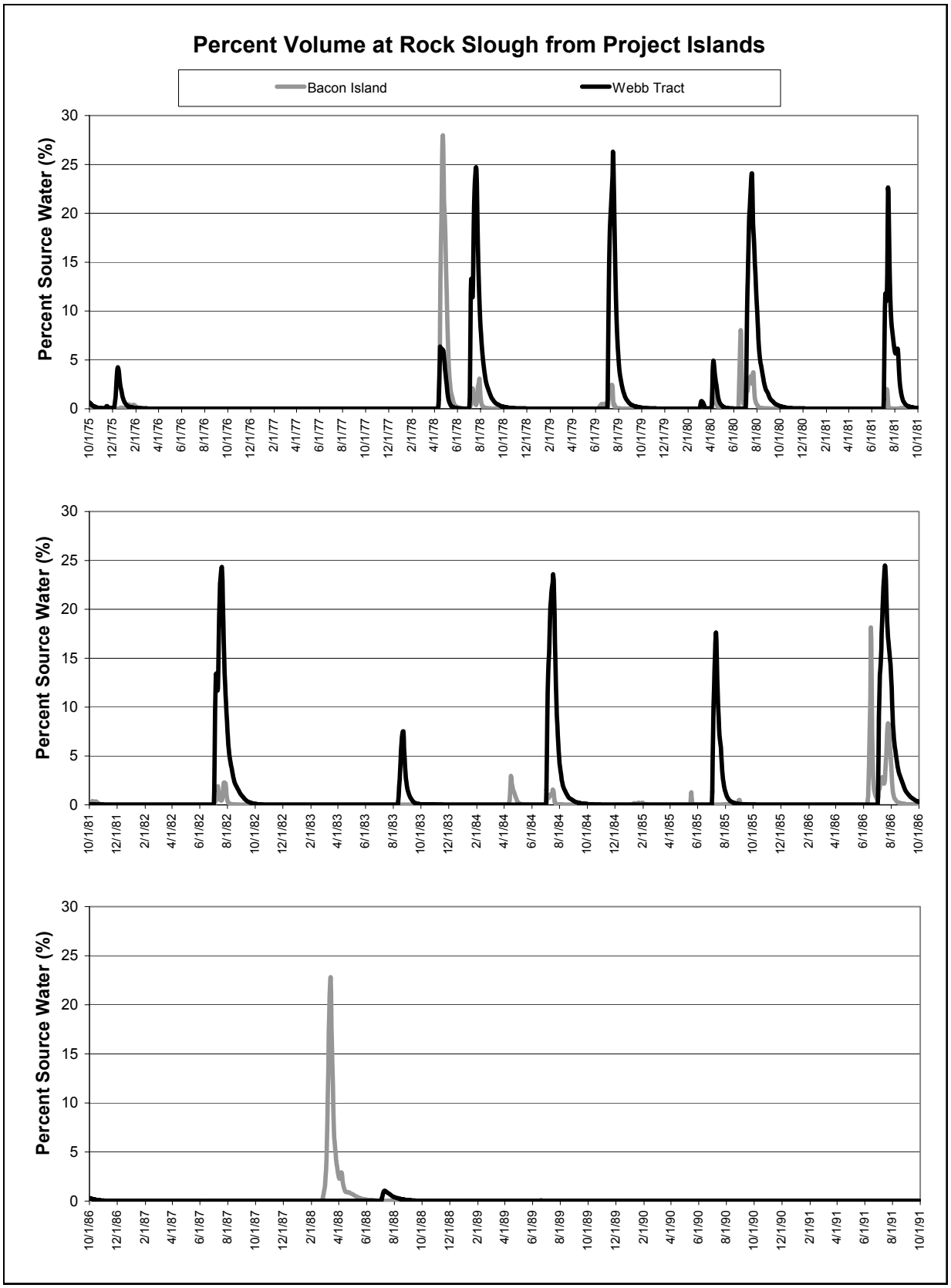

Figure 2.5.5: Percent Volume at Old River at Rock Slough from Project Islands.

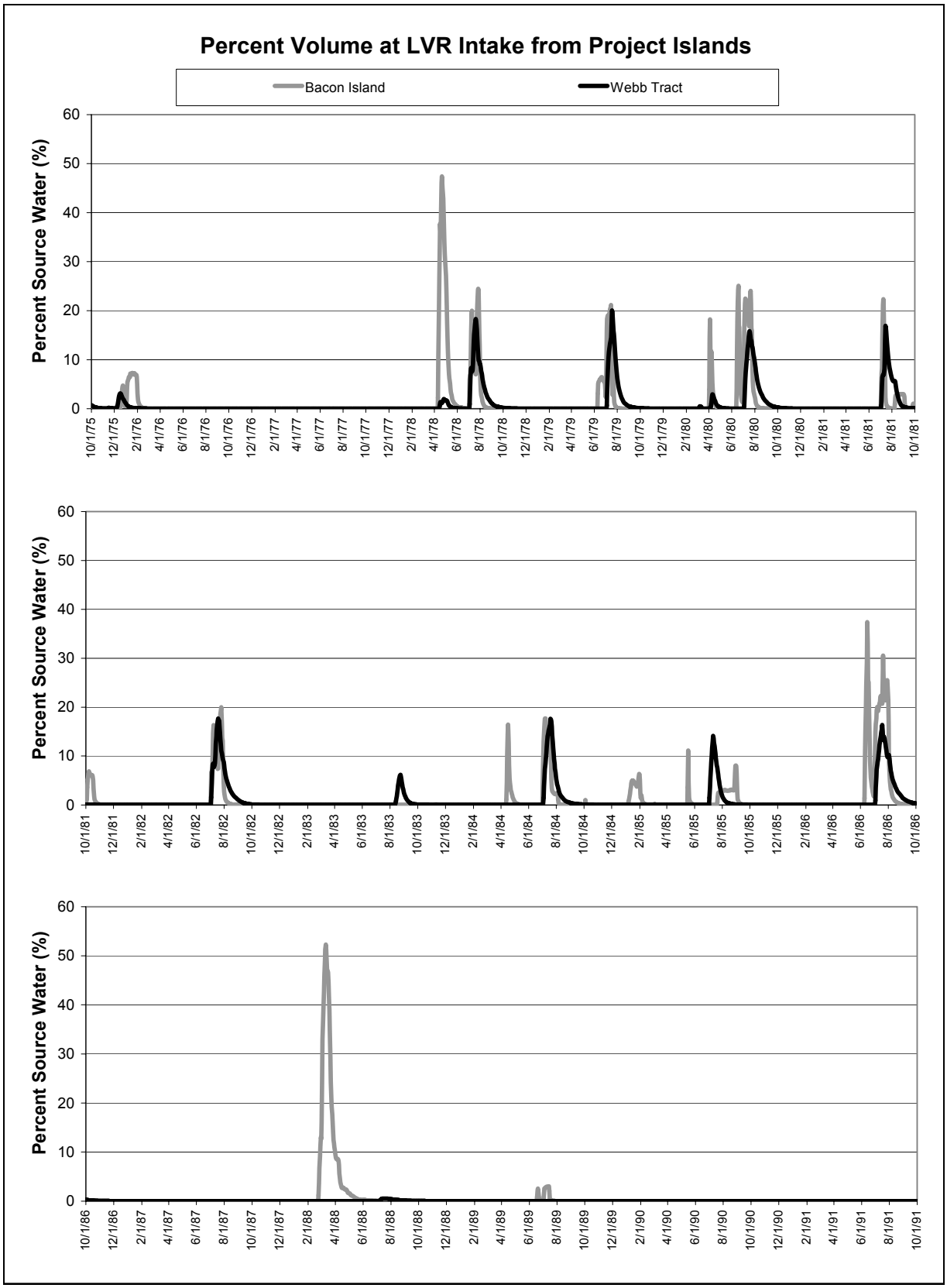

Figure 2.5.6: Percent Volume at Old River at LVR Intake from Project Islands.

