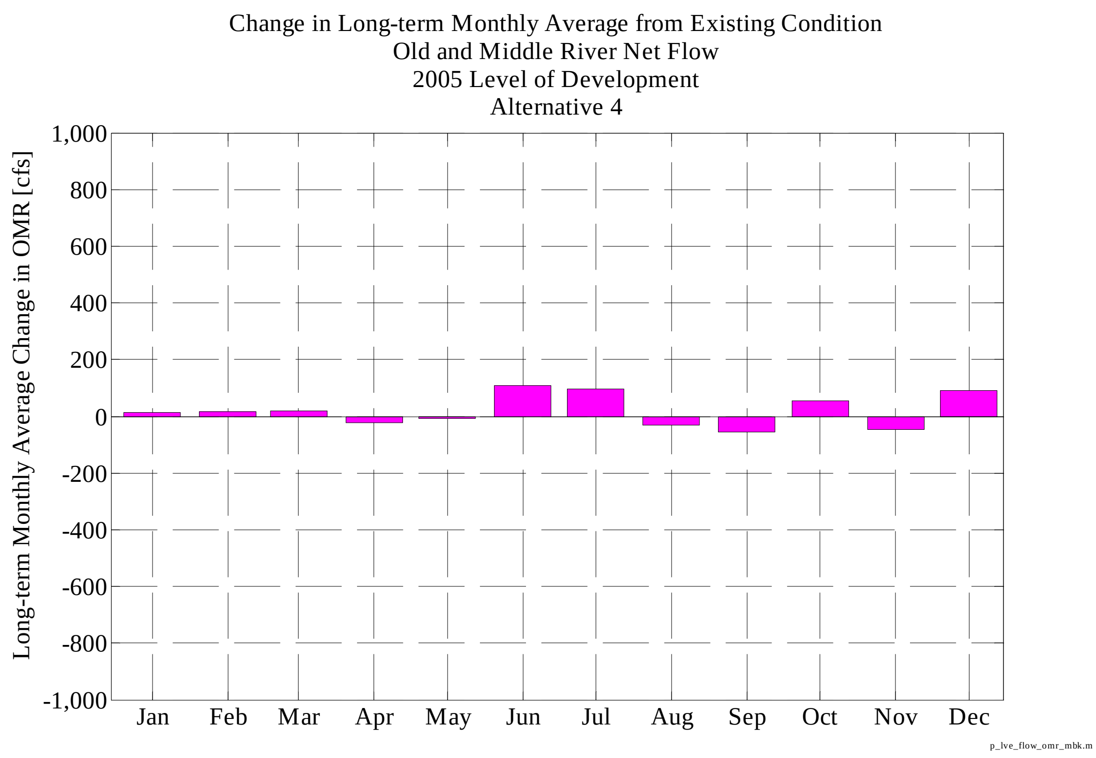
Alternative 4 - Existing Condition
2005 Level of Development

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	127	-9	0	0	0	2	-3	0	0	-43	94	248
1977	-36	38	291	4	4	0	1	-1	0	0	34	1
1978	1	0	-93	-1	0	0	-27	-159	-3	108	0	0
1979	-20	-186	-70	-1	0	1	-138	-141	0	-52	2	-30
1980	212	-5	63	-2	76	99	-87	-16	79	199	-3	-3
1981	2	-1	31	0	0	1	-4	-13	2	-2	-15	19
1982	-3	-13	1	-1	-4	131	-137	-160	-3	105	-130	-3
1983	0	0	284	43	123	30	-2	136	83	197	-3	-2
1984	-1	2	77	75	87	2	-49	-16	1	187	-3	13
1985	19	0	0	-1	-2	1	-4	1	1,429	19	-733	-26
1986	411	-1,486	-296	-4	9	36	-33	-159	132	105	-574	-724
1987	150	916	87	0	0	2	-3	0	3	187	90	1
1988	-1	1	-5	0	1	1	-3	58	4	344	345	1
1989	-53	-278	1,073	14	-22	0	33	135	4	101	-106	-396
1990	-9	270	4	-1	4	0	78	115	2	43	-52	-6
1991	58	-5	-6	108	1	0	1	91	0	36	565	21
Avg	54	-47	90	15	17	19	-23	-8	108	96	-31	-55
W/AN/BN	86	-241	-5	16	42	43	-68	-74	41	121	-102	-107
D/C	29	104	164	14	-2	1	11	43	160	76	25	-15


Old and Middle River Net Flow
2005 Level of Development
January - June
Tidal Residual OMR [cfs], Alt 4
Tidal Residual OMR [cfs], Existing Condition
1:1 line
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-10,000
-5,000
0
5,000
10,000
15,000
20,000
25,000
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Old and Middle River Net Flow
2005 Level of Development
Tidal Residual OMR [cfs]
Existing Condition
Alternative 4
change in OMR
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Old and Middle River Net Flow
2005 Level of Development
Long-term Monthly Average OMR [cfs]
2,000
1,000
0
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
-7,000
-8,000
-9,000
-10,000
Existing Condition
Alternative 4
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Change in Long-term Monthly Average from Existing Condition
Old and Middle River Net Flow
2005 Level of Development
Alternative 4
Long-term Monthly Average Change in OMR [cfs]
1,000
800
600
400
200
0
-200
-400
-600
-800
-1,000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
p_lve_flow_omr_mbk.m
08-Jan-2010 DS

2030 Level of Development

Existing Condition

Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

Future Without Project
2030 Level of Development

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	-6,378	-3,660	-8,471	-4,956	-4,919	-4,405	-356	-629	-2,278	-9,045	-6,868	-6,808
1977	-5,056	-3,271	-7,184	-1,366	-699	-826	-673	-438	-2,563	-4,983	-2,118	-3,863
1978	-2,538	-3,748	-4,972	-3,229	-5,051	-5,056	3,047	1,888	-4,680	-9,901	-10,309	-9,994
1979	-4,075	-5,830	-9,255	-5,086	-5,081	-4,287	1,453	1,457	-3,433	-11,075	-9,706	-8,493
1980	-7,719	-5,129	-9,840	-3,758	1,593	450	1,604	1,283	-3,864	-8,156	-9,762	-9,947
1981	-3,993	-3,030	-9,573	-4,918	-4,958	-2,728	863	-199	-3,547	-11,150	-10,752	-9,724
1982	-8,039	-10,028	-5,855	-4,513	-5,124	-2,432	7,860	4,705	-4,519	-7,585	-9,196	-7,348
1983	-7,226	-5,280	3,364	3,888	10,428	21,676	5,414	4,328	4,403	1,745	-6,929	-7,229
1984	-9,007	-2,329	8,298	-178	-3,718	-4,421	1,481	599	-3,471	-10,280	-10,364	-9,999
1985	-5,164	-9,552	-4,963	-4,908	-5,001	-3,739	524	-452	-3,535	-11,025	-10,550	-7,941
1986	-6,238	-7,394	-7,232	-2,817	-3,909	5,395	3,271	1,845	-3,622	-10,377	-8,162	-4,455
1987	-2,094	-1,358	-8,551	-4,871	-4,870	-2,793	-155	-227	-3,535	-9,675	-3,315	-4,827
1988	-4,644	-4,529	-5,664	-3,280	-221	-881	-183	-444	-2,337	-8,052	-2,520	-3,994
1989	-2,924	-6,673	-2,825	-4,924	-752	-1,164	-536	-1,231	-5,072	-11,113	-10,728	-8,285
1990	-5,604	-4,775	-4,569	-4,870	-3,644	-1,222	-835	-594	-2,507	-8,919	-7,264	-4,045
1991	-1,999	-4,003	-3,476	-483	-1,954	-950	-345	-1,061	-3,356	-8,699	-2,244	-3,821
Avg	-5,169	-5,037	-5,048	-3,142	-2,367	-461	1,402	677	-2,995	-8,643	-7,549	-6,923
W/AN/BN	-6,406	-5,677	-3,642	-2,242	-1,552	1,618	3,447	2,301	-2,741	-7,947	-9,204	-8,209
D/C	-4,206	-4,539	-6,142	-3,842	-3,002	-2,079	-188	-586	-3,192	-9,185	-6,262	-5,923

