Deposition Rates and Oxygen Demands in the Stockton Deep Water Ship Channel of the San Joaquin River

June-November, 2001

Prepared for:

San Joaquin River Dissolved Oxygen TMDL Steering Committee
and
CALFED

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Acronyms

Biochemical oxygen demands:

BOD	Biochemical oxygen demand. The concentration of dissolved oxygen consumed by microorganisms during the utilization of organic and inorganic matter.
BOD_5	oxygen depletion after 5 days.
BOD_{ult}	Ultimate biochemical oxygen demand. The estimated total BOD from long-term BOD measurements.
CBOD	Carbonaceous BOD
NBOD	Nitrogenous BOD
sCBOD	Soluble CBOD
sNBOD	Soluble NBOD
pBOD	Particulate BOD
pCBOD	Particulate CBOD
pNBOD	Particulate NBOD

DO	Dissolved oxygen
DWSC	Deep Water Ship Channel. Also referred to as the Stockton Deep Water Ship Channel. Center depth is typically 37 feet.
EC	Electrical conductivity
ft	feet
ft/s	feet per second
g	grams
k	first-order decay coefficient
L	liter
m	meters
mg	milligrams (0.001 g)
mg/L	milligrams per liter
N	nitrogen
SOD	sediment oxygen demand
TSS	total suspended solids
UVM	ultrasonic velocity meter
VSS	volatile suspended solids

I. Executive Summary

Overview

Water quality measurements, sediment deposition rates, sediment settling rates, and sediment oxygen demand fluxes were measured in the Stockton Deep Water Ship Channel (DWSC) from June 14 through October 25, 2001. These data provide a view of the processes and mechanisms that influence suspended matter entering the DWSC from the San Joaquin River. Suspended matter includes, but is not limited to, inorganic soil, organic debris, and phytoplankton.

Water and suspended sediment sampling was conducted at Navigation Lights 48, 43, and 38 in the DWSC. At these locations sediment traps were placed at four depths to collect settling matter during ebb and flood tides. Water samples were also periodically collected at these locations and trap depths. Laboratory analyses were measured for total suspended solids (TSS), volatile suspended solids (VSS), chlorophyll *a*, pheophytin *a*, and long-term biochemical oxygen demand (BOD). Field water quality measurements included water temperature, pH, dissolved oxygen (DO), turbidity, and Secchi depth. These measurements were also conducted in the San Joaquin River above the DWSC at the USGS ultrasonic velocity station located several hundred meters upstream of the City of Stockton Wastewater Treatment Facility outfall. This station is approximately 2 miles upstream of the DWSC. See Figure II-1 for the locations of these monitoring stations.

Sediment oxygen demand chambers were constructed to collect sediment cores from the bottom of the DWSC. The DO in the water above the cores was monitored over time to estimate the sediment oxygen demand flux. Cores were collected from Lt. 38, 43, 48 and within the Turning Basin of the DWSC.

Suspended Sediment Transport in the DWSC

The behavior and fate of soil, organic debris, and algae in the DWSC was characterized by water quality measurements and sediment trap measurements. Settling velocities were calculated by deposition fluxes obtained from the sediments traps divided by the water concentration at the trap. Water concentrations, sediment deposition fluxes, and settling velocities that are necessary for modeling water quality in the DWSC appear in the body of the report or the Appendices.

Mixing in the DWSC

The behavior and fate of soil, organic debris, and algae in the DWSC was characterized by water quality measurements and sediment trap measurements. Temperature and DO measurements indicate that turbulence within the DWSC is often sufficient to eliminate stratification within the water column. However, warm air temperatures and solar radiation were often sufficient to stratify the upper water column during the afternoon. The turbulence is generated mostly by tidal flows. Flow measurements at Rough and

Ready Island (near Lt. 43) indicate that peak tidal flows of 4000 cfs were common. Throughout most the 2001 monitoring season, the net flow in the San Joaquin River was approximately 1000 cfs. At peak tidal flows of 4000 cfs, the average velocity in the DWSC is approximately 0.2 ft/s. These flows are sufficient to resuspend sediments and provide uniform concentrations of dissolved constituents. Inorganic and organic particulates matter exhibits concentration gradients with the highest concentrations near the sediment-water interface. These observations indicate that mixing is insufficient to maintain uniform concentrations of most particulate matter. Algae do exhibit relatively uniform concentration profiles in the DWSC which may be associated with their lighter density or production near the surface.

Particle Settling in the DWSC

Measurements of turbidity, TSS, VSS, and phytoplankton pigments indicate that suspended particles settle upon entering the DWSC due to the increase in depth and width. Average water velocities are approximately 6 times slower in the DWSC then in the San Joaquin River above the DWSC. Concentrations of TSS in the DWSC for the 2001 season indicate that approximately 30 percent of the TSS was lost to settling between the Lt. 48 and Lt. 43. Beyond Lt. 43, water column concentrations are virtually constant except near the sediment-water interface where average TSS concentrations decreased approximately 20 percent from Lt. 43 to Lt. 38. The behavior of VSS entering the DWSC was similar to TSS, except only about 25 percent was lost from the water column within the first 2 miles of travel to Lt. 43.

Chlorophyll a losses are the most dramatic, approximately 60 percent of the pigment concentration is lost by Lt. 43 after entering the DWSC from the San Joaquin River. Chlorophyll a losses are thought to be caused largely by the settling and subsequent decay of algae below the euphotic zone. The sum of chlorophyll a and pheophytin a concentrations decrease approximately 40 percent. This lower loss rate is associated with the slower decay rate of pheophytin a compared with chlorophyll a. Laboratory tests indicate that chlorophyll a and pheophytin have half-lives of 1.2 and 2.5 days, respectively, when water samples from the San Joaquin River were placed in darkness for 5 days.

Sediment resuspension in the DWSC

Resuspension of sediments in the DWSC is evident in the water concentrations and deposition fluxes. Mass balance calculations indicate that resuspension rates are approximately 95 percent of the total deposition rate measured with the sediment traps. Water concentrations and deposition fluxes measured 0.5 m above the sediment-water interface exhibited the highest values (except for water chlorophyll *a* concentrations) when compared with samples collected at shallower depths. These observations indicate that resuspension is significant in the DWSC. The net settling rates of suspended particles downstream of Lt. 43 approaches zero suggesting that resuspension rates are similar to the settling rate. Therefore, the inorganic suspended load is largely supported by resuspension downstream of Lt. 43. Particle settling rates support this conclusion, since the rates measured in the DWSC are high enough that inorganic suspended matter concentrations would be much lower than measured downstream of Lt. 43. The water concentrations of VSS also appear to approach steady concentrations downstream of Lt. 43. This appears to be caused in part to resuspension, but algal productivity in the DWSC may also play a role. Away from the sediment-water interface VSS concentrations are typically 3 to 4 mg/L. The average chlorophyll *a* and sum of chlorophyll *a* and pheophytin *a* concentrations at Lt. 38 were approximately 11 mg/L and 25 mg/L, respectively. The fraction of these pigment concentrations to algae mass was not determined, but if this fraction is equal to 1 percent, then productivity influences or controls VSS water concentrations beyond Lt. 43.

The particulate settling velocities measured here are relatively high and appear to be caused by aggregation upon settling followed by resuspension. Therefore, models of the DWSC need to incorporate aggregation in their sediment transport algorithm. Laboratory measurements of settling velocities were conducted with San Joaquin River water collected at the USGS UVM station and 0.5 m above the sediment-water interface at Lt. 48. The mass weighted-average settling velocity of the Lt. 48 trapped sediments was 6 times that observed with the San Joaquin River water. Sonication of the Lt. 48 trapped sediments yielded much lower settling velocities, suggesting that the high settling velocities calculated by dividing deposition fluxes by water concentrations are caused by particle aggregation. This aggregation appears to occur primarily upon settling and attachment with other settled particles. Hydraulically induced shear stresses at the sediment-water interface appear sufficiently energetic to resuspend the particles but not to disperse them to their original size distribution before entering the DWSC.

Tidal conditions may influence sediment resuspension as shown with slightly elevated water concentrations and deposition fluxes measured during the ebb flow conditions. The highest water velocities can be expected during ebb tides and therefore, the greatest shear stress at the sediment water interface yielding more sediment resuspension. As anticipated the greatest difference was often observed nearest the sediment-water interface. However, average water concentrations and deposition fluxes during ebb tides were generally less than 10 percent of the flood conditions. Similarly spring tides may also yield higher concentrations of sediments near the bottom when compared with neap conditions especially during ebb tidal flows. During flood flows, the average sediment deposition fluxes were greatest during the neap tides. This result seems to be influence by a relatively high volume of ship traffic during one of the neap, flood tides. While tides appear to have some influence on sediment resuspension, other factors, such as ship traffic may also enhance resuspension rates. A continuous turbidity meter was installed in mid November, 2001, at the Rough and Ready DWR monitoring station, after the fieldwork for this study was completed. Monitoring the turbidity at mid depth and 1 meter from the bottom is recommended to better evaluate the influence of tides and ship traffic on sediment resuspension.

Trapped sediment travel time in the DWSC

The settling and resuspension of particles retards their transport in the DWSC. This will provide greater time for organic matter, including decaying algae, to exert their oxygen demand. To assess this retardation, the half-lives of chlorophyll *a* and pheophytin *a* in water collected from the San Joaquin River at Navy Bridge (just above the DWSC) were measured in the laboratory under darkness. Using these data an algae age model was developed to estimate the relative age of algae samples collected from the water and the trapped sediments using the chlorophyll *a* to chlorophyll *a* plus pheophytin *a* ratio. The algae captured in the sediment traps were estimated to be approximately twice as old as the algae in the water column. Since algae entering the DWSC was on average about 1 day old, the difference in age equates to a trapped sediment to water concentration age ratio of approximately 3. Therefore, trapped sediments appear to have undergone settling and resuspension that have effectively retarded their transport by 3 times. This increases the time these particles spend in the DWSC and exert their oxygen demand by a factor of three.

Ratios of the ultimate BOD to VSS mass for trapped sediments and water concentrations also qualitatively support this estimate of particulate retardation in the DWSC. The ratio of BOD_{ult} to VSS was found to be 1.1 for water samples, but only 0.25 for trapped sediments. It appears that the trapped sediments are of greater age and thus more of their oxygen demand has been exerted leaving behind refractory material. Trapped sediments exhibited a chlorophyll *a* plus pheophytin *a* to VSS ratio of .004, so if the algae contain 2 percent pigment then the trapped sediments are comprised of 20 percent algae that is not expected to be refractory. These calculations are consistent with the low BOD_{ult} to VSS ratios measured for the trapped sediments.

<u>Water and Sediment Biochemical Oxygen Demands</u>

Long-term biochemical oxygen demand tests were performed with water and trapped sediment samples. First-order decay rates were fit to the experimental data. Average decay constants were 0.087 and 0.094 d^{-1} for the San Joaquin River at the USGS UVM station and DWSC, respectively. Trapped sediment exhibited a higher average decay rate of 0.12 d^{-1}. This higher rate appears to be associated with decaying algae, where as the water sample samples contained a variety of soluble and suspended solids that contribute to oxygen demand.

Selected water samples were also evaluated for carbonaceous (CBOD), soluble (sBOD) and soluble carbonaceous BOD (sCBOD) tests. These results provide the calculation of nitrogenous BOD (NBOD), soluble NBOD, particulate BOD (pBOD), pCBOD, and pNBOD. Fractions of these constituents relative to the total BOD at 10 days for San Joaquin River water and the DWSC appear below:

Table I-1: BOD_{10} fractions in the DSWC and San Joaquin River at the USGS UVM Station.

Location	$\frac{NBOD_{10}}{BOD_{10}}$	$\frac{SNBOD_{10}}{BOD_{10}}$	$\frac{PBOD_{10}}{BOD_{10}}$	$\frac{PCBOD_{10}}{BOD_{10}}$	$\frac{PNBOD_{10}}{BOD_{10}}$
San Joaquin River	0.37	.21	.53	0.37	0.16
DWSC	0.42	.17	.55	0.30	0.25

As shown in Table I-1, the largest fraction of BOD, approximately 55 percent, was associated with particulate matter such as phytoplankton. The nitrogen demand also NBOD was about 40 percent of the total BOD. Of the total NBOD approximately 50 percent was soluble, presumably ammonia.

Average first-order rate constants for BOD, CBOD, NBOD, particulate BOD and trapped sediment BOD are shown in Table I-2 below for samples collected from the San Joaquin River and DWSC water channel.

As shown in Table I-2, the decay rates for carbonaceous BOD are significantly higher than the nitrogenous fraction. Particulate BOD and trapped sediment BOD rates were very similar.

Table I-2: Mean and standard deviation of the first-order BOD decay constants at 20°C.

Location	k at 20°C (d^{-1})	$BODult/BOD_5$
	mean	
	BOD / CBOD / NBOD / PBOD / Sediment BOD	BOD / CBOD / NBOD
San Joaquin River	0.087 / 0.11 / 0.057 / na / na	2.8 / 1.7 / 4.0
DWSC	0.094 / 0.11 / 0.076 / 0.12 / 0.12	2.7 / 1.7 / 3.2

Comparisons with 2000 Monitoring Results

Comparisons of 2000 and 2001 data suggests that loading of oxygen depleting substances was probably the greatest factor influencing the lower DO concentrations in the DWSC during 2001. Resuspension as indicated by average deposition fluxes was often very similar for the two years with the exception of the higher deposition of phytoplankton pigments at Lt. 48 during 2001. This may be caused by higher loadings of algae entering the DWSC. During 2001, high deposition rates were measured for chlorophyll *a* and pheophytin *a* during June and July, months that were not monitored during the 2000 season.

Only total BOD measurements were performed during 2000, compared with numerous fractions monitored during 2001. However, decay rate constants were similar for both waters and trapped sediments.

Sediment Oxygen Demand Chamber Studies

The sediment oxygen demand (SOD) was measured directly with sediment cores collected in a chamber. Cores were collected at Lt. 48, Lt. 43, Lt. 38, and the Turning Basin of the DWSC. Values of SOD ranged from 0.3 to 0.8 g m^{-2} d^{-1} at turbidities common to the DWSC. Elevated SOD values (1.8 g m^{-2} d^{-1}) were possible when mixing was great enough to increase the turbidity. The SOD values measured with these chambers were found to be correlated with the turbidity of the water overlying the sediment core.

The SOD was observed to decrease with downstream distance. This is consistent with the net loss of particulate matter observed in the DWSC. Estimates of SOD using the deposition fluxes and water concentrations yield possible values of 2 to 3.5 g m^{-2} d^{-1}. However, when these SOD values are adjusted to consider the decay of settling organic matter in the water column, adjusted values are of the same order of magnitude as the chamber measurements. These data indicate that the SOD plays a relatively small role in the demand in the DWSC. However, the interactions of sediments in the DWSC appear to significantly retard transport of particulate matter, by a factor of 2 or 3, thus providing greater time for the oxygen demand to be expressed in the DWSC.

Recommended Studies

The mechanisms influencing the aggregation of particles in the DWSC are largely unknown. Incorporation of this phenomenon in the sediment interaction element of the model for the DWSC may require additional investigation. While it is anticipated that most of the aggregation occurs upon settling, the flocculation in the DWSC may be possible. Carefully conducted settling column tests are necessary to evaluate settling velocities without disturbing the structure of particles entering the DWSC and resuspended from the sediment bottom.

A continuous, operational, turbidity sensor near the bottom of the DWSC and at mid depth is also recommended to better assess resuspension with specific episodic events such as the passing of ships, strong tidal flows, and high winds.

Additional work is also recommend to evaluate the kinetics of algal growth and decay in the San Joaquin River and DWSC. In particular this work should be started in March or April to collect data on algae and nutrient loads entering the DWSC and their decay response upon entering the tidal waters at Mossdale and in the DWSC.

Biochemical oxygen demand experiments are warranted where nitrogen species are monitored to better estimate the nitrogenous decay rates.

II. Water Quality Measurements, Sediment Deposition Fluxes and Settling Velocities

Introduction

The study was conducted for the San Joaquin River TMDL technical committee as part of the CALFED Directed Action 2001 investigations. Water and suspended sediments in the San Joaquin River and Stockton Deep Water Ship Channel (DWSC) were studied during the summer and fall of 2001 to elucidate settling and resuspension mechanisms that influence dissolved oxygen (DO) concentrations. The width and depth of the San Joaquin River increases significantly upon entering the DWSC reducing flow velocities and turbulence that allows greater settling of particulate matter. Of the suspended solids entering the DWSC from the San Joaquin River, algae have been estimated to be a dominant source of the biochemical oxygen demand (BOD) load (Jones and Stokes, 1998). This work was performed to quantify the setting fluxes and velocities of particulate matter and oxygen demand associated with these suspended sediments. It is anticipated that deposition rates and settling velocity data will be used to calibrate a water quality model of the DWSC.

Sediment deposition rates were measured with a series of traps placed in the DWSC. Water samples from the DWSC and the San Joaquin River upstream of the DWSC were collected to estimate settling velocities from the deposition rates. Algae concentrations of both the water column and the trapped sediments were quantified with chlorophyll *a* measurements. Laboratory biochemical oxygen demand (BOD) tests were performed with the trapped sediment to estimate the oxygen demand of the trapped matter. In combination these measurements provide evidence supporting significant settling and resuspension rates. These data also yield water and sediment quality constituent correlations that may be used for other San Joaquin River TMDL investigations or analyses.

Sediment oxygen demands were also measured with chamber studies using sediment cores collected from the DWSC and the Turning Basin from August to November, 2001.

Sediment traps were used to estimate sediment deposition rates in the Stockton Deep Water Ship Channel (DWSC). Settling velocities (m/hr) were calculated from the sediment deposition flux (mg m^{-2} hr^{-1}) and the composite water concentration collected at each trap station and depth. During the collection of water samples at each trap, field measurements of water temperature, pH, dissolved oxygen, turbidity, and Secchi depth were recorded.

Monitoring was limited to the upper half of the 7-mile critical reach of the San Joaquin River where DO water quality objectives are frequently violated (Lee, 2002). Previous studies have shown that most of particle burial near the Port of Stockton (Channel Point). At this location where the San Joaquin River flows into the DWSC (Litton 1999, Litton and Nikaido, 2000). Historically, the greatest oxygen deficits are also measured within the first 3 miles of the DWSC, downstream from the Port of Stockton. These deficits are most pronounced during periods of low net flows. Only at flows in excess of about 1500 cfs will the DO sag shift beyond a point 3 miles downstream of the Port of Stockton (Foe *et al*., 2002). Average water years generally yield net flows in the DWSC below 1000 cfs, as observed during the 2000 and 2001 monitoring. Therefore, monitoring was concentrated within the first 3.5 miles of the 7 mile critical reach. This reach is shown in Figure II-1 between Navigation Lights 38 and 45.

Physical and hydraulic characteristics of the study region are presented in Table II-1. Each station is approximately 10,000 ft apart. The cross-sectional area of the San Joaquin River increases from about 6 times from 2400 ft^2 to 14,500 ft^2 upon entering the DWSC. This expansion also reduces the flow velocity 6 times, thus permitting some particulate matter to settle. The expansion of the cross-sectional area also yields a significant increase in the net travel time of the water from station to station. As shown in Table II-1, at a net flow of 1000 cfs the travel time for the water from the UVM station to the DWSC is approximately 7 hours. However, the time required for the water to travel to the next monitoring station at the Rough and Ready gage (near Lt 43) is almost 40 hours. This increase in travel time also provides more time for the exertion of BOD transported into the DWSC by the San Joaquin River. Also shown in Table II-1 is the estimated average tidal flow as estimated by Jones and Stokes, 2002b. This estimate provides a means for estimating the tidal excursion at each station.

Table II-1: Geometry, flows, travel times, and tidal excursions[1].

River Segment	Distance (ft)	Surface Area (acres)	Average Cross-Sectional Area (ft^2)	Average/ Maximum Tidal Flow[2] (cfs)	Travel Times: Net Travel Time Q =1000 cfs (hrs)	Travel Times: Average Tidal Flow 4000 cfs (hrs)	Tidal excursion at average tidal flow after 6 hr[4] (ft)
USGS UVM to Lt. 48	11,000 (2.1 mi)		2,400[3]	2,400 5,000	7	1.8	21,600 (4.0 mi)
Lt. 48 to Lt. 43	9,200 (1.7 mi)	125	14,500[3]	4,000 8,000	37	9.2	6000 (1.2 mi)
Lt. 43 to Lt. 38	10,100 (1.9 mi)	140	14,500	5,000 10,000	41	10	(1.4 mi)

[1]Jones and Stokes, 2000b.
[2]Based on an average tidal stage change of 3 feet during a 6-hour flood or ebb tide.
[3]DWR, 2001.
[4]Typical ebb or flood tide duration.

Methods and Materials

Three sediment frame systems, each with four traps, were placed at Light 48 (Channel Point), near Light 43 (directly offshore from the continuous monitoring station on Rough and Ready Island), and at Light 38 in the San Joaquin River. On two occasions the Lt. 38 traps were placed midway between Lt. 48 and 43 at Lt. 45. The distances and estimated travel times at flows of 1000 cfs and 4000 cfs were presented in Table II-1. A schematic diagram of the trap apparatus is shown in Figure II-2. Duplicate traps are shown in Figure II-2. The two traps at each depth had aspect ratios (height to diameter) of 3 and 10. The traps were left to collect sediment during ebb and flood tides lasting approximately 6 hours. The dates and times that the sediment traps were deployed are listed in Table II-2.

Water samples were collected at each trap depth twice during each ebb or flood tide using a peristaltic pump. The inlet tube was attached to a YSI Sonde with a depth sensor. The inside diameter of the tubing was 5/16 in and the pumping rate was approximately 1-2 L min^{-2}. Prior to the collection of each water sample, the tubing was flushed with three tube volumes of water to ensure that water remaining in the system from the previous sampling was removed. Water samples were also collected at a station upstream of the DWSC in the San Joaquin River. Water samples were collected at depths of 4, 8, 12, 16 feet in the center of the San Joaquin River near the UVM Station above the Stockton RWCF discharge outfall shown in Figure II-1. This location is referenced in this report as the San Joaquin River. All other stations are referred to being as in the DWSC, also part of San Joaquin River.

The sediment traps were constructed of 2-inch diameter PVC pipe, 20 inches long. Traps were located at four depths: 2.5 m (8.2 ft), 5.0 m(16.4 ft), and 7.5 m (24.6 ft) below the water surface and at 0.5 m (20 inches) above the sediment surface. The trap near the sediment water interface was secured to a weighted PVC frame with a 3 by 3-ft square footprint. Traps at 2.5, 5 and 7.5 meters were attached to a nylon line anchored to the sediment trap frame and supported by a buoy. The aspect ratio of sediment traps can influence the trapping efficiency. Studies performed during 2000 with 6-inch and 20-inch traps yielded similar trapping rates so only the high aspect ratio were used during 2001 (Litton, 2000). The apparatus shown in Figure II-2 exhibits two traps at each depth. For 2001 only one trap was used based on the trap aspect ratio tests performed in 2000.

Water samples and sediment samples were transferred from the traps to 1-L polypropylene bottles, immediately iced and transferred to a 4°C refrigerator within 2 hours of collection. Volatile and total suspended solids of the water samples and sediment slurry were determined by filtration, drying at 103°C, and ignition at 550°C (APHA, AWWA, and WEF, 1998). Quantification of chlorophyll *a* and pheophytin *a* were also performed in accordance with Standard Methods (APHA *et al.,* 1998).

Field measurements of water temperature, pH, dissolved oxygen were performed with a YSI 600 sonde at each water station and depth. Dissolved oxygen measurements were verified at each trap station with a YSI 55 dissolved oxygen meter and with periodic field titrations using the winkler method (APHA *et al.*, 1998). Turbidity measurements were performed in the field with samples collected with the peristaltic pump system at each station and depth. Secchi depth measurements were conducted at each station using a 6-inch Secchi disk. Where applicable, field instruments were calibrated with standard solutions in the field prior to measurement, periodically checked thereafter, and at the end of the day.

Average settling velocities for TSS, VSS, chlorophyll *a* and pheophytin *a* were calculated at each depth using the deposition flux and the respective composite water concentration. At each trap the deposition flux, J, is equal to the product of the water concentration (C), and the average settling velocity, v_s.

$$J(g \cdot m^{-2} hr^{-1}) = v_s (m \cdot hr^{-1}) \times C(mg \cdot L^{-1}).$$

In the case of chlorophyll *a* and pheophytin *a,* where the concentration is typically reported in terms of $\mu g \cdot L^{-1}$, the deposition flux is reported as $mg \cdot m^{-2} \cdot hr^{-1}$.

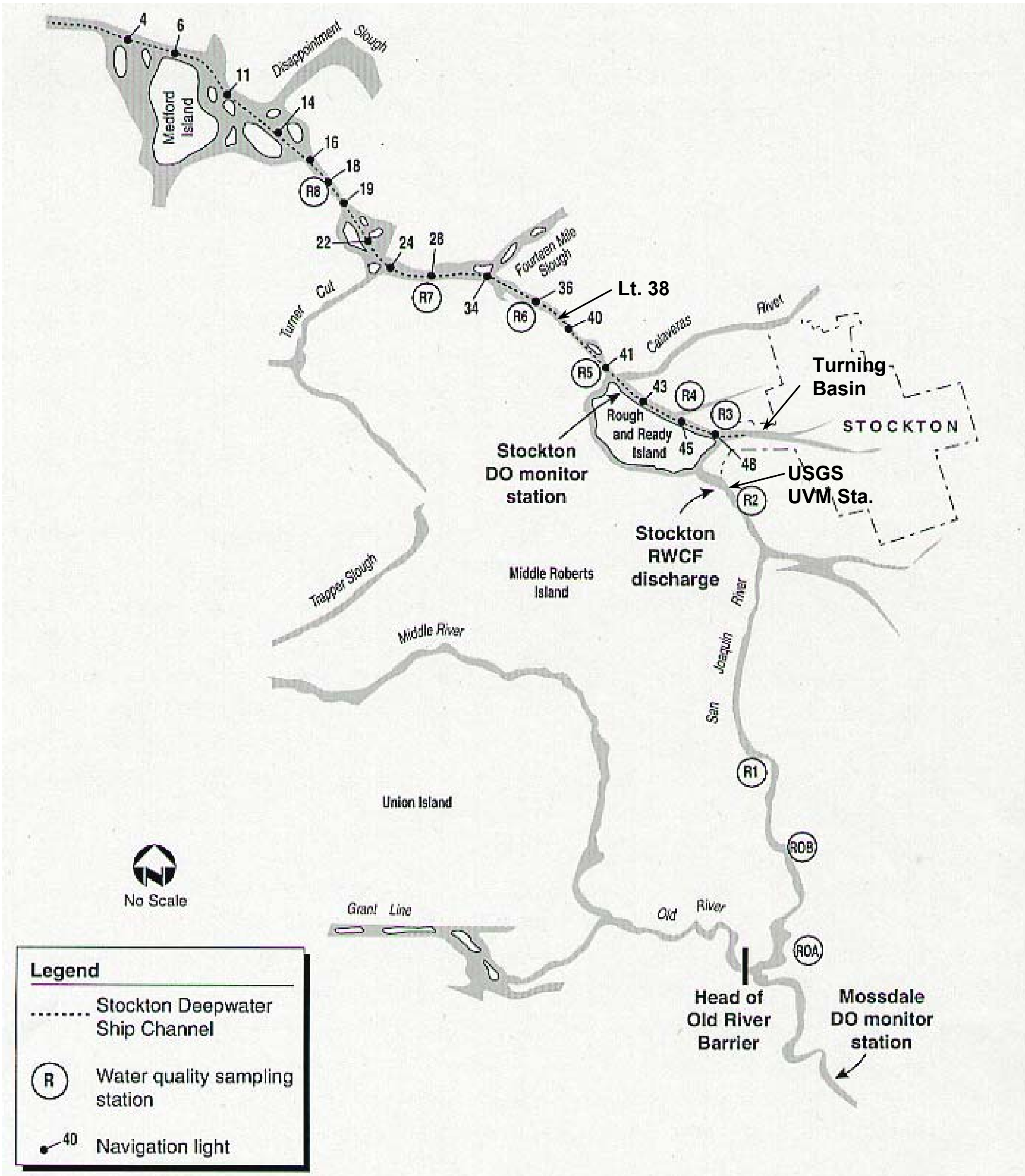


Figure II-1: San Joaquin River and the Stockton Deep Water Ship Channel.

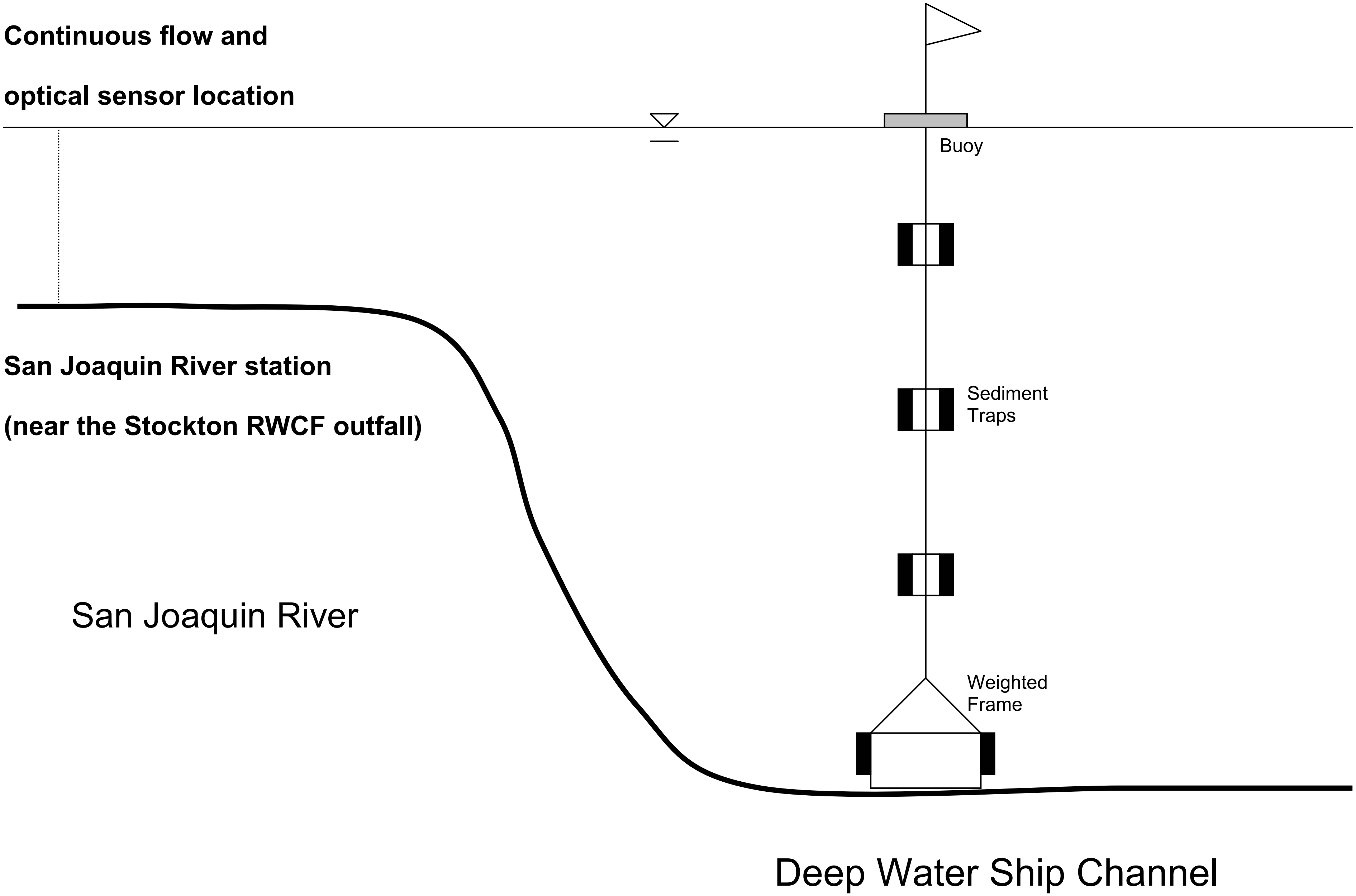


Figure II- 2: Typical Schematic Diagram of a Sediment Trap Station

Table II-2: Dates and approximate times sediment traps were deployed.

Date	Time of Deployment and Recovery	Tide Conditions	Tidal State(s)	Times of Slack Tides	Slack Tide Stage (ft)	Slack Level
6/14/01	Deployed: 7:15 A.M. Recovered: 11:45 A.M Redeployed: 2:20 P.M Recovered: 7:00 P.M.	Neap	Flood Ebb	7:45 A.M. 12:00 P.M.	0.91 2.29 -.026	HH HL LH LL
6/21/01	Deployed: 6:20 A.M. Recovered: 2:10 P.M. Redeployed: 2:10 P.M. Recovered: 7:45 P.M.	Spring (No Moon)	Ebb Flood	5:45 A.M 2:30 P.M. 8:00 P.M.	4.66 0.11 3.04	HH LL LH HL
7/13/01	Deployed: 7:20 A.M. Recovered: 12:45 P.M. Redeployed: 12:45P.M. Recovered: 7:15 P.M.	Neap	Flood Ebb	7:00 A.M. 11:30 A.M. 7:00 P.M.	0.91 2.51 0.49	HH HL LH LL
7/20/01	Deployed: 5:30 A.M. Recovered: 1:50 P.M Redeployed: 2:00 P.M. Recovered: 7:30 P.M.	Spring (No Moon)	Ebb Flood	5:15 A.M 2:30 P.M. 8:00 P.M.	4.76 0.22 3.19	HH LL LH HL
8/25/01	Deployed: 7:00 A.M. Recovered: 12:30 P.M. Redeployed: 12:45 P.M. Recovered: 6:20 P.M.	Neap	Flood Ebb	7:00 A.M 12:15 A.M. 5:45 P.M	0.15 2.6 0.69	LL LH HL HH
9/11/01	Deployed: 7:45 A.M. Recovered: 2:00 P.M. Redeployed: 2:00 P.M. Recovered: 6:30 P.M.	Neap (+ 1 Day)	Flood Ebb	8:30 A.M. 2:45 P.M. 6:00 P.M.	0.24 2.88 1.91	LL LH HL HH
9/18/01	Deployed: 7:10 A.M. Recovered: 2:00 P.M. Redeployed: 2:00 P.M. Recovered: 7:15 P.M.	Spring (+ 1 Day No Moon)	Ebb Flood	7:00 A.M. 2:15 P.M. 8:00 P.M.	3.99 0.47 3.85	HL HH LL LH
10/16/01	Deployed: 6:30 A.M. Recovered: 1:00 P.M. Redeployed: 1:00 P.M. Recovered: 6:30 P.M	Spring (No Moon)	Ebb Flood	6:15 A.M. 12:45 P.M. 6:30 P.M.	3.51 0.59 3.93	LL LH HL HH
10/25/01	Deployed: 9:00 A.M. Recovered: 3:00 P.M. Redeployed: 3:00 P.M. Recovered: 9:30 P.M.	Neap (+ 2 Day)	Flood Ebb	9:00A.M. 3:30 P.M. 8:45 P.M.	-.061 2.69 0.95	HH LL LH HL

LL: Low-Low Slack Tide HL: High-Low Slack Tide
HH: High-High Slack Tide LH: Low-High Slack Tide

Water Quality and Deposition Flux Measurements

Water quality parameters and deposition fluxes were measured by the field *in-situ* or laboratory methods described earlier. Water quality constituent concentrations were needed to calculate settling velocities of the material captured in the sediment traps or were helpful when comparing temporal trends in water quality or sediments fluxes.

Volatile suspended solids (VSS), total suspended solids (TSS), chlorophyll *a* (chl *a*), and the sum of chlorophyll *a* and pheophytin *a* (chl *a* + ph *a*) concentrations in the DWSC and the San Joaquin River are presented in Appendix A, Tables A-7 through A-10. Deposition flux data are presented in Appendix B, Tables B-1 through B-4, and calculated settling velocities are presented in Appendix C, Tables C-1 to C-4.

Trends in the data were assessed by:

1. Temporal variations (averages over depth)
2. Overall averages (averages over time at each station and depth)
3. Comparisons of ebb and flood tide averages,
4. Comparisons of neap and spring tide averages.

Temporal variations in water quality parameters

Water temperature, dissolved oxygen, pH, turbidity, and Secchi depth measurements were performed on dates and times shown in Appendix A, Table A-1. Figures II-3 through II-6 present water column averages at each station and date. These averages were calculated by as follows:

$$\overline{C} = \frac{\sum C_i \times \Delta d_i}{\sum \Delta d_i}$$

where C_i is the parameter value at depth i, and Δd_i is the segment of the water column associated with depth i. Where applicable, measurements were typically made at depths of 0.8, 2.5, 5, 7.5, and 11 meters. The associated water column segment lengths for these depths were assigned at 1.25, 2.5, 2.5, 2.75, and 1.5 m, respectively.

These discrete field measurements were not used directly to determine deposition rates or settling velocities, but provide qualitative information on water column mixing and stratification and also contribute to the database used by the San Joaquin River Technical Committee. The constituent values are presented in Appendix A, Tables A-2 to A-6. These data yield water column profiles that often suggest the San Joaquin River and DWSC are relatively well-mixed. However, the data do indicate that temperature stratification can develop within the DWSC during warm afternoons. In addition, turbidity measurements near the sediment-water interface are usually higher than the rest of the water column, indicating that sediment resuspension in the DWSC is common.

As shown in Figure II-3, water temperatures in the DWSC reached a maximum level of approximately 26°C in late June and slowly decreased throughout the summer and early fall. From June 14 to September 18 temperatures generally remained above 23°C. Oxygen levels in the DWSC where already depressed before the water quality objective of 5 mg/L at Lt. 43 and Lt. 48 when the monitoring began on June 14, 2001. Dissolved oxygen concentrations remained below 5 mg/L from June 14 to until early September. Depth averaged DO concentrations were typically about 4 mg/L throughout the summer in the DWSC near Lt. 43. DO concentrations appear to have risen above 6.0 mg/L in early October at Lt. 43. San Joaquin River DO concentrations entering the DWSC were generally greater than 5 mg/L. The exception to this was measurements of approximately 4.0 mg/L at the Stockton UVM station on the morning of 6/21/01 during an ebb tide. DO concentrations during the afternoon flood tide were above 5.0 mg/L. These values are found in Appendix A.

The increase in the DO at the Stockton UVM station during the flood tide on June 21 could be caused by algal productivity or reaeration in the shallower, more turbulent waters of the San Joaquin River. The DO concentration of the water that flowed up the river from the DWSC during flood tide was less than 4.0 mg/L. Thus the movement of water from DWSC into the river does appear to have gained about 1.2 mg/L during a period of 2 to 3 hours. While chlorophyll *a* concentrations doubled from 16 µg/L in the morning to 31µg/L in the afternoon at the UVM station, algal productivity doesn't appear to be the dominant cause of the DO increase because DO levels didn't continue to increase through the afternoon. In addition, the relatively low chlorophyll *a* concentrations measured on June 21 suggest that DO inputs associated with algal productivity was perhaps small compared to potential contributions measured later in July when chlorophyll *a* concentrations peaked at 80 µg/L. In conclusion, these data indicate that reaeration in the San Joaquin River above the DWSC can be significant during flood tides when the direction of flow reverses.

Turbidity levels are shown for the study period in Figure II-5. The depth-averaged turbidity was highest at the start of the study on June 14 and then rapidly decreased approximately 10 NTU to approximately 20 NTU, where levels remained constant through October 25. The origin of the turbidity appears to be associated with inorganic sediments after inspection of temporal plots of TSS, VSS, chlorophyll *a* and pheophytin *a* shown in Figures II-5 through II-8. The high turbidity appears to be associated with low chlorophyll *a* concentrations suggesting that algal productivity was impacted by the light attenuation. Also shown in Figure II-5 is the turbidity near the sediment-water interface at Lt. 48. These turbidities are significantly higher than levels for the rest of the water column and they are often greater than turbidity entering the DWSC as measured at the UVM station in the San Joaquin River. These observations indicate that sediment resuspension is significant in the DWSC.