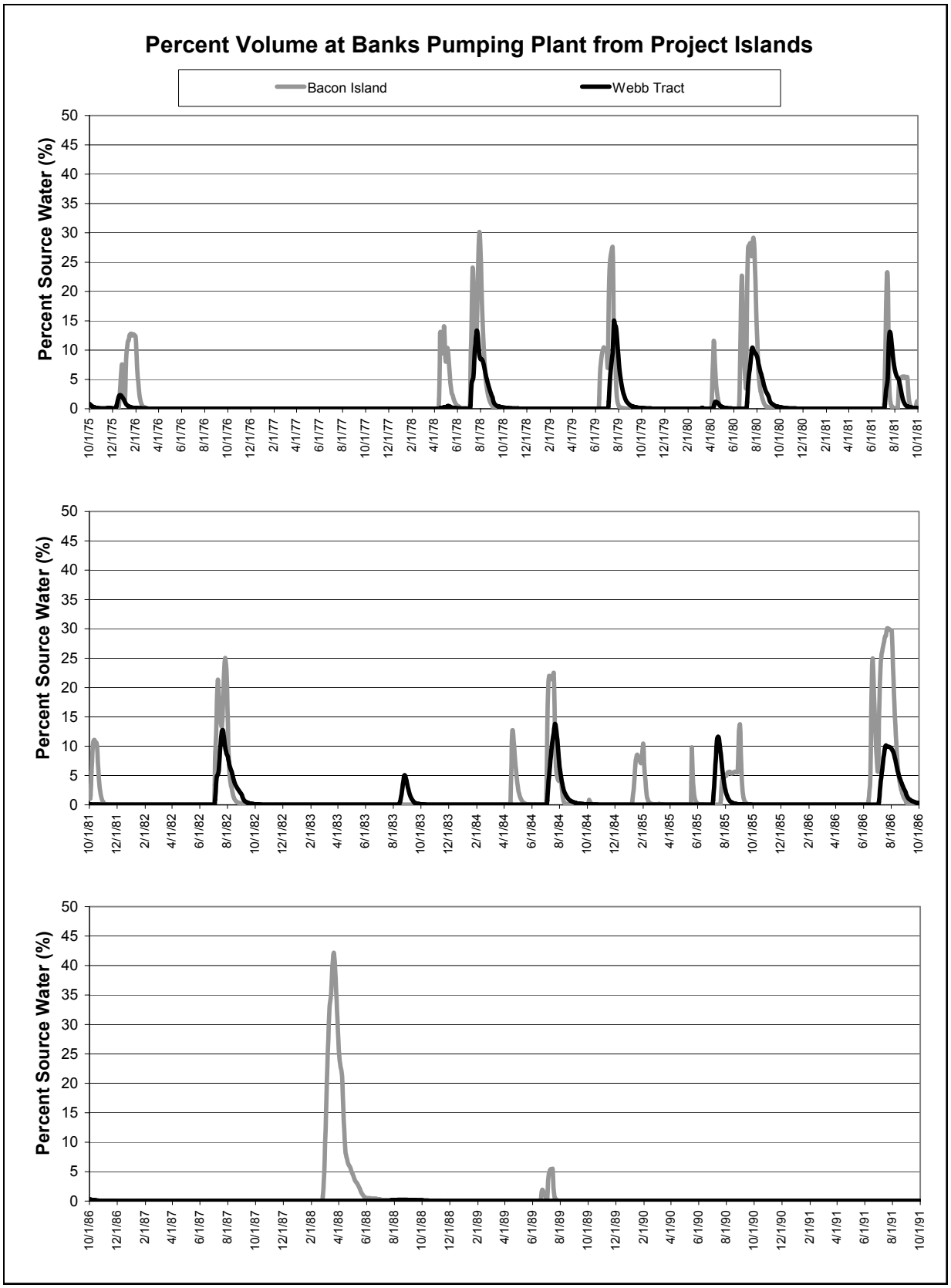

Figure 2.5.7: Percent Volume at Banks Pumping Plant from Project Islands.

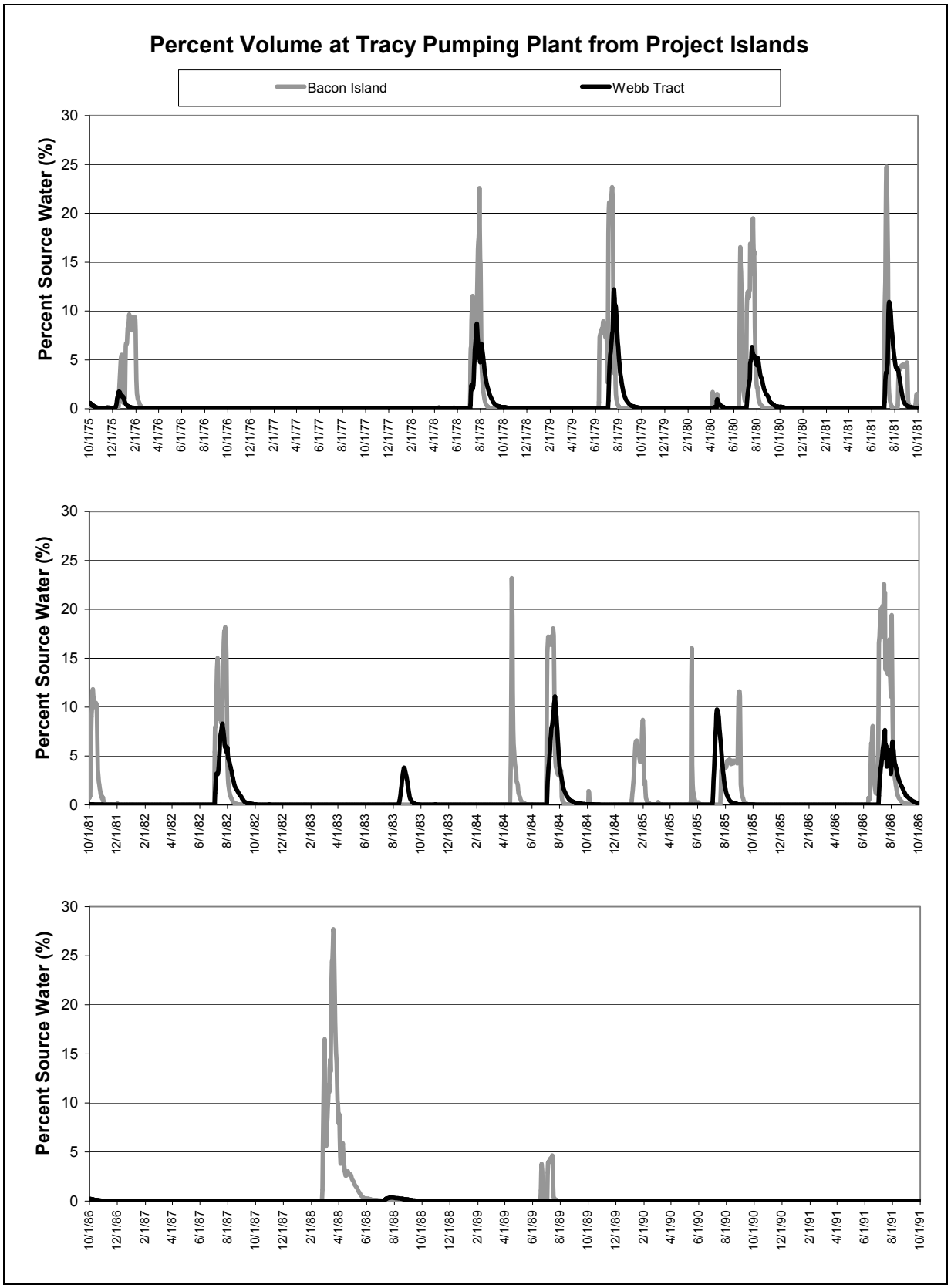

Figure 2.5.8: Percent Volume at Tracy Pumping Plant from Project Islands.

2.5.2 Chloride at Urban Intakes

The EC results from DSM2-QUAL were converted to chloride concentrations at the four major South Delta urban intake locations using the following relationships (Suits, 2001):

$$Chloride_{CCWD\,PP\,\#1} = \frac{EC_{RS} - 89.6}{3.73} \qquad \text{Eqn. 5.10}$$

$$Chloride = \frac{EC - 160.6}{3.66} \qquad \text{Eqn. 5.11}$$

Equation 5.10 was used to convert modeled EC to chloride concentration for Contra Costa Water District's Rock Slough diversion location (Contra Costa Pumping Plant #1). This equation is not only converting EC to chloride, but also transporting it through Rock Slough since it is based on a regression of EC data from the entrance to Rock Slough on the Old River and chloride data at the other end of Rock Slough at the entrance to the CCWD pumping plants. Though the Chloride results are still labeled as Old River at Rock Slough (RS), Equation 5.10 was used to better illustrate the chloride impact at the actual CCWD Rock Slough intake.

Equation 5.11 was used to convert modeled EC to chloride for the remaining three Delta urban water supply intakes: CCWD's Los Vaqueros Reservoir (LVR) intake on the Old River, the SWP's Banks Pumping Plant intake, and the CVP's Tracy Pumping Plant.

Both relationships developed were based on field observations. However, during a few periods QUAL's simulated EC concentrations were so low that using these field conversions resulted in negative chloride concentrations. Since this is not physically possible, these negative values were set to minimum non-negative chloride concentration for each location.

The 16-year minimum, average, and maximum daily averaged chloride at the four urban intakes is shown below in Table 2.5.3. The chloride concentration associated with the 10th, 25th, 50th, 75th, and 90th percentiles for each location is also shown. These percentile concentrations were computed by ranking the 5,844 daily average concentrations for each location in ascending order, and then associating a concentration with a specified percentile. The 10th percentile represents the 584th lowest concentration, the 50th percentile represents the median concentration, and the 90th percentile represents the 5260th lowest concentration (or the 584th highest concentration).

Table 2.5.3: Summary of Daily Averaged Chloride (mg/L) at Urban Intakes.

Urban Intake	Study	Min	Ave	Max	Percentiles				
					10th	25th	50th	75th	90th
RS	Study 1	8	102	318	31	42	81	153	200
	Study 4b	8	103	309	32	43	82	157	201
LVR	Study 1	3	81	257	20	32	68	123	160
	Study 4b	3	82	248	21	33	68	125	160
SWP	Study 1	3	74	215	19	34	67	109	139
	Study 4b	3	74	208	19	34	67	111	148
CVP	Study 1	3	85	223	16	50	84	121	148
	Study 4b	3	86	222	16	50	84	121	148

Although both study 1 and study 4b violated the current (D1641) 250 mg/L chloride Delta water quality standard at Rock Slough and Los Vaqueros Reservoir intake, the 90th percentile results show that for 90% of the 16-year simulation that chloride was less than 201 and 160 mg/L at each location respectively. In other words, the maximum (and minimum) values represent extreme events. Furthermore, though the maximum chloride concentrations decreased in study 4b at all four locations, the percentile results for study 1 and study 4b at each of the four locations were similar. The exception to this trend would be the 75th percentile for Rock Slough, where chloride increased from 153 to 157 mg/L.

The Water Quality Management Plan (WQMP, 2000) limited the operation of the IDS project such that the 14-day running average of chloride would not exceed 90% of the current D-1641 250 mg/L chloride standard. A summary of the 14-day average chloride results is presented in Table 2.5.4. Taking a 14-day average of the daily chloride results did not make any significant changes in the chloride concentration summary statistics.

Table 2.5.4: Summary of 14-Day Average Chloride (mg/L) at Urban Intakes.

Urban Intake	Study	Min	Ave	Max	Percentiles				
					10th	25th	50th	75th	90th
RS	Study 1	9	102	302	32	42	81	153	198
	Study 4b	9	103	291	33	43	82	157	197
LVR	Study 1	3	81	246	21	33	68	123	158
	Study 4b	3	82	237	21	34	68	125	157
SWP	Study 1	3	74	214	20	34	67	110	138
	Study 4b	3	74	207	20	35	67	112	138
CVP	Study 1	3	85	217	17	49	84	121	147
	Study 4b	3	86	217	16	50	84	122	147

As noted in Section 2.2.3, all of CCWD's diversions were assumed to be at Rock Slough. The sensitivity of this assumption on EC and chloride is unknown. However, the daily averaged and 14-day average chloride results shown in Tables 2.5.3 and 2.5.4 show that the chloride at Rock Slough was significantly higher than the chloride at the other three urban intakes.