Alternative 1

Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

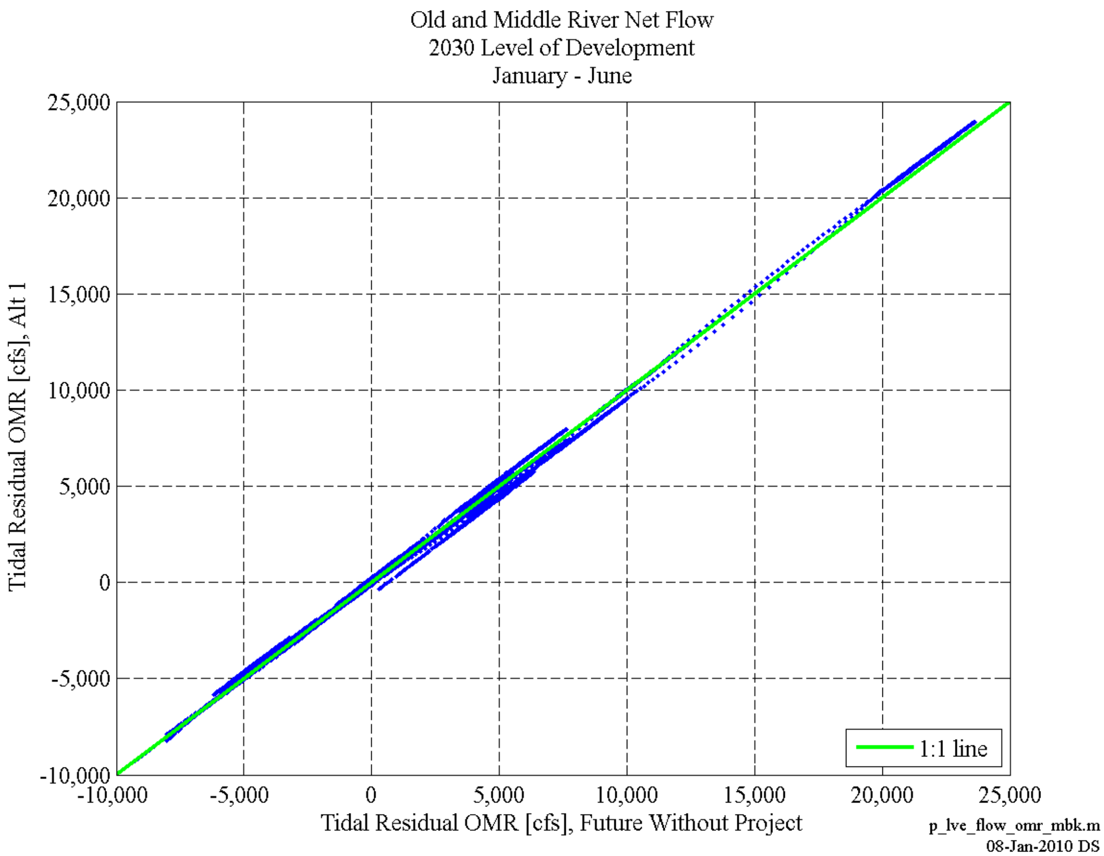
Alternative 1
2030 Level of Development

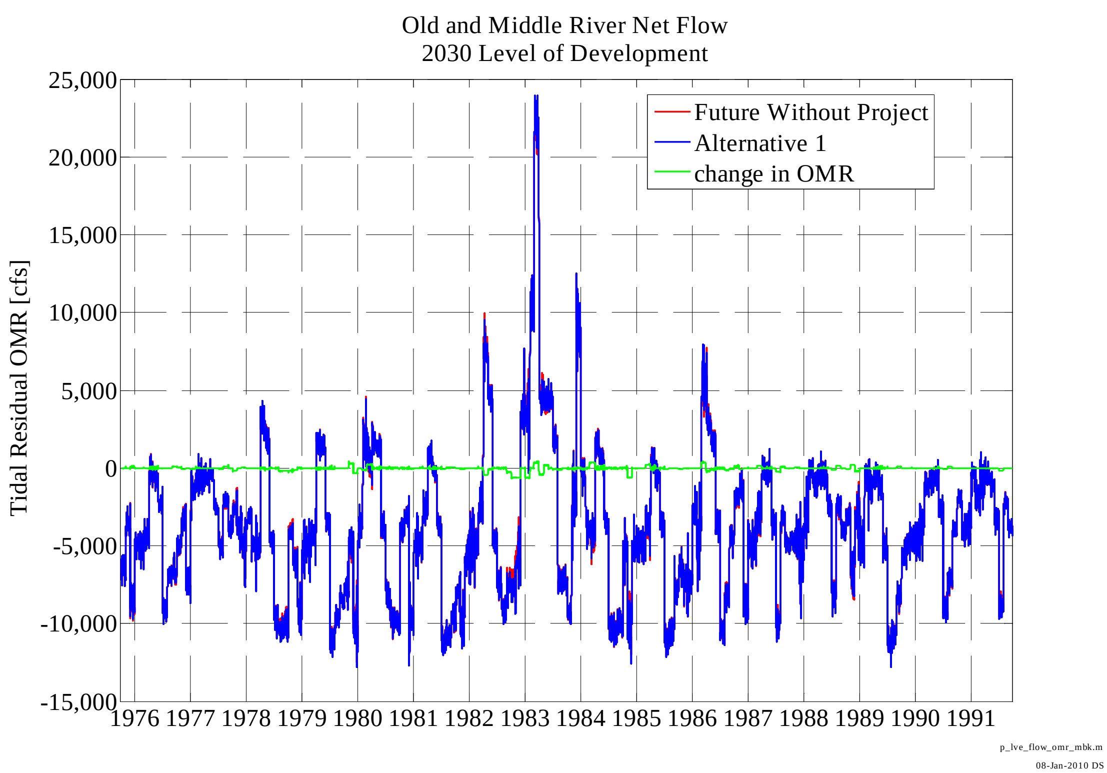
Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	-6,375	-3,667	-8,377	-4,955	-4,920	-4,405	-368	-644	-2,271	-9,054	-6,875	-6,721
1977	-4,997	-3,336	-7,199	-1,410	-688	-829	-673	-438	-2,563	-5,022	-2,028	-3,859
1978	-2,698	-3,750	-4,945	-3,229	-5,051	-5,056	3,044	1,812	-4,676	-9,904	-10,504	-10,155
1979	-4,270	-5,958	-9,267	-5,087	-5,081	-4,286	1,442	1,454	-3,434	-11,110	-9,704	-8,490
1980	-7,717	-4,846	-10,156	-3,761	1,483	670	1,599	1,285	-3,859	-8,159	-9,764	-9,949
1981	-3,990	-3,034	-9,608	-4,921	-4,960	-2,726	857	-213	-3,551	-11,199	-10,743	-9,697
1982	-8,040	-10,069	-5,859	-4,515	-5,121	-2,432	7,417	4,644	-4,517	-7,586	-9,197	-7,620
1983	-7,852	-5,907	3,365	3,263	10,421	22,015	4,995	4,499	4,394	1,683	-7,017	-7,247
1984	-9,030	-2,377	8,296	-240	-3,723	-4,078	1,485	590	-3,466	-10,282	-10,388	-9,996
1985	-5,155	-10,142	-4,968	-4,908	-5,001	-3,520	467	-448	-3,544	-11,073	-10,573	-7,961
1986	-6,296	-7,395	-7,246	-2,818	-3,908	5,749	3,102	1,768	-3,619	-10,381	-8,297	-4,496
1987	-1,977	-1,411	-8,558	-4,872	-4,871	-2,661	-158	-234	-3,534	-9,906	-3,242	-4,830
1988	-4,645	-4,498	-5,666	-3,281	-224	-877	-186	-448	-2,340	-8,163	-2,375	-4,023
1989	-2,995	-6,483	-3,018	-4,928	-755	-1,163	-547	-1,245	-5,075	-11,141	-10,727	-8,216
1990	-5,610	-4,776	-4,562	-4,871	-3,644	-1,222	-835	-601	-2,505	-8,964	-7,191	-4,044
1991	-1,993	-4,004	-3,477	-483	-1,956	-950	-349	-1,067	-3,375	-8,878	-2,277	-3,822
Avg	-5,227	-5,103	-5,078	-3,189	-2,375	-361	1,331	670	-2,996	-8,696	-7,556	-6,945
W/AN/BN	-6,557	-5,757	-3,687	-2,341	-1,569	1,797	3,298	2,293	-2,740	-7,963	-9,267	-8,279
D/C	-4,193	-4,595	-6,159	-3,848	-3,002	-2,039	-199	-593	-3,195	-9,267	-6,226	-5,908