The Secchi depths shown in Figure II-6 are generally consistent with the turbidity measurements shown earlier. The lowest measurements are always measured in the San Joaquin River. The DWSC exhibits higher Secchi depths due to particle settling and lower algae concentrations. These measurements offer evidence that most of the sediment burial occurs near Lt. 48 where the relatively shallow San Joaquin River enters the DWSC. Downstream of Lt. 48 the clarity of the water at Lt. 43 or Lt. 38 is quite similar, suggesting that particle settling and resuspension rates are similar. This trend can also be seen in the temporal plot of TSS presented in Figure II-7. Also shown in Figure II-7 is the reduction in TSS that occurs near Lt. 48 due to particle settling. Further reduction in TSS concentrations with distance downstream in the DWSC can also be observed in the data plotted for Lt. 43 and Lt. 38. This trend is also observed for VSS as shown in Figure II-8. However, water concentrations of TSS and VSS in the DWSC do not decrease from June to October as observed in the San Joaquin River. This suggests that TSS and VSS concentrations in the DWSC are controlled more by resuspension than from San Joaquin River inputs.

Depth-averaged chlorophyll *a* and pheophytin *a* concentrations in the DWSC and at the San Joaquin River USGS UVM station are presented in Figures II-9 and II-10. The biochemical oxygen demand of water in the San Joaquin River has been shown to be better correlated to the sum of chlorophyll *a* and pheophytin *a* concentrations than chlorophyll *a* concentrations alone (Foe *et al.*,2002). Pheophytin *a* is a degradation product of chlorophyll *a*. As shown later in this report, one gram chlorophyll *a* was shown to degrade to 1 gram of pheophytin *a*. As such, the biochemcial oxygen is expected to be better correlated to the sum of chlorophyll *a* and pheophytin *a* since this sum will include algae that are in less than excellent physiological condition. Also shown later in this report, the concentration ratios of chlorophyll *a* to chlorophyll *a* plus pheophytin *a* (pigment) were shown to be correlated to the time spend in darkness. A chlorophyll *a* / pigment ratio of 1 indicates the algae are in perfect physiological condition. Declining ratios indicate a decaying population. For these reasons, the sum of these phytoplankton pigments appears throughout this report.

Chlorophyll *a* concentrations in the DWSC appear to be strongly influenced by algae flowing in from the San Joaquin River. As shown in Figure II-9, chlorophyll *a* concentrations in the DWSC do become attenuated with distance downstream from Lt. 48. For example, on July 13 average chlorophyll *a* concentrations measured at the UVM station, Lt. 48, Lt. 43, and Lt. 38 were 80, 52, 25, and 11 μg/L, respectively. One week later in July, chlorophyll *a* concentrations were remarkably lower, perhaps due to a week of cool, overcast weather. The rapid decline in chlorophyll *a* concentrations indicates that algae entering from the relatively turbulent, shallow San Joaquin River are not well suited for survival in the DWSC, where they settle below the euphotic zone, die and exert an oxygen demand.

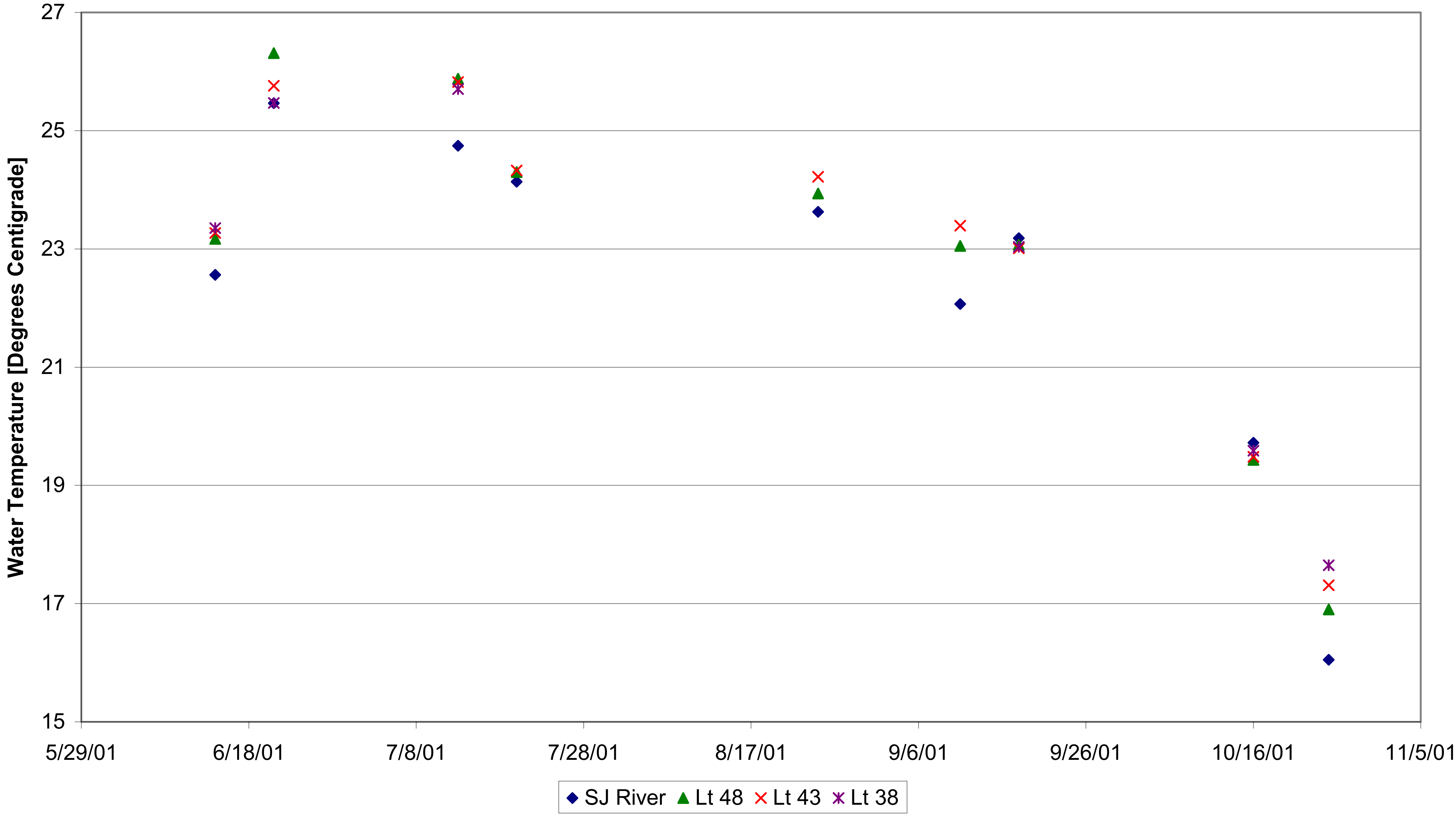


Figure II-3: Depth-averaged water temperatures during the 2001.

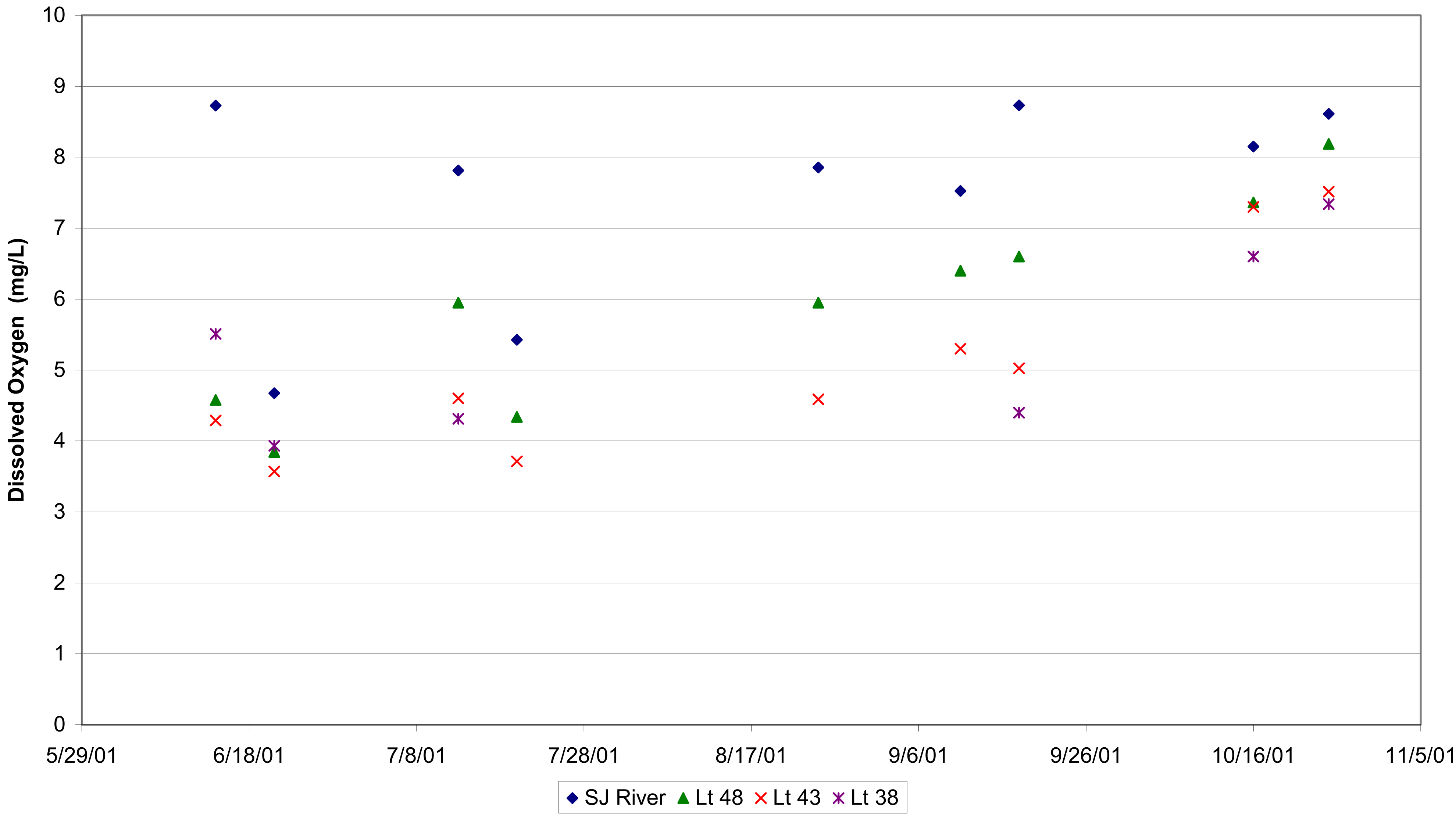


Figure II-4: Depth-averaged DO concentrations during 2001.

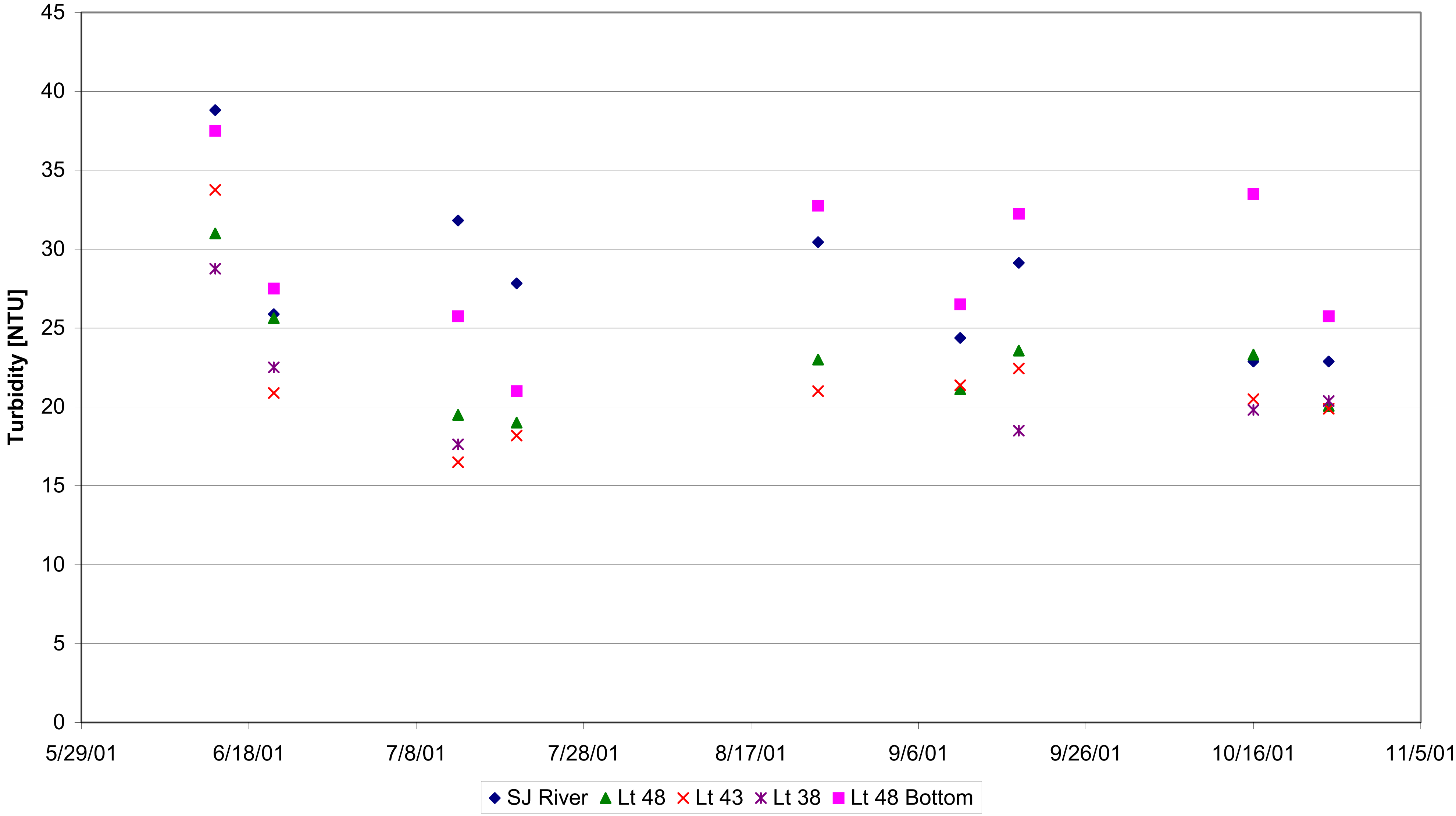


Figure II-5: Depth-averaged turbidities during 2001.

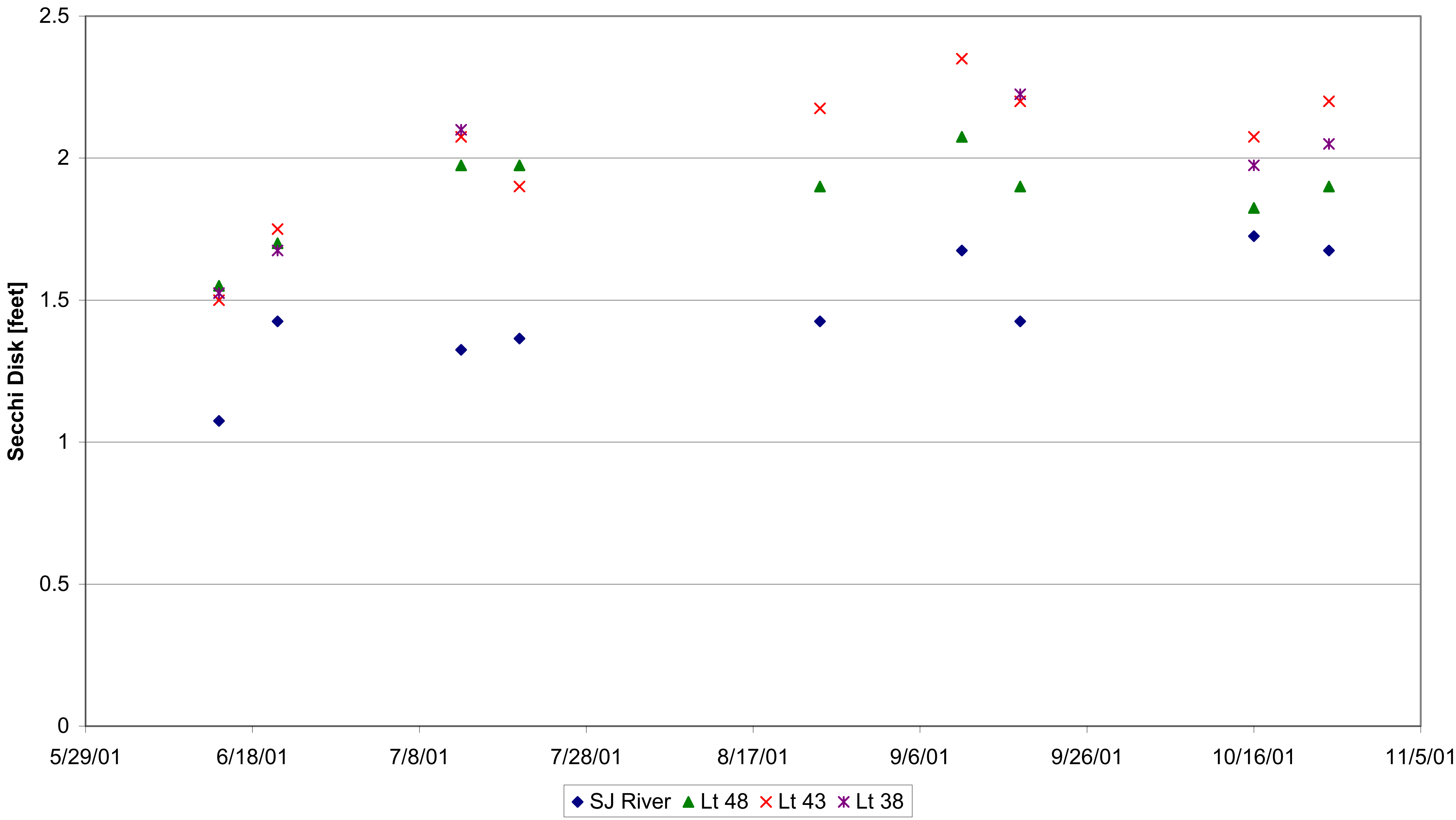


Figure II-6: Secchi disk depths during the 2001.

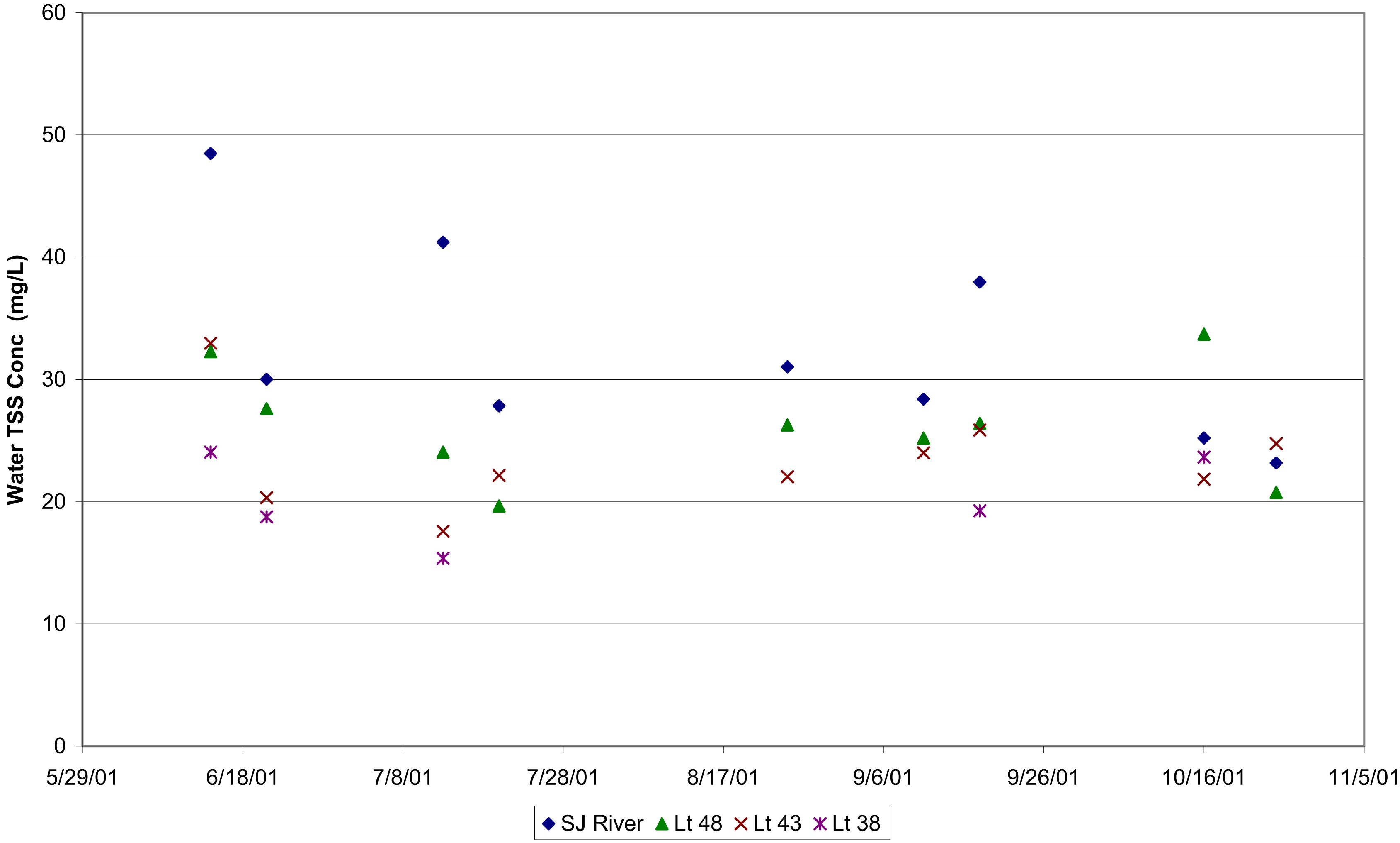


Figure II-7: Depth-averaged TSS water concentrations in the DWSC during periods of trap deployment.

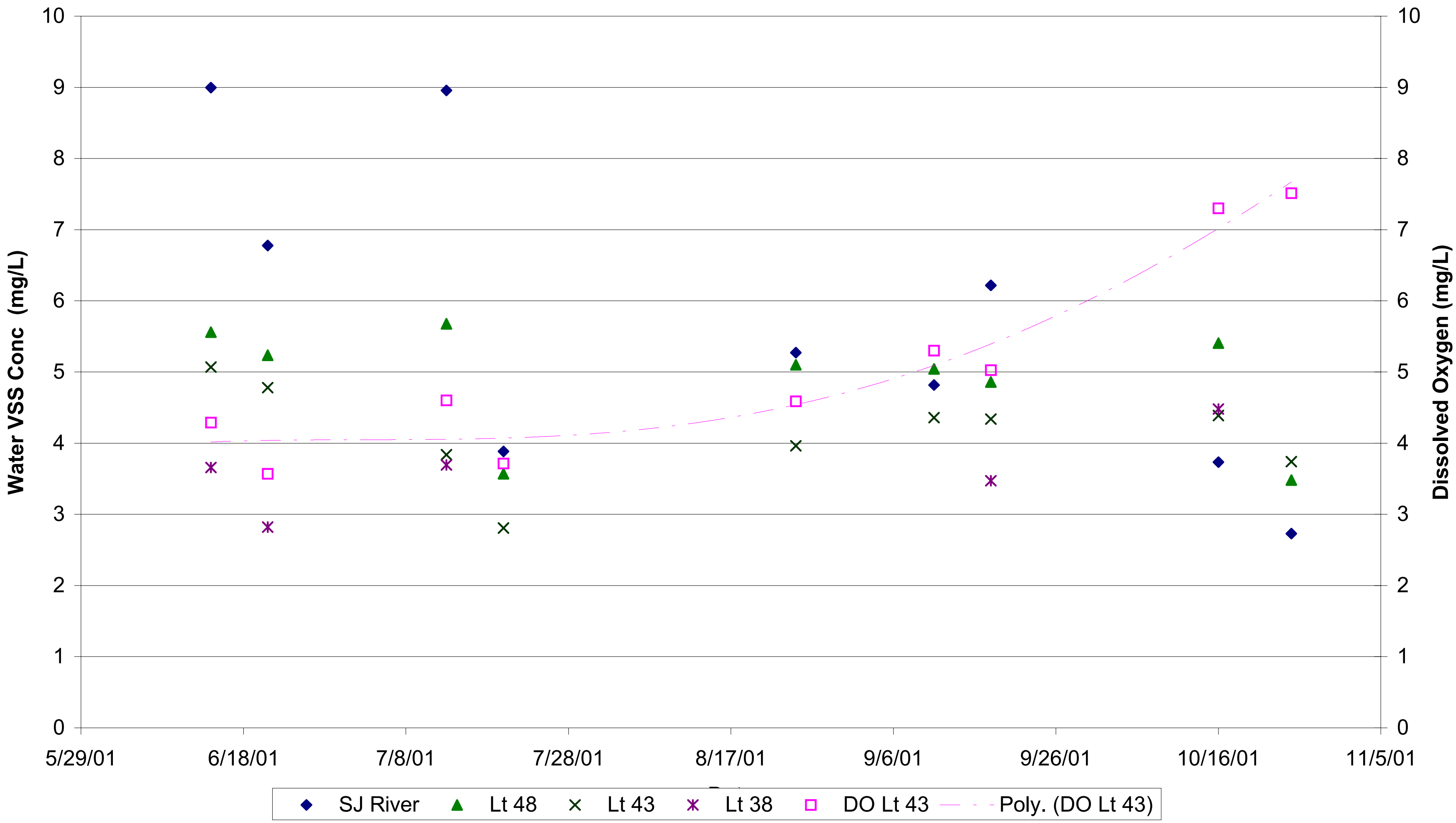


Figure II-8: Depth-averaged VSS water concentrations in the DWSC during periods of trap deployment.

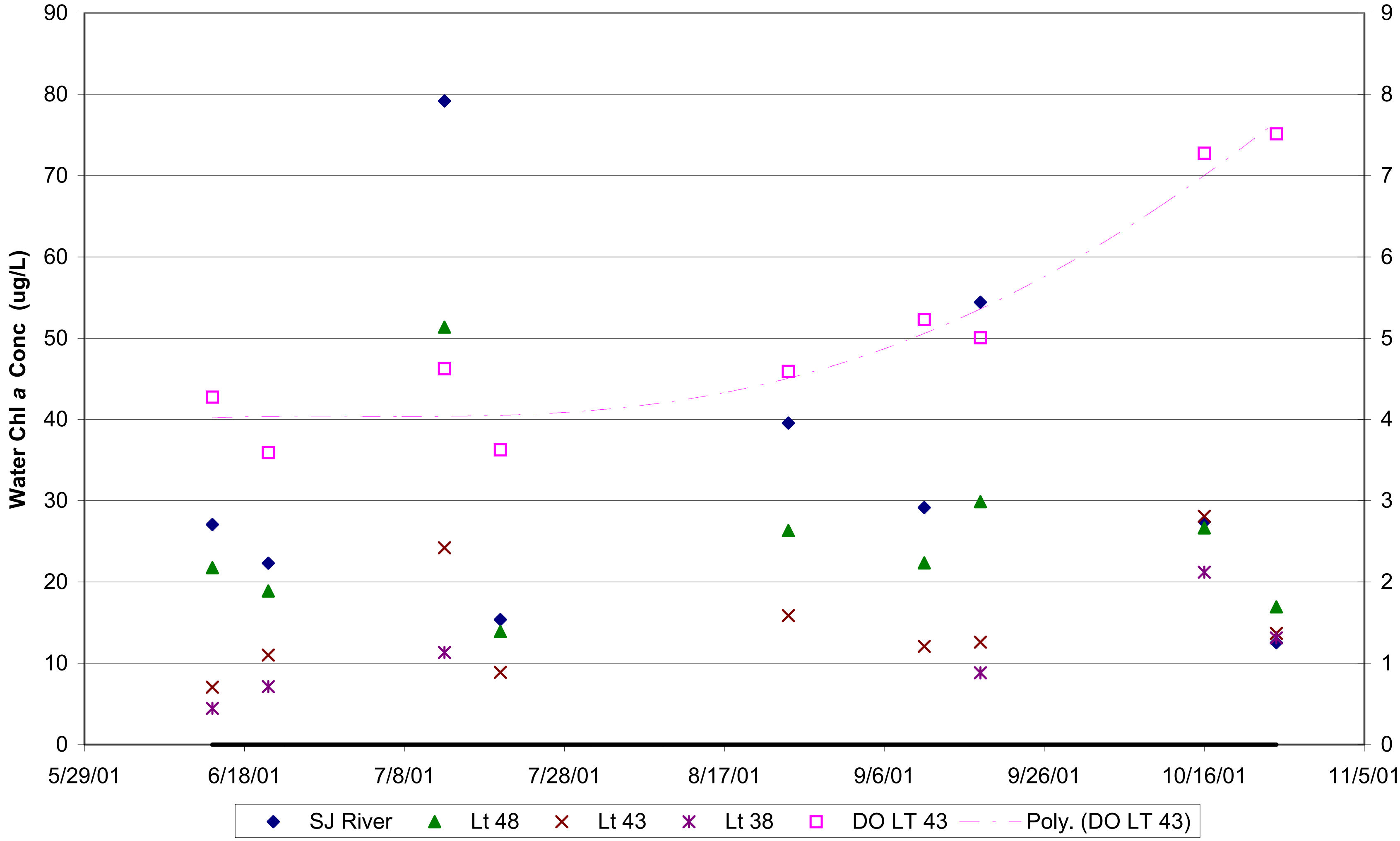


Figure II-9: Depth-averaged chlorophyll *a* water concentrations in the DWSC during periods of trap deployment.

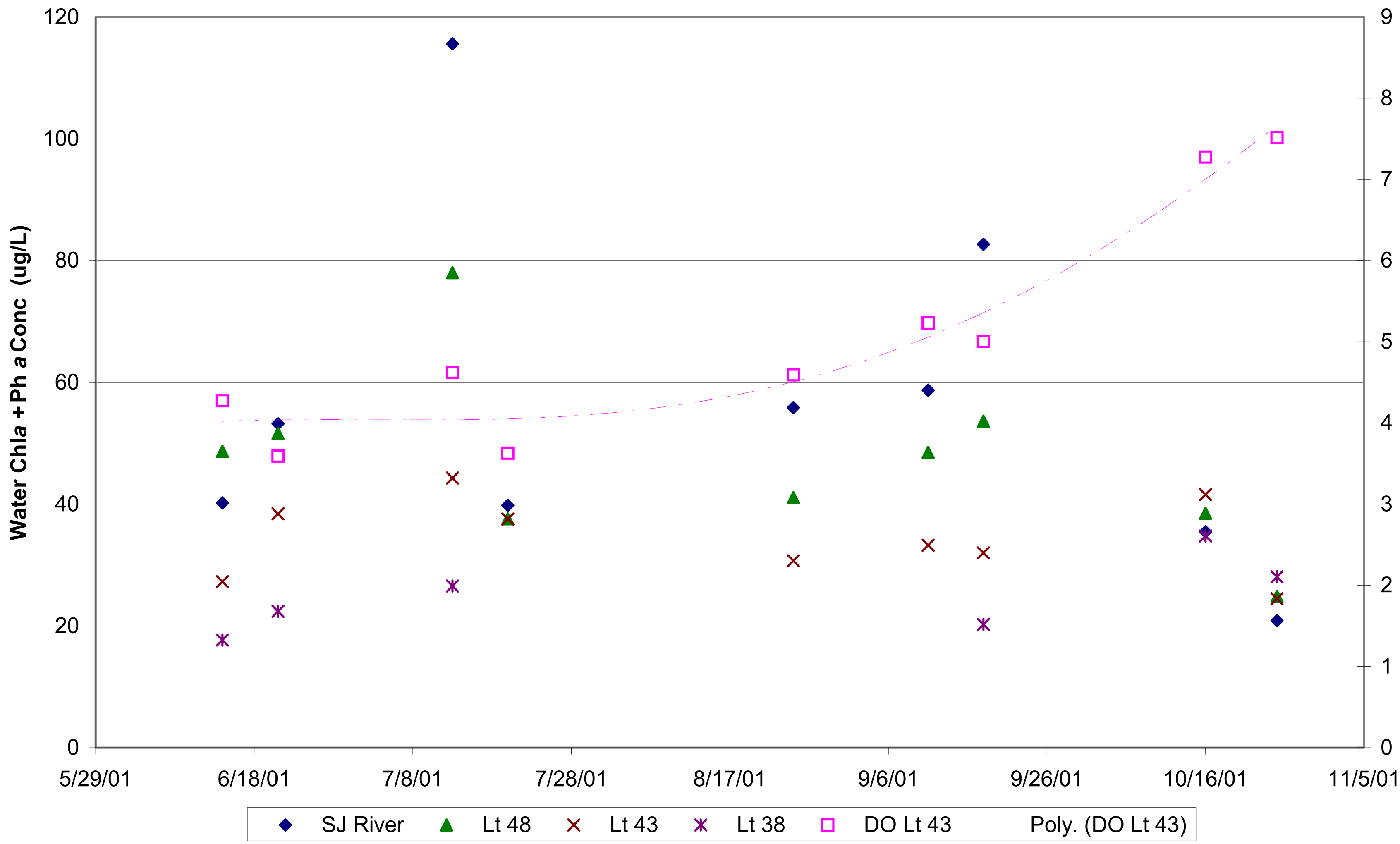


Figure II-10: Depth-averaged chlorophyll *a* plus pheophytin *a* water concentrations in the DWSC during periods of trap deployment.

Temporal variations in deposition fluxes of trapped sediments in the DWSC

The deposition flux measurements of TSS, VSS, chlorophyll *a*, and chlorophyll *a* plus pheophytin *a* captured in the sediment traps are presented in Appendix B, Tables B-1 through B-4. Figures II-11 exhibits the depth-averaged TSS deposition flux measured in the DWSC from June 14 to October 25, 2001. Also shown in Figure II-11, is the average TSS concentration that was measured in the San Joaquin River at the USGS UVM station approximately 2 miles above Lt. 48 in the DWSC. The flux measured at Lt. 48 was always greater than fluxes observed at downstream stations Lt. 43 and Lt. 38. This could be due to the primary settling of suspended particles entering the DWSC and from higher rates of resuspension at Lt. 48. Just above Lt. 48 the San Joaquin River flows into the DWSC where water velocities and associated turbulence decrease significantly due to increases in average depth from 8 to 22 ft and average width from 250 to 500 feet (Jones and Stokes, 1998). Thus, the cross-sectional enlargement of the San Joaquin River results in an average water velocity reduction of approximately 5.5 near Lt. 48. Downstream of Lt. 48 the average deposition fluxes were relatively constant, with the exception of data collected on September 11, 2001.

Average deposition fluxes at Lt. 48 are also influenced by sediment resuspension events. As shown in Figure II-11, the highest average deposition flux measured at Lt. 48 and Lt. 43 occurred on September 11, 2001. The average high flux measured on September 11 is due largely to sediments trapped during the morning tide. During this period three large ships passed through the DWSC and by the sediment traps. This was the most frequent ship traffic observed on the days of monitoring during the 2001 season. The resuspension of sediment by the passing ships and the subsequent collection in the sediment traps appears to provide the best explanation for the elevated deposition fluxes observed on September 11. The San Joaquin River TSS concentrations were relatively low and thus do not explain these elevated deposition fluxes. Interestingly the water concentrations of TSS collected at Lt. 43 and Lt. 48 during the morning tide were also typical and not at elevated levels for the DWSC. Apparently material suspended from the bottom settled quickly and was not collected during the routine water quality monitoring performed twice during each tide. As presented later, settling column experiments of trap particulate matter also exhibited relatively high settling rates. The settling rate data support the idea that resuspended sediments are aggregated and settle quickly.

The depth-averaged VSS deposition fluxes exhibited similar trends as observed with TSS. As shown later, the ratio of VSS to TSS is remarkably constant (approximately 0.10) for the trapped sediments, suggesting that significant quantities of the VSS captured in the sediment traps are bound to inorganic particles. Thus plots of VSS deposition fluxes will appear similar to the TSS graphs. Water concentrations of VSS in the San Joaquin River above the DWSC did decrease during the 2001 monitoring season. Deposition fluxes do not seem to reflect this decline in VSS entering the DWSC. As with TSS, VSS deposition fluxes remained relatively constant (ignoring September 11 data) from June to October, especially downstream of Lt. 48.

Figure II-13 presents the depth-averaged chlorophyll *a* deposition fluxes measured in the DWSC during 2001. The deposition flux measured at Lt. 48 appears to be more strongly influenced by upstream San Joaquin River chlorophyll *a* concentrations and not sediment resuspension events as observed with TSS and VSS. This is probably caused by the reactive nature of chlorophyll *a*. Laboratory tests indicated that chlorophyll *a* had a half-life of approximately 1.25 days when samples were placed in darkness at 20°C. Thus, viable algae that settle in the DWSC can lose much their chlorophyll *a* pigment if not resuspended and returned to the euphotic zone. This may explain the lack of a peak in the chlorophyll a flux at Lt. 48 on September 11 that was prominent for TSS and VSS. However, a small peak is evident at Lt. 43 on September 11.

Review of Figure II-14 for the sum of chlorophyll *a* and pheophytin *a* deposition fluxes indicates that levels are influenced by both the water quality entering the San Joaquin River and resuspension events. At Lt. 48 the deposition flux of chlorophyll *a* and pheophytin *a* appears well correlated to the San Joaquin River concentrations for all dates except September 11. The resuspension events yielding high TSS and VSS deposition fluxes for September 11 also provided relatively high deposition fluxes of pheophytin *a.* Chlorophyll *a* is converted pheophytin *a* upon decay. These data also suggest that the pheophytin *a* is more refractory than chlorophyll *a* and thus it appears in the sediment traps upon resuspension from the bottom. The refractory nature of pheophytin *a* compared to chlorophyll *a* was also evident with the laboratory decay experiments discussed later. The half-life of pheophytin was twice that of chlorophyll *a*.