Time series plots of the 14-day running average chloride concentrations for all four urban intakes are presented in Figures 2.5.9 – 2.5.12. Both the study 1 (base case) and study 4b results are shown for the entire 16-year DSM2 simulation.

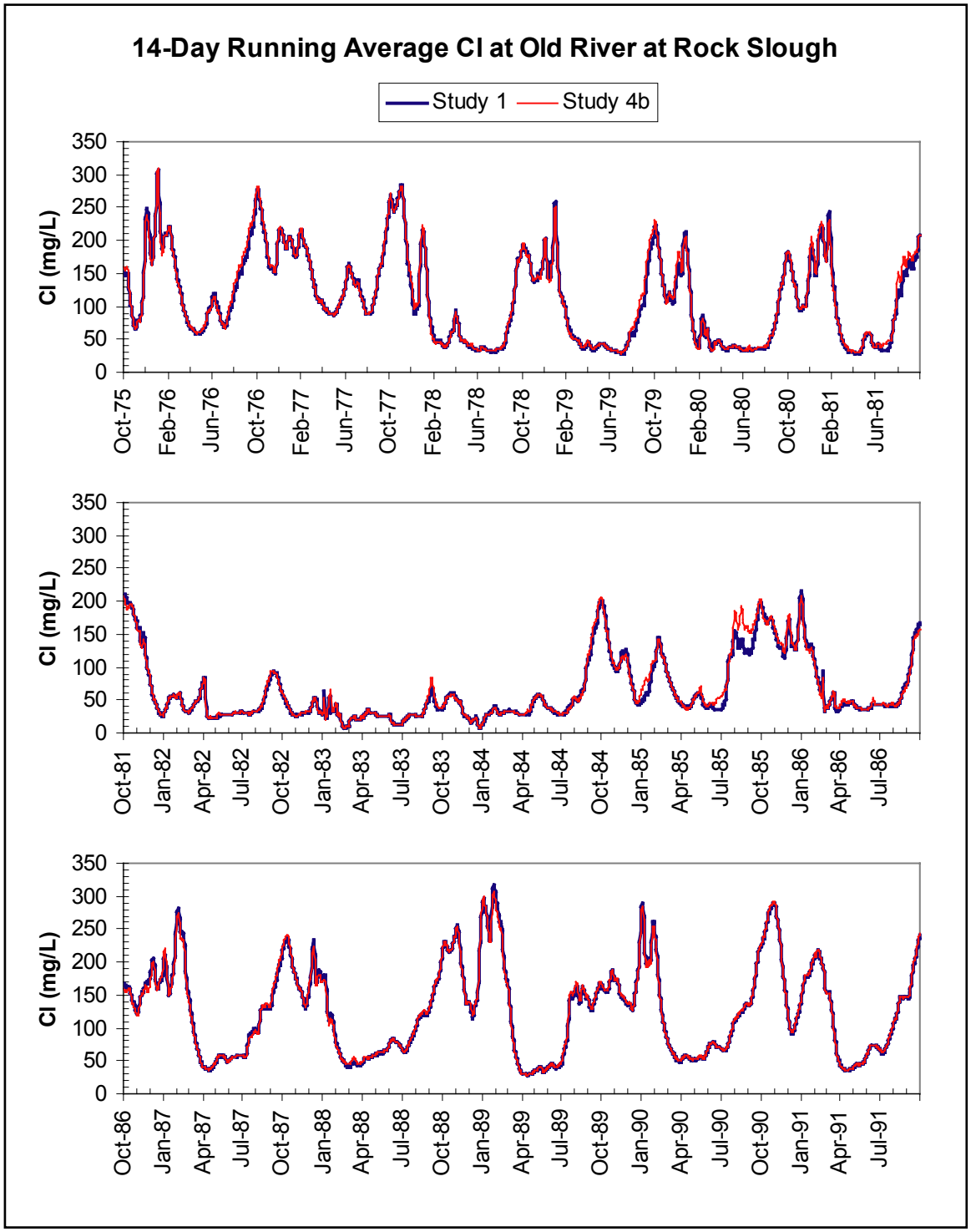

Figure 2.5.9: 14-Day Running Average Cl (mg/L) at Old River at Rock Slough (RS).

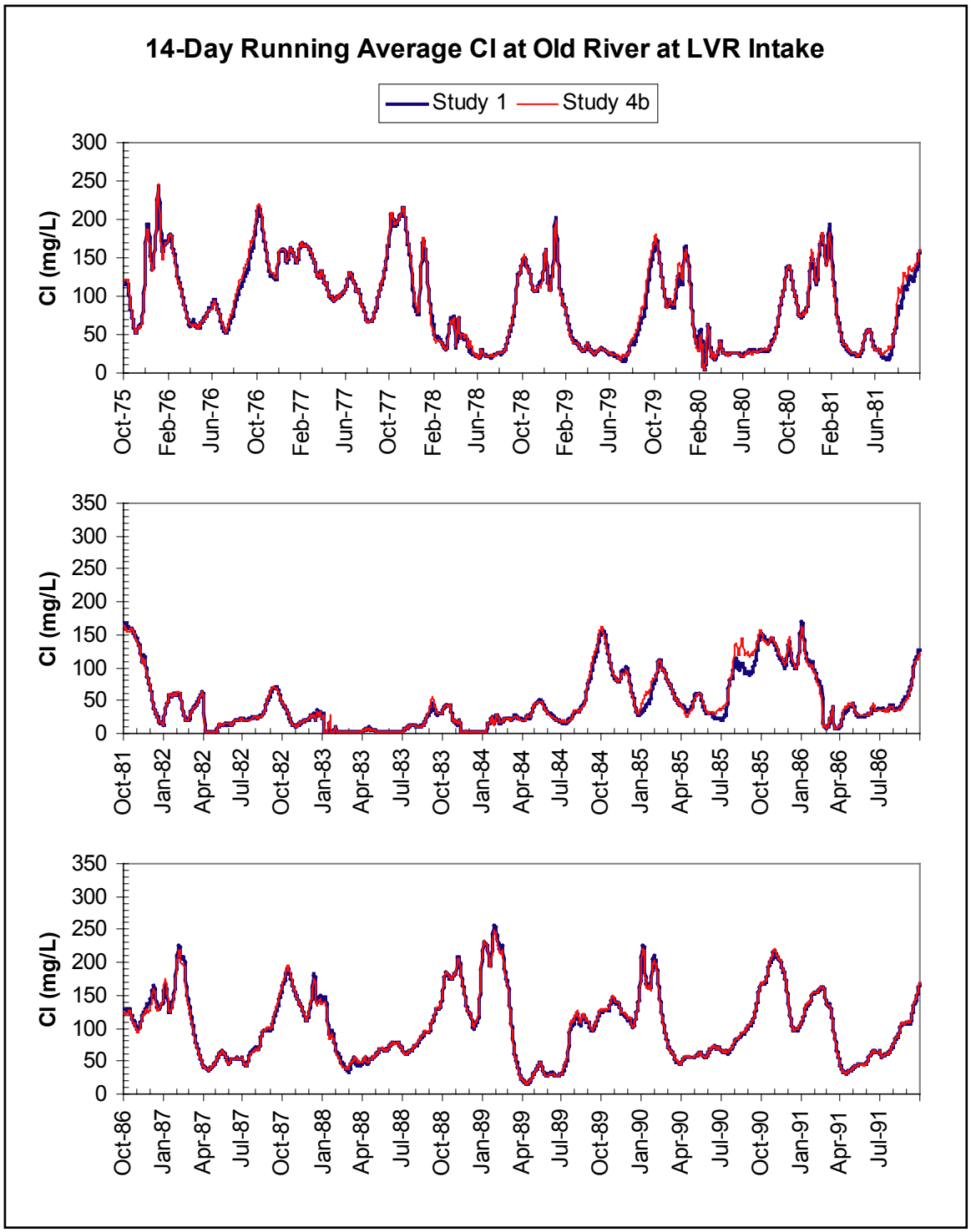

Figure 2.5.10: 14-Day Running Average Cl (mg/L) at Old River at LVR Intake (LVR).