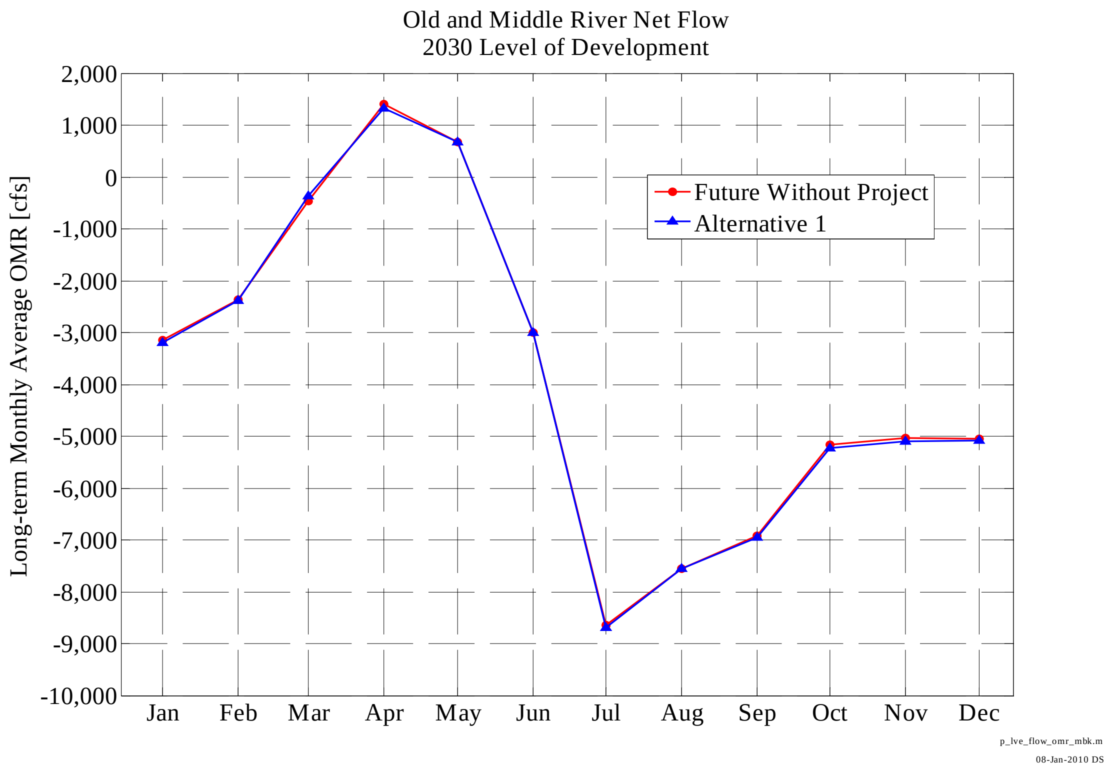
Change in Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

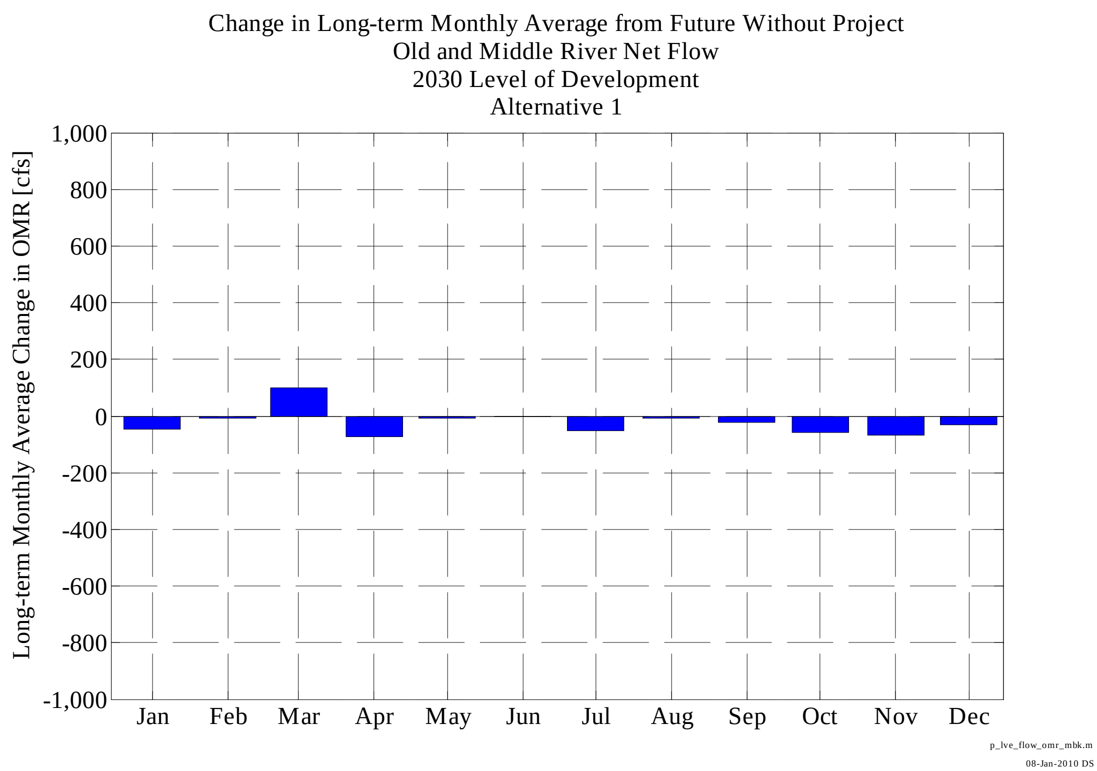
Alternative 1 - Future Without Project
2030 Level of Development