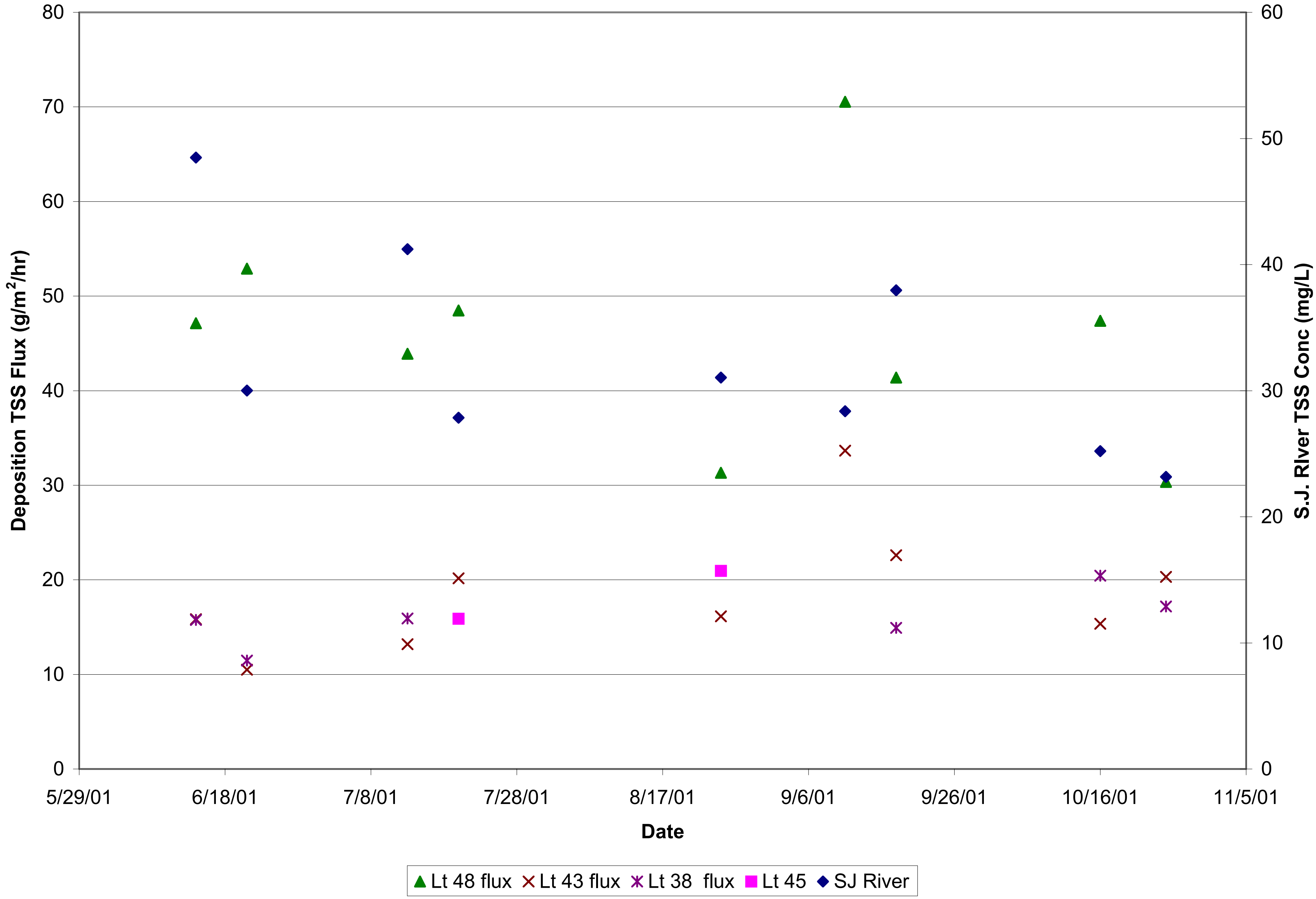


Figure II-11: Depth averaged TSS deposition fluxes measured during 2001.

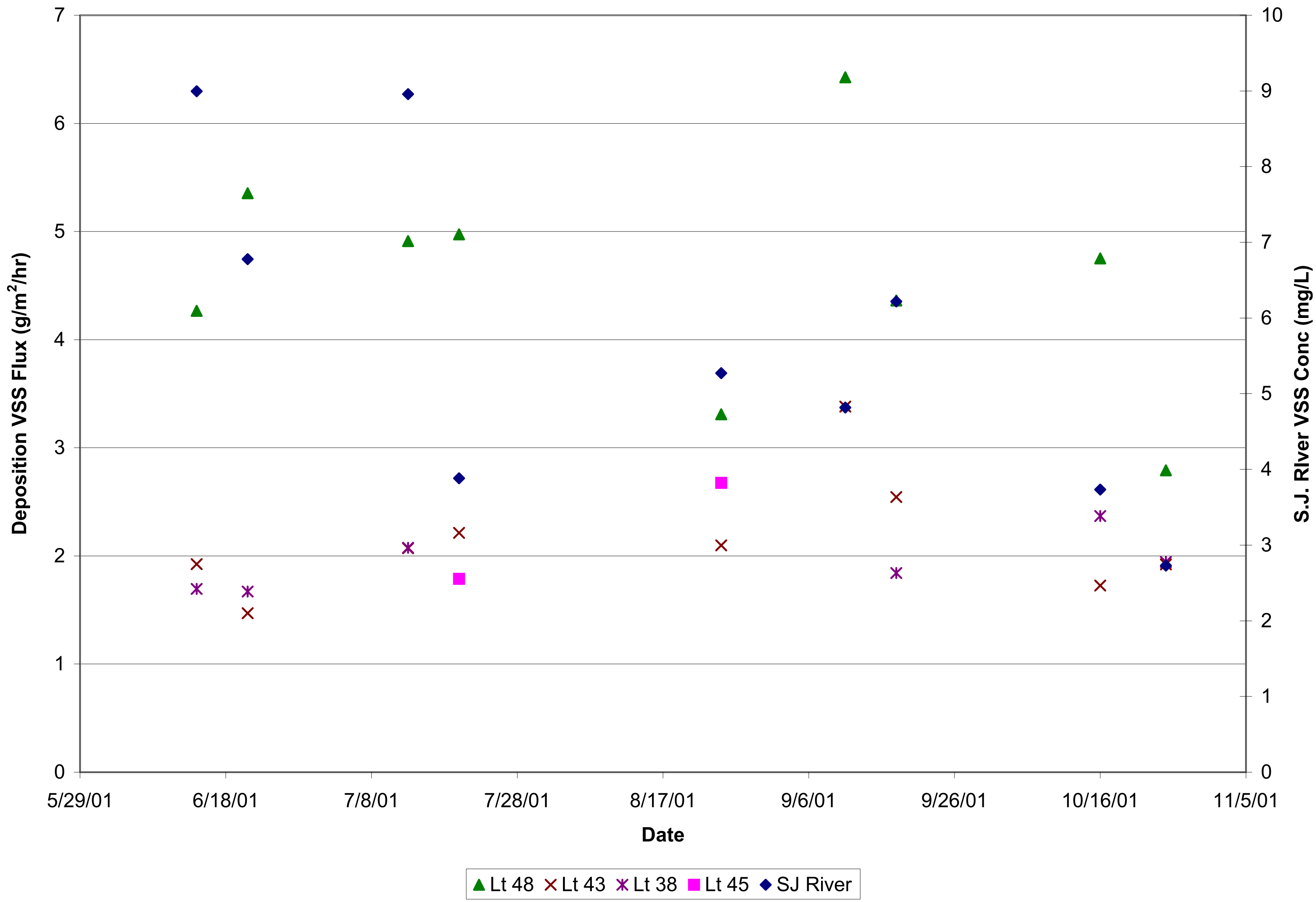


Figure II-12: Depth averaged VSS deposition fluxes measured during 2001.

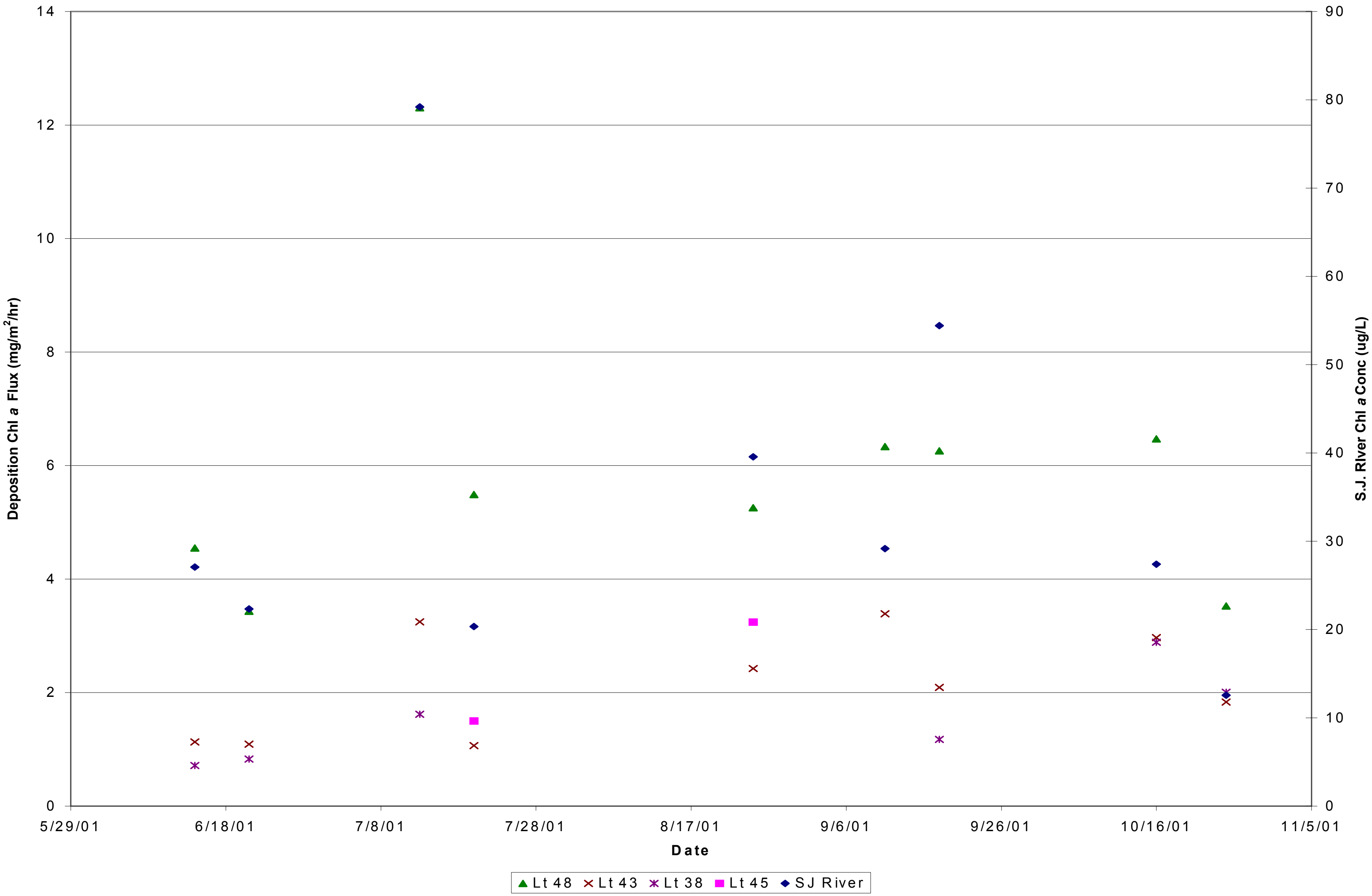


Figure II-13: Depth averaged chlorophyll *a* deposition fluxes measured during 2001.

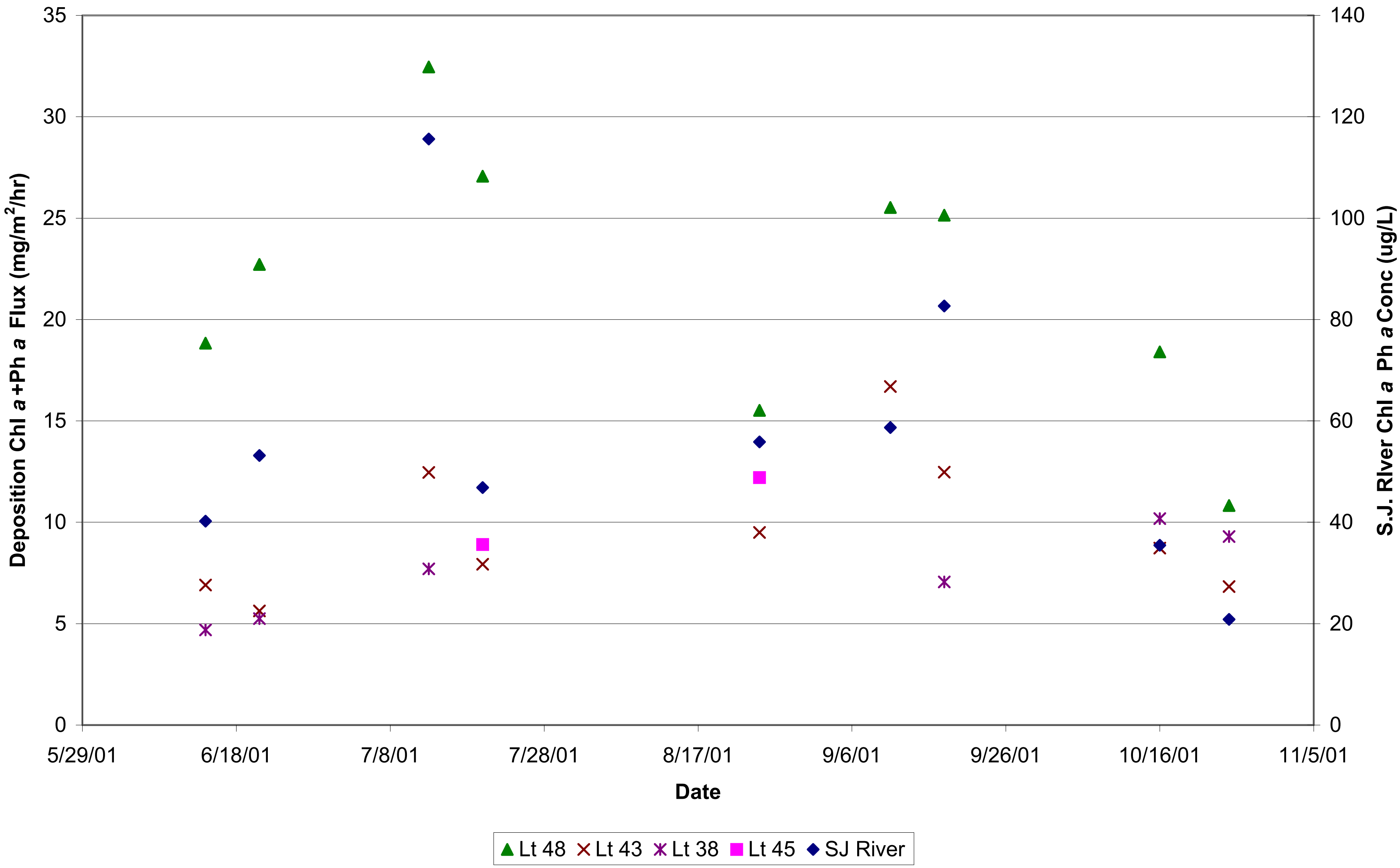


Figure II-14: Depth averaged chlorophyll *a* plus pheophytin *a* deposition fluxes measured during 2001.

Time averaged TSS water concentrations, deposition fluxes, and settling velocities.

Figures II-15 through II-18 graphically display the TSS concentrations at each monitoring station and depth averaged over the 2001 monitoring season. Error bars are used to display one standard deviation about the mean.

The average concentrations of TSS at each station location and trap depth are shown in Figure II-15. The decrease in TSS concentration with distance downstream from Lt. 48 indicates there is a net loss of suspended matter from the water column. Also shown in Figure II-15 are relatively high water concentrations near the sediment-water interface. Resuspension of settled matter appears to be the cause of these elevated concentrations. The average near-sediment concentration of TSS and VSS at Lt. 48 were also higher than the concentrations measured above the DWSC in the San Joaquin River providing further evidence of resuspension.

Deposition fluxes of TSS measured with the sediment traps are shown in Figure II-16. Similar to the water concentrations the deposition rates decrease with downstream distance from Light 48. The greatest deposition flux is observed near Lt. 48 where much of the sediment load from the San Joaquin settles in the DWSC. In addition, the highest deposition fluxes at each station are measured near the sediment water interface (0.5 m above the bottom). The increase in deposition flux with depth also indicates that resuspension is significant within the DWSC. The highest deposition fluxes are measured at near the bottom because water concentrations are higher near the sediment and heavier particles remain distributed lower in the water column when resuspended.

The average settling velocities are presented in Figure II-17. The settling velocity was calculated by dividing the deposition flux by the water concentration of individual measurements. Consistent with the water concentrations and deposition fluxes shown earlier, the highest settling velocities are observed at Lt. 48 were much of the primary load from the San Joaquin River is deposited. At each station, the highest settling velocities were measured nearest the sediment-water interface. Gravity inhibits heavier particles from becoming uniformly distributed in the DWSC water column, yielding the highest settling rates near the bottom and the lowest velocities at the highest sediment trap. The settling velocities at Lt. 43 and Lt. 38 are very similar in magnitude suggesting that deposition fluxes at these stations are mostly controlled by resuspension processes and not influenced by the primary load input from the San Joaquin River.

The settling velocities shown here are relatively high. In the absence of resuspension the water column would clear quickly. For example, particles with settling velocities of 1 m/hr would settle out of the DWSC (maximum depth of approximately 12 meters) in 12 hours. Assuming a net flow of 1000 cfs in the DWSC and an average cross-sectional area of 11,000 ft^2, the time required to travel from Lt. 48 to Lt. 43, a distance of 9,200 ft, is 28 hours. Even at the maximum tidal flow rate of 4000 cfs, it would take 6.5 hours for water to reach Lt. 43 from Lt. 48, a time that would permit more than one-half of these particles to settling out.

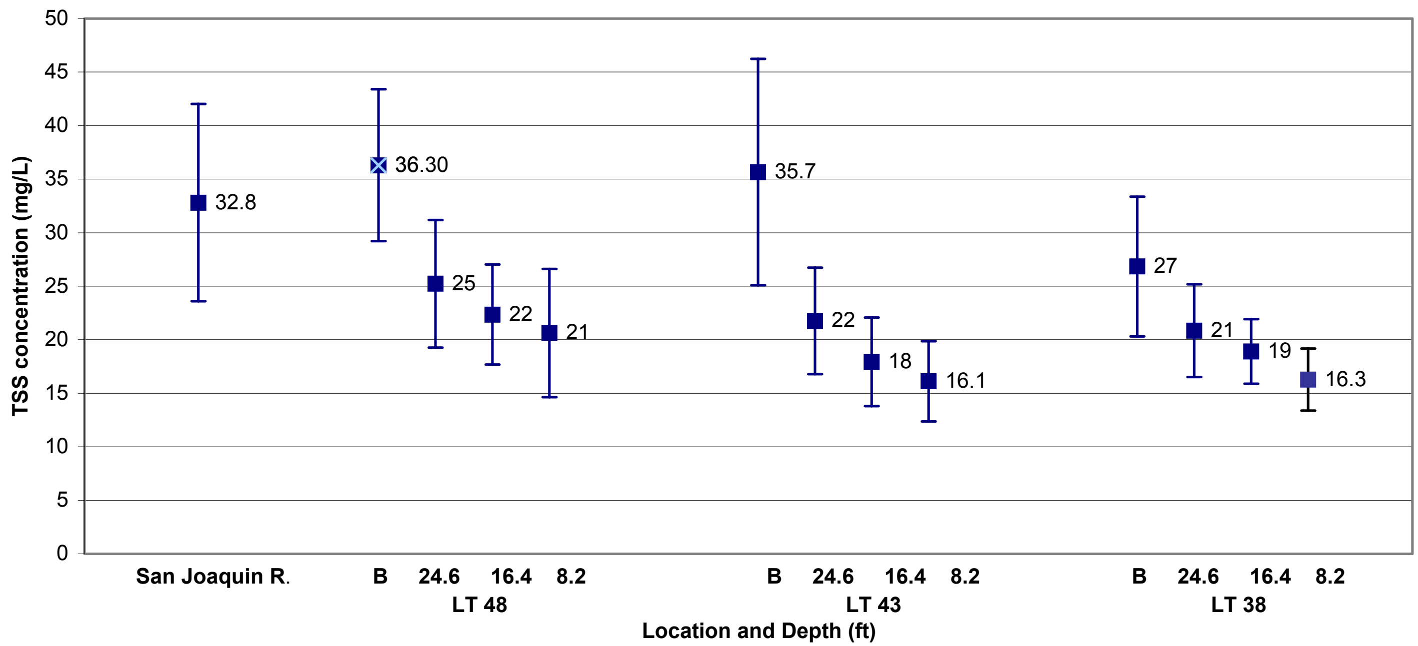


Figure II-15: Averages and standard deviations of TSS water concentrations in the DWSC during periods of trap deployment.

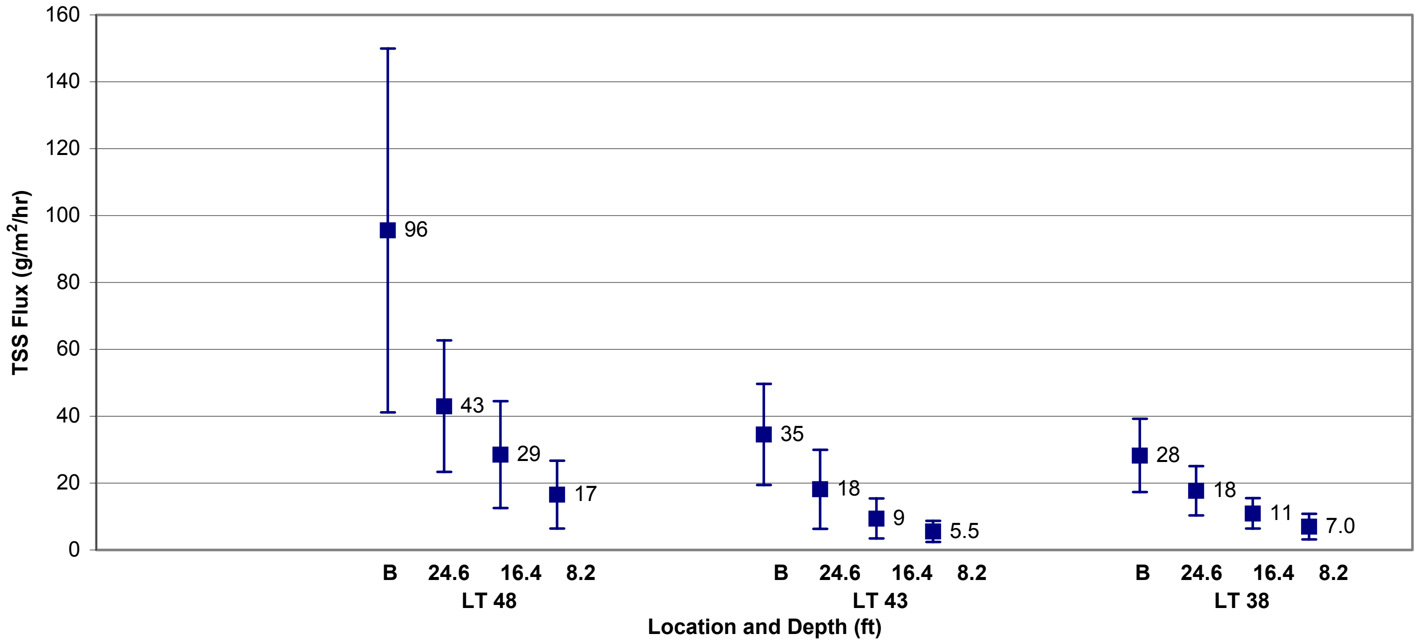


Figure II-16: Averages and standard deviations of TSS deposition fluxes in the DWSC during periods of trap deployment.

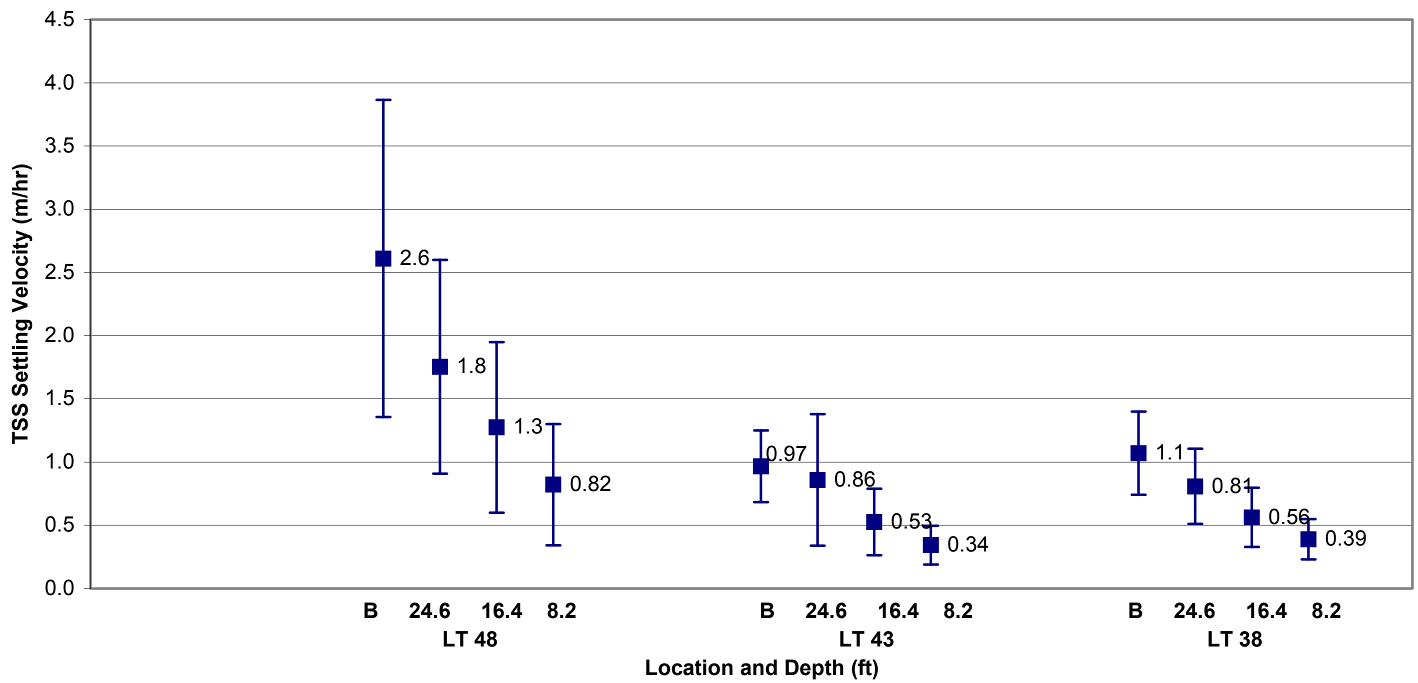


Figure II-17: Average and standard deviation of TSS settling velocities in the DWSC during periods of trap deployment.

The high settling velocities presented here with deposition fluxes and water concentrations were verified with laboratory settling column experiments conducted with sediments collected in a trap 0.5 m above the sediment-water interface at Lt. 48 and from the San Joaquin River above the DWSC. A 6-ft high, 6-in diameter, settling column with one sampling port located near the bottom was used. The method for measuring discrete settling in dilute suspensions has been described elsewhere (e.g., Peavy *et al.*, 1985). In summary, a well-mixed water sample is placed in the settling column and samples are collected from the sampling port at the bottom of the column at discrete time intervals. The samples were analyzed for TSS and VSS. Settling velocities are calculated by dividing the high of the water in the column above the sampling port by the time of the sample collection. Therefore, fast settling particles will fall below the sampling port at some time, *t*, and will not contribute to the concentration of the sample collected at this time. Particles remaining above the sampling port at time *t* have a settling velocity, v_s, less than the height of the water divided by *t*. The difference of the initial concentration and the concentration at time, *t*, represents the mass lost to settling. This loss was expressed as the mass fraction settled.

The results are shown in Figure II-18 for three different experiments. Since the settling velocities estimated with the measured deposition fluxes and composite water concentrations from field sampling represent a mass-averaged settling velocity, mass-averaged velocities were also calculated for each of the three laboratory experiments shown in Figure II-18 to permit direct comparisons between the laboratory and field generated results. Because there is a fraction of the mass with relatively high settling velocities, the mass-averaged velocities will be greater than the velocity observed at the 50 percent settling.

The weighted average settling velocities for the Lt. 48 trap sample was 2.2 m/hr. This measurement was performed in the laboratory under quiescent conditions. It is similar but somewhat higher than the 1.7 mg/hr average settling velocity measured with the deposition flux and water concentrations for October 25. The lack of mixing in the laboratory column experiment is a probable explanation for the higher laboratory value. Also shown in Figure II-18, the Lt. 48 trapped sediment settling velocity is approximately 6 times faster than the weighted-average velocity measured for water collected from the San Joaquin River at the USGS UVM station. To test whether particle aggregation was causing the higher settling velocities, the Lt. 48 sediment sample was sonicated for 5 minutes in a bath sonicator (Branson, Model No. 2210) with the sediment solution was suspended from the bath walls. A repeat of the laboratory settling test yielded lower settling velocities as shown in Figure II-18. Thus it appears that the high settling velocities measured with the settling traps are caused by aggregation of solids in the DWSC either while settling or once settled at the bottom. Since water salinity does not change appreciably between the UVM station and Lt. 48 and particle flocculation was not visually observed, it is anticipated that most of the particle aggregation occurs near the sediment-water interface or upon contact with the bottom sediments. If this is true then resuspension processes are apparently not energetic enough to disperse the particles to their original size distribution observed above the DWSC in the San Joaquin River resulting in higher settling velocities for resuspended matter captured in the sediment traps.

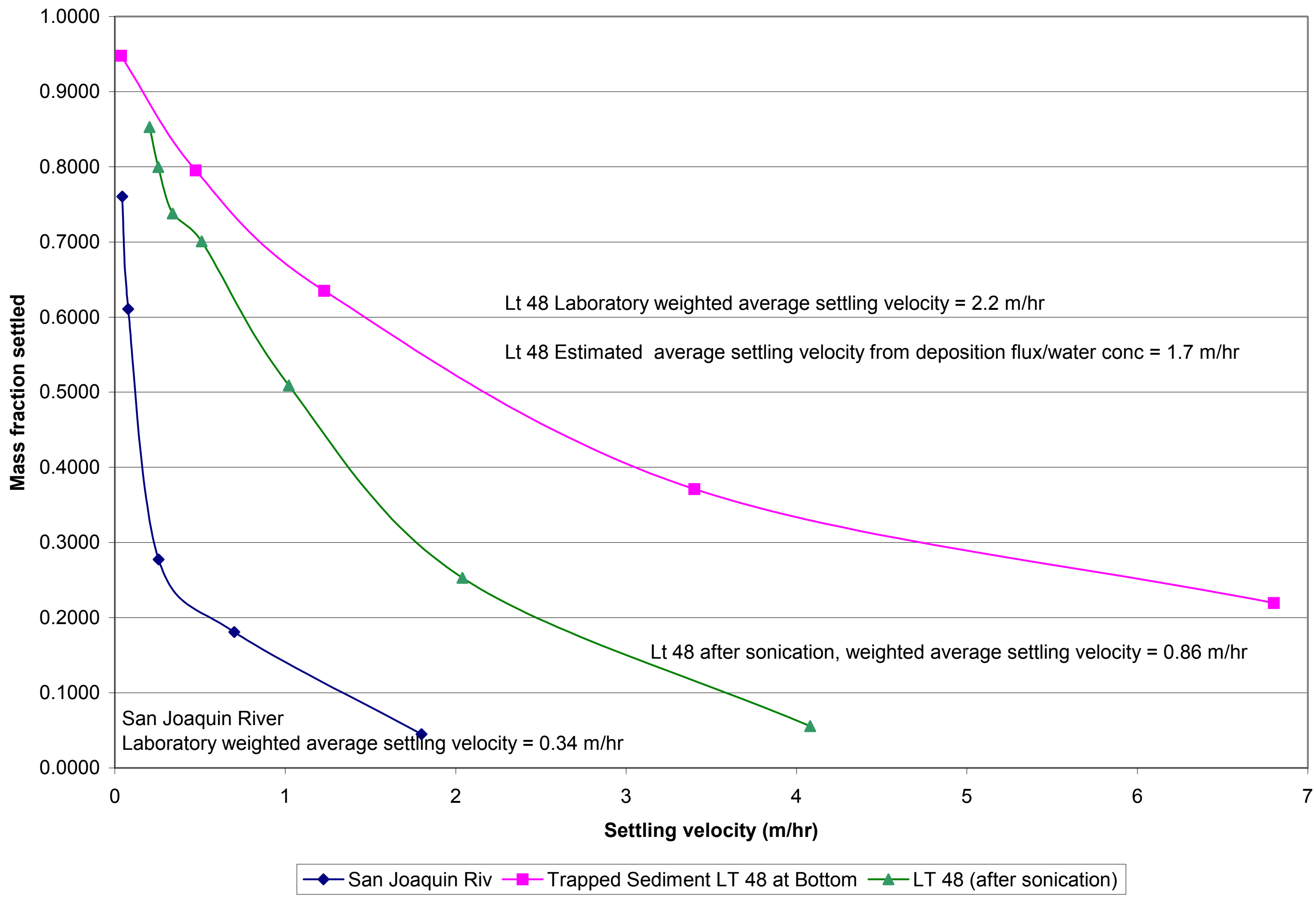


Figure II-18: Fraction of settled mass and respective settling velocities for sediments collected on 10/25/01.

Time averaged VSS water concentrations, deposition fluxes, and settling velocities.

The average VSS water concentrations are presented in Figure II-19. The water concentrations of VSS exhibit trends that were similar to the TSS concentrations. The concentration of VSS decreases with downstream distance suggesting a net loss of VSS in the water column. This loss could be associated with burial at the channel bottom or decay within the water column. Evidence of resuspension is shown with the highest water concentrations measured nearest the sediment-water interface.

Averages of the VSS deposition flux measurements are presented in Figure II-20. Again the highest deposition fluxes where measured at Lt. 48 indicating that settling of organic matter entering the DWSC from the San Joaquin River is significant. Deposition fluxes also increase with water column depth an indication of resuspension. Deposition fluxes also appear to approach a steady-state condition beyond Lt. 43, evidence that settling, resuspension, and algal production and decay reach a balance approximately 2 miles downstream from the Port of Stockton.

The association of VSS with TSS can also be seen by plotting these two parameters against each other for the water concentrations and trapped sediment masses. Figure II-22 presents the correlation of VSS and TSS water concentrations in the DWSC and the San Joaquin River at the USGS UVM station. Figure 22 indicates that 10 to 30 percent of the TSS measured in the water samples is VSS. The sediment trap data also exhibits a VSS to TSS concentration ratio of approximately 10 percent as shown in Figure II-23. The VSS is expected to settle much more slowly than the inorganic fraction associated with the TSS since the density of VSS is only slightly greater than water while the density of inorganic sediments are often approximately 2.7 times higher.

Table II-3 compares measured settling velocities in the DWSC with literature values for phytoplankton, particulate organic particles, and inorganic sediments. The TSS settling velocities measured in the DWSC are at the upper range of silt-sized sediments and very-fine sands. Measured VSS settling velocities in the DWSC are typically 55 to 70 percent of TSS values. However, the measured VSS settling velocity range is about 10 times higher than literature values. The same is also true for chlorophyll *a* settling velocities. These data suggest that the organic matter and phytoplankton that settles in the DWSC is aggregated with heavier, faster settling particles.

Table II-3: Typical ranges of settling velocities of suspended particles in water and measured in the DWSC.

Particle type	Settling Velocity ($m\ hr^{-1}$)
Phytoplankton[1]	0.004 - 0.04
Particulate organic carbon[1]	0.008 - 0.1
Clay[1]	0.01 - 0.04
Silt[1]	0.1 - 1
Chlorophyll *a*[2]	0.1 - 0.4
Chlorophyll *a* + pheophytin *a*[2]	0.1 - 0.7
VSS[2]	0.2 - 1.5
TSS[2]	0.3 - 2.6

[1]Chapra, 1997.

[2] Average settling velocities determined with deposition trap fluxes and water concentrations.

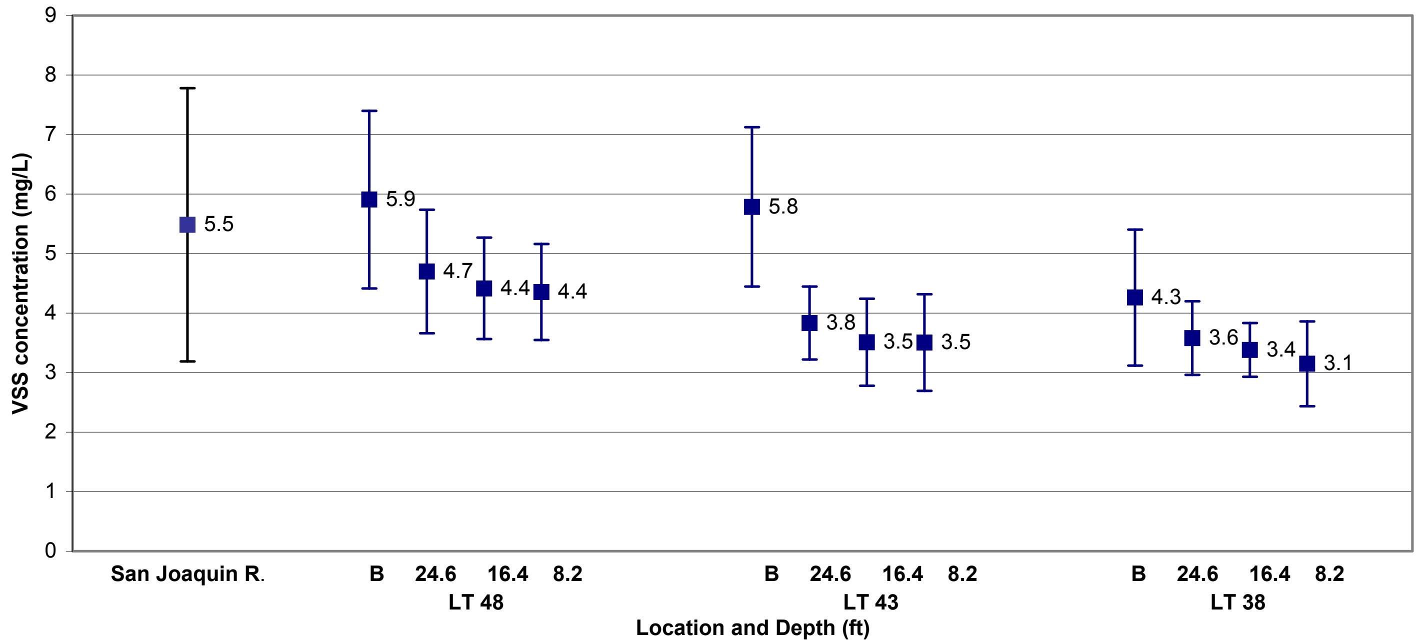


Figure II-19: Averages and standard deviations of VSS water concentrations in the DWSC during periods of trap deployment.

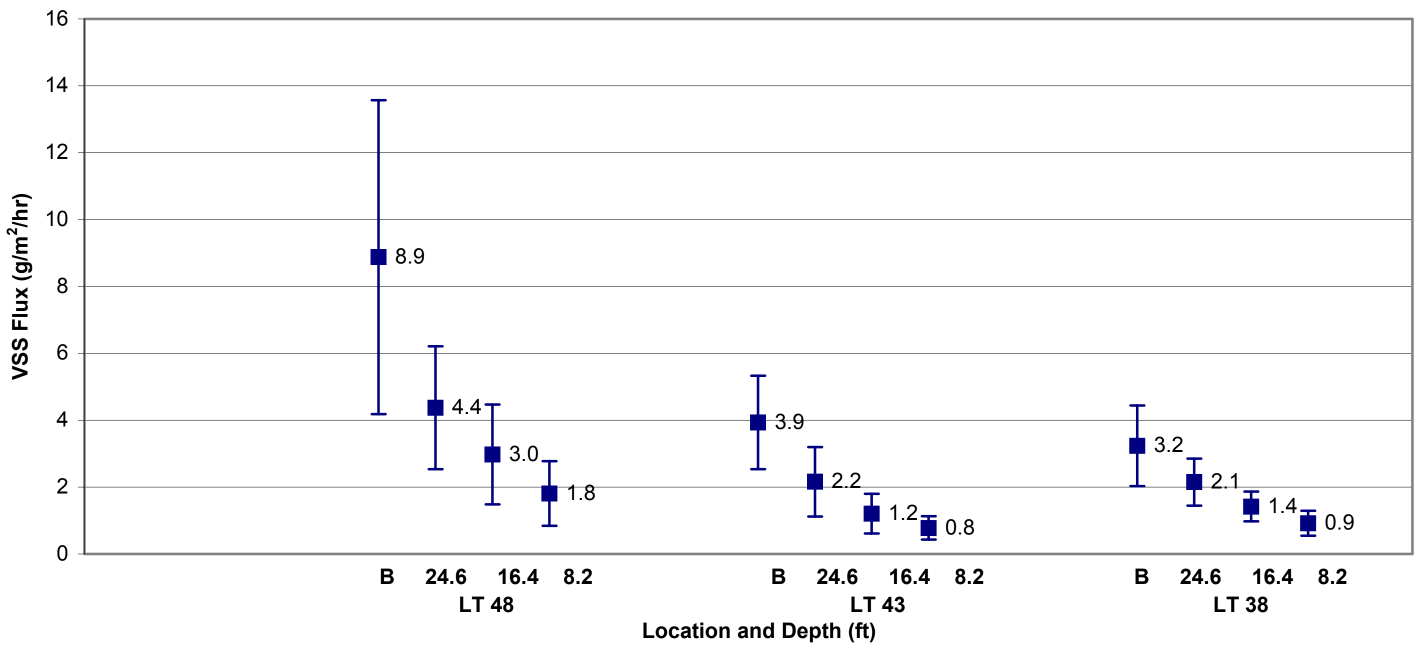


Figure II-20 Averages and standard deviations of VSS deposition fluxes in the DWSC during periods of trap deployment.