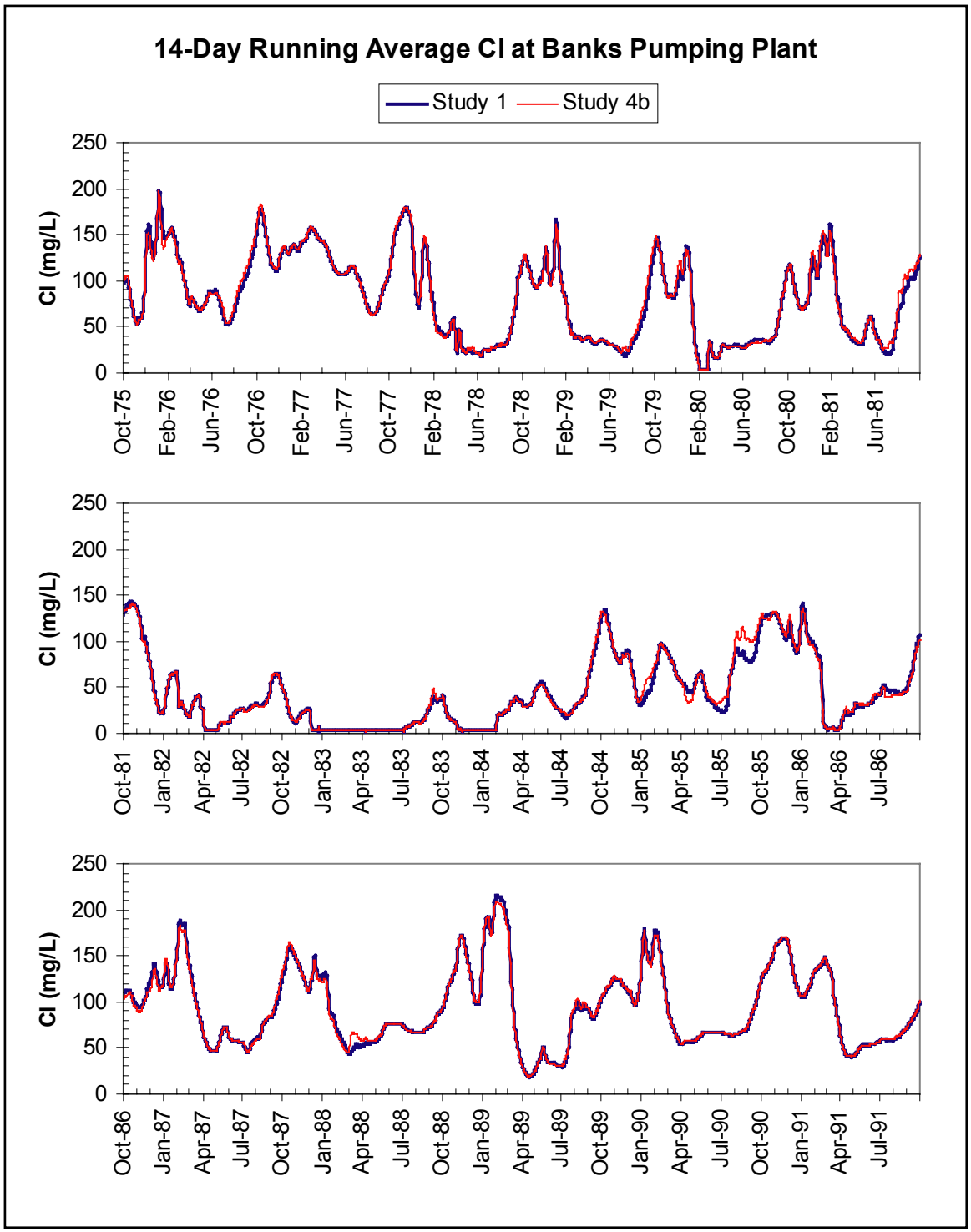

Figure 2.5.11: 14-Day Running Average Cl (mg/L) at Banks Pumping Plant (SWP).

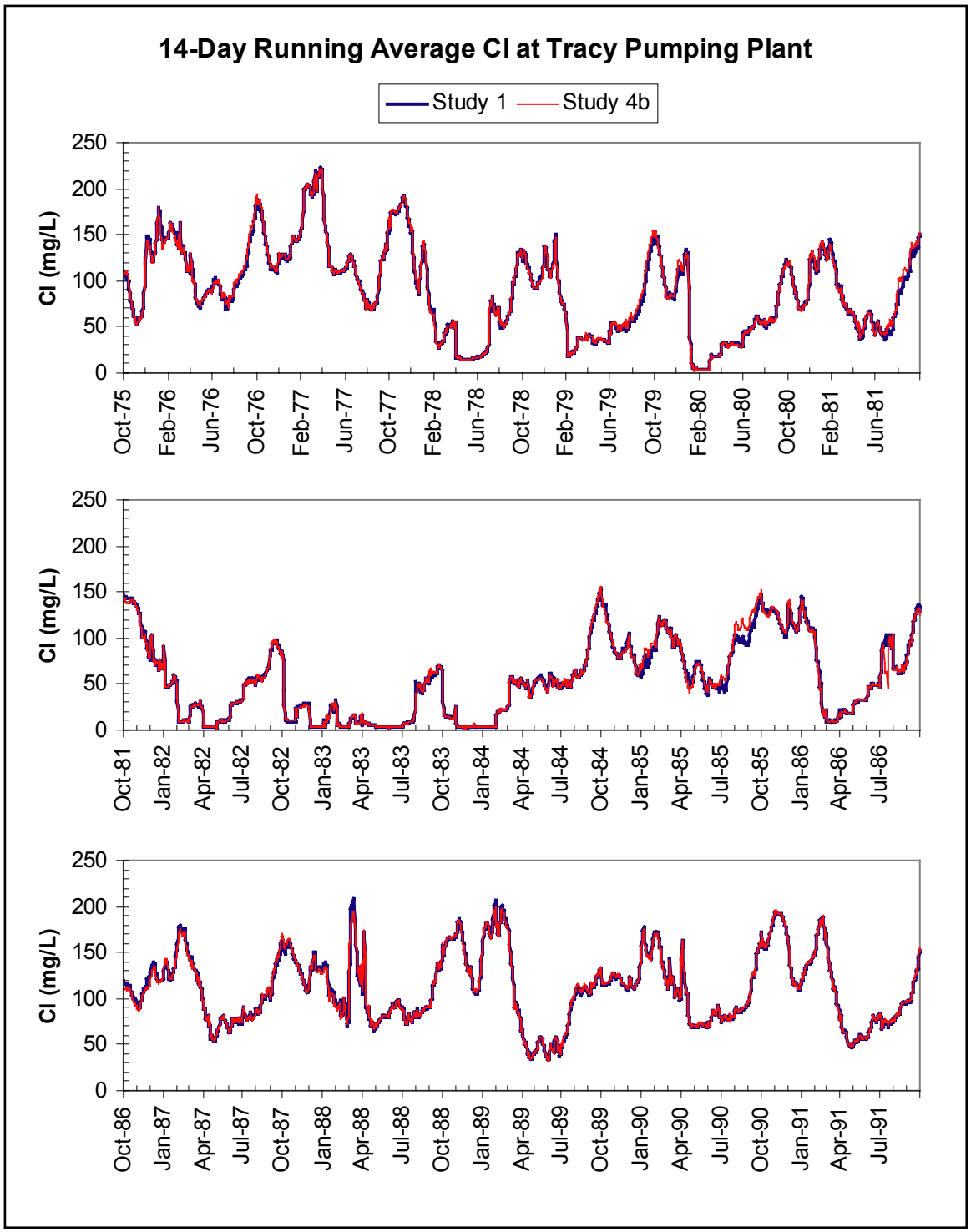

Figure 2.5.12: 14-Day Running Average Cl (mg/L) at Tracy Pumping Plant (CVP).

The WQMP stipulated that the maximum increase in 14-day average chloride concentration due to operation of the project is 10 mg/L when the 14-day average base case (study 1) chloride concentration is less than 225 mg/L, otherwise no increase is allowed (Hutton, 2001). The change in the 14-day average chloride was calculated (see Table 2.5.5) at each of the four urban intake locations as the difference between study 4b

and study 1. Though the 16-year maximum increase in chloride violated the 10 mg/L standard at each of the four locations, the 90% chloride concentrations was less than 10 mg/L at all of the intakes. The average change in chloride concentrations is slightly higher than the median (50% results), thus implying the presence of a few extreme values or outliers.

Table 2.5.5: Summary of Change in 14-Day Ave. Chloride (mg/L) at Urban Intakes.

Urban Intake	Min	Ave	Max	Percentiles				
				10th	25th	50th	75th	90th
RS	-12.5	1.2	40.7	-3.6	-0.7	0.4	2.1	5.8
LVR	-12.2	0.9	32.1	-3.3	-0.9	0.2	1.7	5.1
SWP	-15.4	0.6	23.5	-3.1	-0.8	0.1	1.4	4.2
CVP	-21.8	0.4	17.5	-2.4	-0.7	0.1	1.1	3.2

The number of days and percentage of time in the 16-year simulation (5844 days) that the WQMP change in chloride constraint was exceeded are listed in Table 2.5.6. These counts do not take into account the degree or magnitude of the exceedence of the WQMP standard.

Table 2.5.6: Number of Days and Frequency the WQMP Chloride Constraint is Exceeded.

Urban Intake	# Days > Standard	% Days > Standard
RS	464	8%
LVR	259	4%
SWP	181	3%
CVP	86	1%

Time series plots of the change (study 4b – study 1) in 14-day running average chloride at all four urban intakes are shown below in Figures 2.5.13 – 2.5.16. The WQMP D1643 change in chloride standard is also shown. When the study 1 chloride concentration was greater than 225 mg/L, the WQMP chloride standard dropped to 0 mg/L. Otherwise, the increase in chloride was limited to 10 mg/L.