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	3	-8	94	0	-2	0	-12	-15	7	-10	-8	86
1977	59	-65	-15	-45	11	-2	0	0	0	-40	90	4
1978	-161	-2	28	0	0	0	-3	-76	4	-3	-195	-162
1979	-195	-128	-12	-2	0	0	-11	-3	-1	-35	2	3
1980	2	283	-316	-2	-111	220	-5	2	5	-3	-2	-1
1981	3	-5	-35	-3	-2	2	-6	-15	-5	-48	10	27
1982	-1	-41	-3	-2	2	0	-444	-60	2	-1	-1	-272
1983	-626	-626	1	-625	-7	340	-420	170	-9	-62	-88	-18
1984	-23	-49	-2	-61	-5	343	4	-9	6	-2	-24	3
1985	9	-591	-5	0	0	219	-57	4	-9	-48	-23	-20
1986	-57	-1	-14	-1	1	354	-169	-77	3	-5	-136	-42
1987	118	-53	-7	-1	-1	133	-4	-7	0	-232	72	-3
1988	-2	31	-3	-1	-3	4	-2	-4	-3	-111	145	-29
1989	-71	190	-193	-4	-3	1	-11	-14	-3	-28	1	69
1990	-6	-1	7	-1	0	0	0	-7	2	-45	73	1
1991	6	-1	-1	0	-1	0	-4	-5	-19	-179	-33	0
Avg	-59	-67	-30	-47	-7	101	-71	-7	-1	-53	-7	-22
W/AN/BN	-152	-80	-46	-99	-17	180	-150	-8	1	-16	-63	-70
D/C	13	-56	-18	-6	0	40	-11	-7	-3	-82	36	15


Old and Middle River Net Flow
2030 Level of Development
January - June
Tidal Residual OMR [cfs], Alt 1
Tidal Residual OMR [cfs], Future Without Project
1:1 line
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Old and Middle River Net Flow
2030 Level of Development
Tidal Residual OMR [cfs]
Future Without Project
Alternative 1
change in OMR
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Old and Middle River Net Flow
2030 Level of Development
Long-term Monthly Average OMR [cfs]
2,000
1,000
0
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
-7,000
-8,000
-9,000
-10,000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Future Without Project
Alternative 1
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Change in Long-term Monthly Average from Future Without Project
Old and Middle River Net Flow
2030 Level of Development
Alternative 1
Long-term Monthly Average Change in OMR [cfs]
1,000
800
600
400
200
0
-200
-400
-600
-800
-1,000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
p_lve_flow_omr_mbk.m
08-Jan-2010 DS