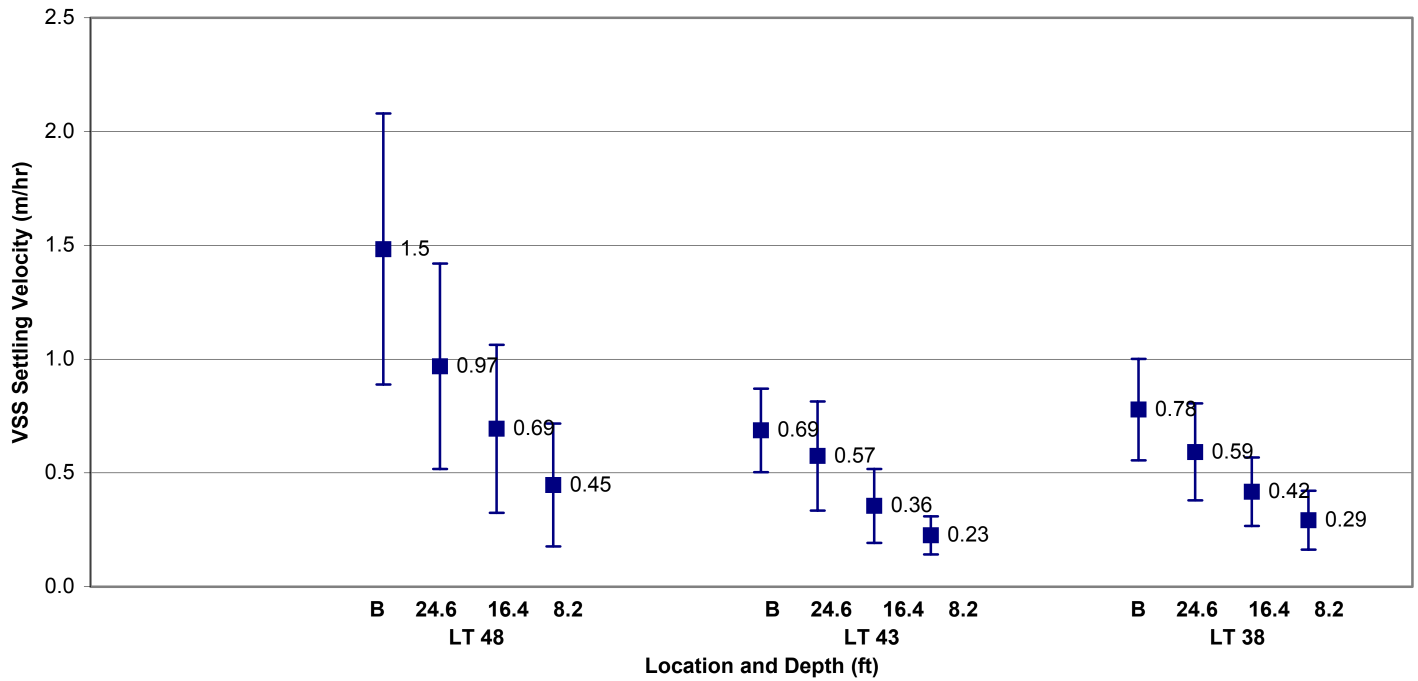


Figure II-21: Averages and standard deviations of VSS settling velocities in the DWSC during periods of trap deployment.

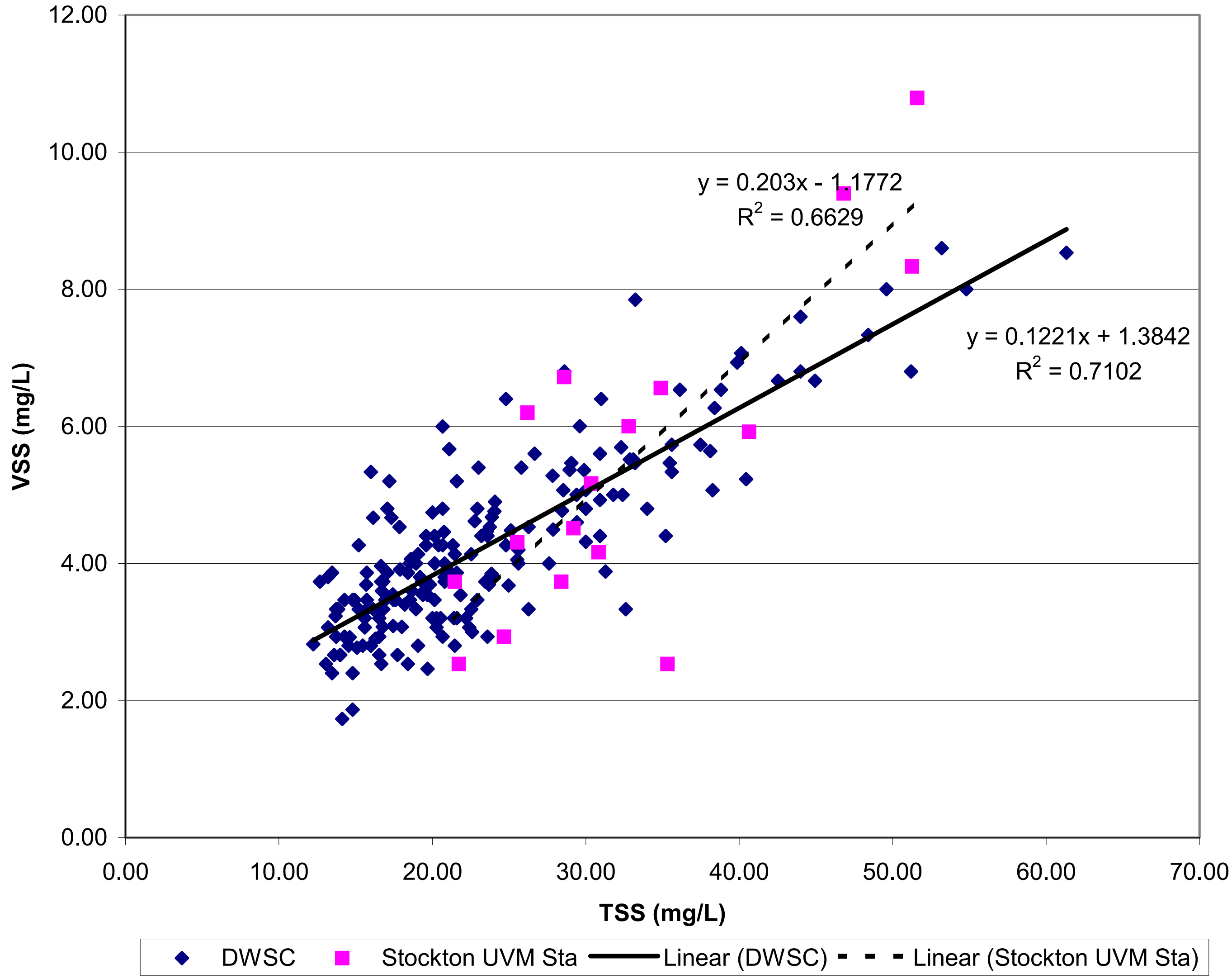


Figure II-22: VSS and TSS water concentrations.

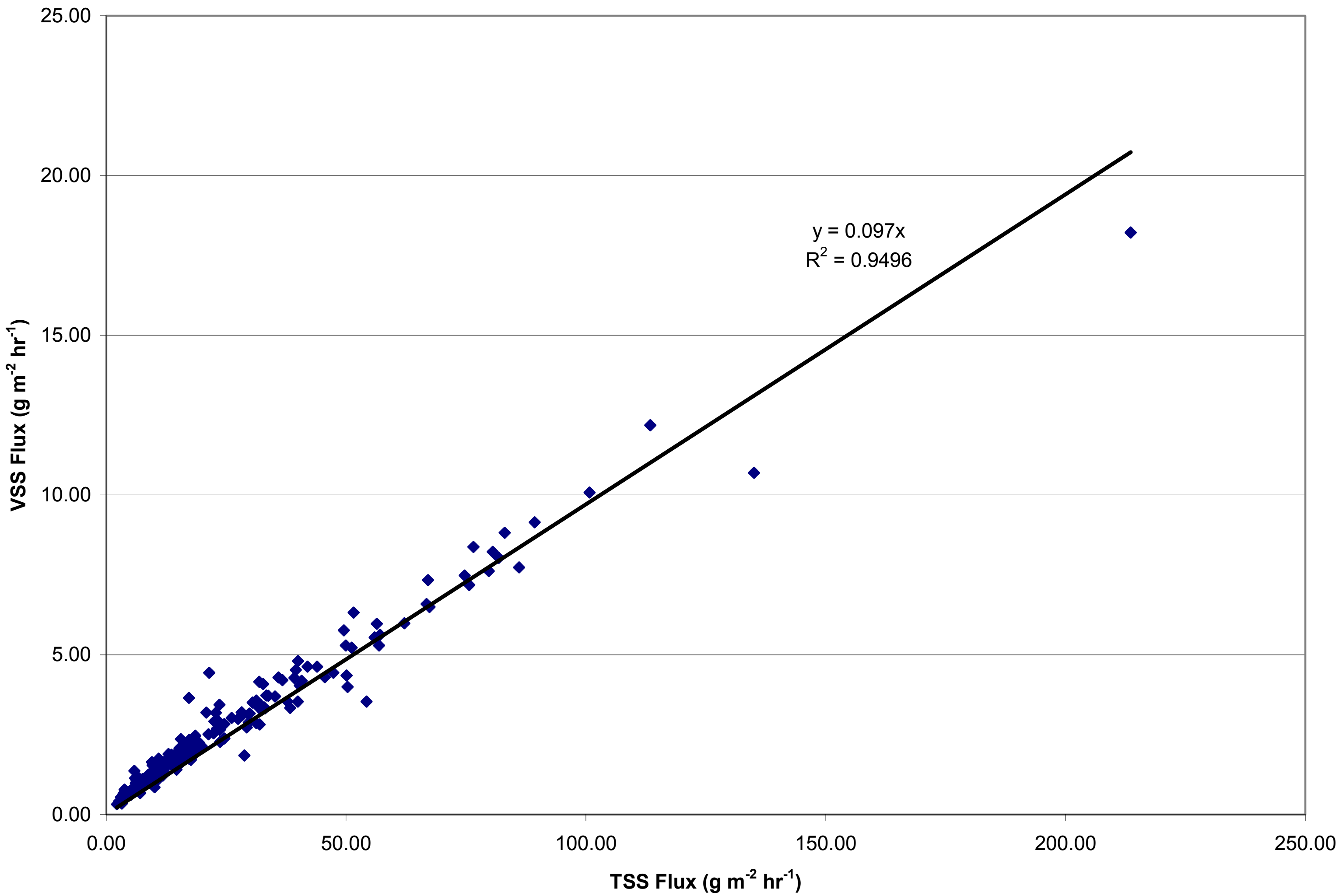


Figure II-23: VSS and TSS trapped sediment fluxes.

Time averaged chlorophyll a water concentrations, deposition fluxes, and settling velocities.

As shown in Figure II-24, the average chlorophyll *a* concentrations decrease with distance from the upper monitoring station in the San Joaquin River. Approximately 25 percent of the chlorophyll *a* is lost between the USGS UVM station and Lt. 48. The chlorophyll *a* concentration is further reduced by 50 percent (26 μg/L to 14 μg/L) between Lt. 48 and Lt. 43, a distance of approximately 2 miles. From Lt. 43 to Lt. 38 the average chlorophyll *a* concentration degrades from approximately 14 μg/L to 11 μg/L. The chlorophyll *a* concentration at Lt. 38 was approximately 1/3 the level measured above the DWSC in the San Joaquin River. The net decrease in chlorophyll *a* appears to be associated with the die-off of algae upon entrance to the DWSC from the San Joaquin River.

Unlike TSS and VSS, the chlorophyll *a* concentrations were quite uniform with depth. Mixing in the DWSC appears to often be sufficient to maintain relatively uniform concentrations of algae throughout much of the water column (and other dissolved constituents such as DO). However, temperature profiles suggest that stratification and reduced water column mixing does occur in the DWSC, predominantly during warm afternoons (see Table A-2). This is also seen with the slightly elevated chlorophyll *a* concentrations measured at the shallowest depths (2.5 m, 8.2 ft) in Figure II-24. These elevated concentrations appear to be caused by algal productivity in the euphotic zone, a conclusion also supported by higher levels of pH and DO near the water surface. The elevated DO concentrations near the water surface are also associated with reaeration.

The deposition flux of chlorophyll *a* is presented in Figure II-26. These fluxes exhibit trends similar to those observed with TSS and VSS. Settling velocities are shown in Figure II-27. The increase in settling velocity with depth suggests an association with heavy inorganic matter, similar to that discussed earlier for VSS settling velocities.

Figure II-28 shows a plot of the sum of chlorophyll *a* and pheophytin *a* concentration in the water column at each depth. As presented later, laboratory studies indicate that chlorophyll *a* is transformed to pheophytin *a* as the algae decay when subjected to darkness. However, pheophytin *a* concentrations also decay with the utilization by bacteria and higher microorganisms, yielding an oxygen demand in the water column. The sum of these pigments have been correlated to the BOD in the San Joaquin River above the Delta (Foe, 2001), but are poorly correlated to the BOD in the DWSC (Lehman, 2001; Litton, 2001). The decrease in the sum of chlorophyll *a* and pheophytin *a* with distance downstream of the USGS UVM station are also indicative of the decay of algae upon entrance to the DWSC. Unlike chlorophyll *a*, pheophytin *a* concentrations were highest near the sediment water interface at Lt. 48 and Lt. 43. These elevated pheophytin *a* concentrations suggest that resuspension of particulate matter includes pheophytin *a*, and to a lesser degree chlorophyll *a*.

The average deposition fluxes for chlorophyll *a* plus pheophytin *a* are shown in Figure II-29. The highest fluxes were measured near the sediment-water interface and at Lt. 48; these trends are similar to the deposition fluxes for TSS, VSS, and chlorophyll *a*. Shown in Figures II-30 are calculated settling velocities of chlorophyll *a* plus pheophytin *a*. These data exhibit a similar pattern as the VSS and TSS results. Similar to these other data, these settling velocities for organic matter and algae are quite high suggesting again that resuspension is significant and that some fraction may be associated with the heavier inorganic sediments. As presented earlier in Table II-3, the observation that phytoplankton pigment settling velocities are approximately 10 times greater than literature values for phytoplankton supports this argument.

The higher settling velocities for the pheophytin *a* compared with chlorophyll *a* may also support this hypothesis. If pheophytin pigments are associated with dying or decaying algae, then the higher pheophytin settling velocities may be caused by algal biomes bound to inorganic sediments that are subsequently resuspended in the water column and permanently captured in the sediment traps. The lower chlorophyll *a* settling velocities, when compared to pheophytin *a* values, may also be caused by algae that can regulate their position in the water column and thus avoid gravitational settling and capture in the traps.

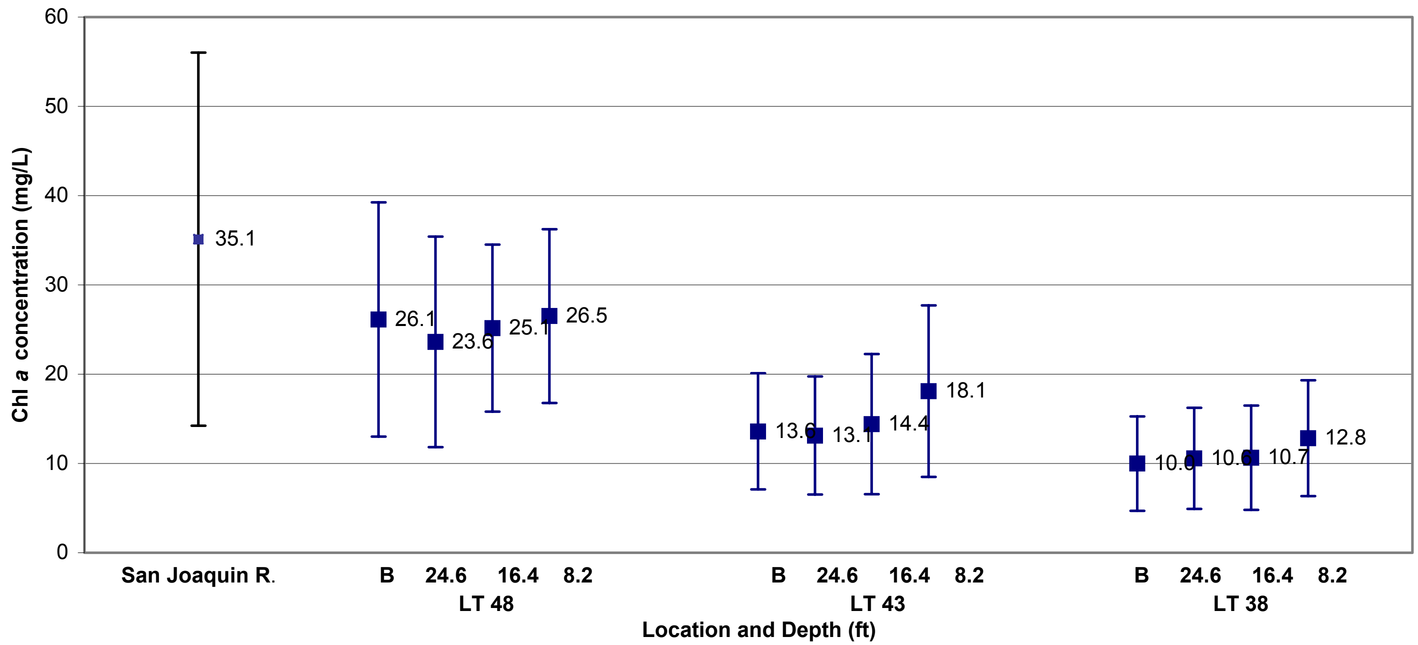


Figure II-24: Averages and standard deviations of chlorophyll *a* water concentrations in the DWSC during periods of trap deployment.

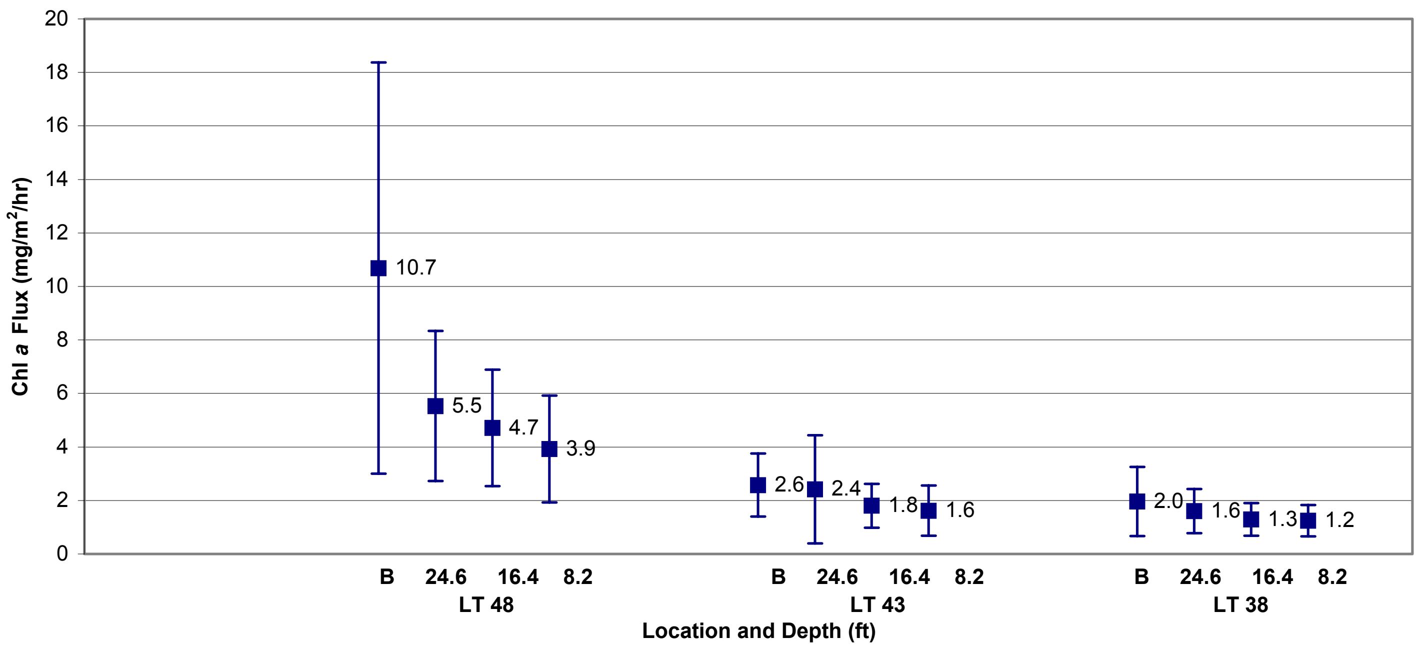


Figure II-25: Averages and standard deviations of chlorophyll *a* deposition fluxes in the DWSC during periods of trap deployment.

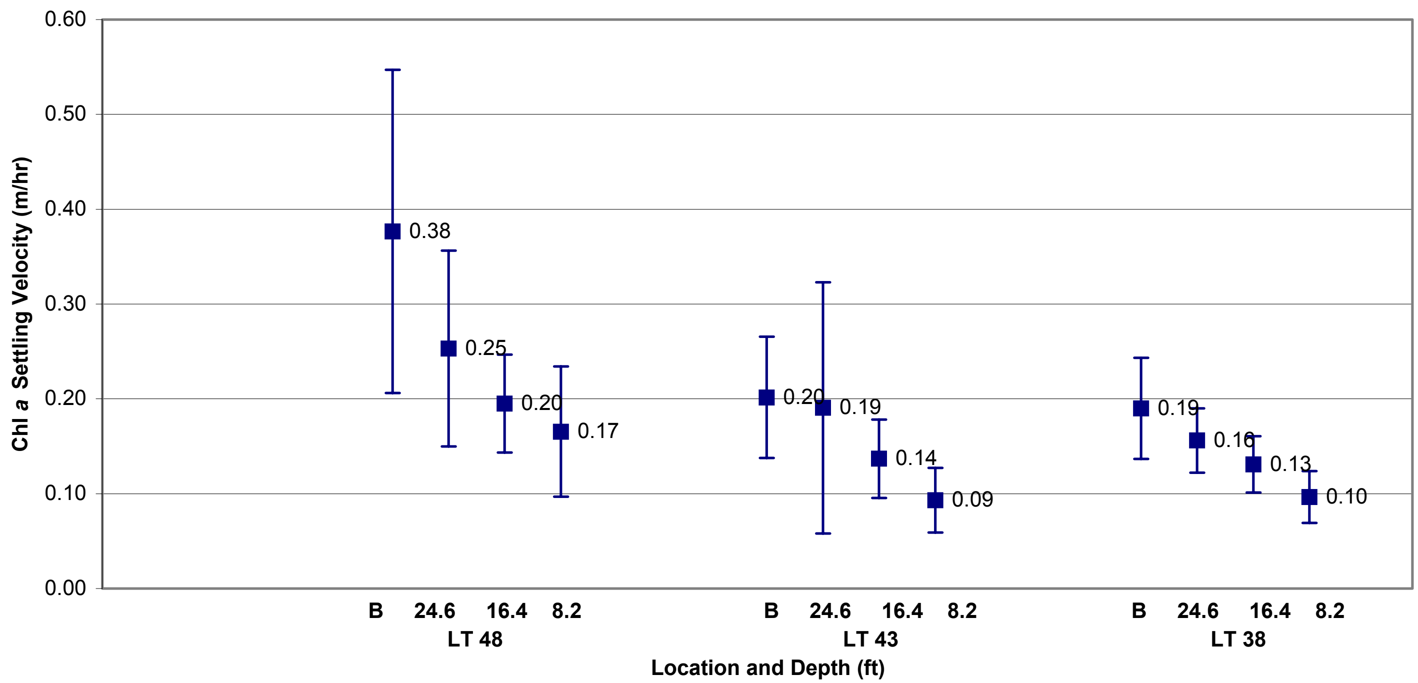


Figure II-26: Averages and standard deviations of chlorophyll *a* settling velocities in the DWSC during periods of trap deployment.

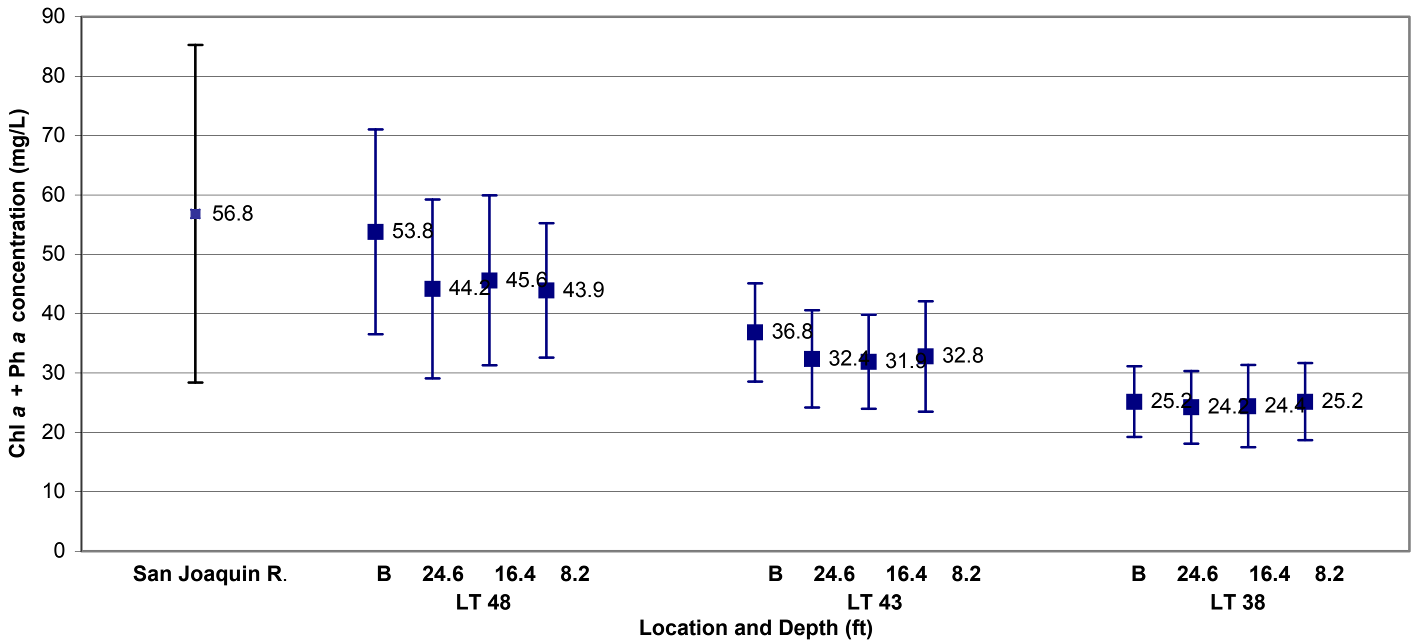


Figure II-27: Averages and standard deviations of chlorophyll *a* plus pheophytin in the water column.

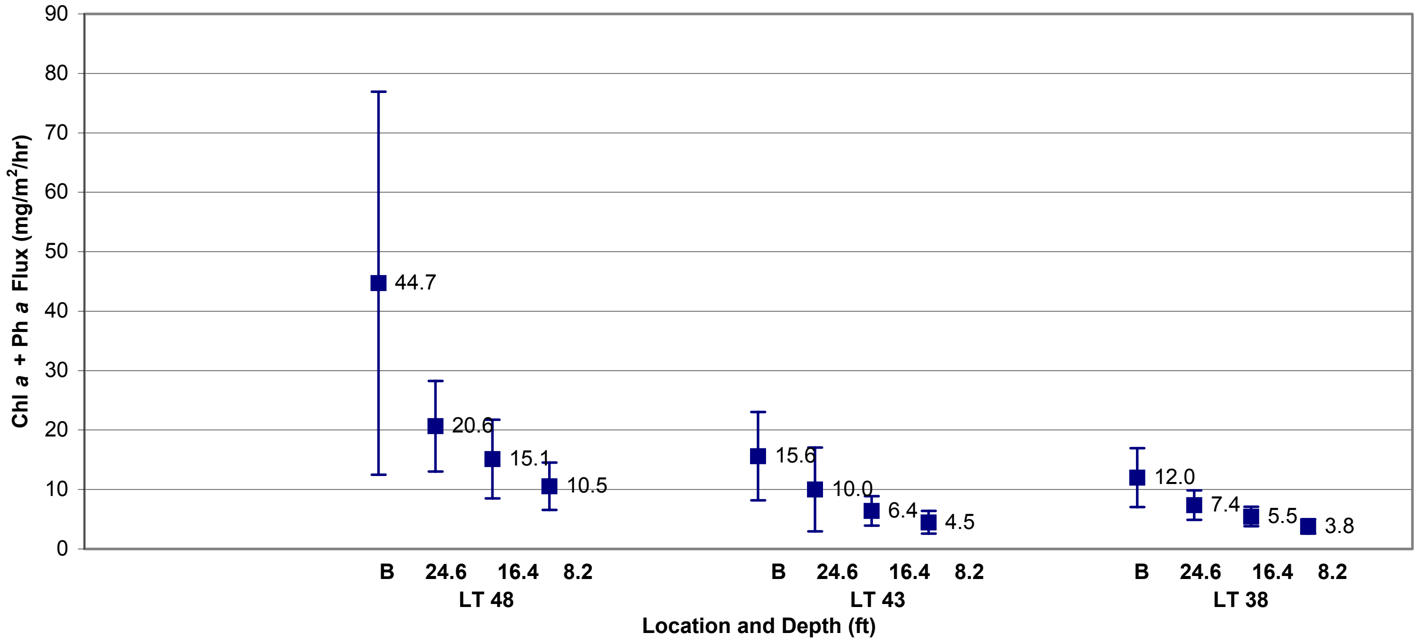


Figure II-28: Averages and standard deviations of chlorophyll *a* plus pheophytin *a* deposition fluxes in the DWSC.

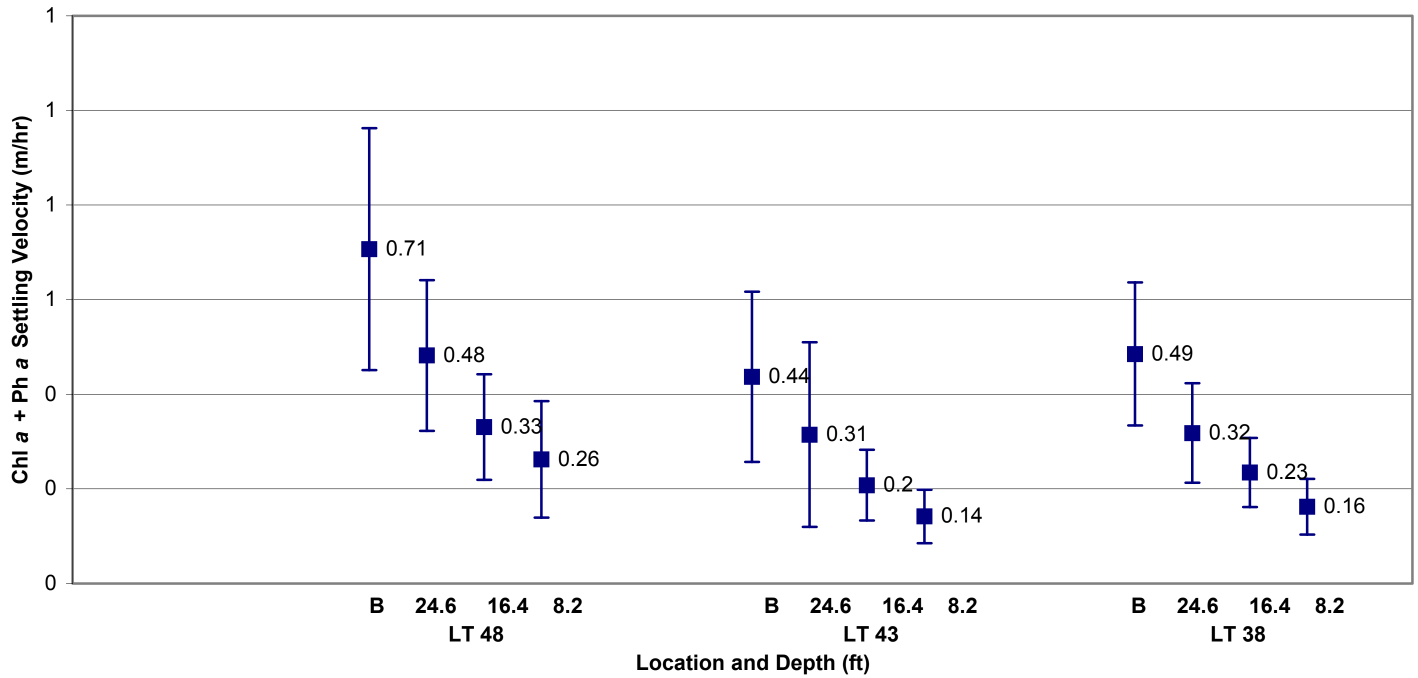
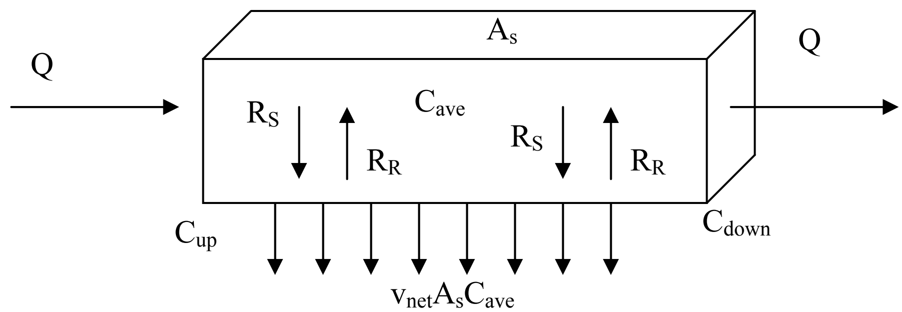


Figure II-29: Averages and standard deviations of chlorophyll *a* plus pheophytin *a* settling velocities in the DWSC.

Inorganic matter net settling velocities and resuspension rates.

Employing a simple mass balance of the mass of inorganic matter (i.e., TSS less VSS concentrations) lost between monitoring stations, the net settling velocity, v_{net}, was estimated for the DWSC.



The concentration inorganic matter, C, was modeled as:

$$V dC/dt = Q(C_{up}-C_{down}) - v_{net}A_sC_{ave}$$

where V is the volume of the river segment, Q is the net flow, and A_s is the surface area of the segment. At steady concentrations within the segment:

$$v_{net} = Q(C_{up}-C_{down})/A_sC_{ave}.$$

Table II-4 contains the values of the parameters used to calculate the net settling velocities. Also shown in Table II-4 are the values of v_{net}, 0.029 and 0.020 m/hr, for the segments of the DWSC between Lt. 48 and Lt. 43 and Lt. 43 and Lt. 38, respectively. These net velocities are at least an order of magnitude smaller than the settling rates measured with the deposition fluxes and water concentrations as previously shown in Figure II-21. For steady conditions at the sediment water interface,

$$\text{Settling Rate } (R_S) \text{ - Resuspension Rate } (R_R) = \text{Net Settling Rate.}$$

The average settling velocity is 1.1 and 0.7 m/hr for the two river segments respectively. Thus, the resuspension rate of inorganic matter is approximately 98 percent of the settling rate if average water concentrations are used. This approach could also be used to estimate settling rates of VSS, and phytoplankton pigments, but these are reactive species so decay and reproduction must be incorporated into the model.

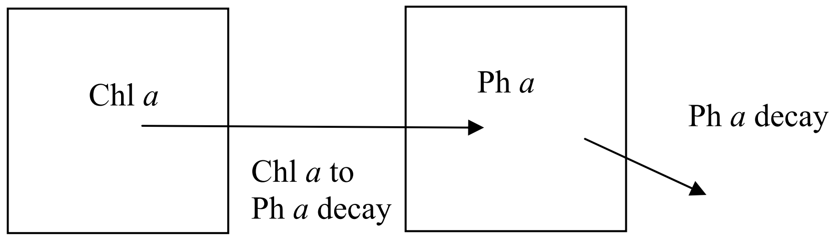
Table II-4: Net settling velocities of inorganic sediments in the DWSC.

	River Segment	
	Lt. 48 to Lt. 43	Lt. 43 to Lt. 38
Average depth (ft)	24.5	24.5
Average width (ft)	590	600
Cross-sectional area (ft^2)	14,500	14,500
Surface area (ft^2)	5.4×10^6	6.1×10^6
Length (ft)	9,200	10,100
Average TSS-VSS at upper end (mg/L)[1]	21.2	18.8
Average TSS-VSS at lower end (mg/L)[1]	18.8	17.2
Average net flow (cfs)	900	900
Average velocity (ft/s)	0.062	0.062
Travel time (d)	1.7	1.9
Net settling velocity (ft/d)	1.7	1.1
(m/hr)	0.022	0.014
Average settling velocity (m/hr)	1.1	0.7
Resuspension rate/settling rate	98%	98%

Apparent Algae Ages

Laboratory experiments were performed with San Joaquin River water to assess decay rates of chlorophyll *a* and pheophytin *a* when the sample was subjected to continued darkness at temperatures of 4°C and 20°C. The initial purpose of these trials was to verify recommended chlorophyll a sample holding times prior to filtration. However, the tests performed at 20°C yielded some interesting kinetic information about algae entering the San Joaquin River and settling below the euphotic zone. These decay rates were further used to estimate the age of algae entering the DWSC.

The age of the algae in the water column and trapped sediments were used to estimate the retardation of their movement when subjected to settling and resuspension in the DWSC. As simple mass balance conceptual model for the water samples appears below for the concentration of chlorophyll *a* and pheophytin *a*. In box 1, chlorophyll *a* decays to pheophytin *a* according to an assumed first-order rate law. In box 2, the pheophytin *a* concentration is influenced by the rate of decay of chlorophyll *a* to pheophytin *a* (increases the pheophytin *a* concentration) and the decay of pheophytin *a*. Pheophytin *a* is also assumed to decay at a first-order rate.



Governing Equations: $\frac{d(Chla)}{dt} = -k_c Chla \qquad \frac{d(Pha)}{dt} = A_{c \to p} \frac{d(Chla)}{dt} - k_p Pha$

Solutions:

$$Chla = (Chla_0)e^{-k_c t} \tag{eq. 1}$$

$$Pha = (Chla_0)A_{c \to p} \frac{k_c}{k_p - k_c}[e^{-k_c t} - e^{-kpt}] + (Pha_0)e^{-k_p t} \tag{eq. 2}$$

Where:
- $Chla$ = chlorophyll *a* concentration at time t
- $Chla_0$ = initial concentration of chlorophyll *a*
- Pha = pheophytin *a* concentration at time t
- Pha_0 = initial concentration of pheophytin *a*
- $A_{c \to p}$ = chlorophyll *a* to pheophytin *a* mass conversion factor (set to 1)
- k_c = first-order decay rate of chlorophyll *a*
- k_p = first-order decay rate of pheophytin *a*

Samples in excellent physiological conditions are considered to contain no pheophytin *a* (APHA *et al.,* 1998). Chlorophyll *a* is converted to pheophytin *a* upon loss of the magnesium atom. Regression expressions for the spectrophotometric determination of chlorophyll *a* indicate that 1 μg/L of pure chlorophyll *a* is converted to 1 μg/L of pure pheophytin *a* upon complete loss of its magnesium atom (APHA *et al.*, 1998). Therefore, $A_{c \to p}$, was set to 1 for the analysis presented here.