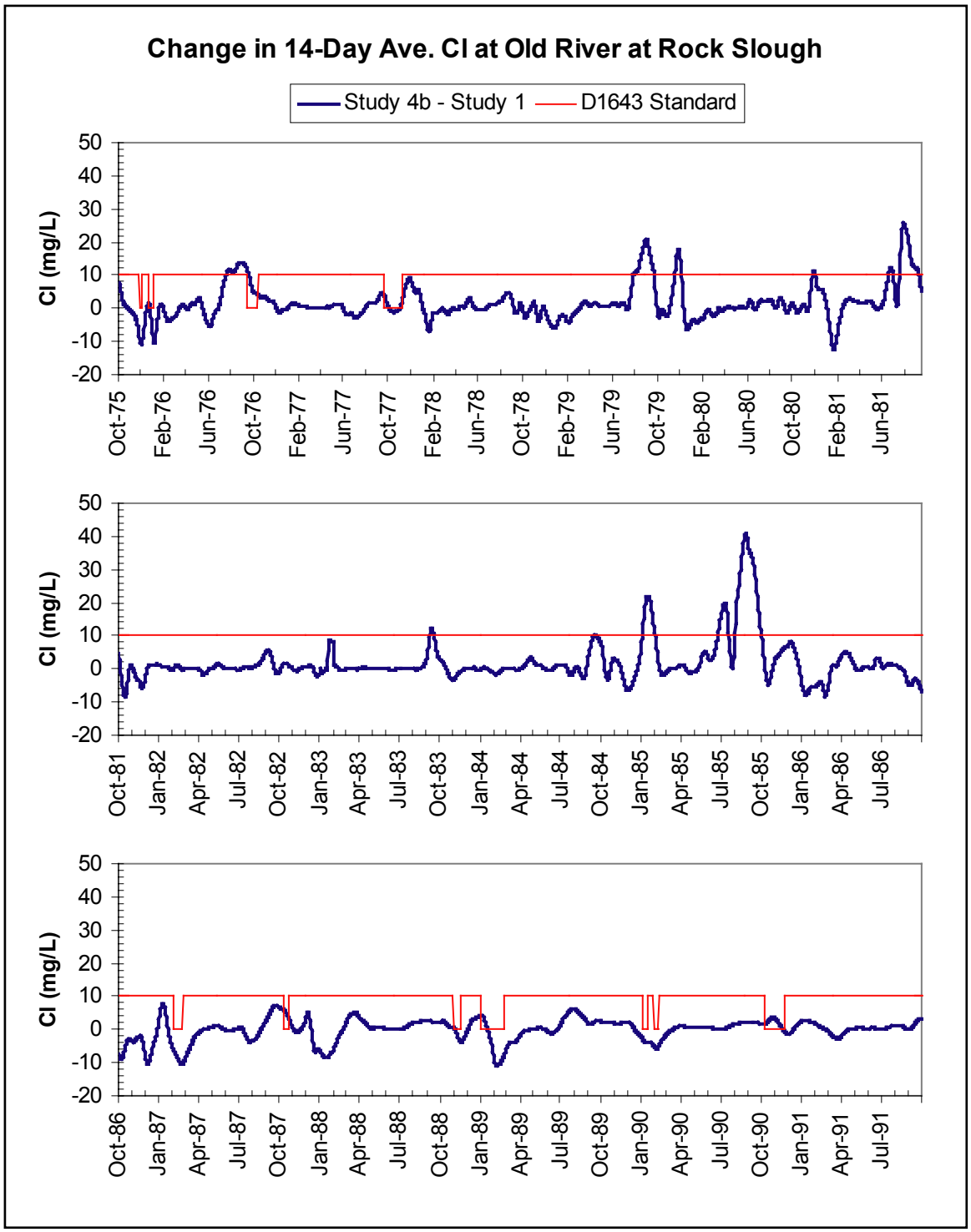

Figure 2.5.13: Change in 14-Day Average Cl (mg/L) at Old River at Rock Slough (RS).

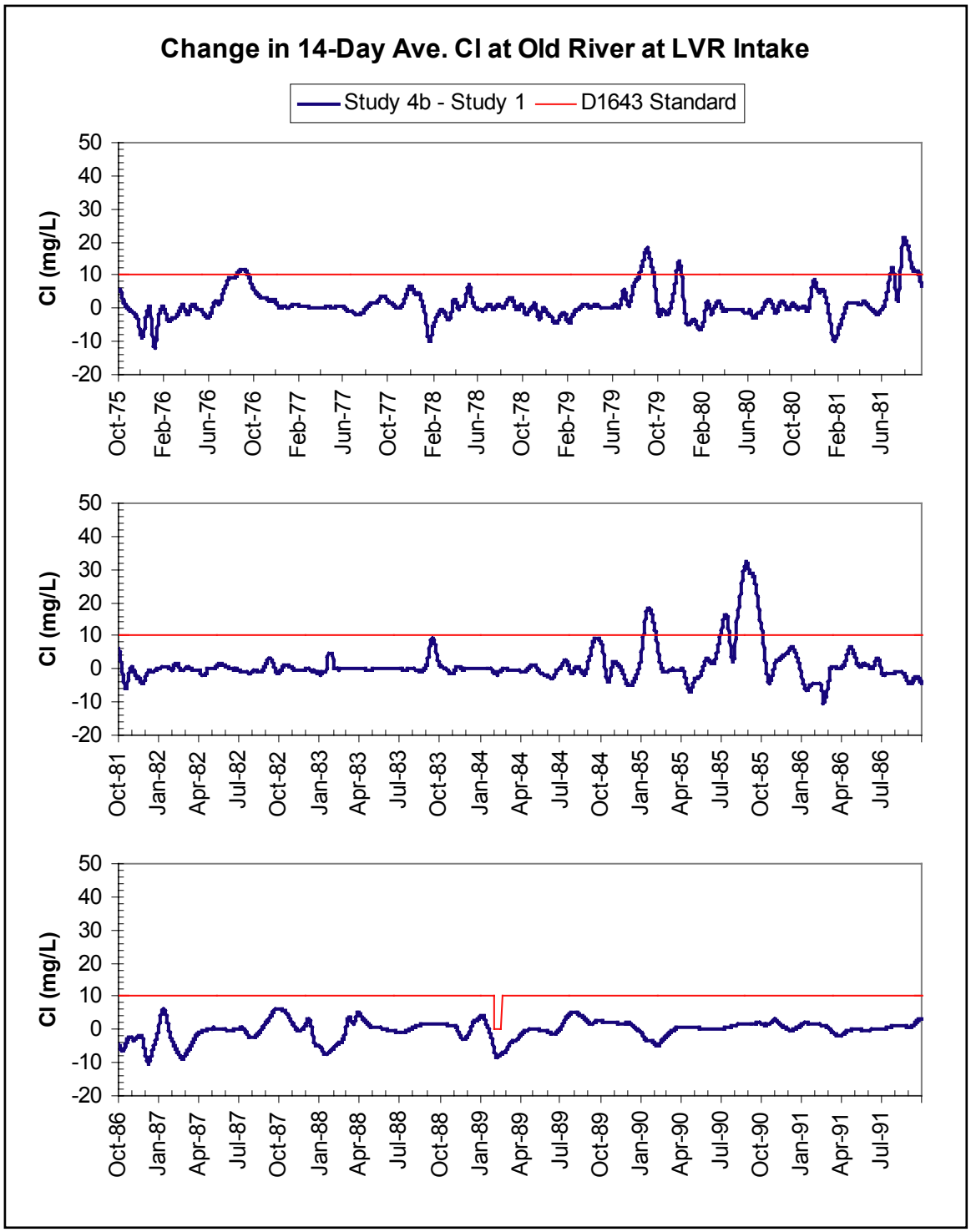

Figure 2.5.14: Change in 14-Day Average Cl (mg/L) at Old River at LVR Intake (LVR).

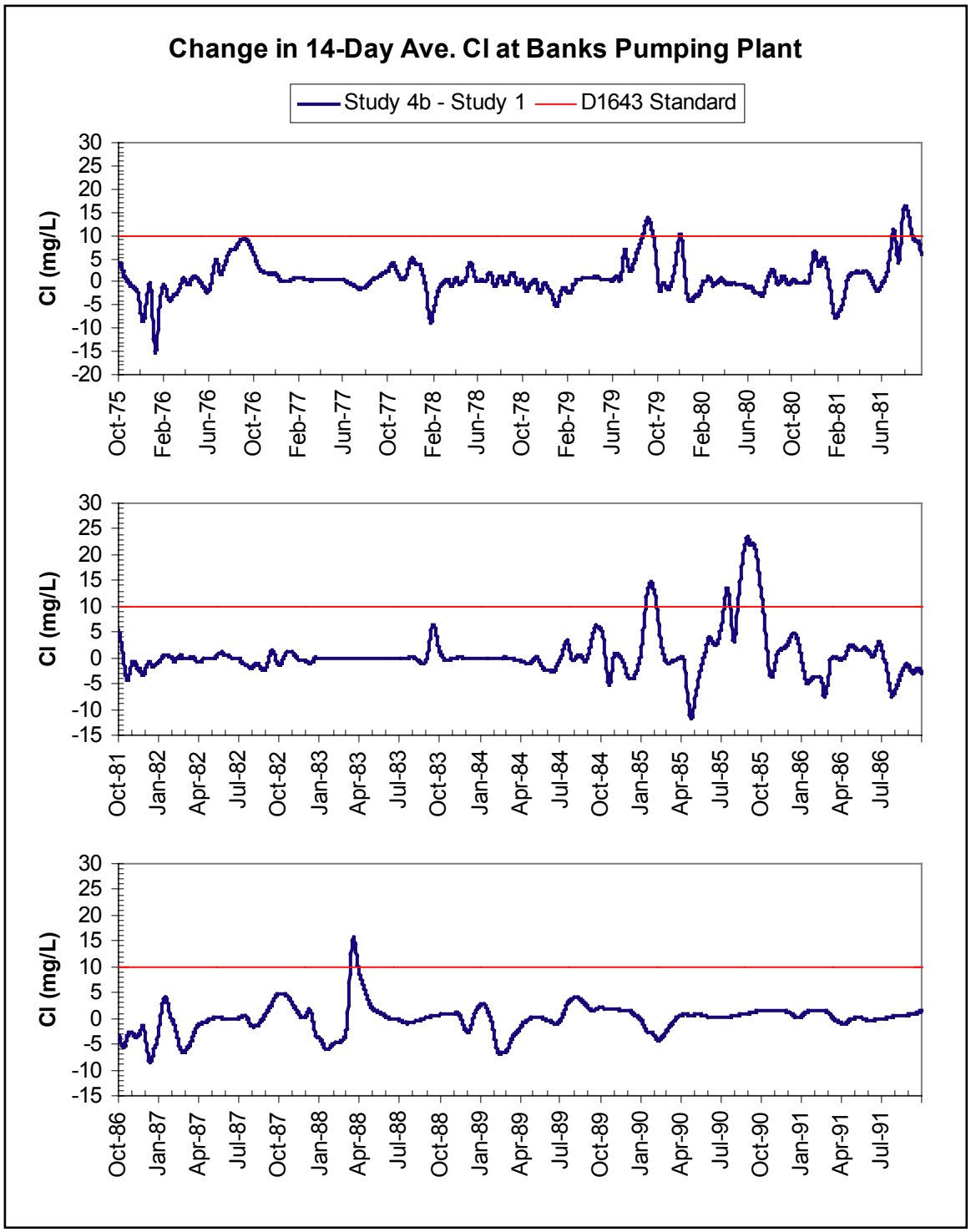

Figure 2.5.15: Change in 14-Day Average Cl (mg/L) at Banks Pumping Plant (SWP).