Alternative 2

Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

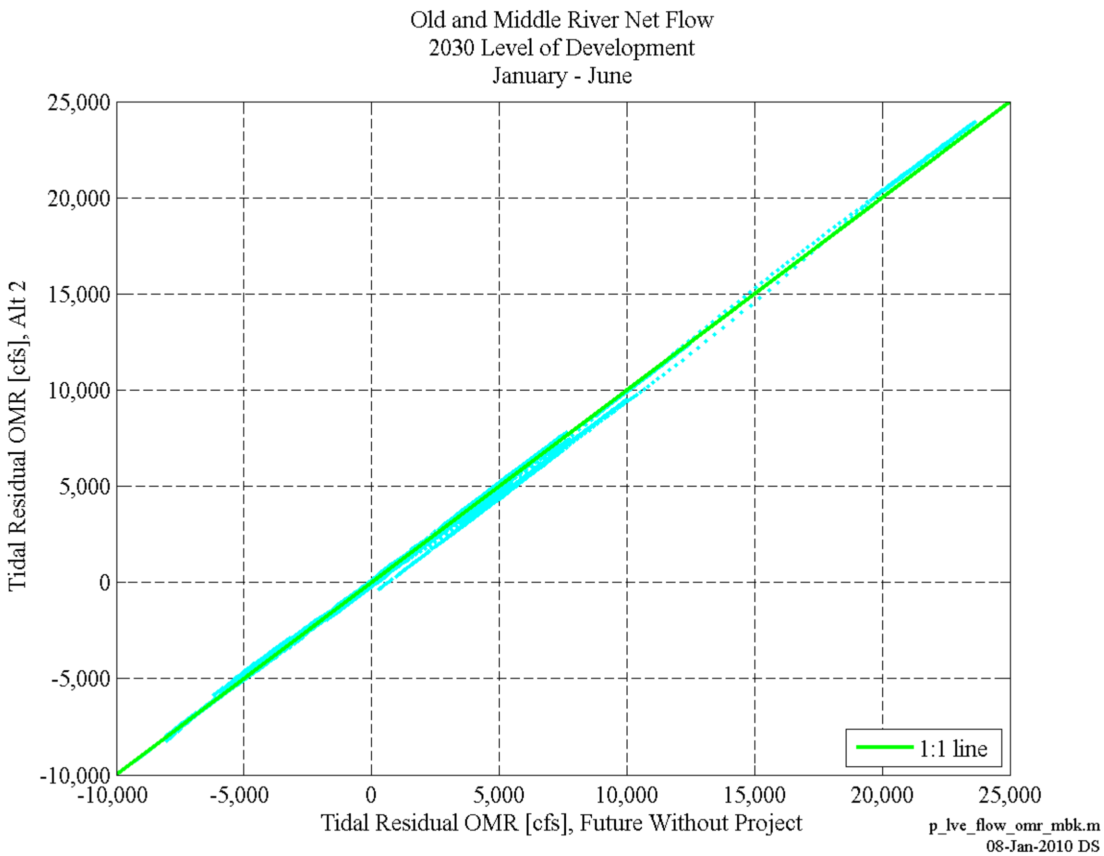
Alternative 2
2030 Level of Development

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	-6,375	-3,662	-8,417	-4,956	-4,920	-4,405	-368	-644	-2,271	-9,050	-6,872	-6,719
1977	-4,997	-3,334	-7,199	-1,392	-687	-829	-673	-438	-2,563	-5,016	-2,026	-3,859
1978	-2,709	-3,750	-4,934	-3,229	-5,051	-5,056	3,044	1,812	-4,676	-9,904	-10,504	-10,155
1979	-4,267	-5,957	-9,266	-5,087	-5,081	-4,286	1,441	1,454	-3,434	-11,110	-9,704	-8,487
1980	-7,716	-4,845	-10,156	-3,761	1,436	548	1,595	1,284	-3,859	-8,159	-9,764	-9,949
1981	-3,991	-3,034	-9,608	-4,921	-4,960	-2,726	857	-213	-3,551	-11,199	-10,743	-9,698
1982	-8,040	-10,155	-5,859	-4,515	-5,121	-2,432	7,374	4,647	-4,516	-7,588	-9,198	-7,614
1983	-7,853	-5,907	3,365	3,262	10,368	21,993	4,808	3,904	4,239	1,421	-7,013	-7,488
1984	-9,307	-2,555	8,293	-365	-3,768	-4,101	1,485	590	-3,465	-10,282	-10,388	-9,996
1985	-5,155	-10,174	-4,968	-4,908	-5,001	-3,520	466	-448	-3,542	-11,077	-10,577	-7,964
1986	-6,323	-7,396	-7,248	-2,818	-3,908	5,570	3,100	1,768	-3,619	-10,381	-8,296	-4,486
1987	-2,006	-1,412	-8,558	-4,871	-4,871	-2,793	-160	-234	-3,534	-9,906	-3,243	-4,830
1988	-4,645	-4,498	-5,666	-3,281	-224	-877	-186	-448	-2,340	-8,164	-2,376	-4,023
1989	-2,987	-6,484	-3,030	-4,928	-754	-1,163	-547	-1,245	-5,075	-11,143	-10,723	-8,211
1990	-5,611	-4,776	-4,560	-4,871	-3,644	-1,222	-835	-601	-2,505	-8,963	-7,207	-4,044
1991	-1,994	-4,004	-3,477	-483	-1,956	-950	-349	-1,067	-3,373	-8,866	-2,273	-3,821
Avg	-5,249	-5,121	-5,081	-3,195	-2,384	-391	1,316	633	-3,005	-8,712	-7,557	-6,959
W/AN/BN	-6,602	-5,795	-3,687	-2,359	-1,589	1,748	3,264	2,209	-2,762	-8,000	-9,267	-8,311
D/C	-4,196	-4,598	-6,165	-3,846	-3,002	-2,054	-199	-593	-3,195	-9,265	-6,227	-5,908

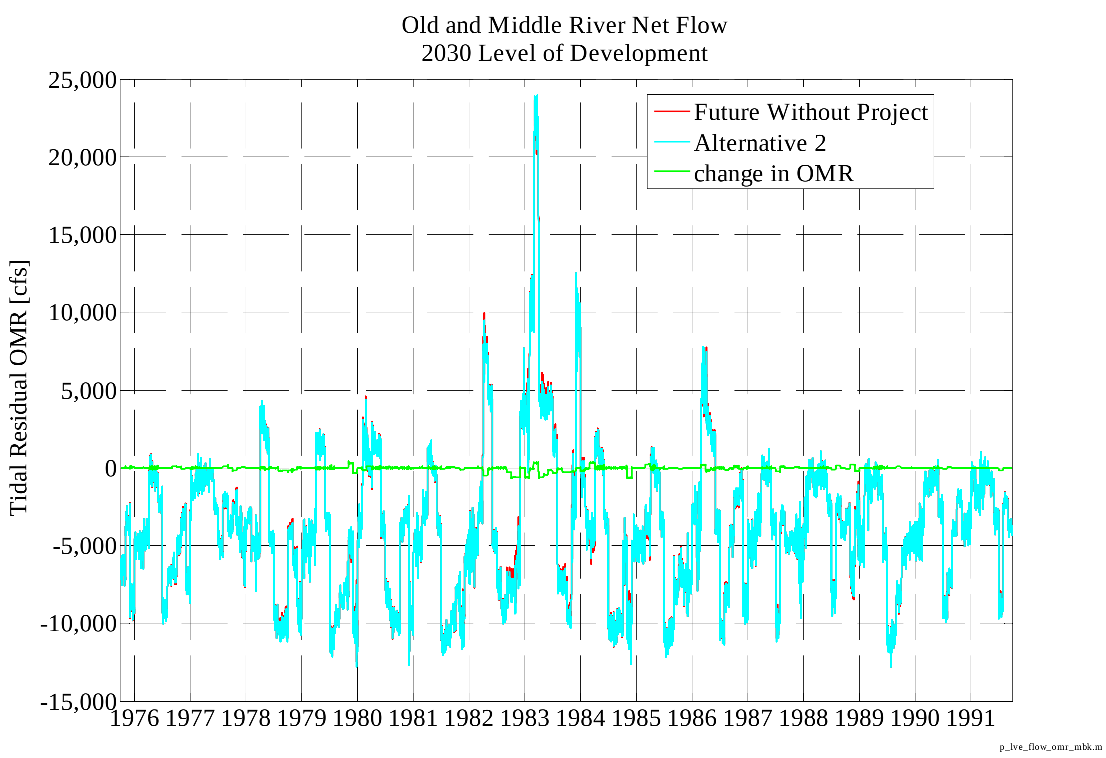
Change in Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

Alternative 2 - Future Without Project
2030 Level of Development

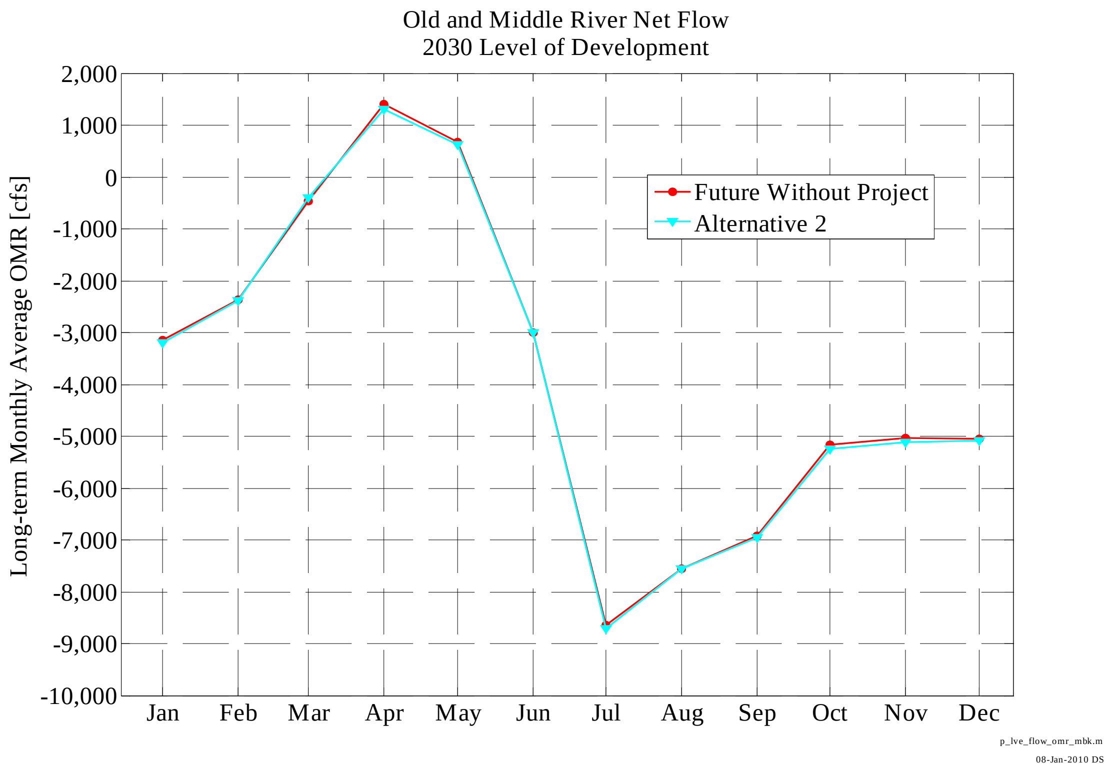
Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	3	-2	54	0	-2	0	-12	-15	7	-6	-5	89
1977	59	-63	-15	-26	12	-2	0	0	0	-33	92	4
1978	-171	-2	39	0	0	0	-3	-76	4	-3	-195	-162
1979	-192	-127	-11	-2	0	0	-12	-3	-1	-35	2	6
1980	3	284	-316	-2	-157	98	-10	2	5	-3	-2	-1
1981	2	-5	-35	-3	-2	2	-6	-14	-5	-48	9	26
1982	-1	-127	-4	-2	2	-1	-486	-58	3	-2	-1	-267
1983	-628	-626	1	-626	-60	317	-607	-424	-164	-323	-84	-259
1984	-300	-227	-5	-187	-50	320	4	-9	6	-2	-24	2
1985	9	-622	-5	0	0	219	-58	4	-7	-52	-27	-23
1986	-85	-1	-16	-1	1	175	-171	-77	3	-5	-135	-31
1987	88	-54	-7	-1	-1	0	-5	-7	0	-231	72	-3
1988	-2	31	-3	-1	-3	4	-2	-4	-3	-112	144	-29
1989	-64	189	-205	-4	-3	1	-11	-14	-3	-30	4	74
1990	-6	-1	9	-1	0	0	0	-7	2	-43	58	1
1991	5	-1	-1	0	-1	0	-4	-5	-17	-167	-29	0
Avg	-80	-85	-33	-53	-16	71	-86	-44	-11	-68	-8	-36
W/AN/BN	-196	-118	-45	-117	-38	130	-183	-92	-21	-53	-63	-102
D/C	10	-59	-23	-4	0	25	-11	-7	-3	-80	35	15