The samples collected from the San Joaquin River exhibited aging upon collection as indicated by the presence of pheophytin *a*. To adjust for this deterioration before reaching the DWSC, the time was adjusted by Δt, in the modified solutions for chlorophyll *a* and pheophytin *a* concentrations:

$$\text{Chl } a = \text{Chl } a_0^{a} \exp(-k_c t + \Delta t) \tag{eq. 3}$$

$$\text{Ph } a = k_c \text{ Chl } a_0^a A_{c\rightarrow p}/(k_p-k_c)[\exp(-k_c(t+\Delta t))-\exp(-k_p(t+\Delta t))] \qquad \text{(eq. 4)}$$

Where, Chl a_0^a is the estimated concentration of chlorophyll *a* when the population was in excellent physiological condition. Under this condition the initial pheophytin *a* concentration, Ph a_0, is zero. The data for the two decay rate experiments performed with water collected from the San Joaquin River are shown in Figures II-30 and II-31. Decay constants of 0.55 d^{-1} for k_c and 0.27^{-1} for k_p, were found to provide a reasonable fit of the model to both sets of experimental data. The high decay rate of chlorophyll *a* observed during this test may be caused in part by zooplankton grazing.

As shown in Figures II-30 and II-31, the values of Δt also yielded good fits of these above equations were 20 hr and 1.92 days, respectively. Chl a_0^a was also determined with the model fit. Values of Chl a_0^a are expected to be greater than or equal to the sum of the initial chlorophyll a, Chl a_0, and initial pheophytin *a*, Ph a_0.

The ratio of Chl *a* over Chl *a* plus Ph *a* , R, can be calculated with the analytical model developed above.

$$R = \frac{e^{-k_c\tau}}{\frac{k_c}{k_p - k_c}\left(e^{-k_c\tau} - e^{-k_p\tau}\right)} \qquad \text{(eq. 5)}$$

Where τ is the apparent age of the algae sample. Solving for τ,

$$\tau = \frac{1}{k_c - k_p}\ln\left[\frac{1}{R} + \frac{k_p}{k_c}\left(1 - \frac{1}{R}\right)\right] \qquad \text{(eq. 6)}$$

Note that R is independent of Chl a_0^a, therefore the apparent age of an algae sample can be estimated from R and the rates of chlorophyll *a* and pheophytin *a* decay. Figure II-32, exhibits the ratios of the samples collected from the San Joaquin River on July 30 and August 3. Equation 5 is also plotted in Figure II-32 using k_c = 0.55 d^{-1} and k_p=0.27 d^{-1}. Equation 5 provides good agreement with the experimental data up to ages of 4 or 5 days. After 5 days the model appears to underestimate the apparent age of the algae.

Tables II-5 and II-6 contain the average algae ages for water and trapped sediment samples. The water sample ages increase with distance downstream and with depth. The aging with downstream distance is due to the increase travel time of the algae. During much of the 2001 monitoring season, the net flow in the DWSC was approximately 900 cfs (Jones and Stokes, 2002a). For this flow, the net travel times from the USGS Station to Lt 48, Lt. 43, and Lt. 38 are .25, 1.4, and 2.7 days, respectively (see Table II-1). The algae ages in the water samples are typically less than the average hydraulic travel time. This is probably associated with algal productivity in the DWSC that will increase the estimated age using the chlorophyll *a* to sum of chlorophyll *a* and pheophytin *a* ratio. The estimated ages for algae captured in the sediment traps is typically 1.6 to 2 times greater than the water age as shown in Table II-7. This appears to be associated with the retarded transport of the trapped associated with settling and resuspension. As shown earlier, trapped sediments have relatively high settling velocities associated with aggregation suggesting that a significant fraction of the material captured in the traps had experienced settling and resuspension cycles.

Table II-5: Average algae age in water samples using chlorophyll *a* to chlorophyll *a* plus pheophytin *a* water concentration ratios.

Depth	Location			
	San Joaquin R.	Lt. 48	Lt. 43	Lt. 38
8.2 ft (2.5 m)	1.0	1.2	1.4	1.7
16.4 ft (5.0 m)		1.3	2.0	2.1
24.6 ft (7.5 m)		1.4	2.2	2.1
1.7 ft (0.5 m) above bottom		1.7	2.6	2.3

Table II-6: Average algae age in trapped sediments using chlorophyll *a* / chlorophyll *a* + pheophytin *a* deposition flux ratios.

Depth	Location		
	Lt. 48	Lt. 43	Lt. 38
8.2 ft (2.5 m)	2.4	2.6	2.9
16.4 ft (5.0 m)	2.8	3.1	3.6
24.6 ft (7.5 m)	3.4	3.7	4.0
1.7 ft (0.5 m) above bottom	3.5	4.8	4.6

Table II-7: Ratio of algae age in trapped sediment age to algae age in water.

Depth	Location		
	Lt. 48	Lt. 43	Lt. 38
8.2 ft (2.5 m)	2.0	1.8	1.8
16.4 ft (5.0 m)	2.1	1.6	1.7
24.6 ft (7.5 m)	2.3	1.6	1.9
1.7 ft (0.5 m) above bottom	2.1	1.9	2.0

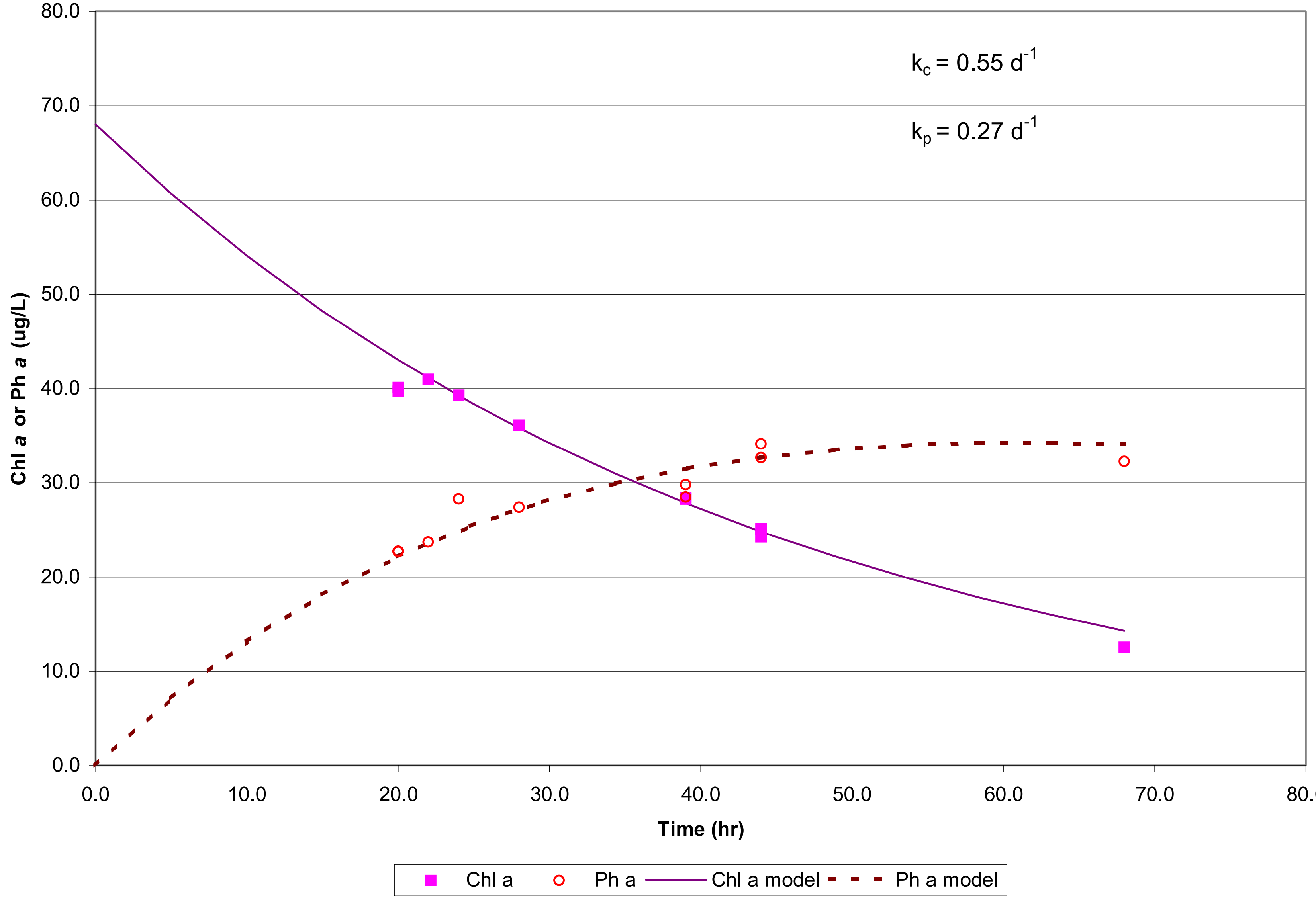


Figure II-30: Laboratory tests on the decay of chlorophyll *a* and pheophytin *a* with water collected from the San Joaquin River on July 30, 2001. Samples were kept in darkness at 20°C.

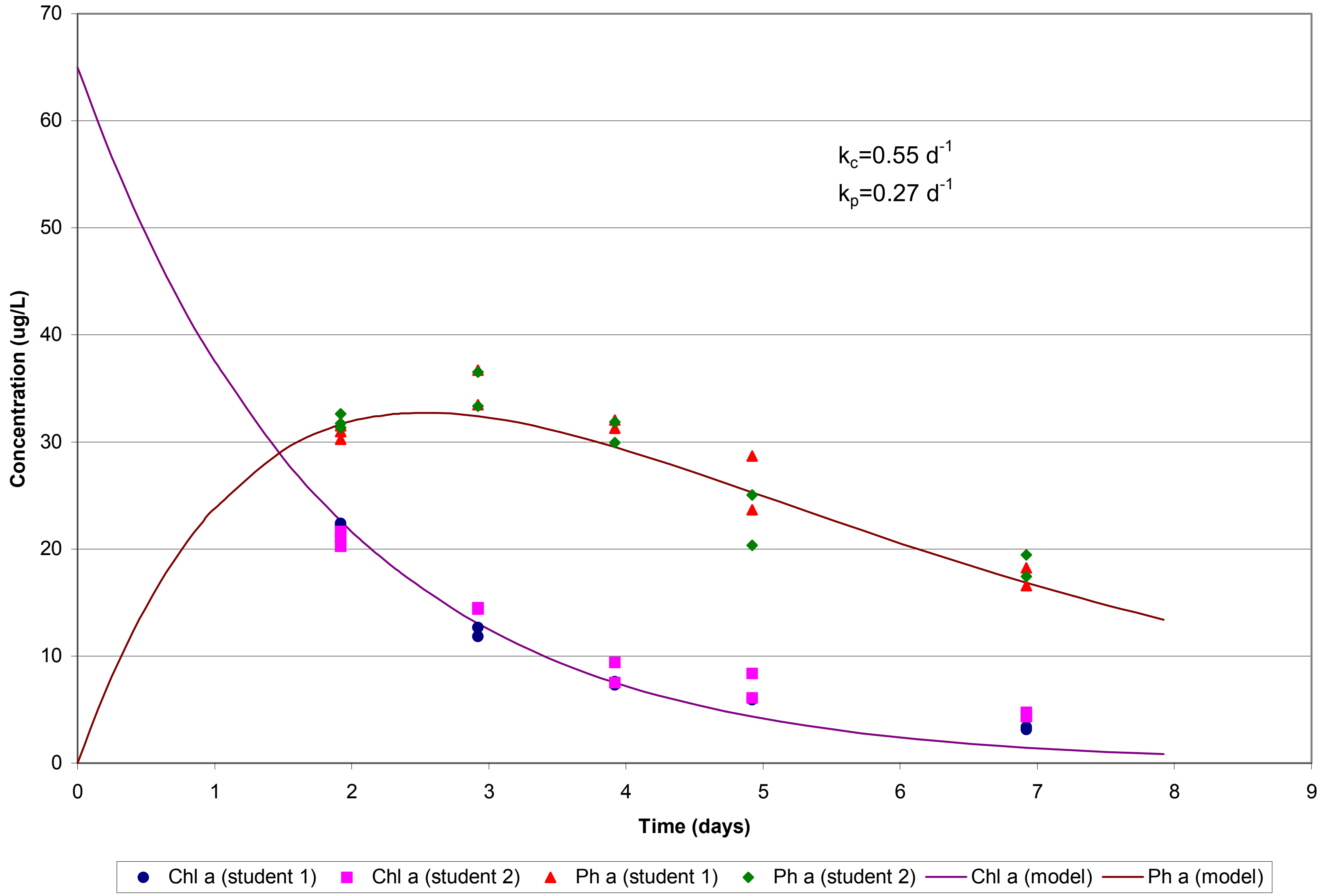


Figure II-31: Laboratory trials of chlorophyll *a* and pheophytin *a* response at 20°C to darkness using San Joaquin River water collected on August 3, 2001.

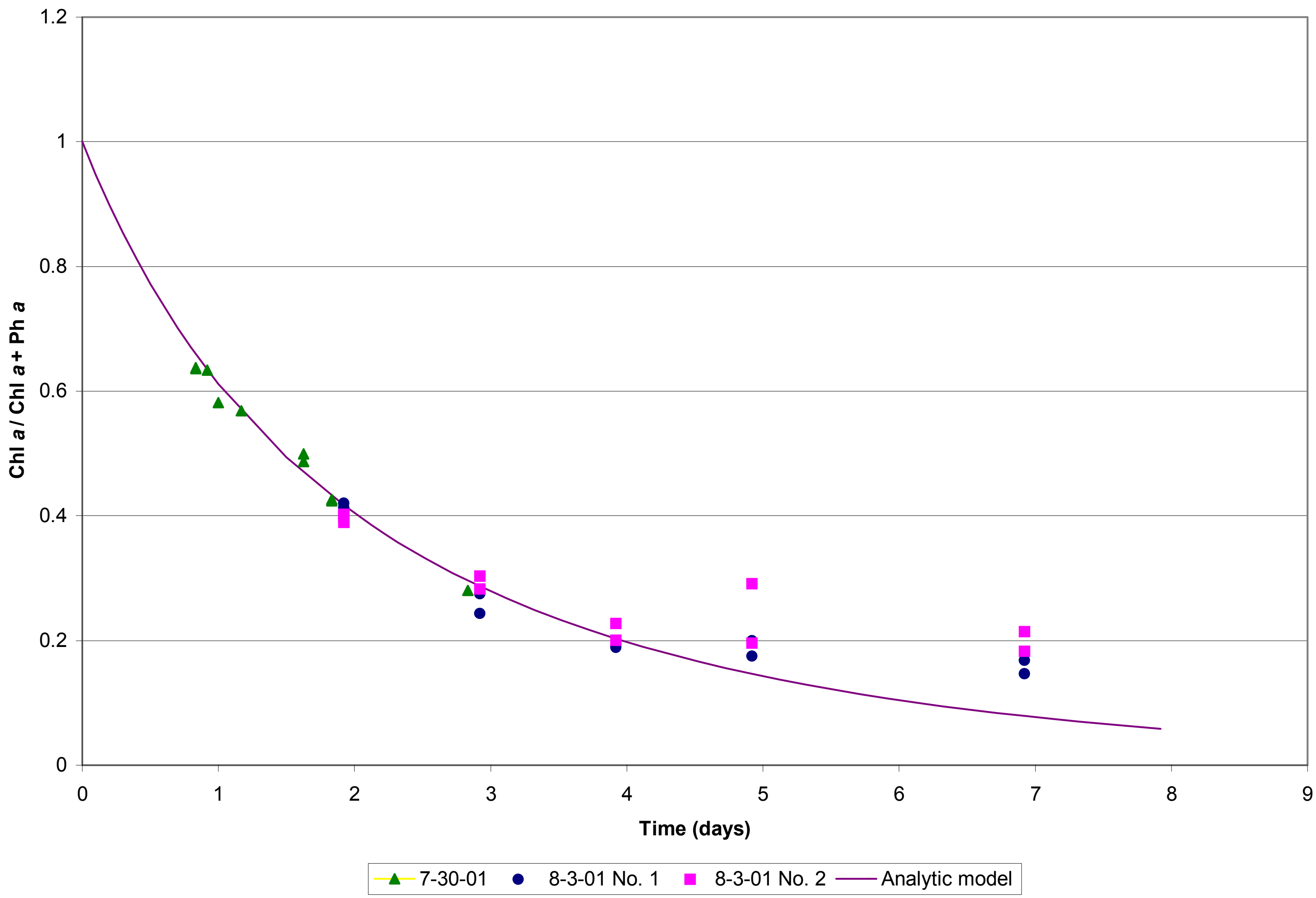


Figure II-32: Ratio of chlorophyll *a* to chlorophyll *a* plus pheophytin *a* for San Joaquin River samples collected on July 30 and August 3, 2001.

Comparisons of ebb and flood tide averages for TSS, VSS, chlorophyll a and pheophytin a data.

Average water concentrations of TSS, VSS, chlorophyll *a*, and chlorophyll *a* plus pheophytin *a* measured during flood or ebb tides are plotted in Figures II-33 through II-36. For TSS, ebb tides averages were greater than flood tide averages near the sediment-water interface, but were similar to flood tide averages at higher in the water column as shown in Figure II-33. This suggests that the increased water velocity observed during ebb tides was sufficient to enhance resuspension. Similar trends are also seen in Figure II-34 for VSS. However, the differences between flood and ebb tide measurements seem to diminish with distance downstream as little differences are observed at Lt. 38. Sediment cores collected for the sediment oxygen demand experiments may provide an explanation. Cores from Lt. 38 often exhibited sediments that were well aggregated with a gelatinous nature that resisted resuspension. Where as cores from Lt. 48 often contains fine sediments that were easily disturbed. The concentrations of chlorophyll *a* and chlorophyll *a* plus pheophytin *a* also exhibited trends common to TSS and VSS, but were much less pronounced.

The average deposition fluxes of TSS, VSS, chlorophyll *a* and chlorophyll *a* plus pheophytin *a* also indicate that the highest measurements were generally observed during ebb tides as shown in Figures II-37 through II-40. Like the water concentrations, the greatest differences between the flood and ebb tidal averages are observed at the sediment water interface and at the upstream stations (i.e., Lt. 48 and Lt. 43). These observations further support the idea that the ebb tides yield higher resuspension of sediment due to increased flow velocities observed at during ebb conditions. During the 2001 study, the net flow in the DWSC was approximately 1000 cfs in the downstream (Brown, 2002). Thus, ebb flows can be expected to be approximately 1000 cfs higher than the flood flows, yielding velocities approximately 25 to 30 percent higher during ebb flow.

Average calculated settling velocities during ebb and flood tides are compared for TSS, VSS, chlorophyll *a* and chlorophyll *a* plus pheophytin *a* in Figures II-41 through II-44. The average settling velocities for ebb and flood tides are similar for each of the four constituents. The greatest differences are observed at Lt. 48 for each of the trap sediment parameters. However, it appears these differences are small compared to the standard deviation of these measurements, and therefore average differences may be insignificant. Applying the Student's *t*-Test to the TSS settling velocities calculated for flood and ebb tides, there is a 83 percent probability the two means are different.

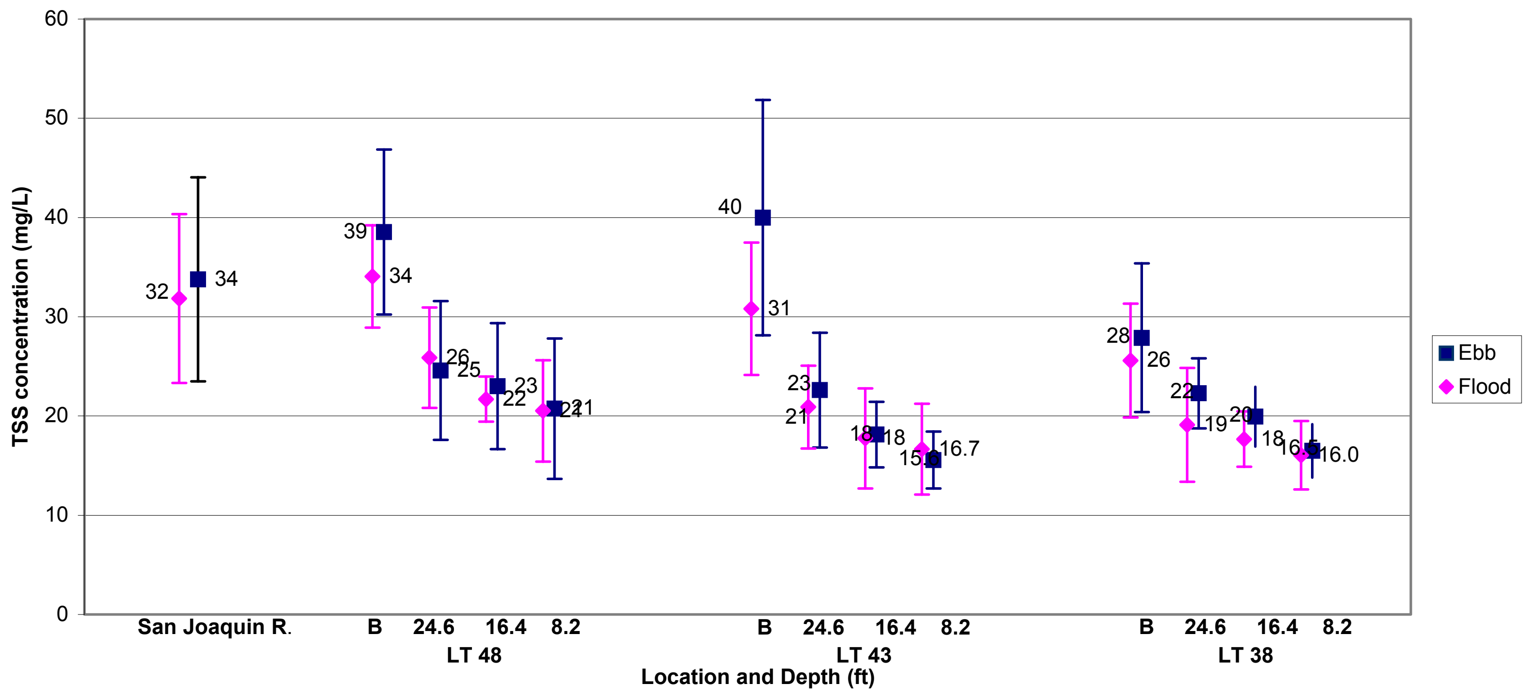


Figure II-33: Averages and standard deviations of TSS water concentrations in the DWSC for flood and ebb tides during periods of trap deployment.

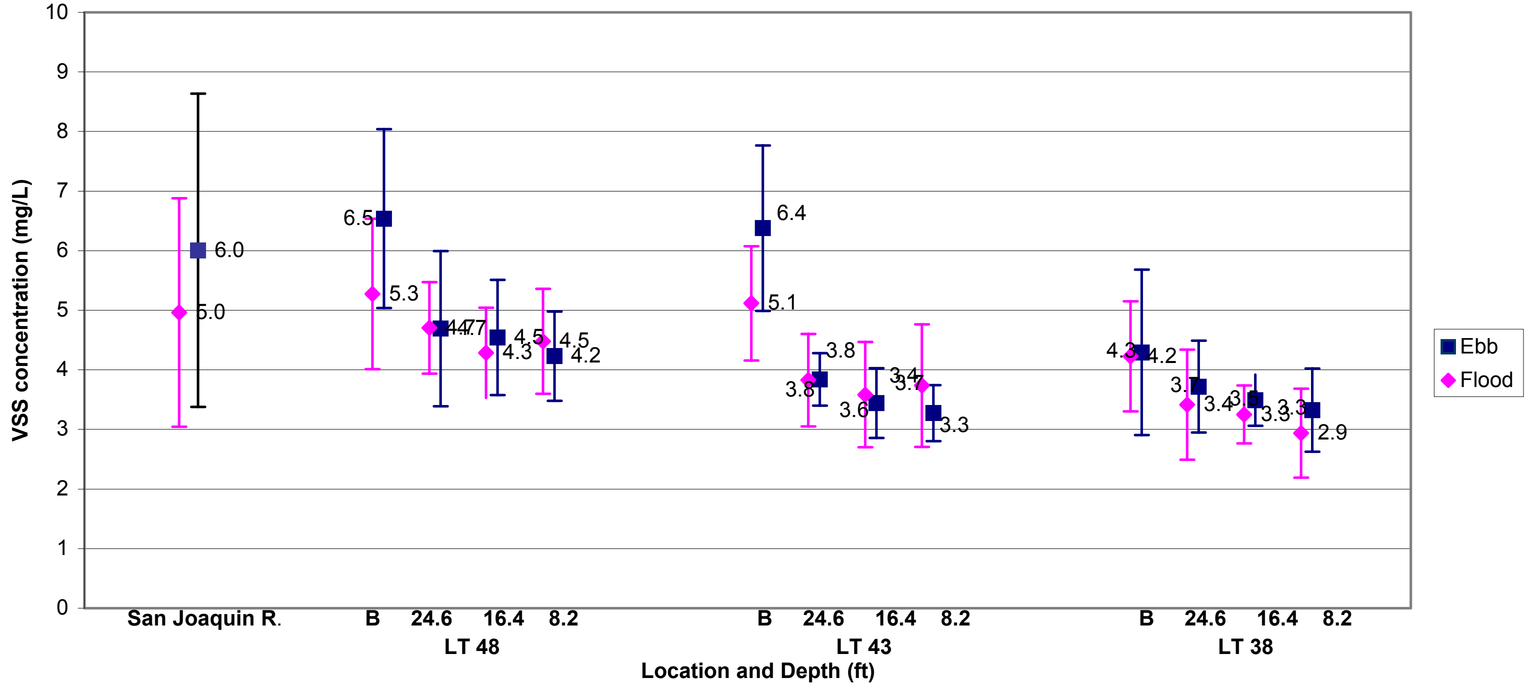


Figure II-34: Averages and standard deviations of VSS water concentrations in the DWSC for flood and ebb tides during periods of trap deployment.

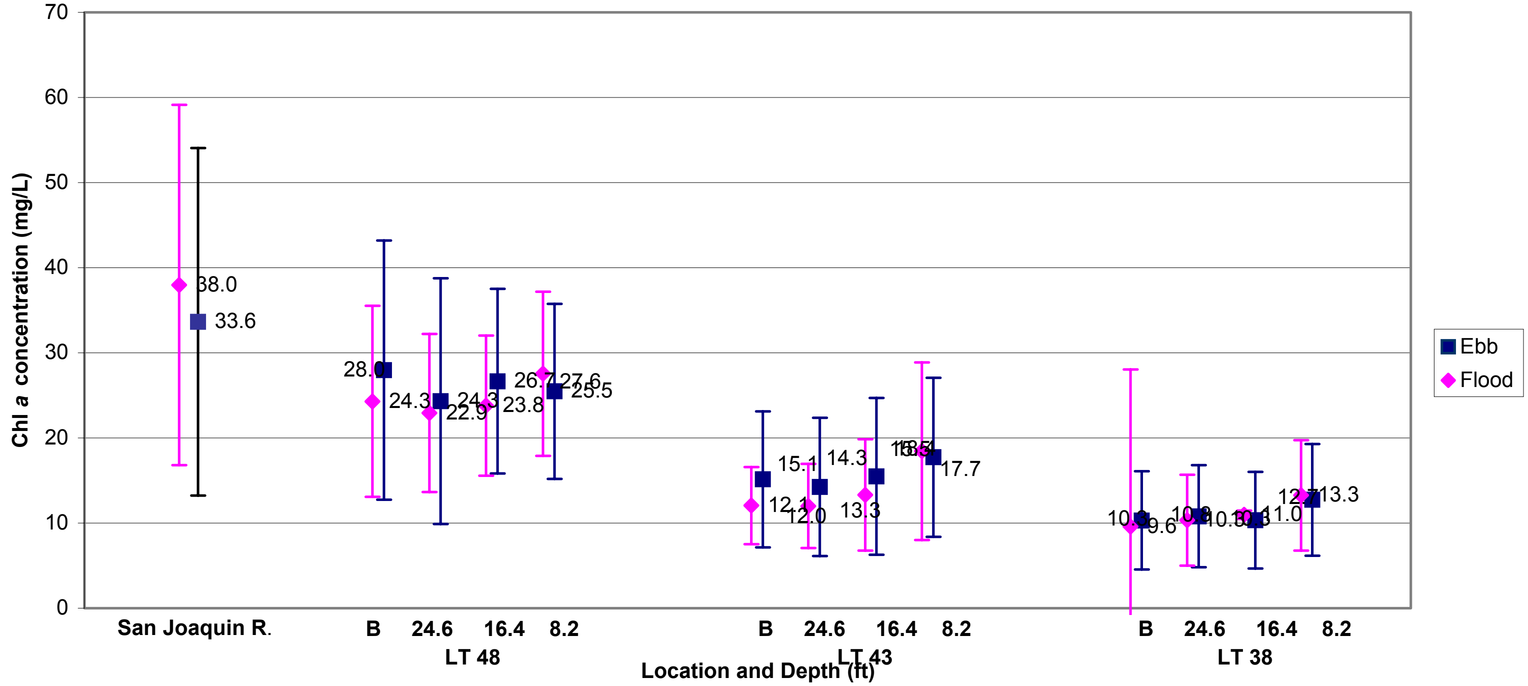


Figure II-35: Averages and standard deviations of chlorophyll *a* water concentrations in the DWSC for flood and ebb tides during periods of trap deployment.

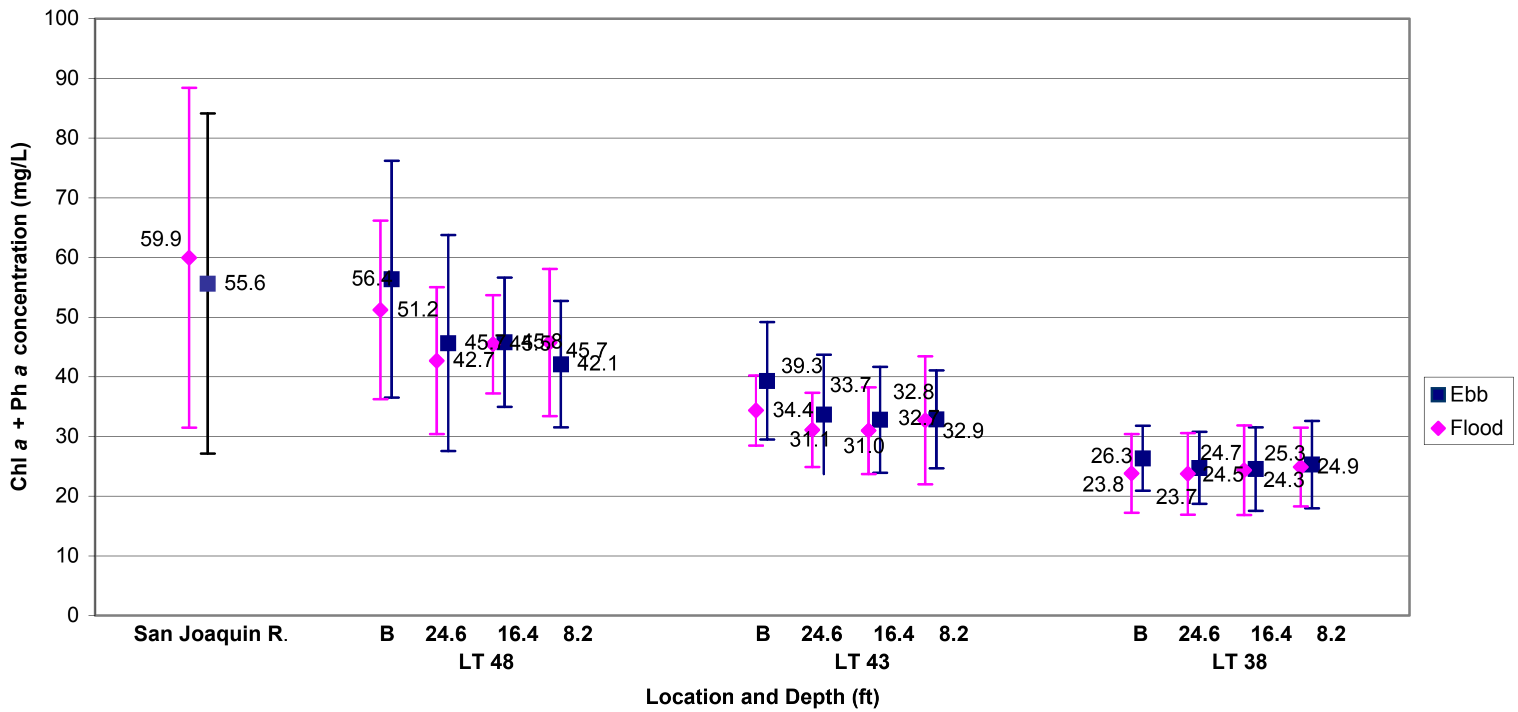


Figure II-36: Averages and standard deviations of chlorophyll *a* plus pheophytin *a* water concentrations in the DWSC for flood and ebb tides during periods of trap deployment.

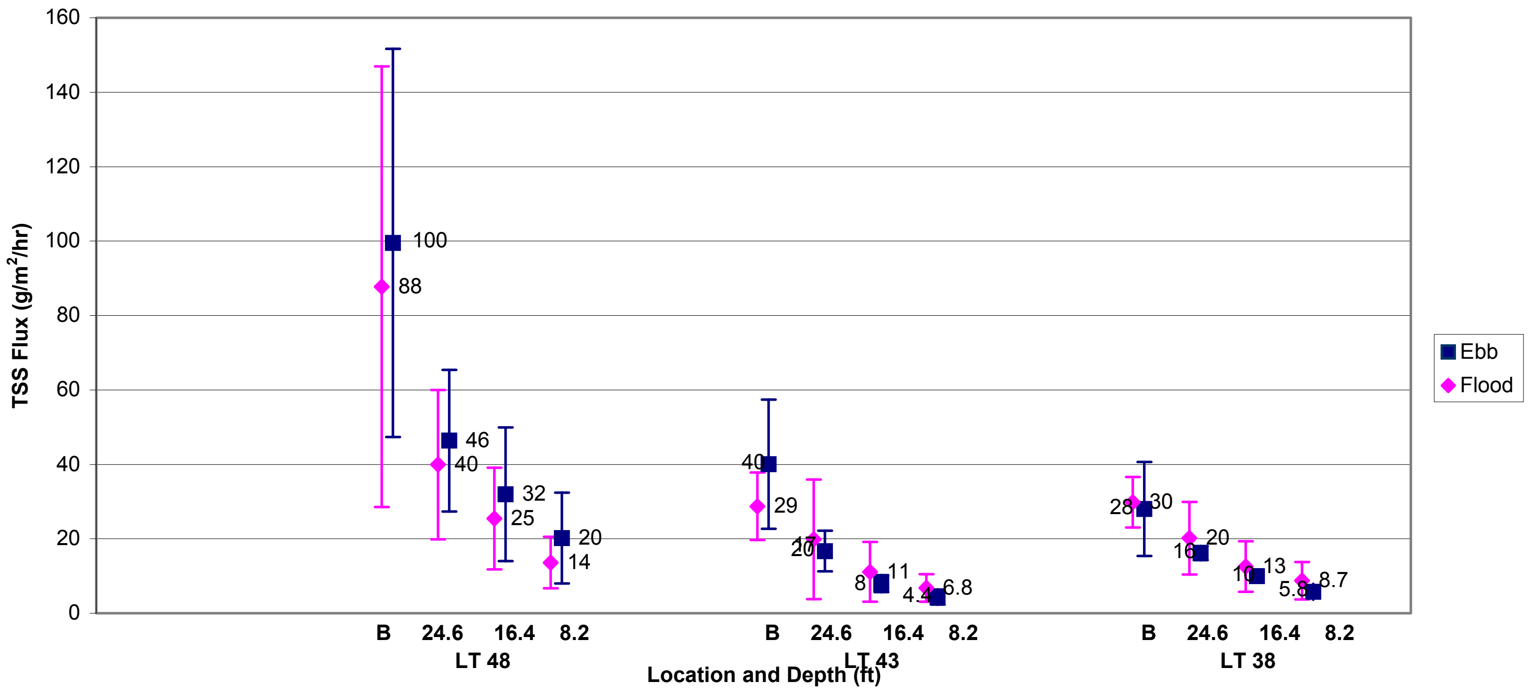


Figure II-37: Averages and standard deviations of TSS deposition fluxes in the DWSC for flood and ebb tides during periods of trap deployment.

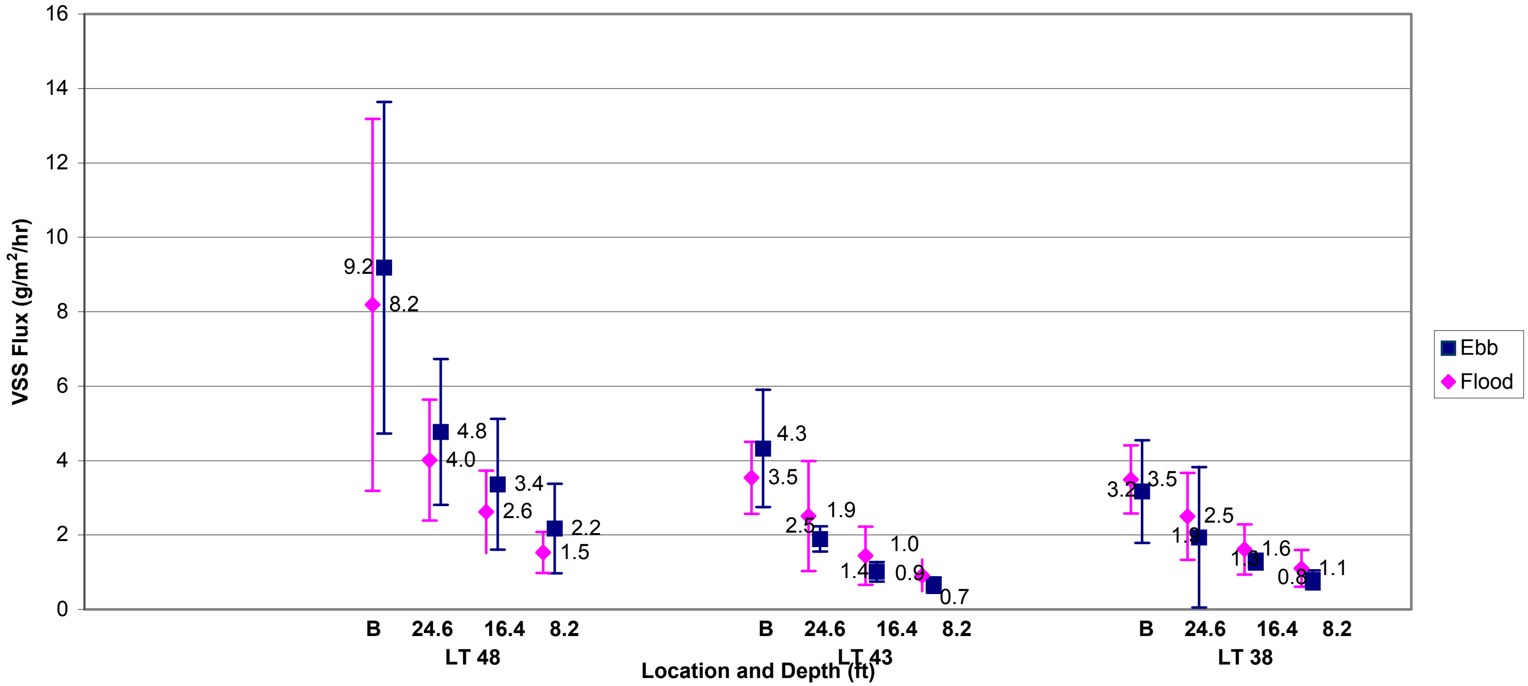


Figure II-38: Averages and standard deviations of VSS deposition fluxes in the DWSC for flood and ebb tides during periods of trap deployment.