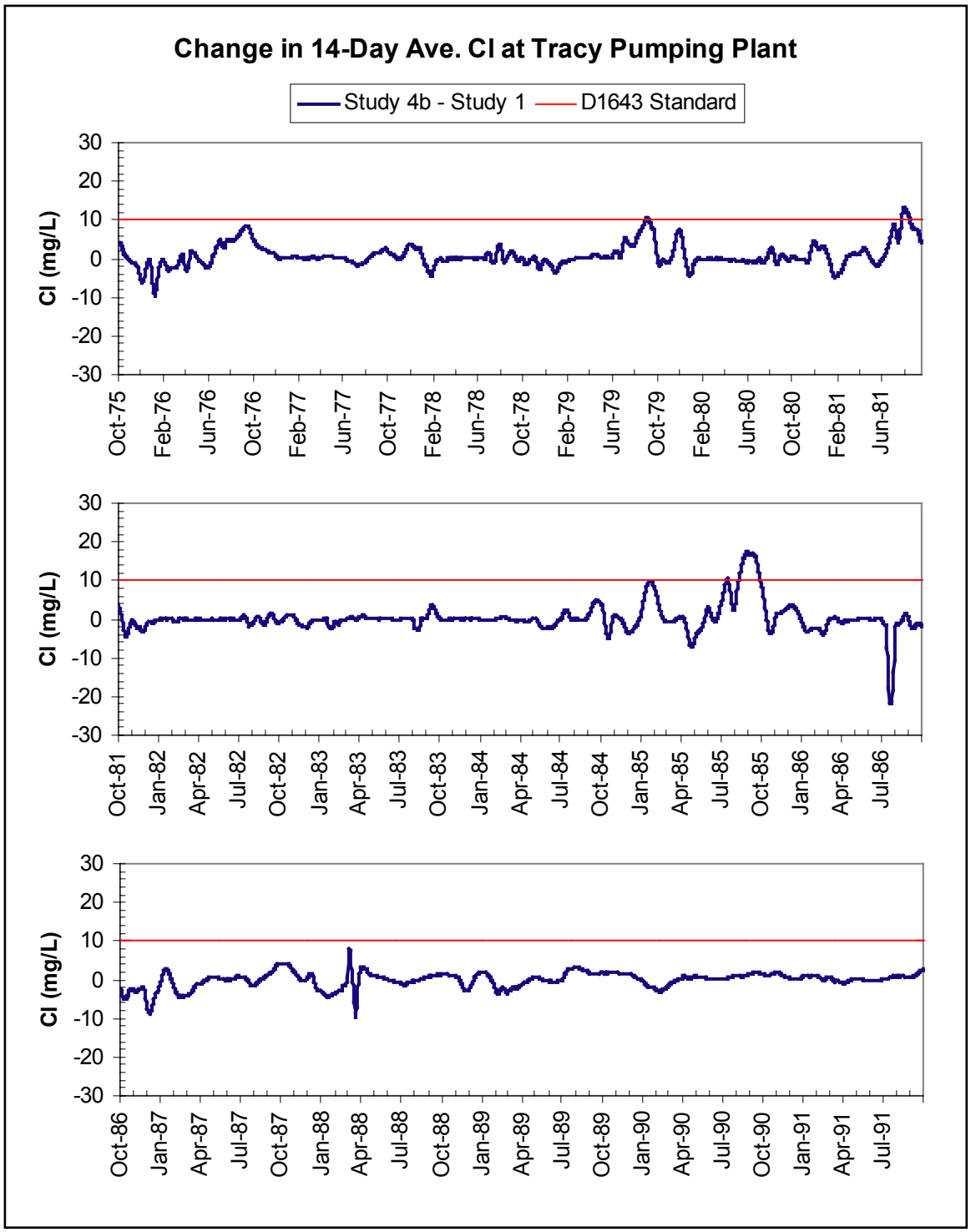

Figure 2.5.16: Change in 14-Day Average Cl (mg/L) at Tracy Pumping Plant (CVP).

2.5.3 DOC at Urban Intakes

DSM2 directly simulated DOC both in the channels as a conservative constituent and project islands as a non-conservative constituent. The increase in carbon mass (non-conservative treatment of organic carbon) was limited to just the project islands (see

Section 2.4.4). Otherwise the mixing and dispersion of DOC in the Delta was similar to how QUAL simulates EC (see *Section 2.4.3*).

The 16-year minimum, average, and maximum daily averaged DOC concentration at the four urban intakes is shown below in Table 2.5.7. The DOC concentration associated with the 10th, 25th, 50th, 75th, and 90th percentiles for each location is also shown. The method and interpretation of percentile water quality results is described in *Section 2.5.2*.

Table 2.5.7: Summary of Daily Averaged DOC (mg/L) at Urban Intakes.

Urban Intake	Study	Min	Ave	Max	Percentiles				
					10th	25th	50th	75th	90th
RS	Study 1	2.1	3.3	11.3	2.2	2.4	2.9	3.7	5.0
	Study 4b	2.2	3.7	11.3	2.6	2.9	3.4	4.1	5.2
LVR	Study 1	2.2	3.6	11.3	2.5	2.7	3.3	4.1	5.3
	Study 4b	2.4	4.2	11.3	3.0	3.3	3.9	4.8	5.7
SWP	Study 1	2.3	3.7	11.3	2.6	2.9	3.4	4.2	5.3
	Study 4b	2.6	4.4	11.3	3.2	3.6	4.1	4.9	5.8
CVP	Study 1	2.4	3.7	11.1	2.8	3.0	3.4	4.0	5.1
	Study 4b	2.6	4.3	11.1	3.2	3.5	3.9	4.7	5.7

The 14-day average DOC constraints called for by the Delta Wetlands WQMP were calculated every day as the average of the 14 previous days (WQMP, 2000). This was done not only to remain consistent with CALSIM, but also under the assumption that forecasting and operations would make use of the previous 14 days worth of field and modeling data. A summary of the 14-day averaged DOC concentrations is shown in Table 2.5.8.

Table 2.5.8: Summary of 14-Day Average DOC (mg/L) at Urban Intakes.

Urban Intake	Study	Min	Ave	Max	Percentiles				
					10th	25th	50th	75th	90th
RS	Study 1	2.1	3.3	10.8	2.2	2.4	2.9	3.7	5.0
	Study 4b	2.3	3.7	10.9	2.7	2.9	3.4	4.1	5.2
LVR	Study 1	2.2	3.6	10.6	2.5	2.7	3.3	4.2	5.3
	Study 4b	2.5	4.2	10.6	3.0	3.4	3.9	4.8	5.6
SWP	Study 1	2.3	3.7	10.8	2.6	2.9	3.4	4.2	5.3
	Study 4b	2.7	4.4	10.8	3.3	3.6	4.1	4.9	5.8
CVP	Study 1	2.4	3.7	11.0	2.8	3.0	3.4	4.0	5.1
	Study 4b	2.7	4.3	11.0	3.3	3.5	3.9	4.7	5.6

Time series plots of the 14-day running average DOC at all four urban intakes are shown below in Figures 2.5.17 –2. 5.20. Study 4b's 14-day running average DOC is consistently higher than study 1 at all four locations and throughout the entire 16-year simulation. However, the magnitude of this difference is fairly small and is discussed below in greater detail.

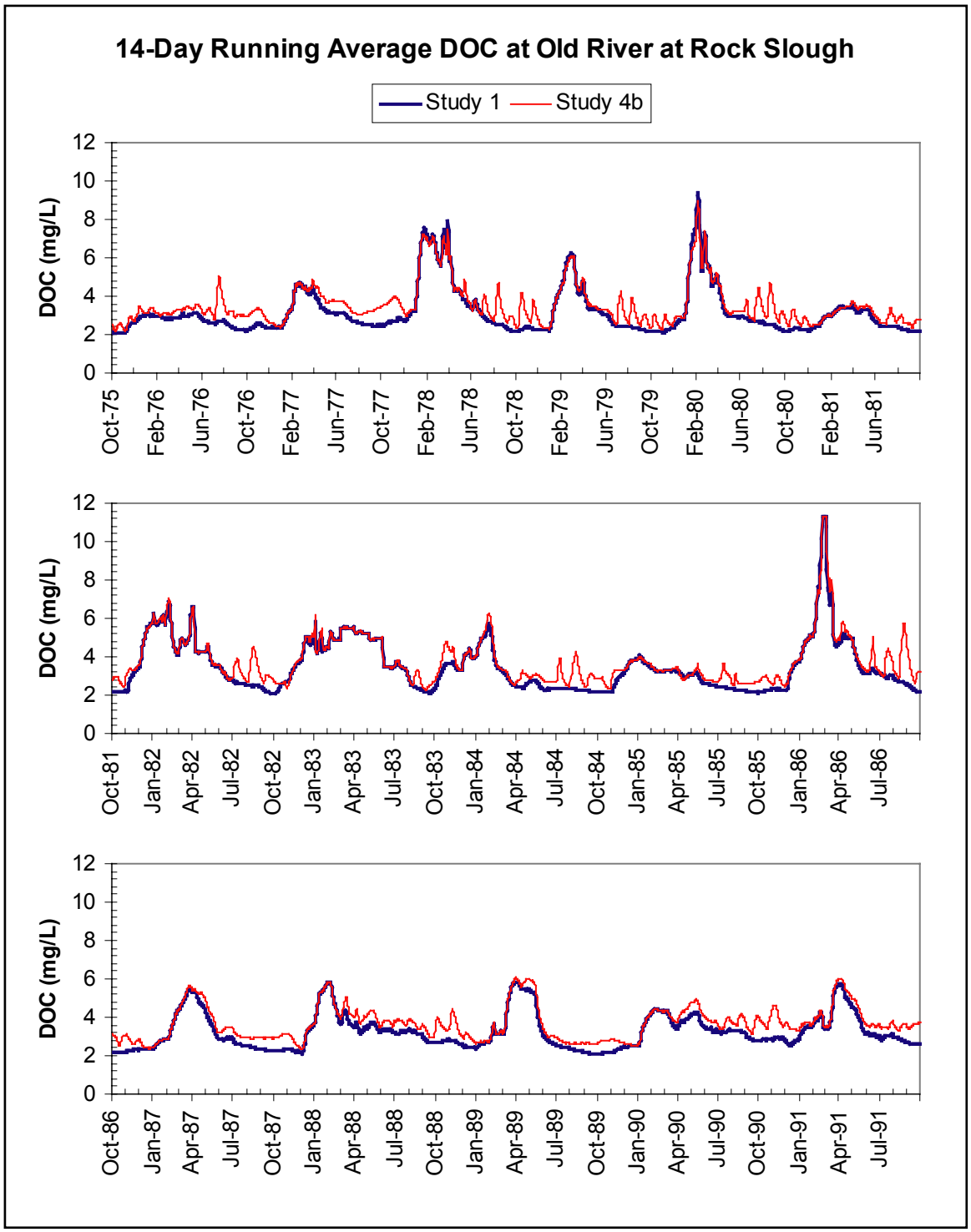

Figure 2.5.17: 14-Day Running Average DOC (mg/L) at Old River at Rock Slough (RS).