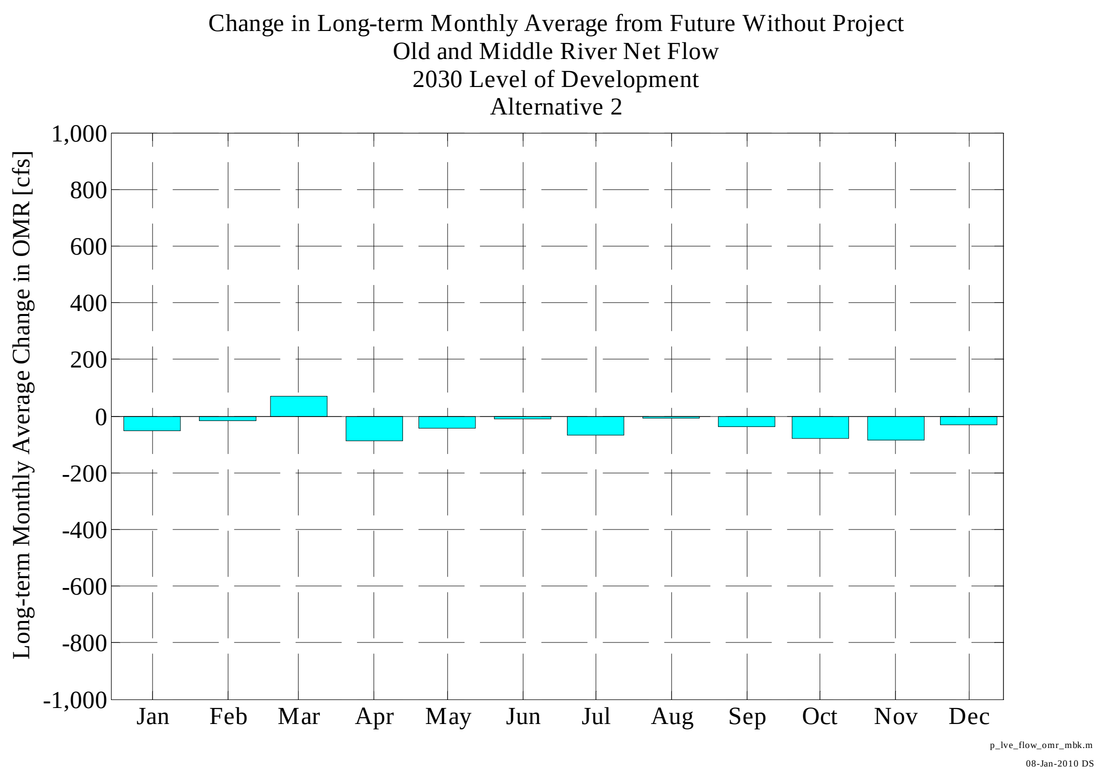


Old and Middle River Net Flow
2030 Level of Development
January - June
Tidal Residual OMR [cfs], Alt 2
Tidal Residual OMR [cfs], Future Without Project
1:1 line
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
p_lve_flow_omr_mbk.m
08-Jan-2010 DS



Old and Middle River Net Flow
2030 Level of Development
Tidal Residual OMR [cfs]
Future Without Project
Alternative 2
change in OMR
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Old and Middle River Net Flow
2030 Level of Development
Long-term Monthly Average OMR [cfs]
2,000
1,000
0
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
-7,000
-8,000
-9,000
-10,000
Future Without Project
Alternative 2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Change in Long-term Monthly Average from Future Without Project
Old and Middle River Net Flow
2030 Level of Development
Alternative 2
Long-term Monthly Average Change in OMR [cfs]
1,000
800
600
400
200
0
-200
-400
-600
-800
-1,000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
p_lve_flow_omr_mbk.m
08-Jan-2010 DS