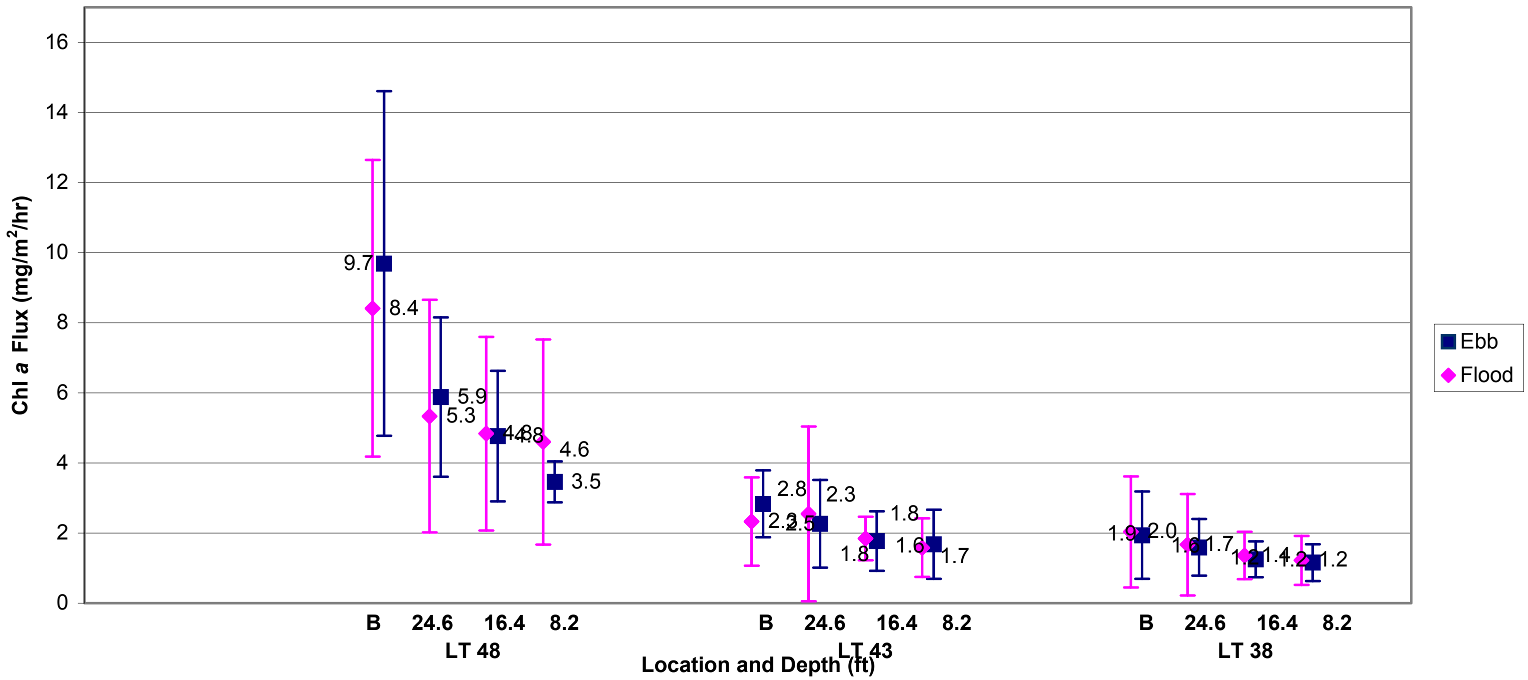


Figure II-39: Averages and standard deviations of chlorophyll *a* deposition fluxes in the DWSC for flood and ebb tides during periods of trap deployment.

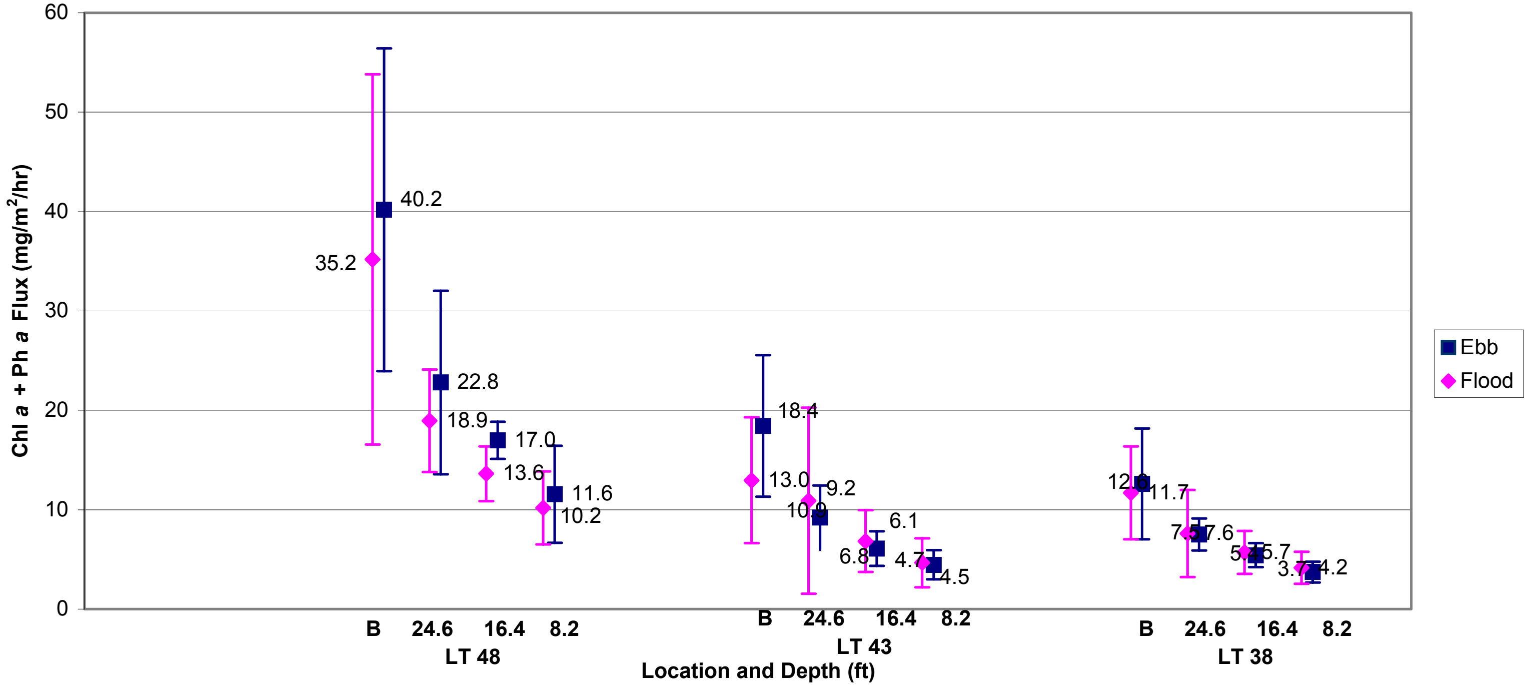


Figure II-40: Averages and standard deviations of chlorophyll *a* plus pheophytin *a* deposition fluxes in the DWSC for flood and ebb tides during periods of trap deployment.

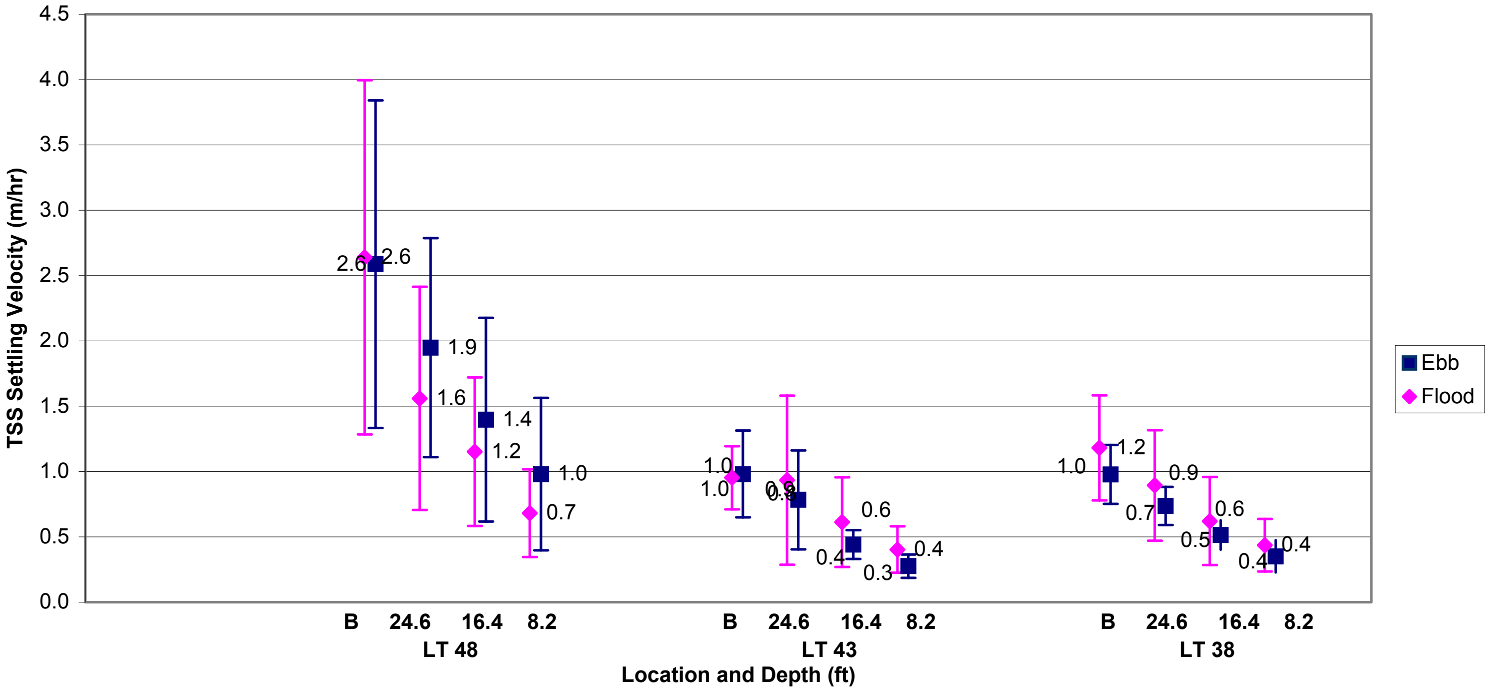


Figure II-41: Averages and standard deviations of TSS settling velocities in the DWSC for flood and ebb tides during periods of trap deployment.

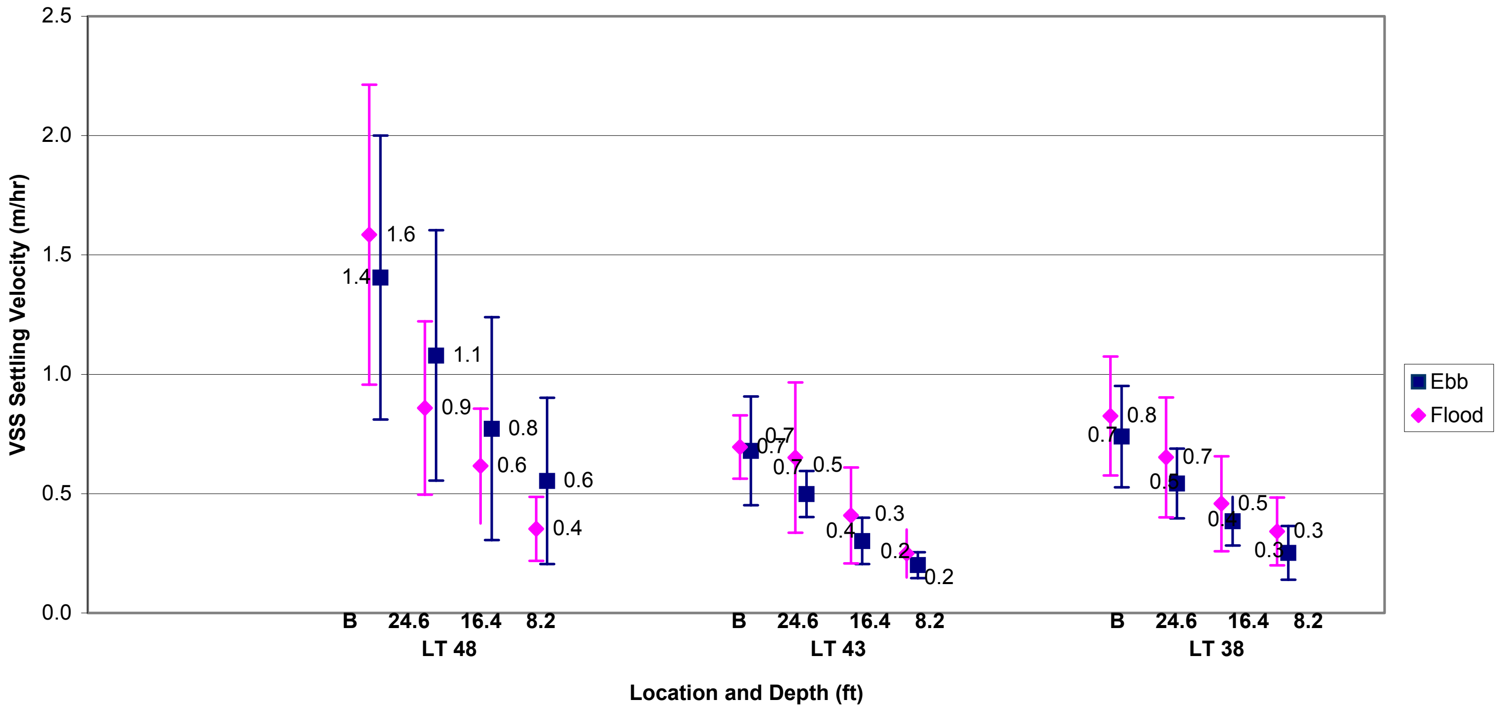


Figure II-42: Averages and standard deviations of VSS settling velocities in the DWSC for flood and ebb tides during periods of trap deployment.

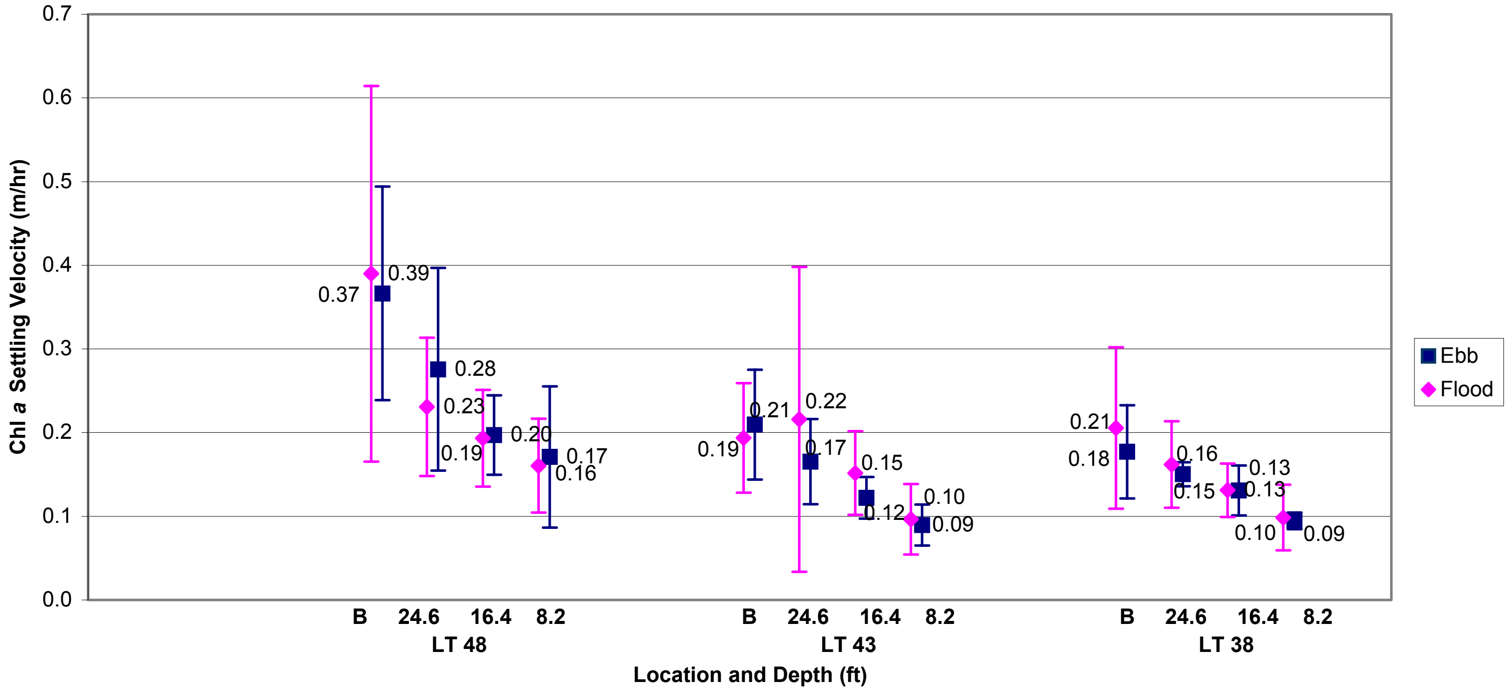


Figure II-43: Averages and standard deviations of chlorophyll *a* settling velocities in the DWSC for flood and ebb tides during periods of trap deployment.

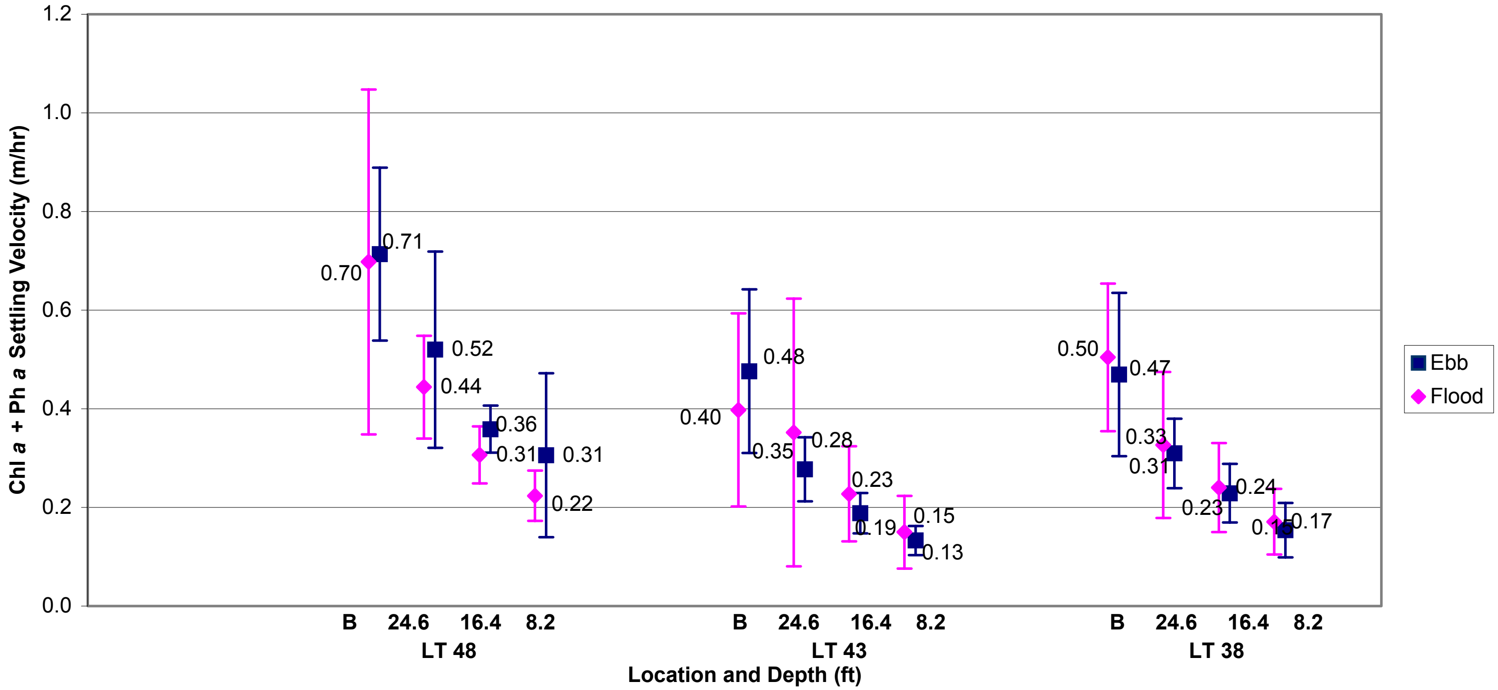


Figure II-44: Averages and standard deviations of chlorophyll *a* plus pheophytin *a* settling velocities in the DWSC for flood and ebb tides.

The settling velocities shown in Figure II-23 for TSS are generally higher during ebb tides. The highest values were calculated for the Lt. 48 station where average ebb tide velocities ranged from 1.5 to 3.1 m/hr and flood tide velocities varied from 1.0 to 2.4 m/hr. As with the TSS deposition fluxes, settling velocities do not appear to be tidally influenced at Lt. 43 and Lt. 38 for all trap depths except at the channel bottom. The relatively high average settling velocities observed at Lt. 43 near the channel bottom are caused by two suspect deposition flux measurements for the bottom traps on September 28 and October 19. Global positioning systems (GPS) measurements of the trap position at Lt. 43 indicated that the trap had been moved during one of the tides on each day. Dragging the trap along the bottom would disturb the sediments and yield artificially high deposition rates.

As shown in Figure II-24, settling velocities for VSS are similar to TSS observations, but exhibit lower calculated velocities. As with TSS the highest calculated settling velocities are near the sediment-water interface where resuspension increases trap deposition fluxes that in turn yield high calculated settling velocities. Settling velocities appear greatest for ebb tides at Lt. 48, but relatively little difference in settling velocities was observed at the other two downstream trap stations (Lt. 43 and Lt. 38). Chlorophyll *a* calculated settling velocities ranged from 0.1 to 0.3 m/hr. Chlorophyll *a* + pheophytin *a* settling velocities exhibit a steeper gradient in the water column than chlorophyll *a* alone suggesting that resuspension effects have a greater influence on non-vital algae. Chlorophyll *a* and pheophytin *a* settling velocities do not appear to be influenced by the tidal flows as shown in Figures II-25 and II-26.

Comparisons of water concentrations, deposition fluxes, and settling velocities for neap and spring tides

Care is required when reviewing the spring and neap tide average values since the number of observations is relatively small. Sediment trap data lost to acts of vandalism or damage by ship traffic sometimes reduced the data available at a station. A minimum of 3 and a maximum of 5 samples were typically used to calculate these averages used to compare differences between neap and spring tides.

The TSS water concentrations averaged over spring and neap tides for the San Joaquin River and the DWSC are presented in Figures II-45 and II-46. Figure II-45 shows these averages during ebb tidal flows. At Lt. 48 the TSS average spring tide water concentrations were approximately 10 percent greater than the flood tide average. Increased water concentrations were also observed at Lt. 43 and Lt. 38 for ebb tides. Smaller differences in the average values were observed higher in the water column at Lt. 43 and Lt. 38. As shown in Figure II-46, the averages for neap and spring tides during flood conditions generally contradict the ebb tide averages. During flood flow, the neap tide averages were often greater than the average spring tides values. The deposition fluxes shown in Figures II-47 and II-48 for ebb and flood tides are consistent with the water concentrations. However, for the deposition fluxes, the differences were often greater. For example, at Lt. 48, the deposition fluxes under ebb flows for the spring tides were often 2 or 3 times greater neap tide averages. Again the differences were usually most pronounced at Lt. 48 and near the sediment water interfaces. As discussed earlier, sediment resuspension caused by ship traffic on the morning of September 11, 2001 yielded high deposition fluxes during the morning flood/neap tide. These data influence the averages shown in Figures II-46 and II-48. However, excluding the September 11 data still yield average sediment fluxes that exceed the spring after during flood flow conditions. For example, the average sediment deposition flux for the bottom trap at Lt. 48 is 126 g m^{-2} hr^{-1} and 82 g m^{-2} hr^{-1} with and without the September 11 data, respectively. Thus, both of these neap tide averages remain above the 59 g m^{-2} hr^{-1} spring tide average.

The settling velocities associated with the deposition fluxes and water concentrations are presented in Figures II-49 and II-50. Since the settling velocity is determined by dividing the deposition flux by the water concentration, the settling velocities exhibit the same trends observed earlier. The highest settling velocities were measured at Lt. 48 and nearest the sediment-water interface. At Lt. 48, the calculated spring tide settling velocities were more than double the neap tide average during the ebb flows. However, during flood flows the neap tide averages were typically greater than the spring tide results.

Conclusions for the spring and neap tide comparisons for TSS are difficult due to the relatively few data and other processes occurring in the DWSC. The differences observed during ebb tides certainly suggest that the higher flows associated with the spring tides increase sediment resuspension. However, the higher water concentrations and deposition fluxes measured during flood events indicate that other factors, such as ship traffic, can cloud the effects. It is recommended that a review of continuous turbidity measurement at Rough and Ready Island be performed to better evaluate tidal effects. This data will also assist with evaluating ship traffic effects. To date, these data are not available but are expected soon.

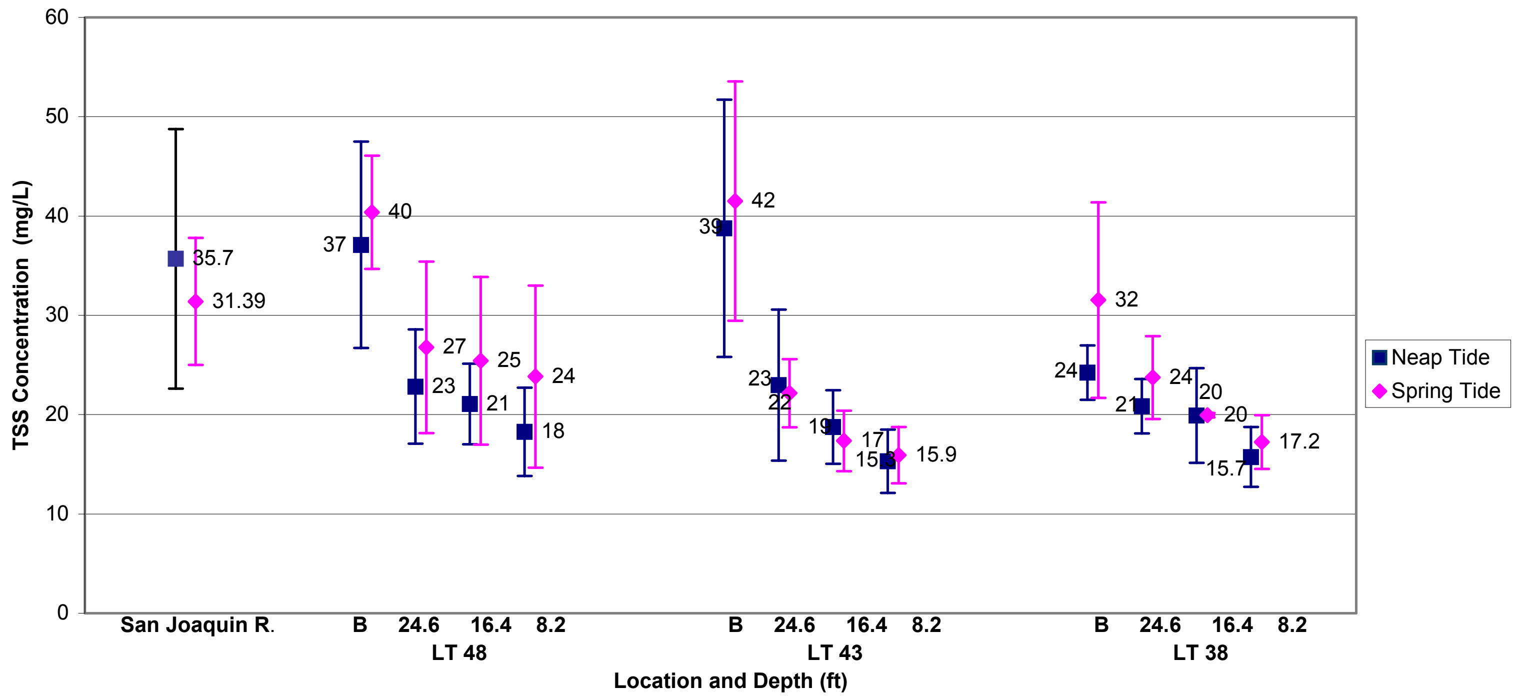


Figure II-45: Averages and standard deviations of TSS water concentrations in the DWSC and San Joaquin River for neap and spring tides during ebb conditions.

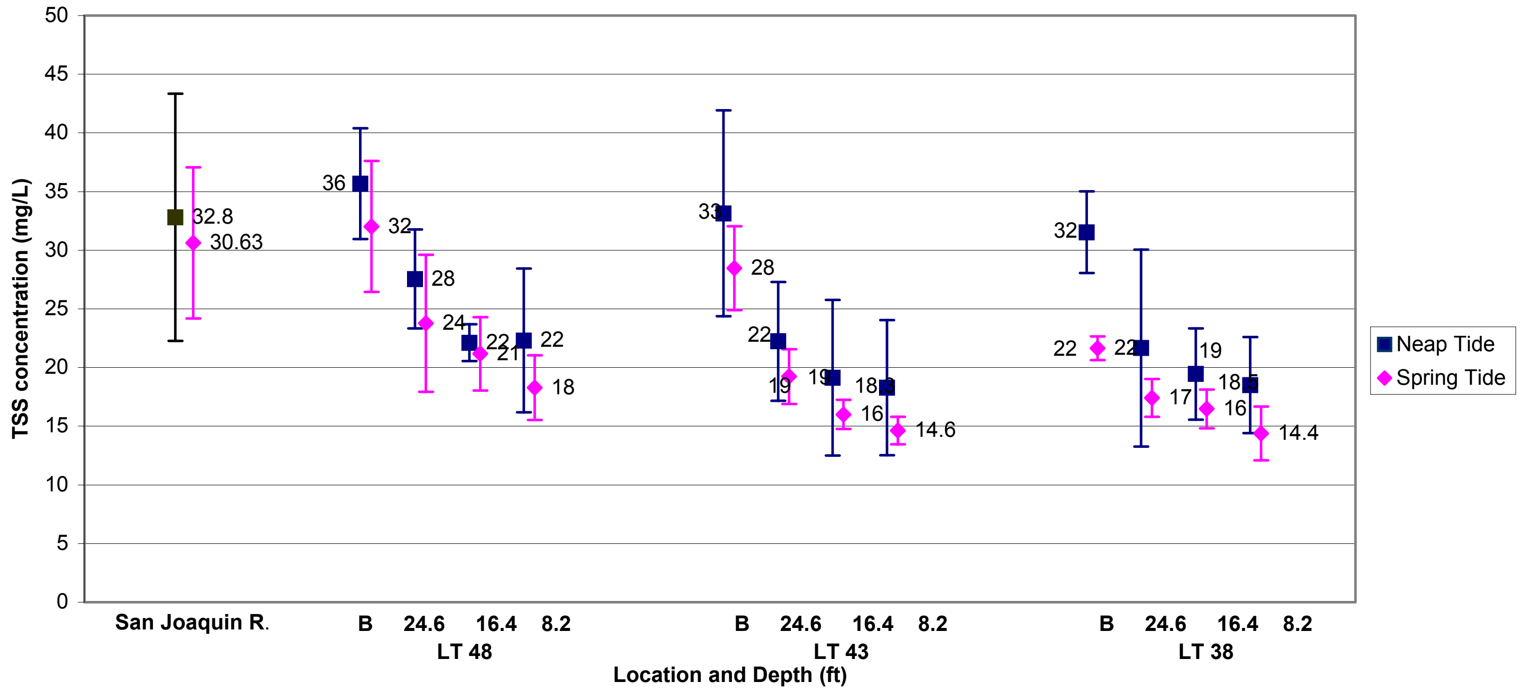


Figure II-46: Averages and standard deviations of TSS water concentrations in the DWSC and San Joaquin River for neap and spring tides during flood conditions.

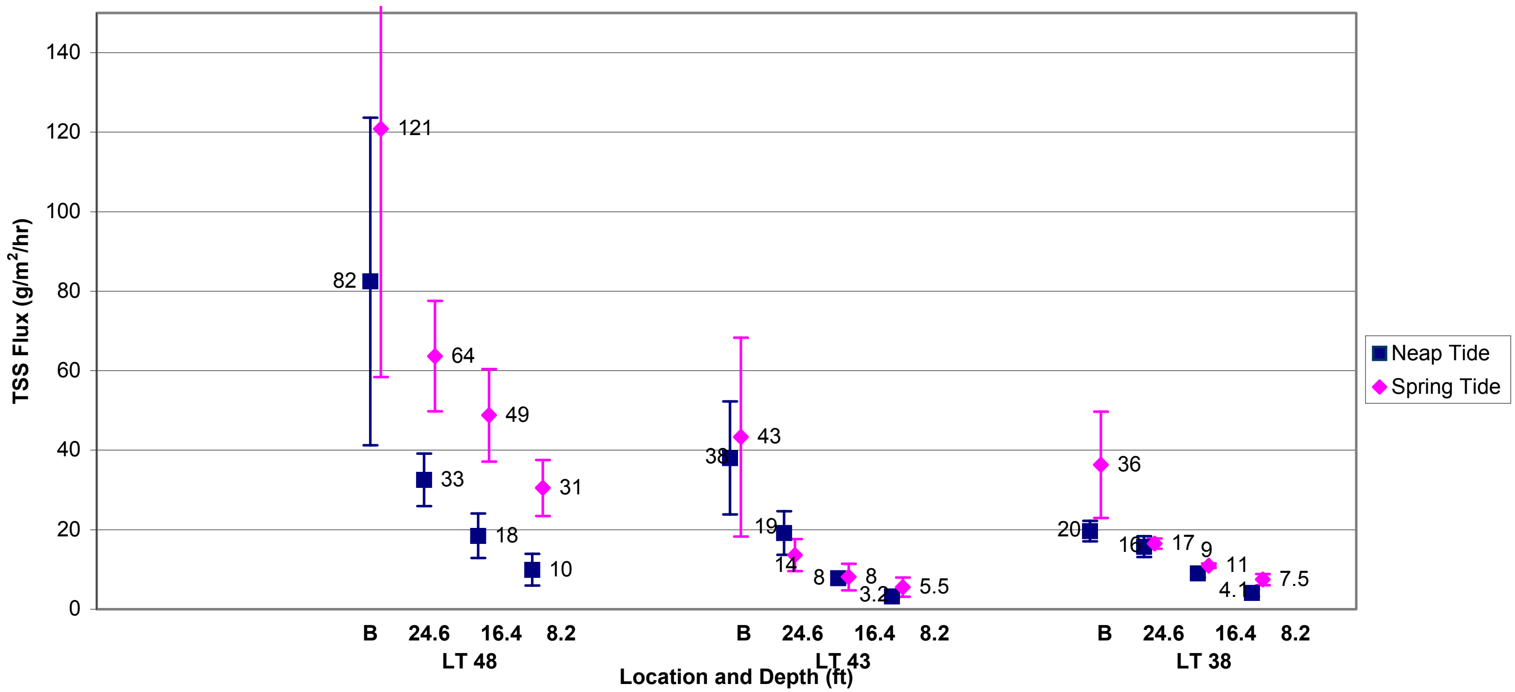


Figure II-47: Averages and standard deviations of TSS deposition fluxes in the DWSC for neap and spring tides during ebb conditions.

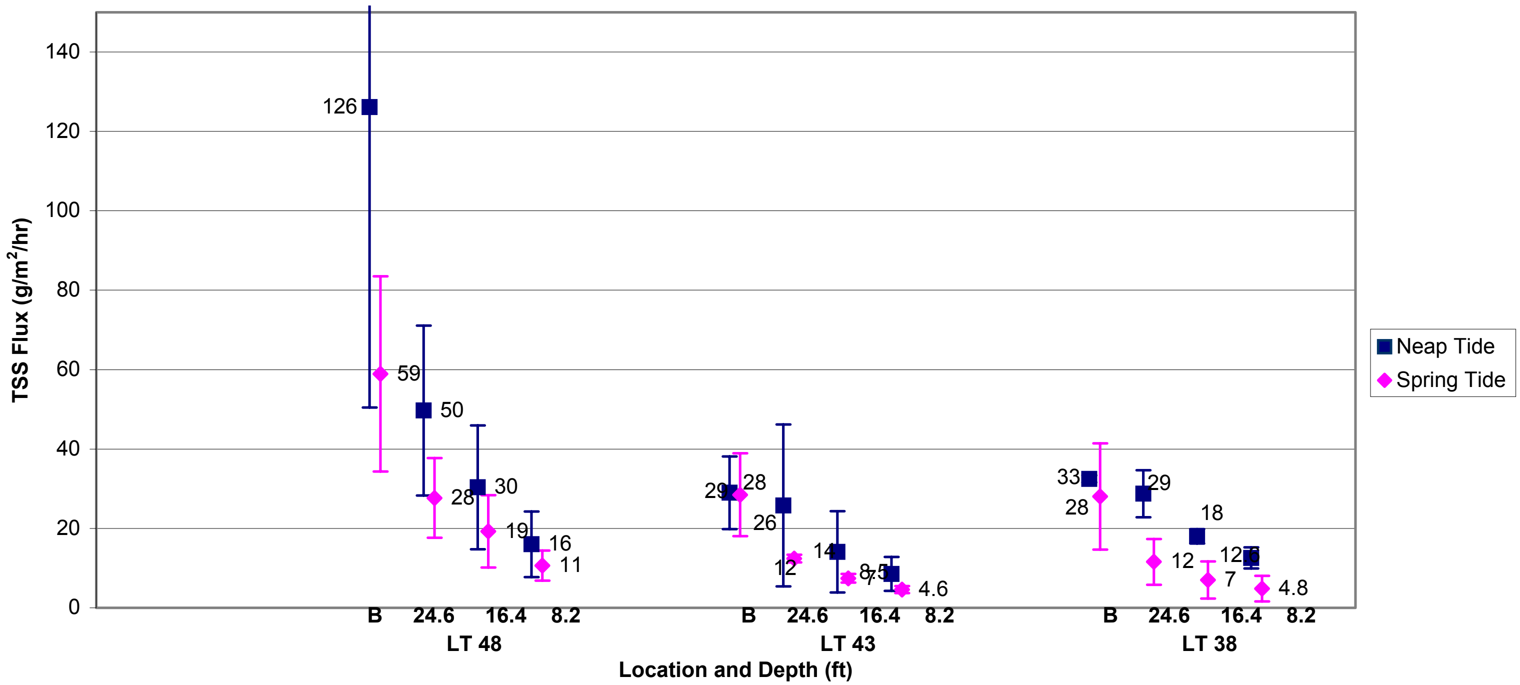


Figure II-48: Averages and standard deviations of TSS deposition fluxes in the DWSC for neap and spring tides during flood conditions.