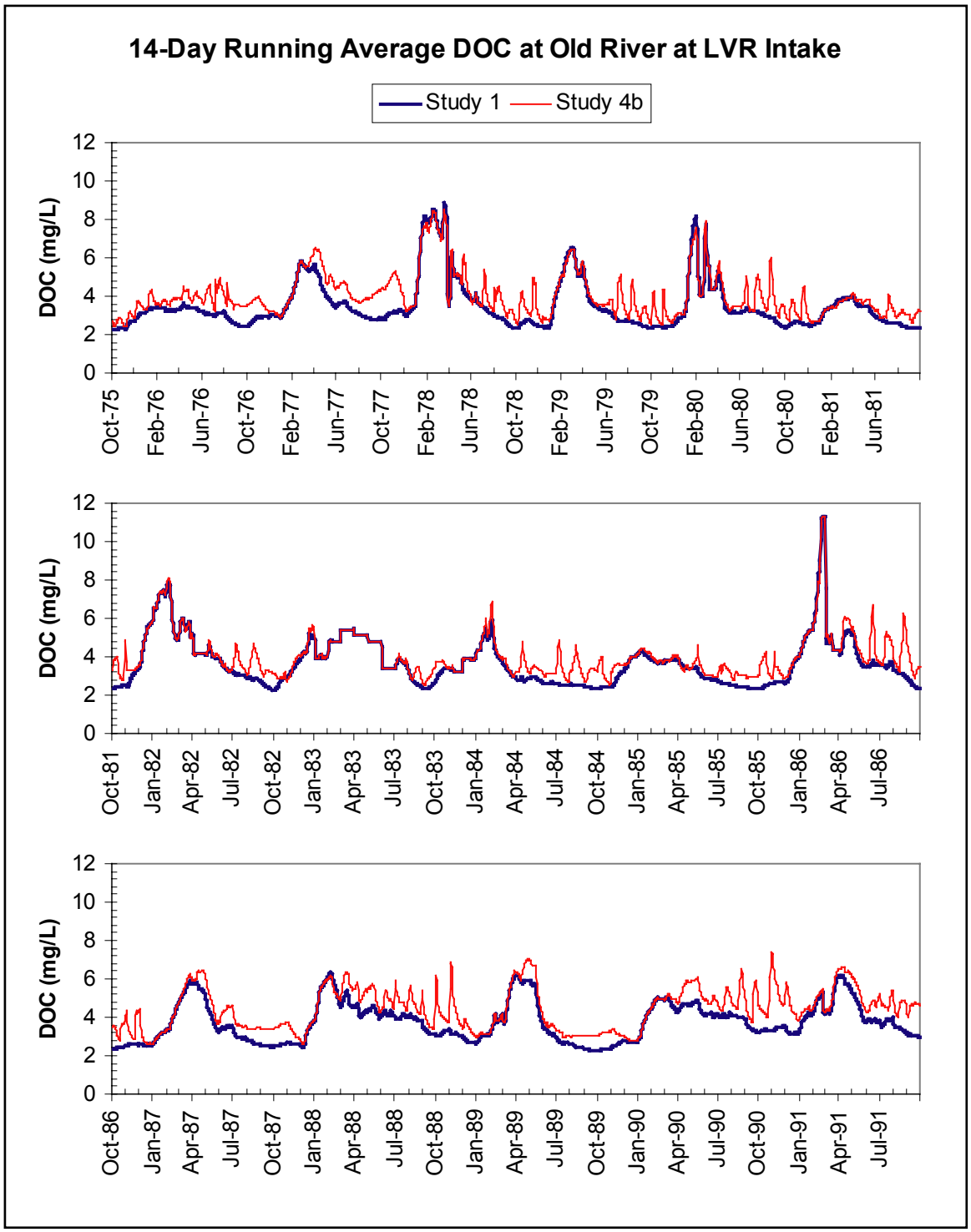

Figure 2.5.18: 14-Day Running Average DOC (mg/L) at Old River at LVR Intake (LVR).

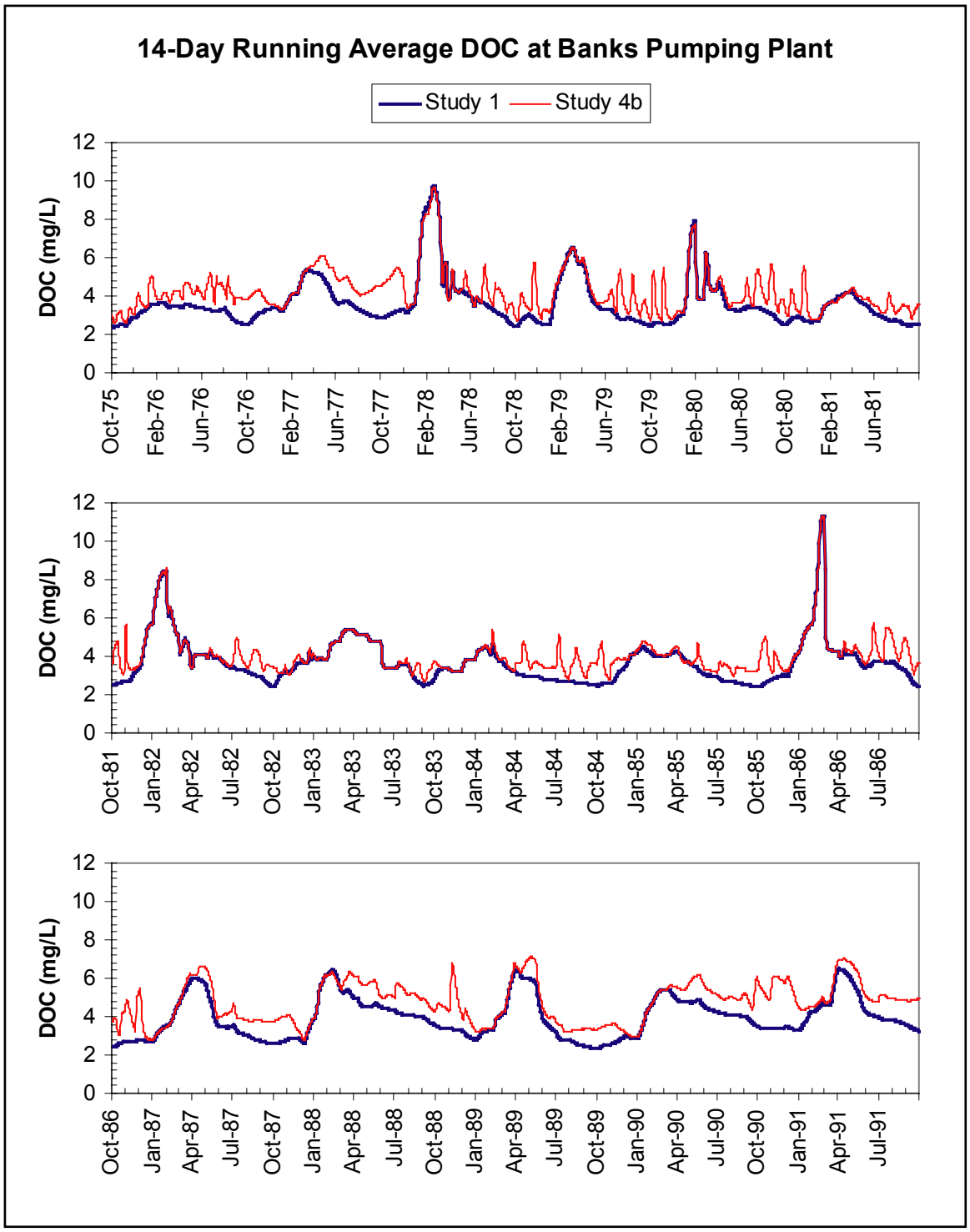

Figure 2.5.19: 14-Day Running Average DOC (mg/L) at Banks Pumping Plant (SWP).