Alternative 4

Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

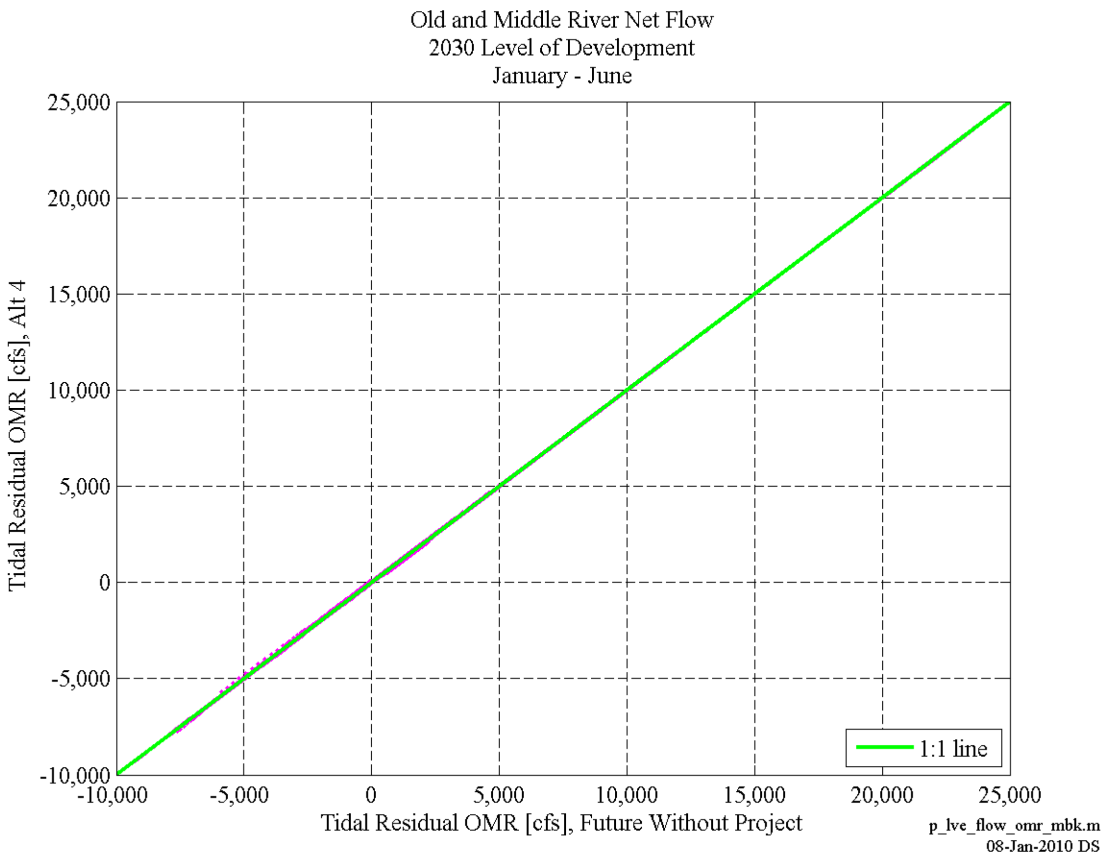
Alternative 4
2030 Level of Development

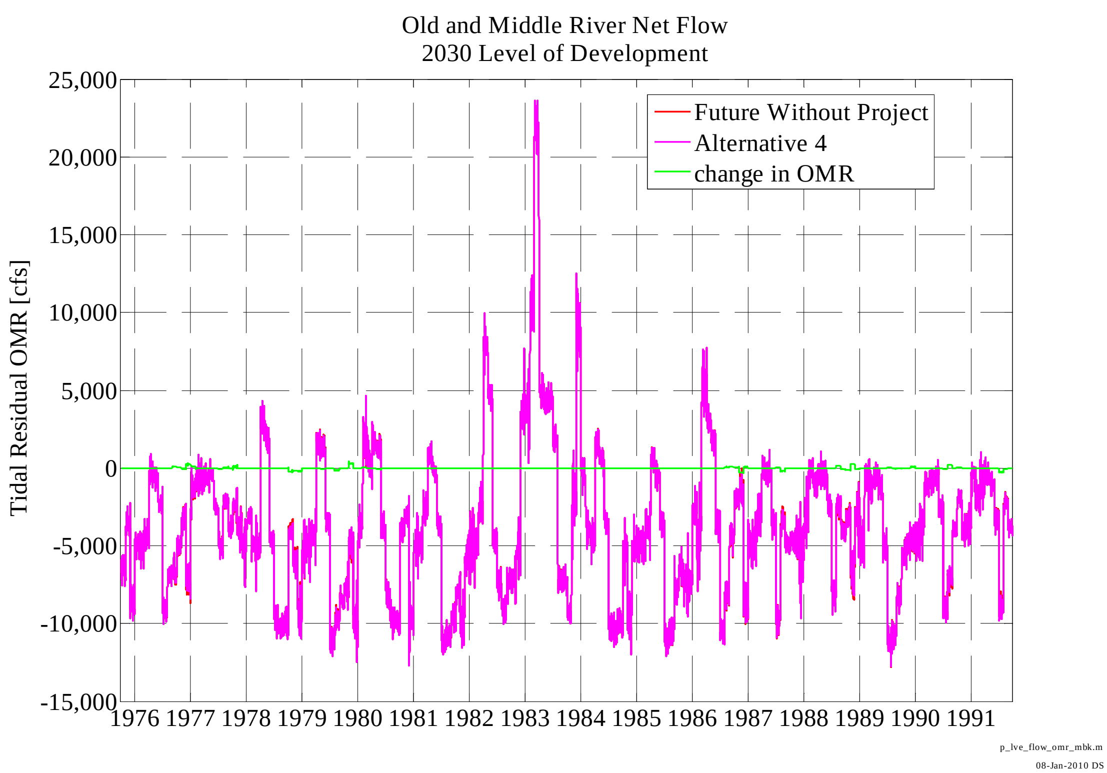
Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	-6,378	-3,661	-8,476	-4,956	-4,918	-4,405	-356	-629	-2,278	-9,040	-6,865	-6,713
1977	-4,998	-3,308	-6,950	-1,273	-701	-826	-673	-437	-2,562	-5,039	-2,106	-3,863
1978	-2,460	-3,776	-4,967	-3,229	-5,051	-5,056	3,047	1,888	-4,680	-9,901	-10,309	-9,994
1979	-4,287	-6,022	-9,456	-5,086	-5,078	-4,286	1,429	1,379	-3,433	-11,079	-9,857	-8,507
1980	-7,726	-4,847	-9,836	-3,758	1,645	450	1,604	1,193	-3,865	-8,163	-9,765	-9,950
1981	-3,987	-3,030	-9,572	-4,918	-4,958	-2,728	863	-201	-3,547	-11,150	-10,760	-9,739
1982	-8,039	-10,034	-5,855	-4,513	-5,124	-2,429	7,860	4,703	-4,519	-7,593	-9,200	-7,350
1983	-7,226	-5,280	3,363	3,889	10,428	21,676	5,415	4,325	4,403	1,744	-6,933	-7,232
1984	-9,009	-2,327	8,298	-178	-3,718	-4,421	1,477	596	-3,471	-10,281	-10,364	-10,002
1985	-5,166	-9,552	-4,963	-4,908	-5,001	-3,739	524	-452	-3,535	-11,025	-10,547	-7,938
1986	-6,227	-7,394	-7,231	-2,816	-3,909	5,395	3,271	1,845	-3,622	-10,376	-8,097	-4,379
1987	-2,043	-1,659	-8,492	-4,870	-4,870	-2,793	-155	-227	-3,535	-9,636	-3,509	-4,825
1988	-4,644	-4,521	-5,663	-3,280	-221	-878	-182	-443	-2,337	-8,048	-2,365	-4,083
1989	-3,060	-6,430	-2,870	-4,925	-754	-1,164	-536	-1,231	-5,072	-11,092	-10,762	-8,324
1990	-5,632	-4,776	-4,498	-4,869	-3,645	-1,222	-835	-594	-2,507	-8,966	-7,063	-4,043
1991	-1,983	-4,004	-3,473	-483	-1,954	-950	-345	-1,062	-3,385	-8,955	-2,307	-3,822
Avg	-5,179	-5,039	-5,040	-3,136	-2,364	-461	1,401	666	-2,997	-8,663	-7,551	-6,923
W/AN/BN	-6,425	-5,669	-3,669	-2,242	-1,544	1,618	3,443	2,276	-2,741	-7,950	-9,218	-8,202
D/C	-4,210	-4,549	-6,106	-3,831	-3,003	-2,078	-188	-586	-3,195	-9,217	-6,254	-5,928