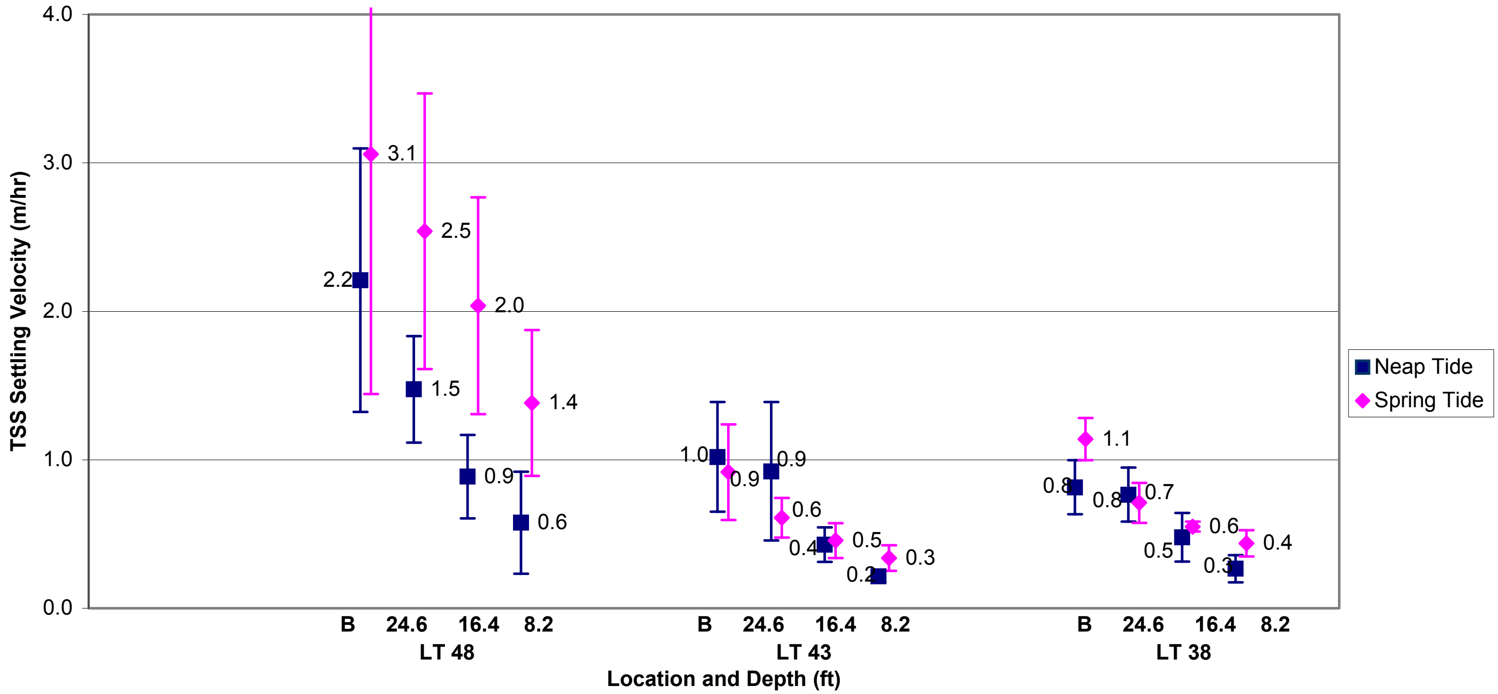


Figure II-49: Averages and standard deviations of TSS settling velocities in the DWSC for neap and spring tides during ebb conditions.

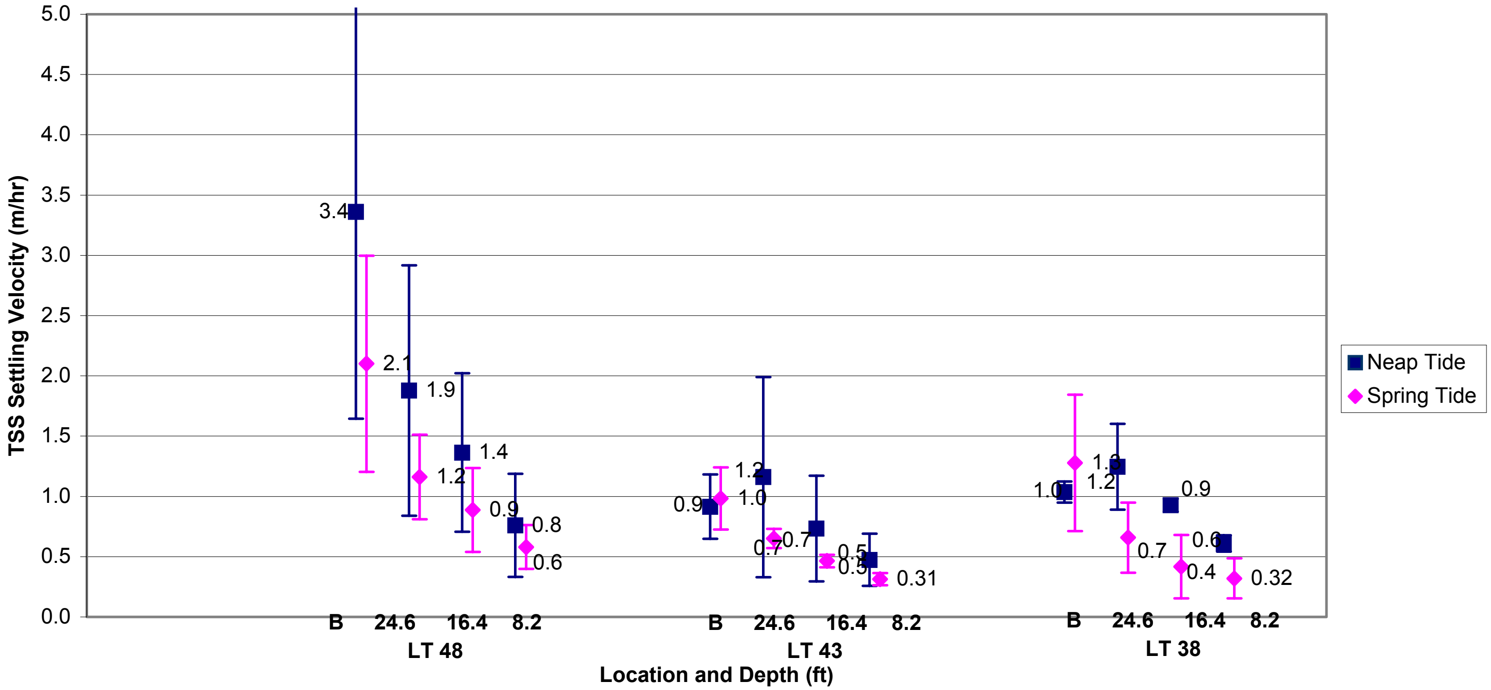


Figure II-50: Averages and standard deviations of TSS settling velocities in the DWSC for neap and spring tides during flood conditions.

Neap and spring tide averages for VSS water concentrations, deposition fluxes, and settling velocities are presented in Figures II-51-56. VSS data exhibit virtually the same trends as the TSS data. As shown earlier, VSS and TSS are well correlated for the sediment collected in the traps; water concentrations also exhibit a VSS and TSS correlation, but it is not as strong as observed for the sediment data. Therefore, the similarities between VSS and TSS trends are expected.

Average neap and spring tide water chlorophyll *a* concentrations are shown in Figures II-58 and II-59. Water concentrations appear relatively independent of the tidal conditions, and more dependent on the concentrations entering the DWSC. The high neap tide concentrations often observed at Lt. 48 are influenced by high chlorophyll *a* concentrations coming into the DWSC during early July (see July 13 data or Figure II-9). The near-surface (8.2 ft, 2.5m) averages are also higher for spring tides under flood flow conditions as shown in Figure II-58. This appears to be caused by an algae bloom in the DWSC on or near October 16, 2001. Evidence of the algae bloom is also seen in the elevated dissolved oxygen concentrations measured at depths of 1 and 2.5 m at Lt. 38 and Lt. 43 (see Table A-5).

As shown in Figures II-59 and II-60, the average deposition fluxes for chlorophyll *a* measured during spring and neap tides also appear to be influenced more concentrations entering the DWSC than by differences in tidal flows. The plots of the settling velocities presented in Figures II-61 and II-62 also exhibit little evidence that spring or neap tides influence settling velocities.

The water concentrations for the sum of chlorophyll *a* and pheophytin *a* are presented in Figures II-63 and II-64. These average concentrations are quite similar for ebb flood conditions as shown in Figure II-63. Concentrations averaged for the flood flow conditions do exhibit elevated concentrations of chlorophyll *a* and pheophytin *a* throughout the water column at Lt. 38 and Lt. 43. Elevated chlorophyll *a* concentrations were also observed at Lt. 38 during spring, flood tides. These differences may be also be associated with the timing of the measurements. All the spring, flood tides were occurred during the afternoon, while all of the neap, flood tides occurred during the morning. Thus, higher pigment concentrations could be associated with greater afternoon algal productivity. However, tides during neap, ebb conditions were also measured during the afternoon and comparisons of ebb tide data do not exhibit significant differences.

Average deposition fluxes of chlorophyll *a* plus pheophytin *a* are shown in Figures II-65 and II-66. During ebb flows average spring tide deposition fluxes were significantly greater than the neap value at Lt. 48 , but not at the downstream stations, except at sediment water interface. This behavior was also common of the TSS and VSS data as shown earlier, but not observed with the chlorophyll *a* deposition fluxes. This suggests that the elevated deposition fluxes observed during spring, ebb tides for chlorophyll *a* plus pheophytin *a* are associated with the resuspension of sediments. Tidal conditions could have a substantial effect on resuspension due to the higher velocities associated with spring and ebb tides. Spring and neap tide average settling velocities for chlorophyll *a* plus pheophytin *a* are shown in Figures II-67 and II-68 and typically mirror the deposition flux results. Again the highest differences in spring and neap tide were observed at Lt. 48 for ebb flow conditions.

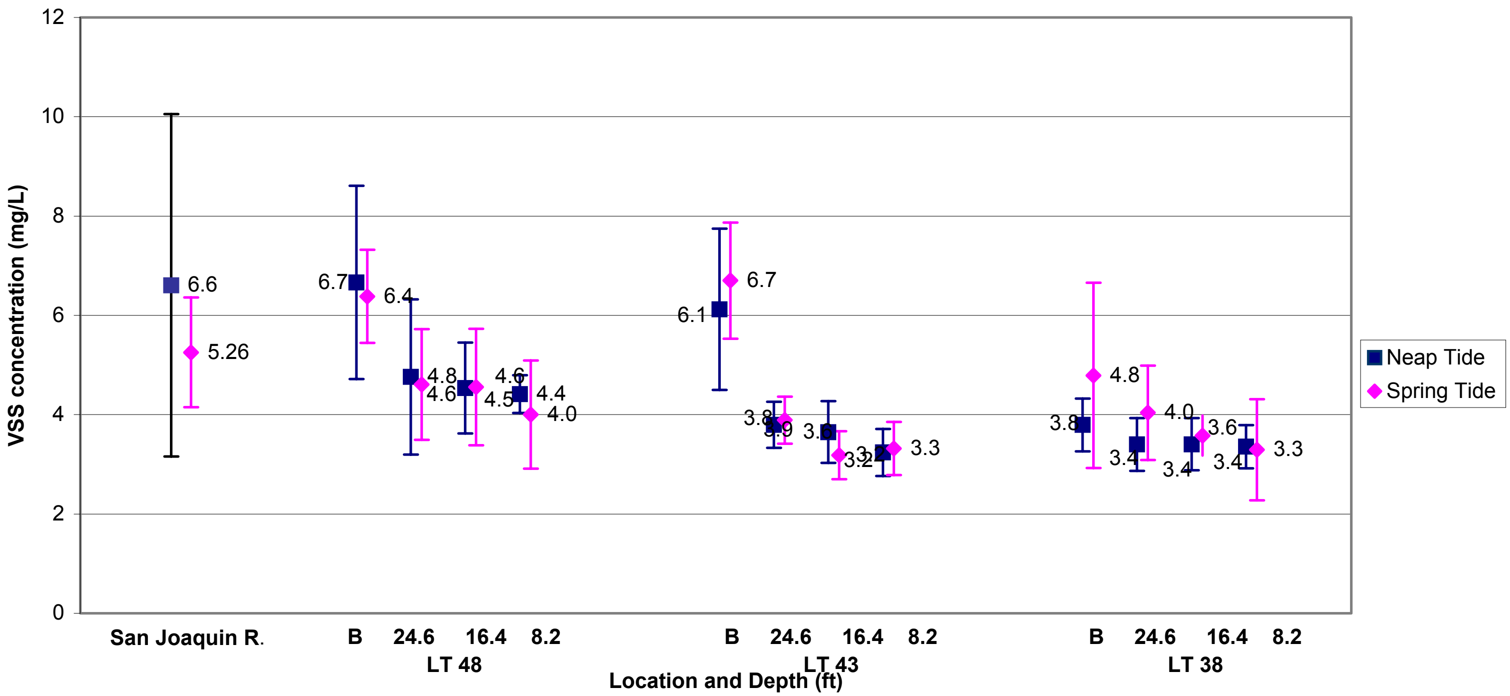


Figure II-51: Averages and standard deviations of VSS water concentrations in the DWSC and San Joaquin River for neap and spring tides during ebb conditions.

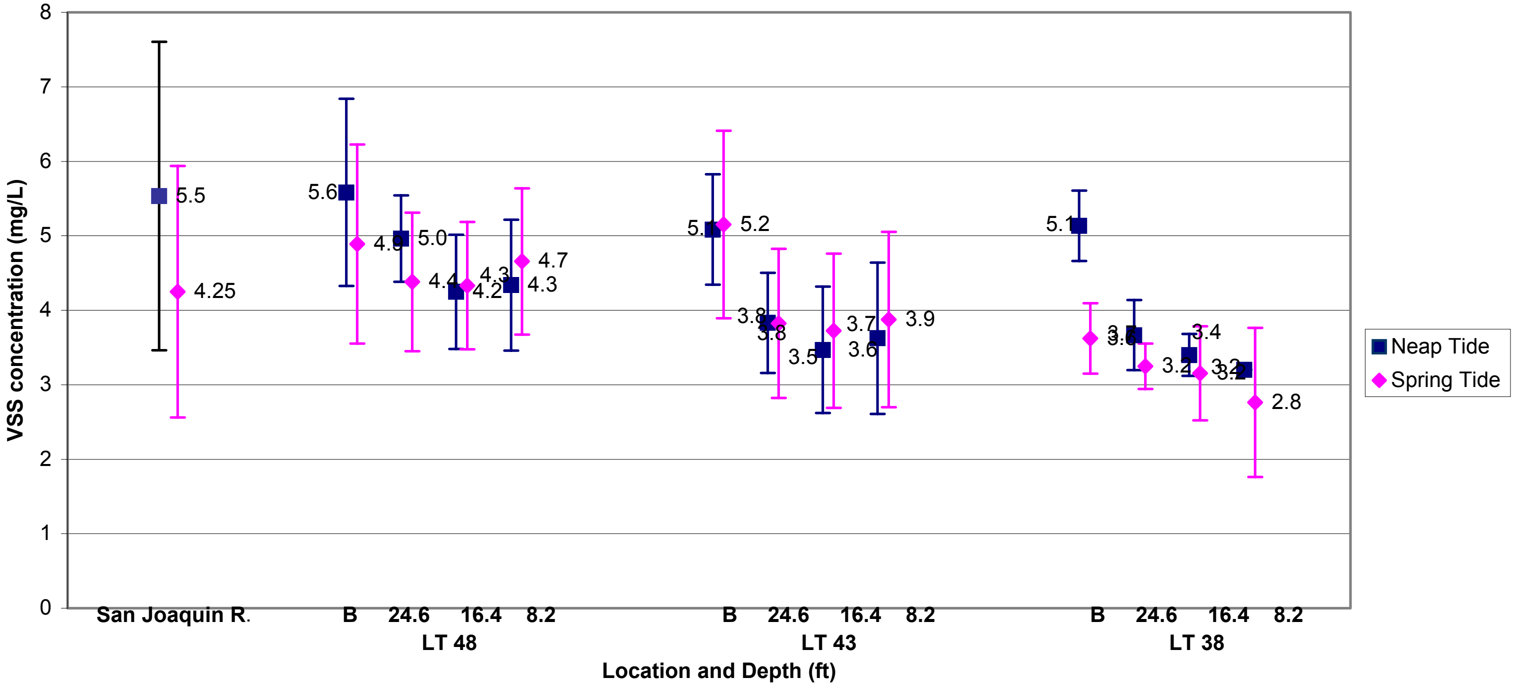


Figure II-52: Averages and standard deviations of VSS water concentrations in the DWSC and San Joaquin River for neap and spring tides during flood conditions.

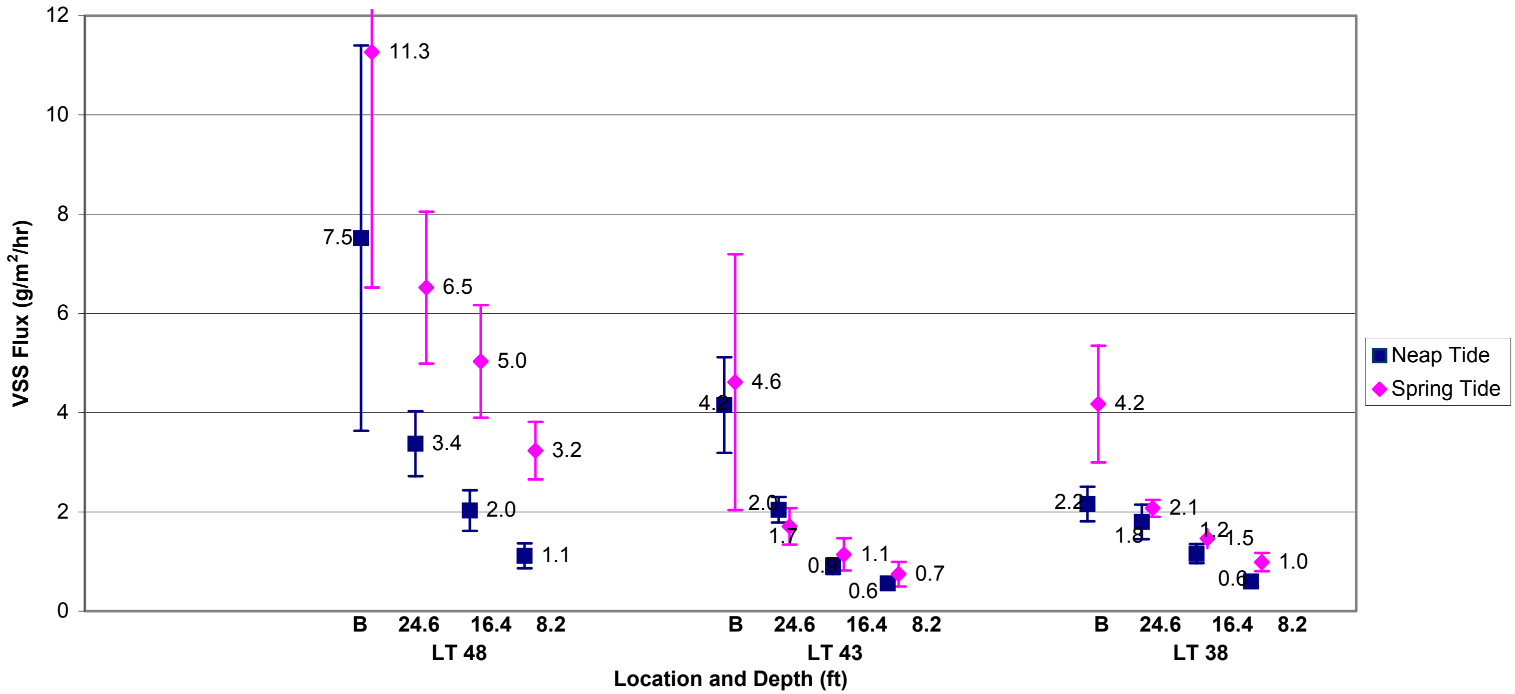


Figure II-53: Averages and standard deviations of VSS deposition fluxes in the DWSC for neap and spring tides during ebb conditions.

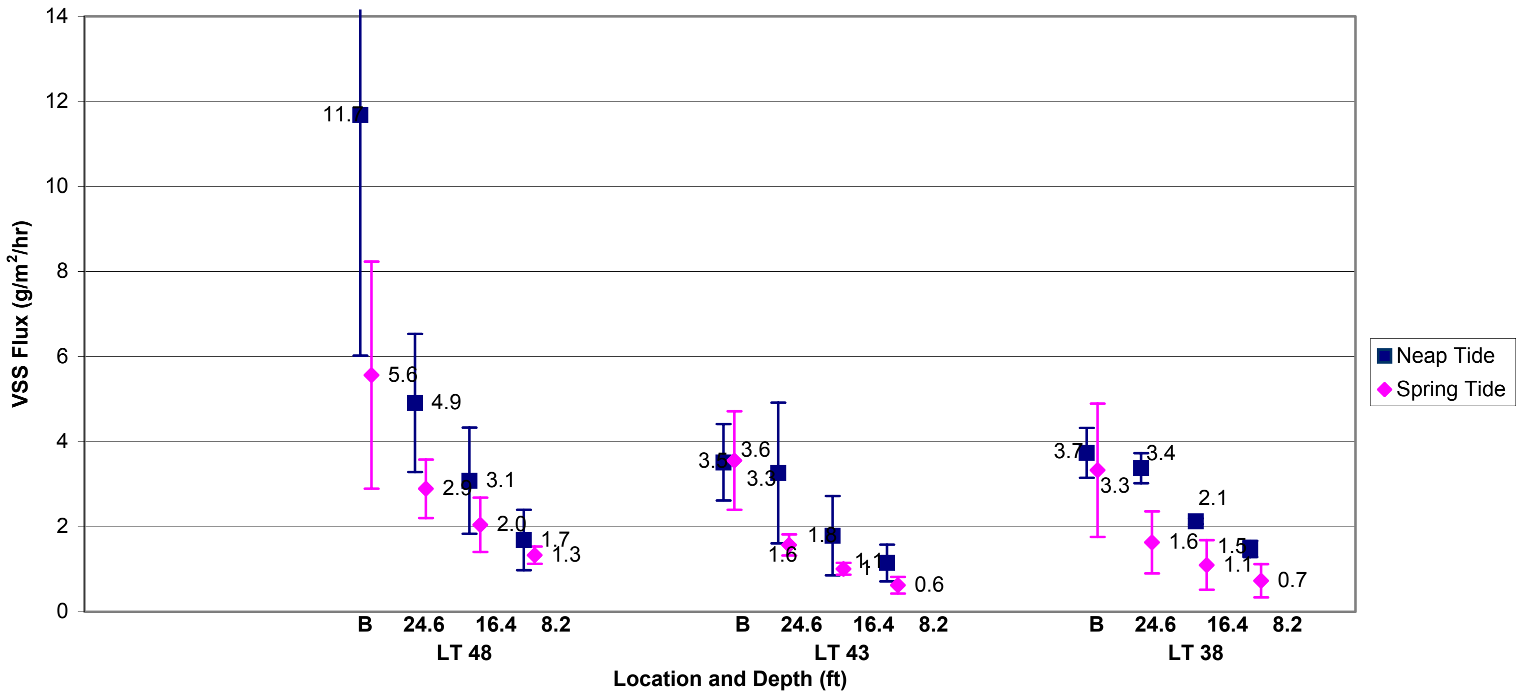


Figure II-54: Averages and standard deviations of VSS deposition fluxes in the DWSC for neap and spring tides during flood conditions.

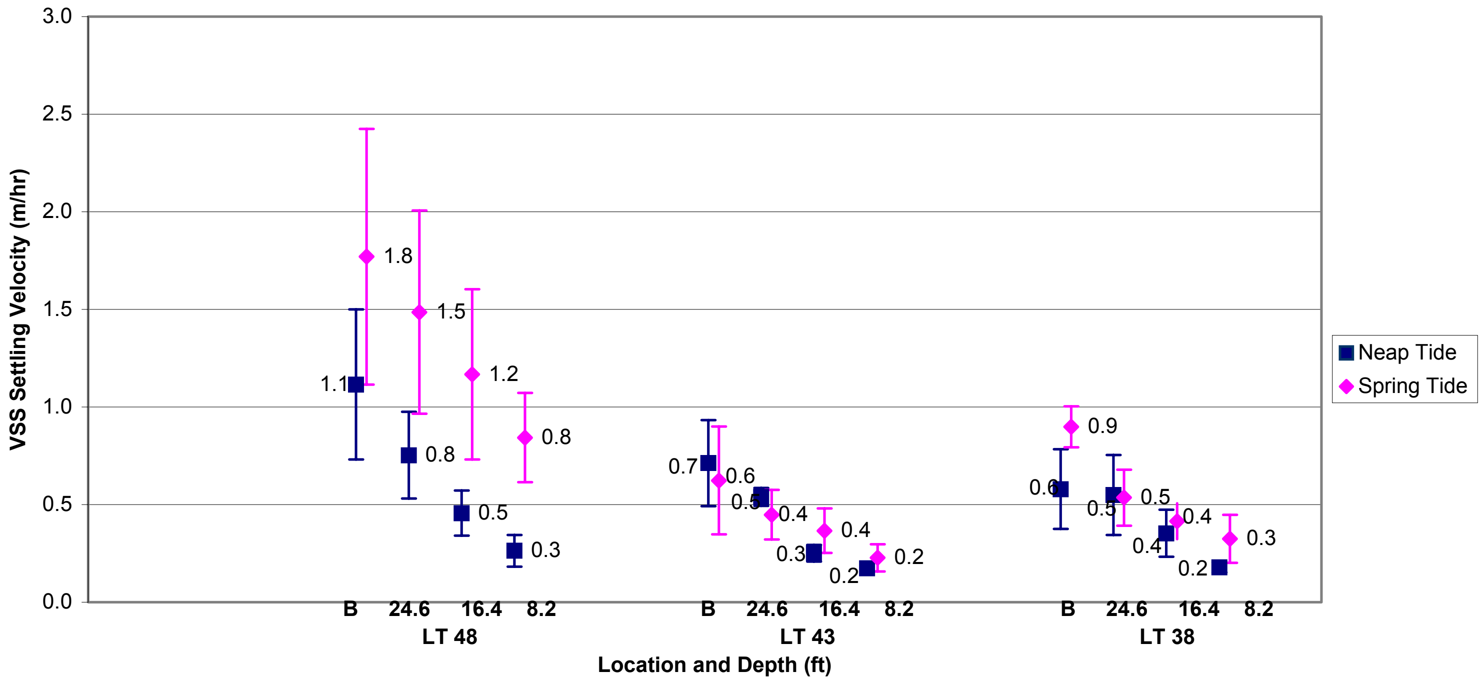


Figure II-55: Averages and standard deviations of VSS settling velocities in the DWSC for neap and spring tides during ebb conditions.

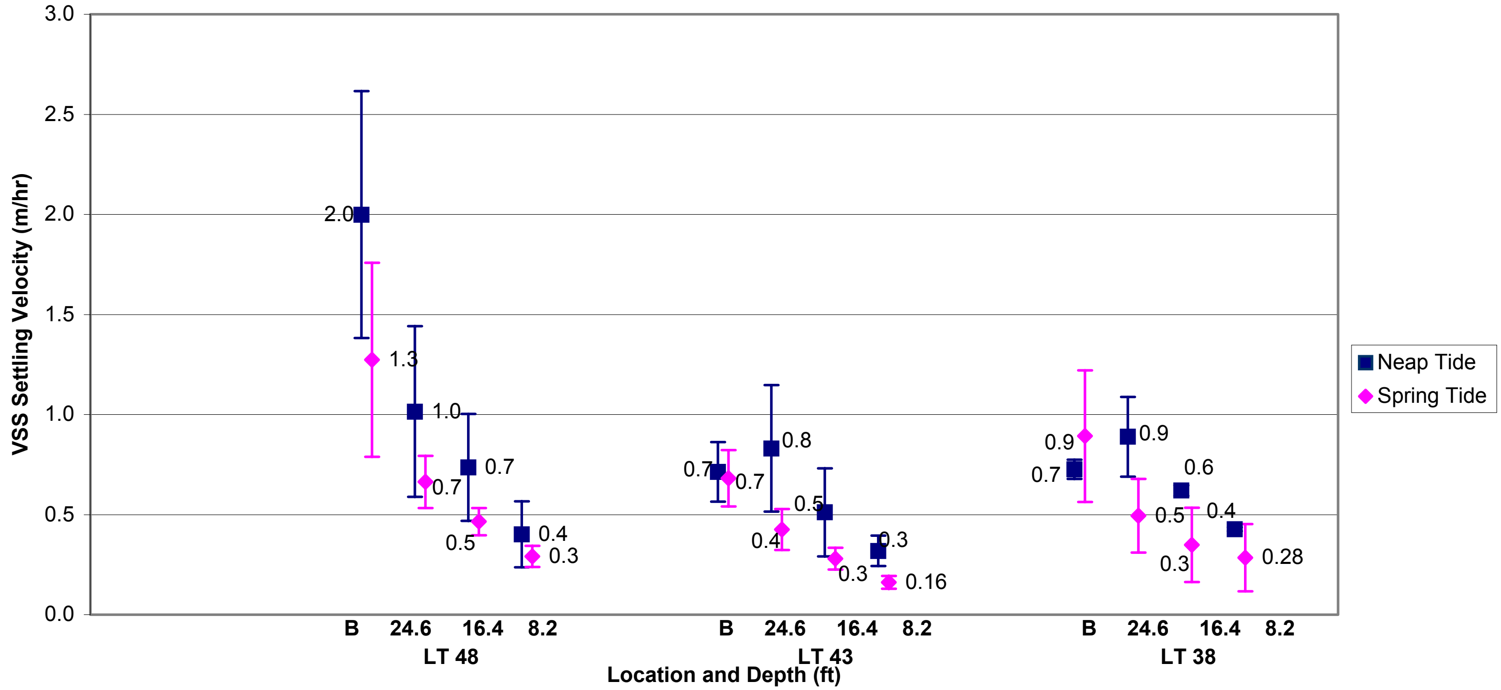


Figure II-56: Averages and standard deviations of VSS settling velocities in the DWSC for neap and spring tides during flood conditions.

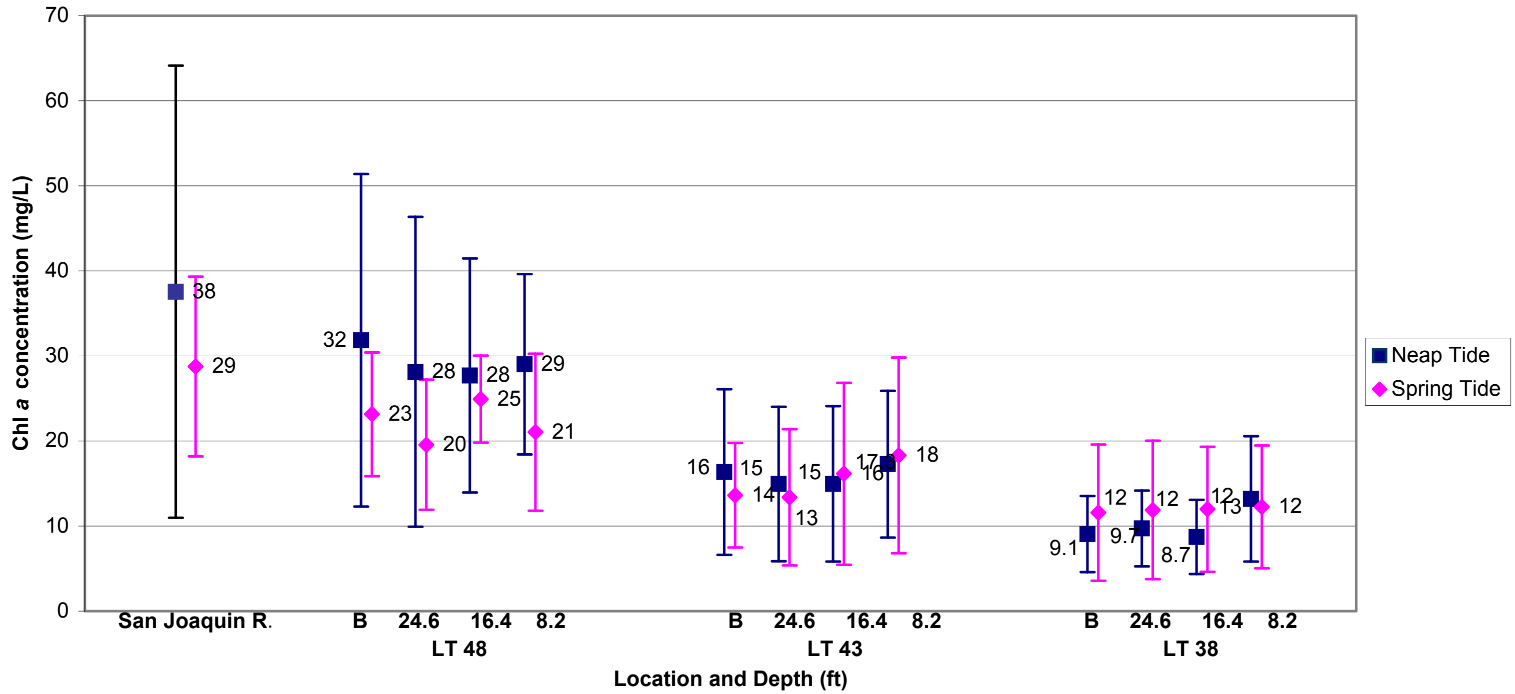


Figure II-57: Averages and standard deviations of chlorophyll *a* water concentrations in the DWSC and San Joaquin River for neap and spring tides during ebb conditions.

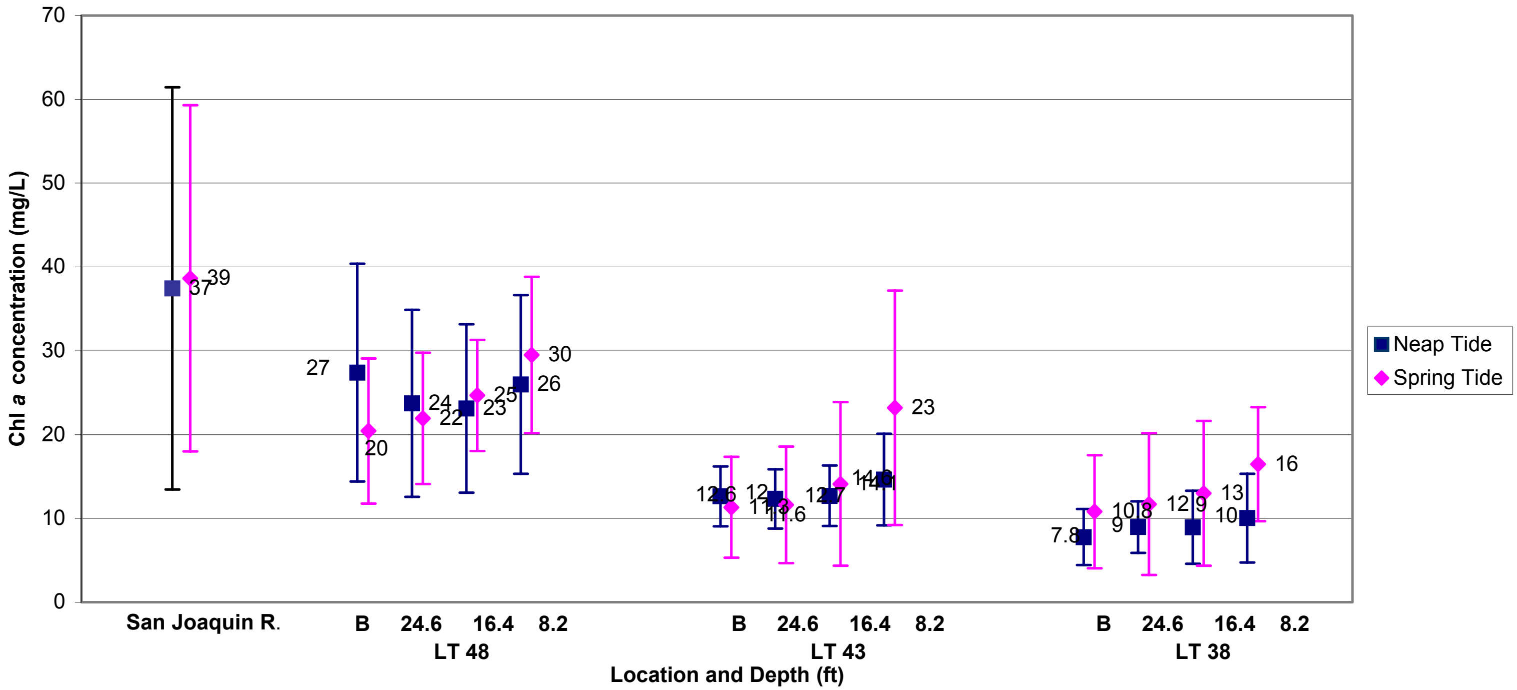


Figure II-58: Averages and standard deviations of chlorophyll *a* water concentrations in the DWSC and San Joaquin River for neap and spring tides during flood conditions.

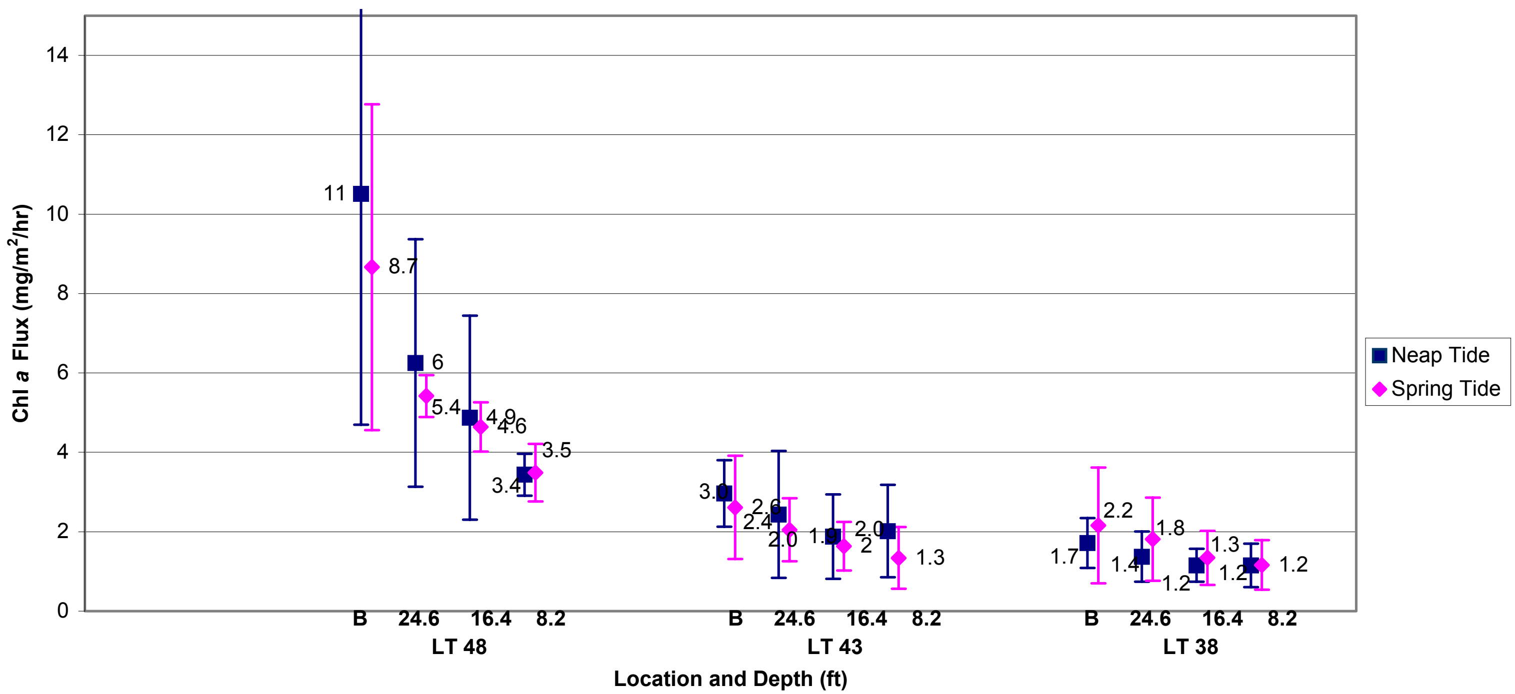


Figure II-59: Averages and standard deviations of chlorophyll *a* deposition fluxes in the DWSC for neap and spring tides during ebb conditions.