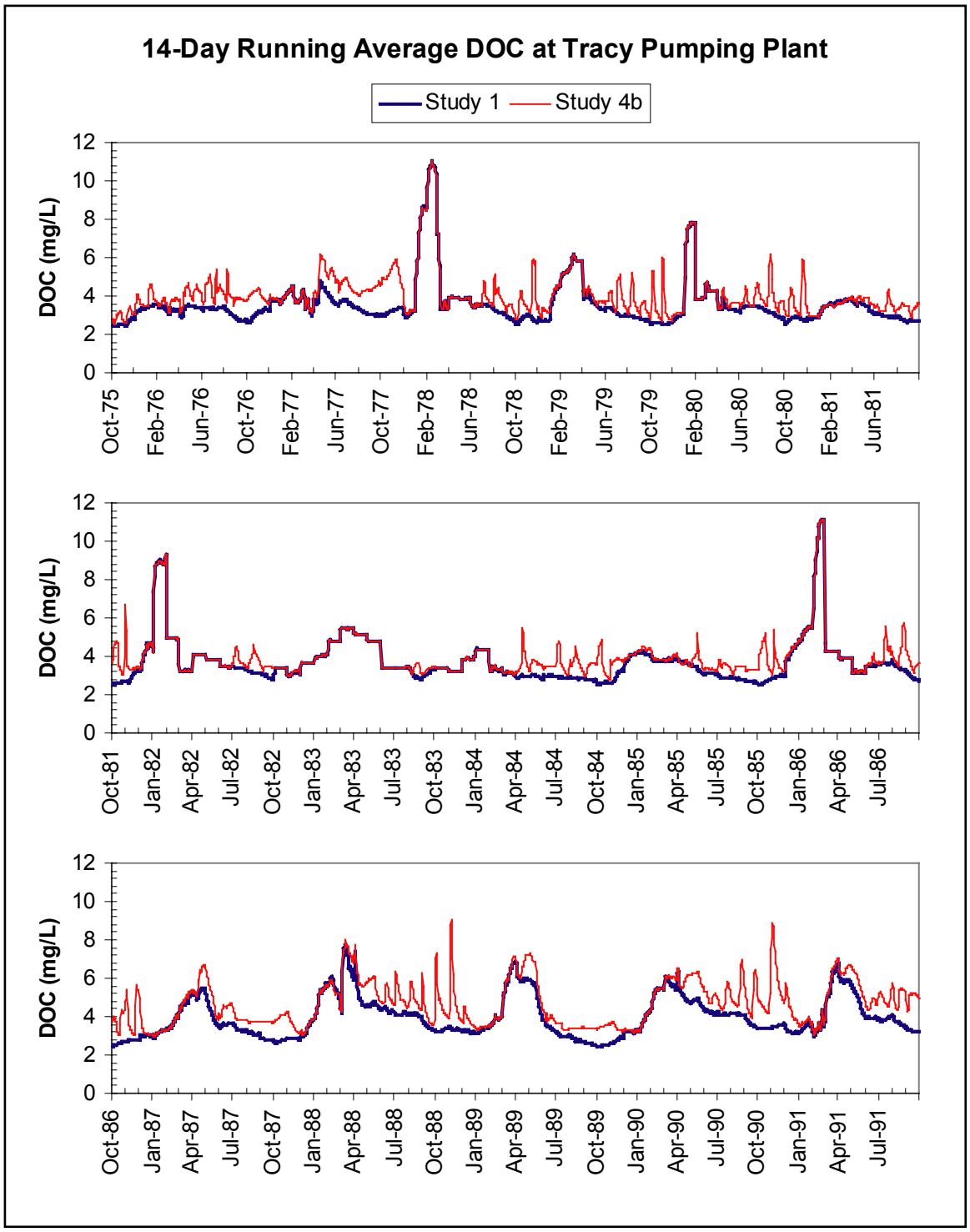

Figure 2.5.20: 14-Day Average DOC (mg/L) at Tracy Pumping Plant (CVP).

Violations of the Water Quality Management Plan (WQMP) DOC standard are not based on the 14-day averages, but instead on the difference between the new IDS operation and the modeled base case (WQMP, 2000). According to the WQMP, when the modeled base case DOC is less than 3 mg/L or greater than 4 mg/L, the maximum increase in DOC at any urban intake is 1 mg/L. When the base case DOC is between 3 mg/L and 4

mg/L, the 14-day average DOC at any urban intake can not exceed 4 mg/L (in other words, the maximum allowed increase is the difference between 4 mg/L and the base case). The incremental WQMP constraint is illustrated below in Figure 2.5.20(a).

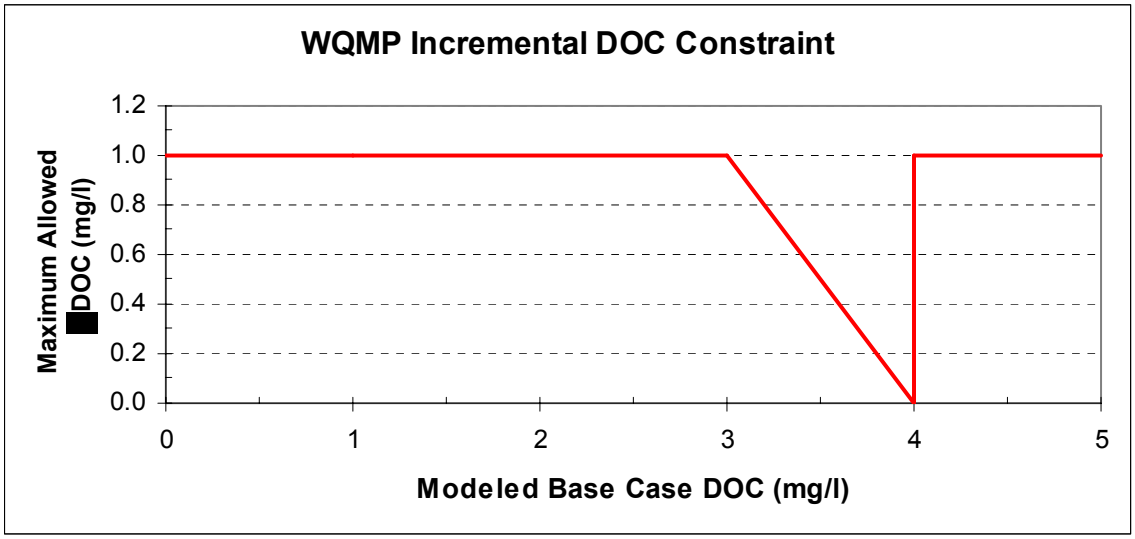

Figure 2.5.20(a): WQMP Incremental DOC Constraint.

The 16-year minimum, average, and maximum change (study 4b - study 1) in the 14-day average DOC at the urban intakes is shown in Table 2.5.9. The 10th percentile results so no impact due to the operation of the project. With the exception of Rock Slough, the 90th percentile results are greater than 1 mg/L. It is important to note that the WQMP DOC constraint listed above varies between 0 and 1 mg/L, thus the percentile results can only be used to estimate the magnitude of the change in DOC due to the operation of the project, but not the frequency that the WQMP DOC constraint is exceeded.

Table 2.5.9: Summary of Change in 14-Day Ave. DOC (mg/L) at Urban Intakes.

Urban Intake	Min	Ave	Max	Percentiles				
				10th	25th	50th	75th	90th
RS	-0.6	0.4	2.6	0.0	0.1	0.3	0.6	0.8
LVR	-0.6	0.5	3.3	0.0	0.1	0.4	0.8	1.2
SWP	-0.4	0.6	2.7	0.0	0.1	0.5	1.0	1.3
CVP	-0.2	0.5	4.4	0.0	0.0	0.4	0.8	1.3

The number and frequency of days out of the 5,844 day simulation when the variable WQMP DOC constraint was exceeded were calculated using the modeled base case (study 1) to find the WQMP standard and the change in 14-day average DOC (Table 2.5.10).

Table 2.5.10: Number and Frequency of Days the WQMP DOC Constraint is Exceeded.

Urban Intake	# Days > Standard	% Days > Standard
RS	517	9%
LVR	1,369	23%
SWP	1,925	33%
CVP	1,513	26%

Time series plots of the change (study 4b – base) in 14-day running average DOC at all four urban intakes are shown below in Figures 2.5.21 – 2.5.24. The WQMP D1643 change in DOC standard is also shown.

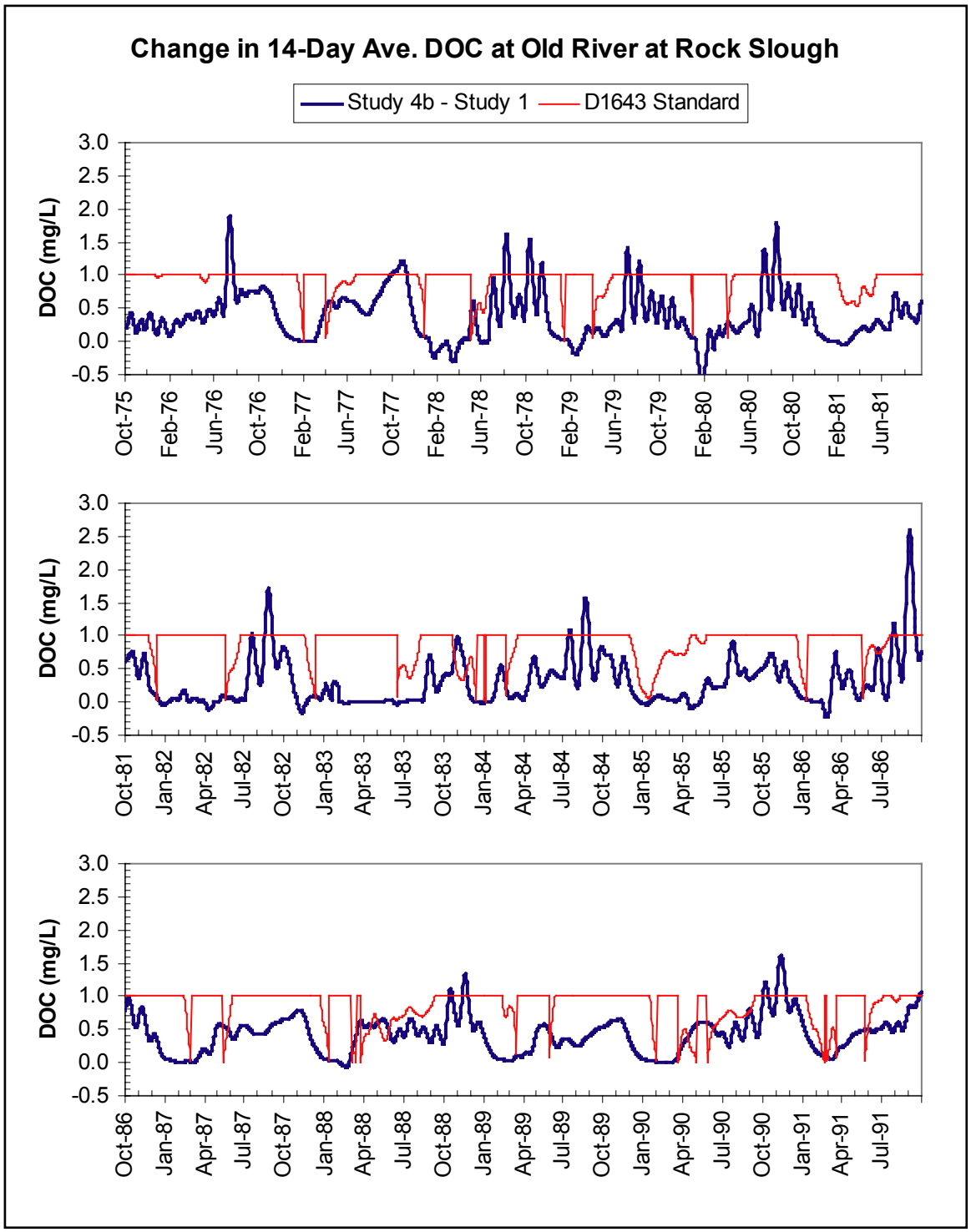

Figure 2.5.21: Change in 14-Day Average DOC (mg/L) at Old River at Rock Slough (RS).