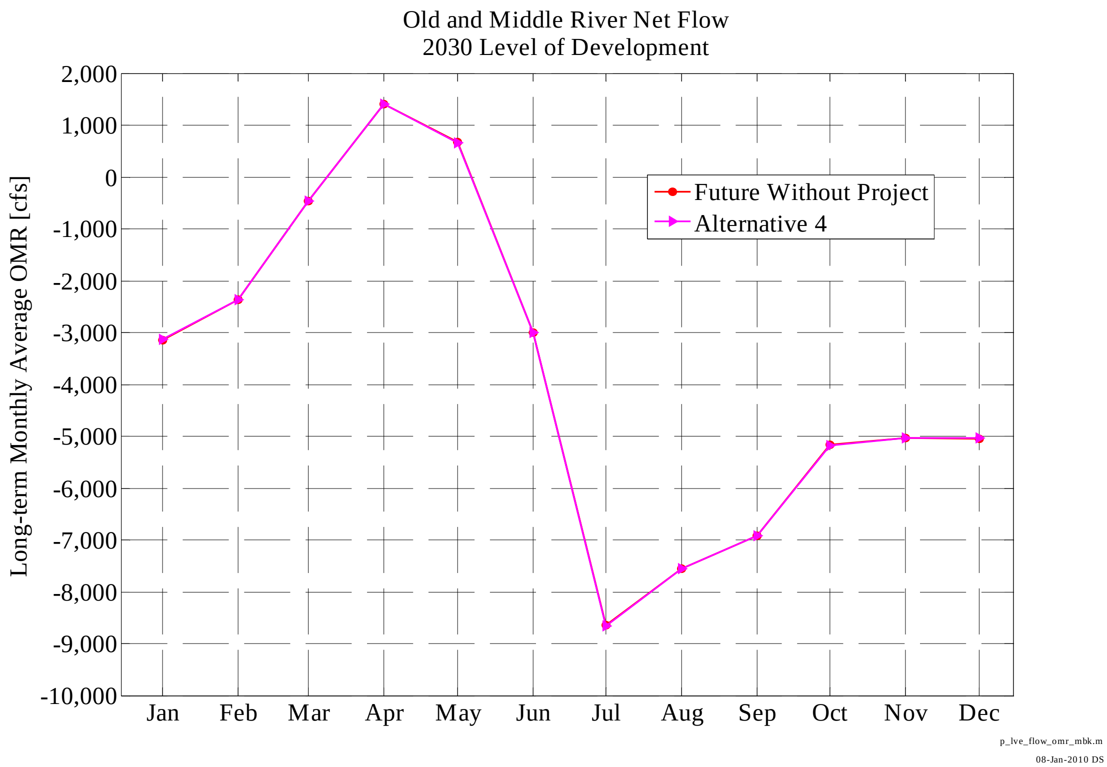
Change in Old and Middle River Net Flow
Monthly Average of Tidally Filtered Simulated Values (cfs)

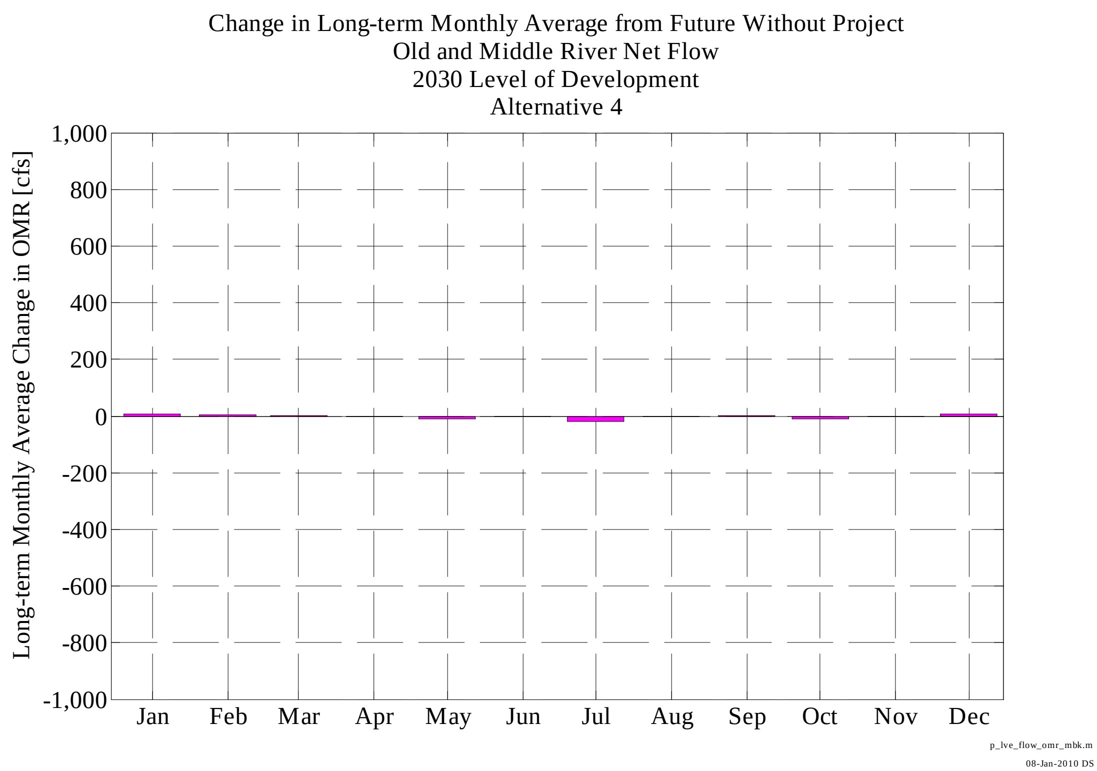
Alternative 4 - Future Without Project
2030 Level of Development

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	0	-1	-5	0	0	0	0	0	0	5	2	95
1977	58	-37	233	93	-2	1	0	1	0	-57	12	1
1978	78	-28	5	0	0	0	0	0	0	0	0	0
1979	-212	-192	-201	-1	3	0	-24	-78	0	-4	-151	-14
1980	-7	282	4	0	51	0	0	-89	-1	-8	-4	-3
1981	6	0	1	0	0	0	0	-3	0	0	-8	-15
1982	0	-6	0	0	0	3	0	-1	0	-8	-4	-2
1983	0	0	0	0	0	0	1	-3	0	0	-4	-2
1984	-1	2	0	0	0	0	-4	-3	0	0	0	-3
1985	-2	0	0	0	0	0	0	0	0	0	4	3
1986	11	0	1	1	0	0	0	0	0	0	65	76
1987	51	-300	58	1	0	0	0	0	0	39	-195	2
1988	0	7	1	0	0	4	1	1	0	3	155	-89
1989	-136	243	-45	-1	-3	0	0	0	0	21	-34	-38
1990	-28	-1	70	1	-1	0	0	0	0	-46	202	2
1991	16	0	2	0	0	0	0	0	-29	-256	-64	0
Avg	-10	-2	8	6	3	0	-2	-11	-2	-19	-1	1
W/AN/BN	-19	8	-27	0	8	1	-4	-25	0	-3	-14	7
D/C	-4	-10	35	10	-1	0	0	0	-3	-32	8	-4


Old and Middle River Net Flow
2030 Level of Development
January - June
Tidal Residual OMR [cfs], Alt 4
Tidal Residual OMR [cfs], Future Without Project
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-10,000
-5,000
0
5,000
10,000
15,000
20,000
25,000
1:1 line
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Old and Middle River Net Flow
2030 Level of Development
Tidal Residual OMR [cfs]
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991
Future Without Project
Alternative 4
change in OMR
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Old and Middle River Net Flow
2030 Level of Development
Long-term Monthly Average OMR [cfs]
2,000
1,000
0
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
-7,000
-8,000
-9,000
-10,000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Future Without Project
Alternative 4
p_lve_flow_omr_mbk.m
08-Jan-2010 DS


Change in Long-term Monthly Average from Future Without Project
Old and Middle River Net Flow
2030 Level of Development
Alternative 4
Long-term Monthly Average Change in OMR [cfs]
1,000
800
600
400
200
0
-200
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