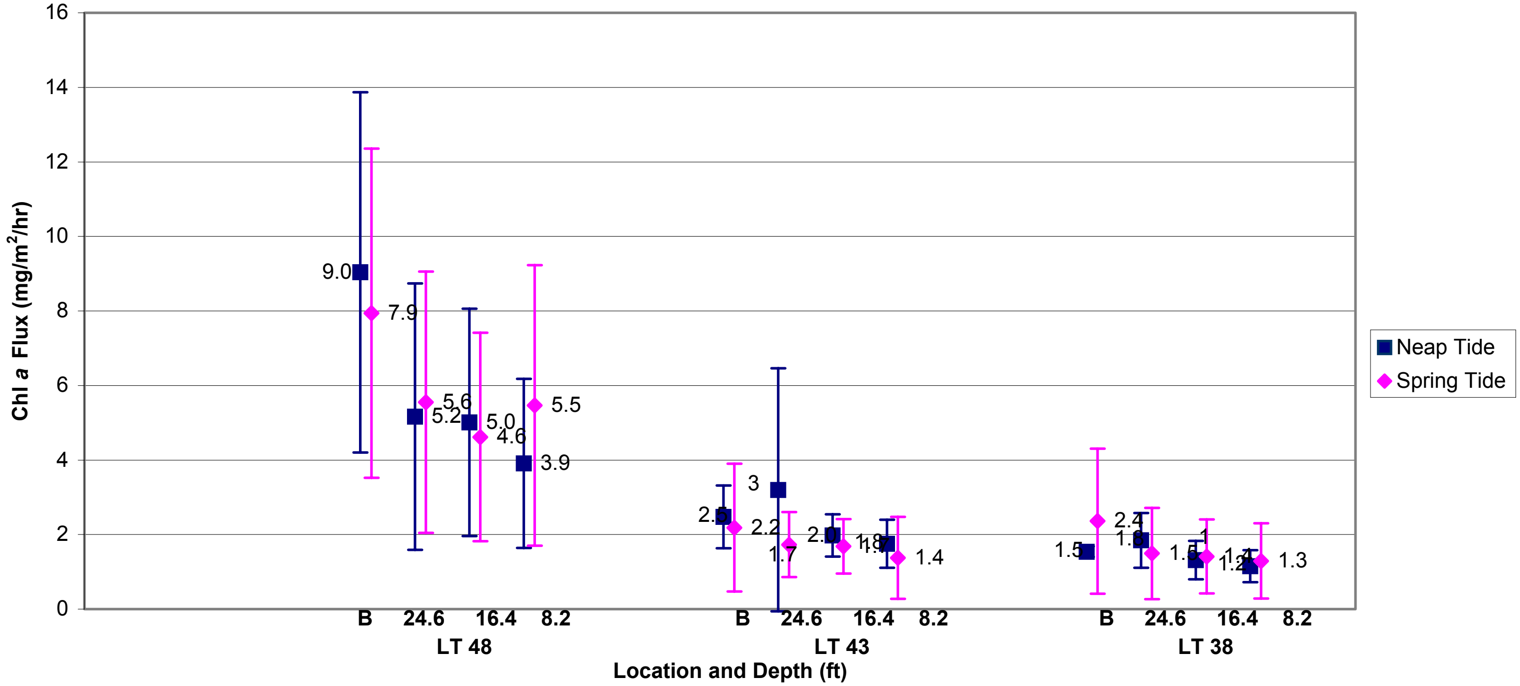


Figure II-60: Averages and standard deviations of chlorophyll *a* deposition fluxes in the DWSC for neap and spring tides during flood conditions.

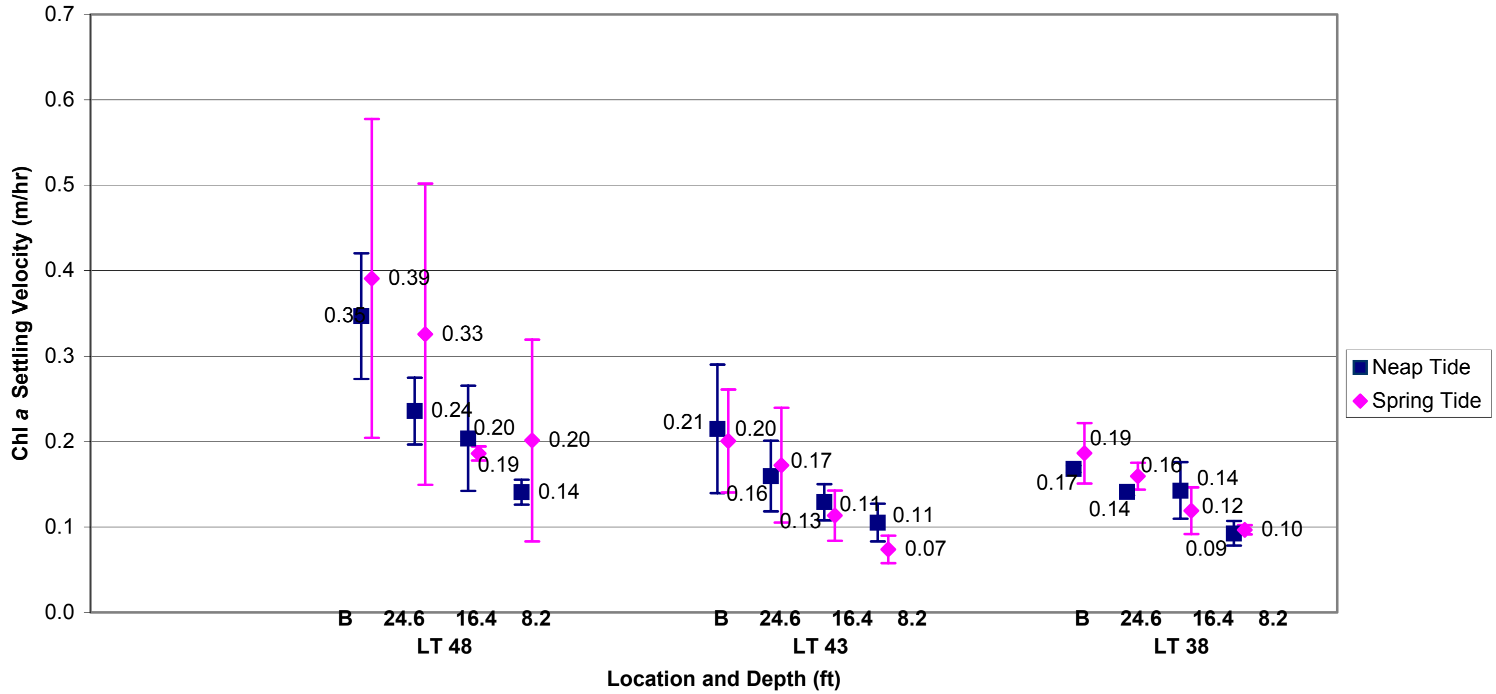


Figure II-61: Averages and standard deviations of chlorophyll *a* settling velocities in the DWSC for neap and spring tides during ebb conditions.

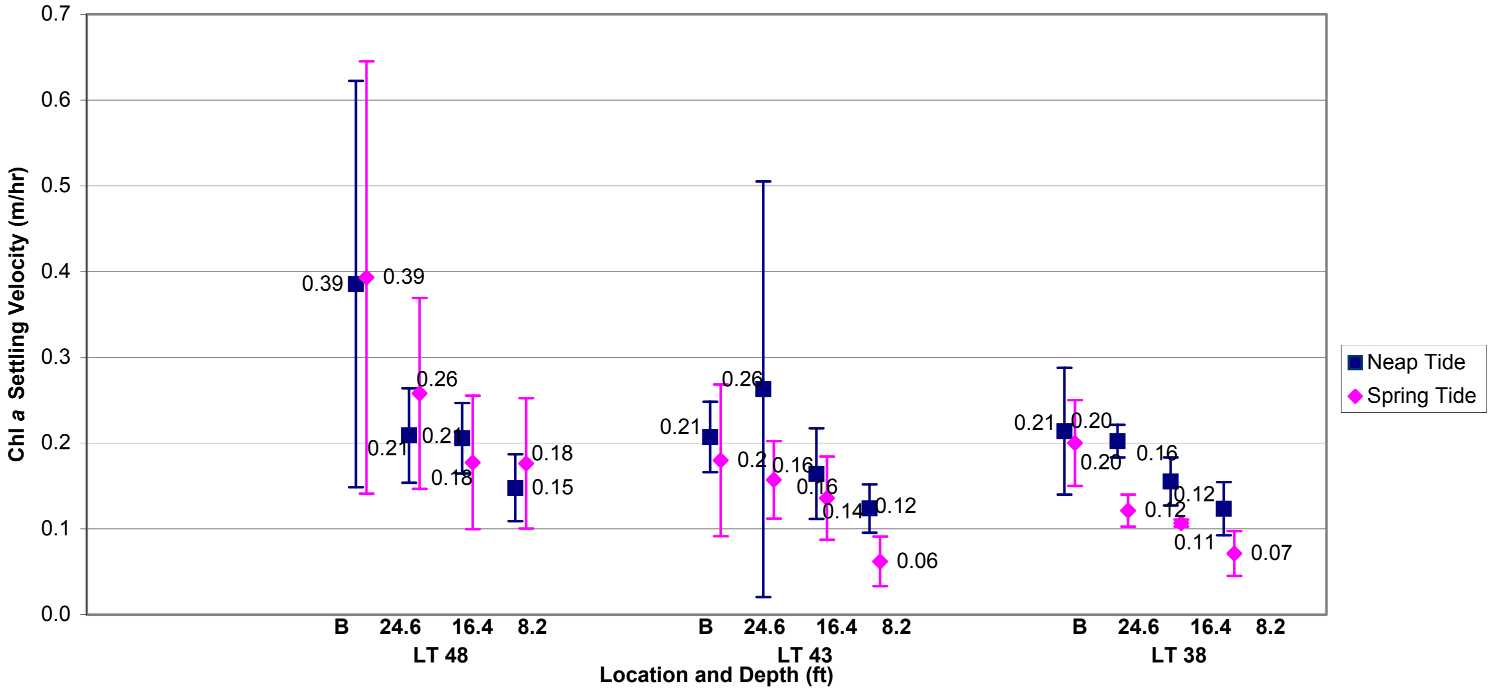


Figure II-62: Averages and standard deviations of chlorophyll *a* settling velocities in the DWSC for neap and spring tides during flood conditions.

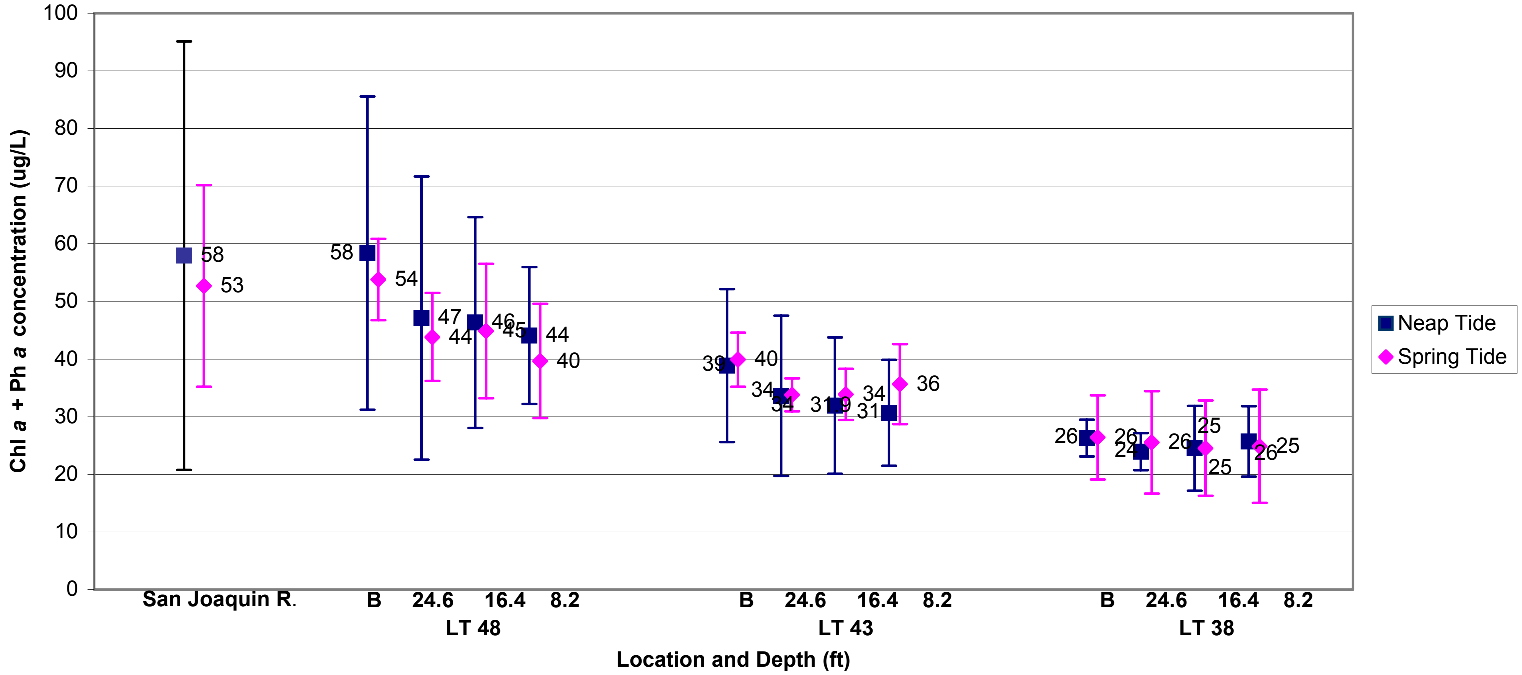


Figure II-63: Averages and standard deviations of chlorophyll *a* plus pheophytin *a* water concentrations in the DWSC and San Joaquin River for neap and spring tides during ebb conditions.

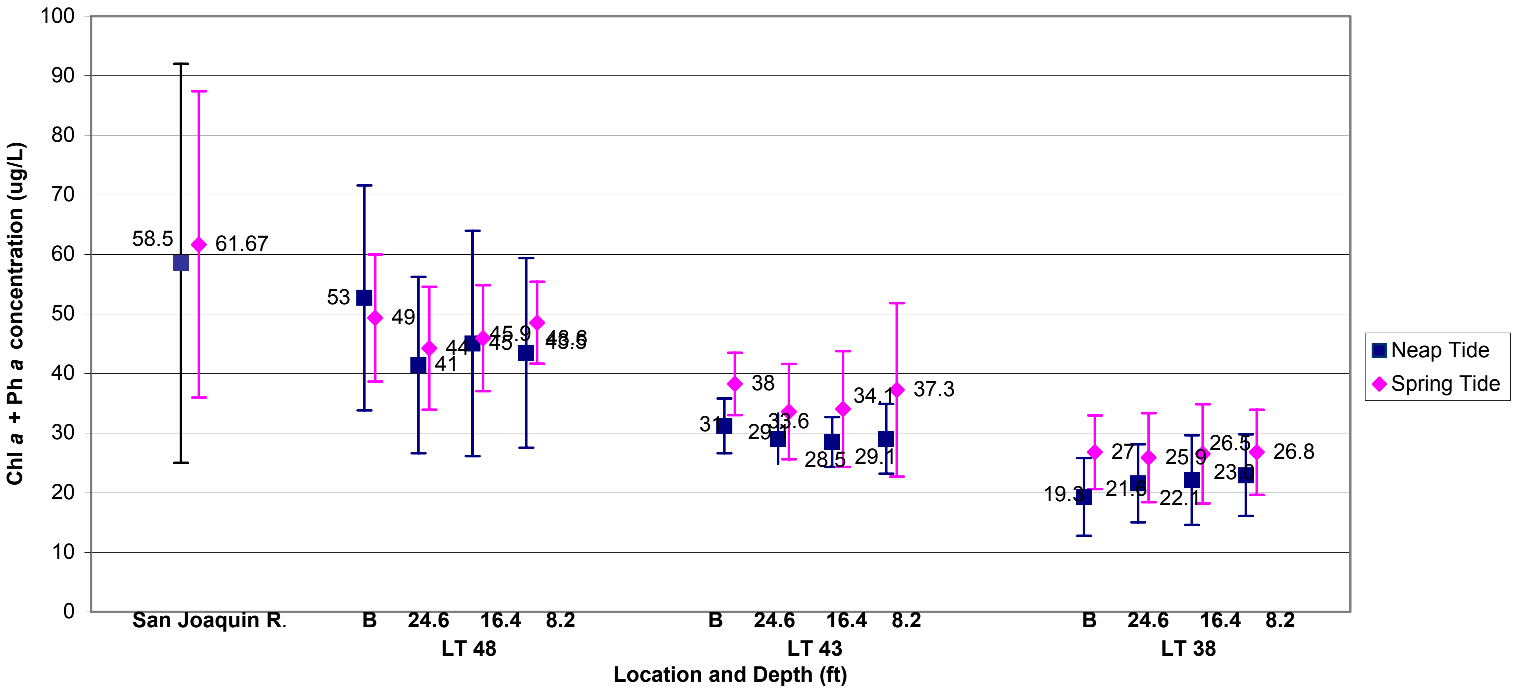


Figure II-64: Averages and standard deviations of chlorophyll *a* plus pheophytin *a* water concentrations in the DWSC and San Joaquin River for neap and spring tides during flood conditions.

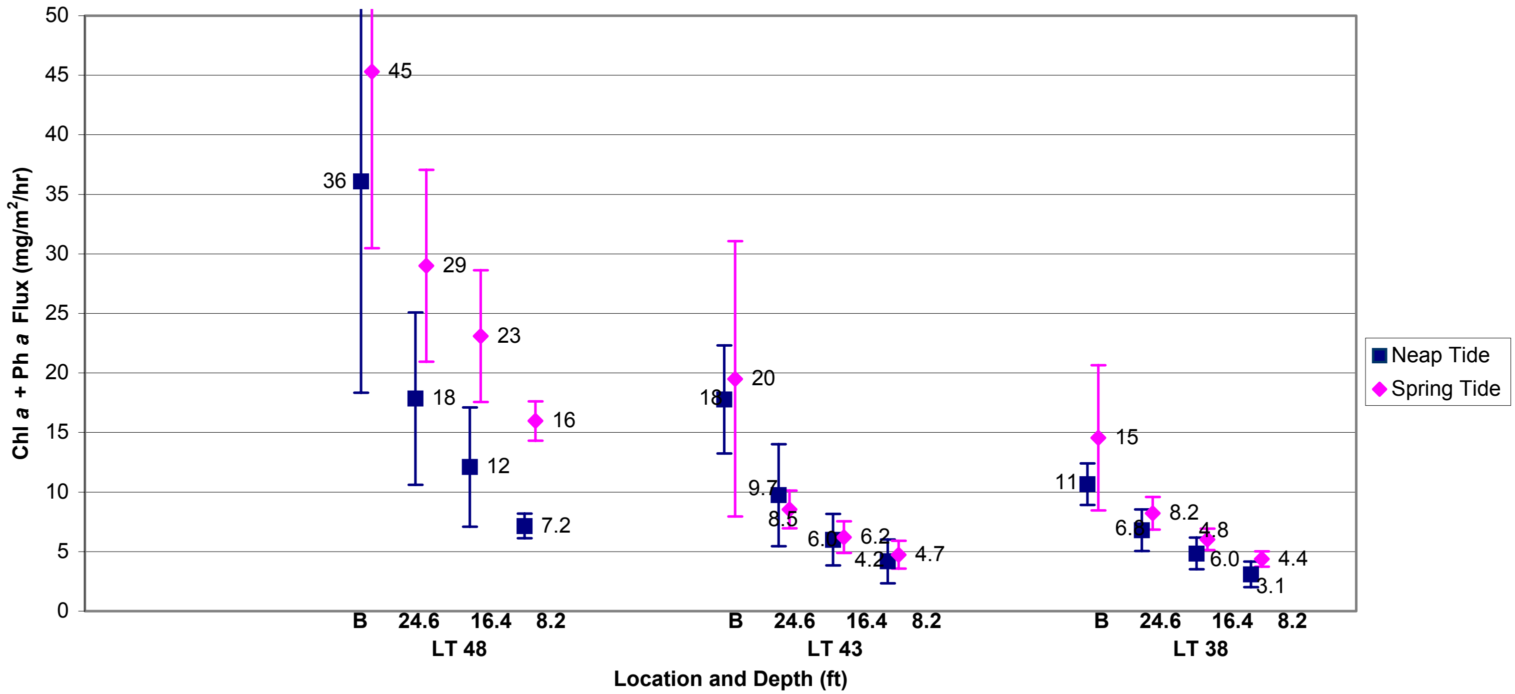


Figure II-65: Averages and standard deviations of chlorophyll *a* plus pheophytin *a* deposition fluxes in the DWSC for neap and spring tides during ebb conditions.

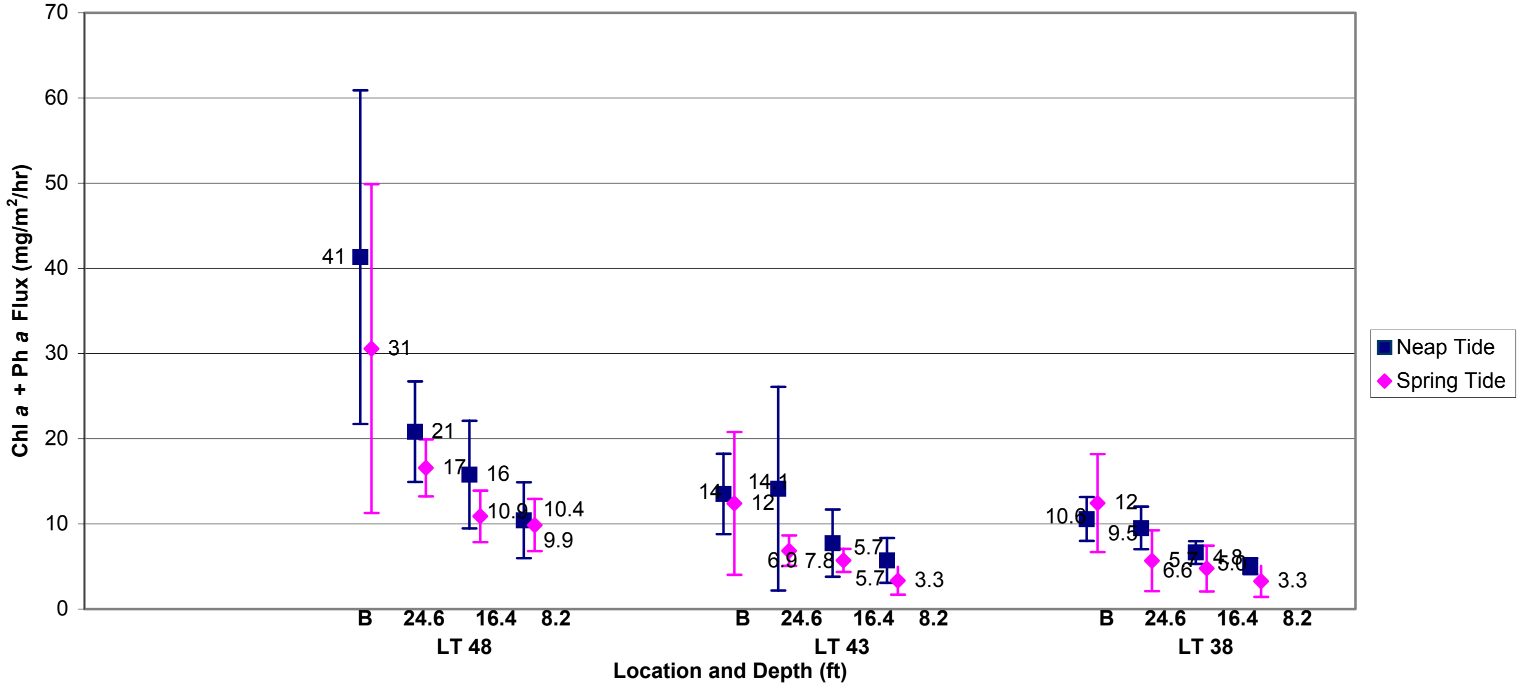


Figure II-66: Averages and standard deviations of chlorophyll *a* plus pheophytin *a* deposition fluxes in the DWSC for neap and spring tides during flood conditions.

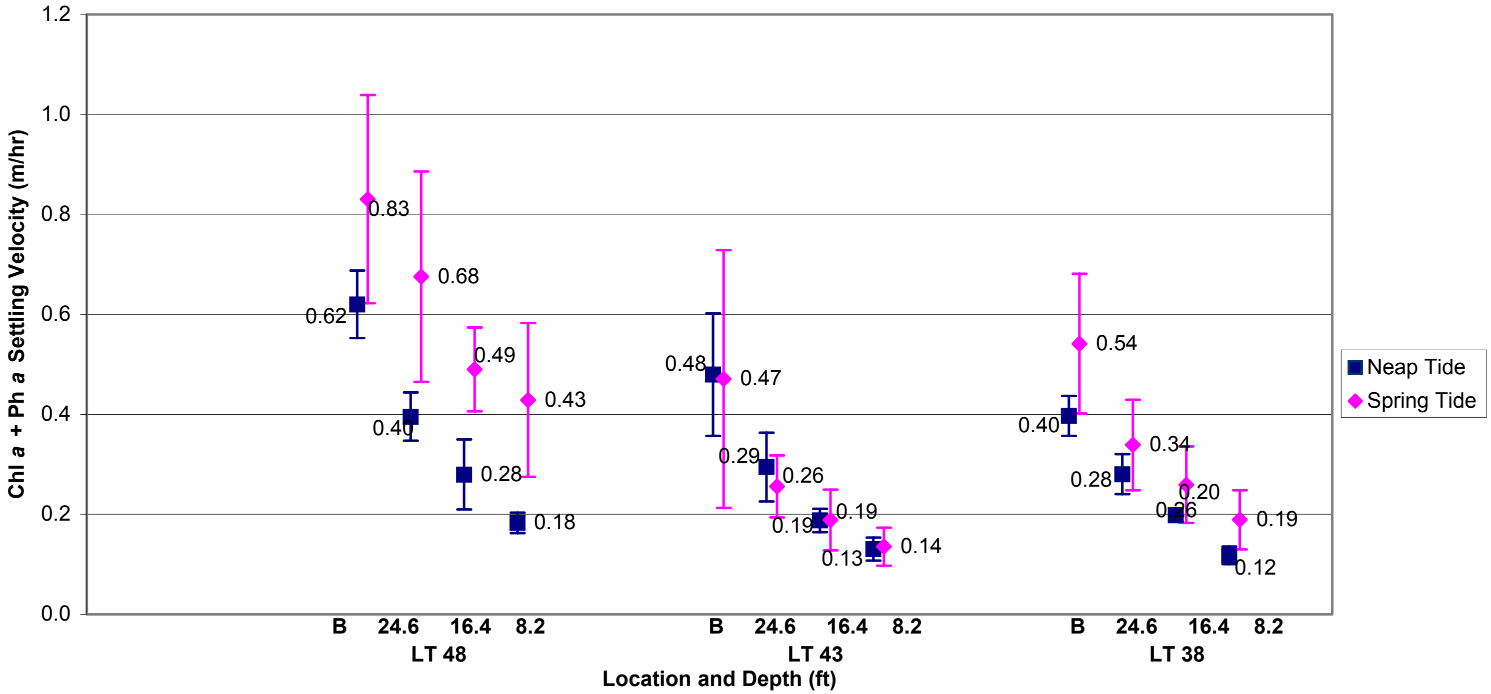


Figure II-67: Averages and standard deviations of chlorophyll *a* plus pheophytin *a* settling velocities in the DWSC for neap and spring tides during ebb conditions.

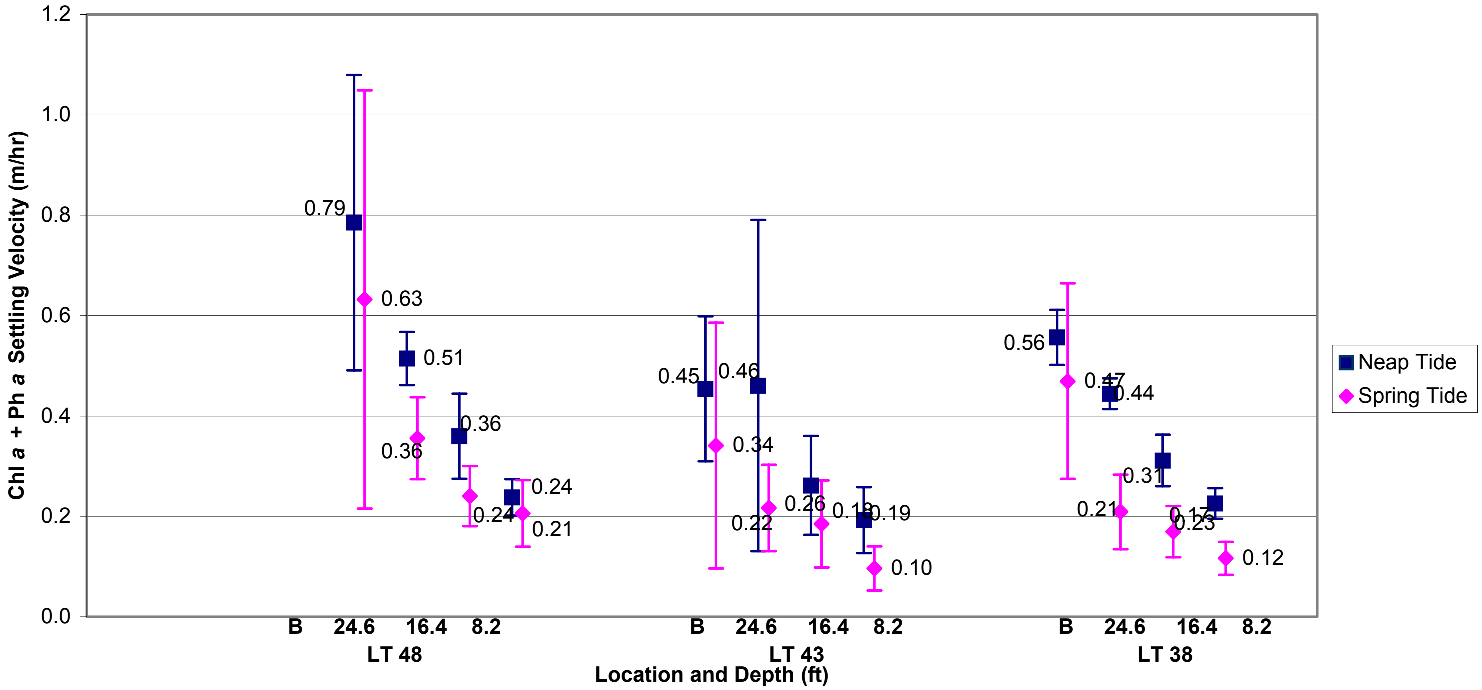


Figure II-68: Averages and standard deviations of chlorophyll *a* plus pheophytin *a* settling velocities in the DWSC for neap and spring tides during flood condition.

III. Long-Term Biochemical Oxygen Demand Measurements

Long-term biochemical oxygen demand (BOD) measurements were performed with water and trapped sediments collected from the DWSC and the San Joaquin River.

Materials and Methods

Selected water and sediment samples were placed in 300-mL BOD bottles without dilution or seeding. Measurements of dissolved oxygen were performed periodically over 40 days using a DO electrode and meter. Readings were periodically checked with a different meter and by the Winkler method (APHA *et al.,* 1998). When DO levels were measured below 4 or 5 mg/L, reaeration was accomplished by shaking the sample in a 4-L Erlenmeyer flask until saturation was achieved. One or two blanks and glucose-glutamic acid standards (with seed) were also included with each trial.

The kinetic rate decay constant and the ultimate BOD, L_0, was estimated by linearizing the data and fitting with a least-squares line. Assuming the decay of organic matter to behave as a first-order reaction,

$$BOD_t = L_0[1 - e^{-kt}]$$

where BOD_t is the biochemical oxygen demand calculated at time, t, in mg/L, k is the first-order decay rate constant, and L_0 is the ultimate BOD. Determination of k and L_0 is determined graphically by using the following linear approximation of the above equation:

$$\left[\frac{t}{y_t}\right]^{1/3} = (kL_0)^{-1/3} + \left[\frac{k^{2/3}}{6L_0^{1/3}}\right]t,$$

where $y_t = BOD_t$.

A plot of $\left[\frac{t}{y_t}\right]^{1/3}$ vs. *t* is a straight line with slope $m = \frac{1}{6}k^{2/3}L_0^{-1/3}$ and y-intercept of $b = (kL_0)^{-1/3}$. The first-order rate constant and ultimate BOD are calculated from k=6m/b and $L_0=1/(6mb^2)$.

Estimates of the decay constant and ultimate BOD

Examples of the BOD data are presented in Figures III-1 and III-2 for water collected from the San Joaquin River and the DWSC, respectively, for July 13, 2001 data. As shown in Figures III-1 and III-2, total BOD, carbonaceous BOD (CBOD), soluble BOD (sBOD), and soluble CBOD (sCBOD), were performed with San Joaquin River and DWSC water at selected stations and depths. The goodness of fit was evaluated by squared correlation coefficients (R^2) and visual inspection. Anomalous data points were selectively removed so as not to skew the fitted line. However, virtually all the k values were estimated with at least four data points. Experiments were often conducted for 30 days. The fitting parameters for the water and sediment samples are provided in Appendix D, Tables D-1 and D-2. The water BOD data were evaluated on a 5, 10, 20 day basis at 20°C. These calculations appear in Table D-1 along with the BOD_{ult}. The sediment demands were expressed on 10 day and ultimate basis in Table D-2.

Figure III-3 shows the results of the total BOD sediment and associated water tests. The sediment oxygen demand was determined by subtracting the water demand. Shown later the oxygen demand of the trapped sediments were calculated on a TSS, VSS, chlorophyll *a*, or chlorophyll *a* plus pheophytin *a* mass basis.

Figure III-4 presents the BOD_{10} results for water samples collected from the San Joaquin River and the DWSC for each monitoring run conducted from June through October. The BOD_{10} values were calculated from the fitted rate constant and the BOD_{ult} values shown in Table D-1. The highest BOD_{10} measurements observed in the San Joaquin River was 9.5 mg/L on the first monitoring day, June 14, 2001. The BOD_{10} usually remained above 7.5 mg/L through August and then exhibited a decreasing trend to a low of 3 mg/L measured on October 25, 2001. These data suggest that the BOD of water entering the DWSC is strongly influenced by the algae concentrations and productivity in the San Joaquin River above the DWSC.

The BOD_{10} values measured for the DWSC exhibited more variability than the San Joaquin River during the summer months, typically ranging between 4 and 9.5. The lowest BOD_{10} values measured for the DWSC were determined during the last monitoring run, conducted on October 25, 2001. Prior to October 25, the BOD measurements in the DWSC do not exhibit a clear temporal trend.

The fitted first-order rate constant at 20°C for the BOD experiments are plotted in Figure III-5 for the DWSC and the San Joaquin River at the USGS UVM station. The BOD for These data vary from 0.04 to 0.17 d^{-1} for individual experiments. The San Joaquin River data exhibit much less variability than the DWSC. The average decay constants for the San Joaquin River and the DWSC are shown in Table III-1. The $BOD_{uLt.}/BOD_5$ ratio was be determined from,

$$BOD_{ult} / BOD_5 = 1/(1 - e^{-k \times 5}),$$

Table III-1: Mean and standard deviation of the first-order BOD decay constants at 20°C.

Location	k at 20°C (d^{-1})		$BODult/BOD_5$
	mean	std. dev.	
	BOD / CBOD / NBOD	BOD / CBOD / NBOD	BOD / CBOD / NBOD
San Joaquin River	0.087 / 0.11 / 0.057	0.019 / 0.022 / 0.017	2.8 / 1.7 / 4.0
DWSC	0.094 / 0.11 / 0.076	0.034 / 0.023 / 0.038	2.7 / 1.7 / 3.2

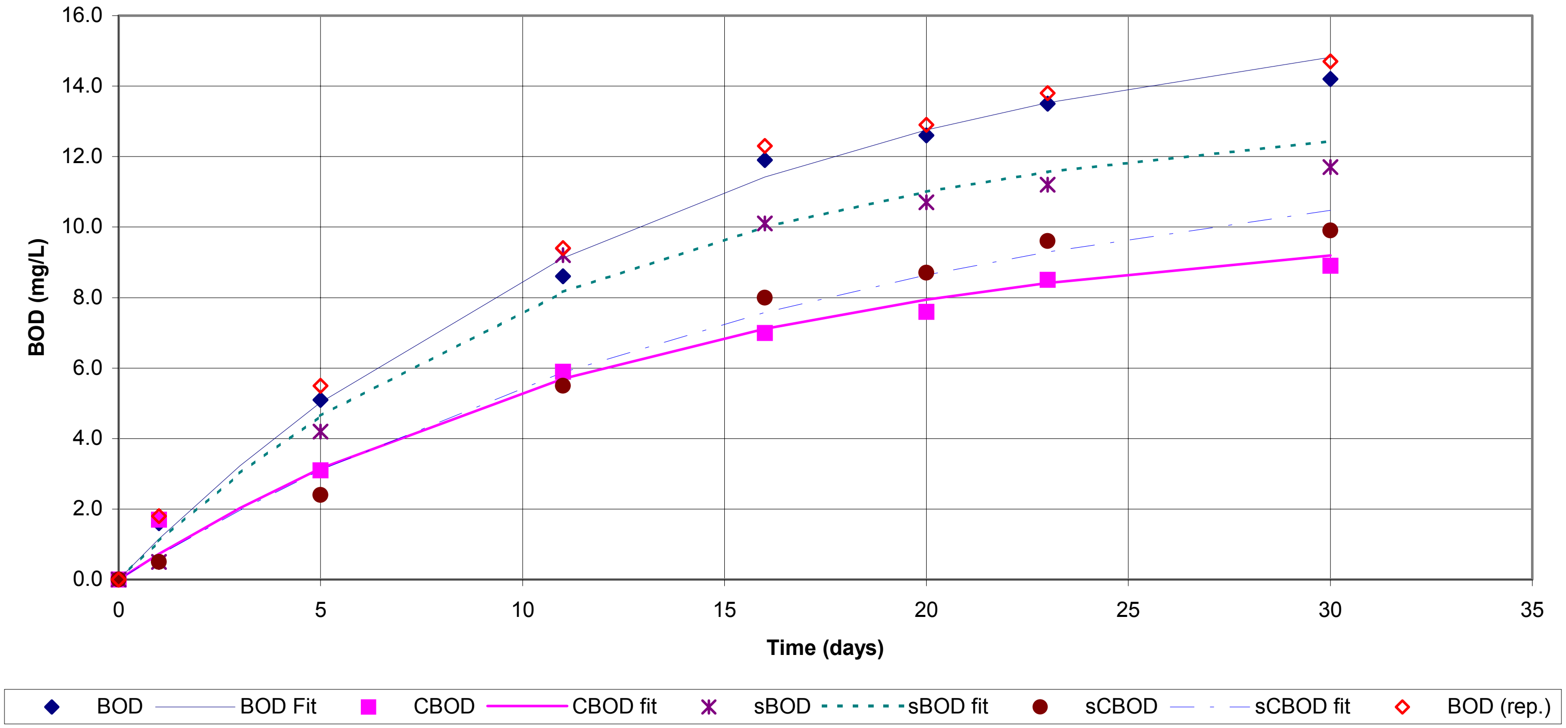


Figure III-1: Oxygen demand results and fitted curves for water collected from the San Joaquin River at the USGS UVM Station on July 13, 2001 during ebb tide.

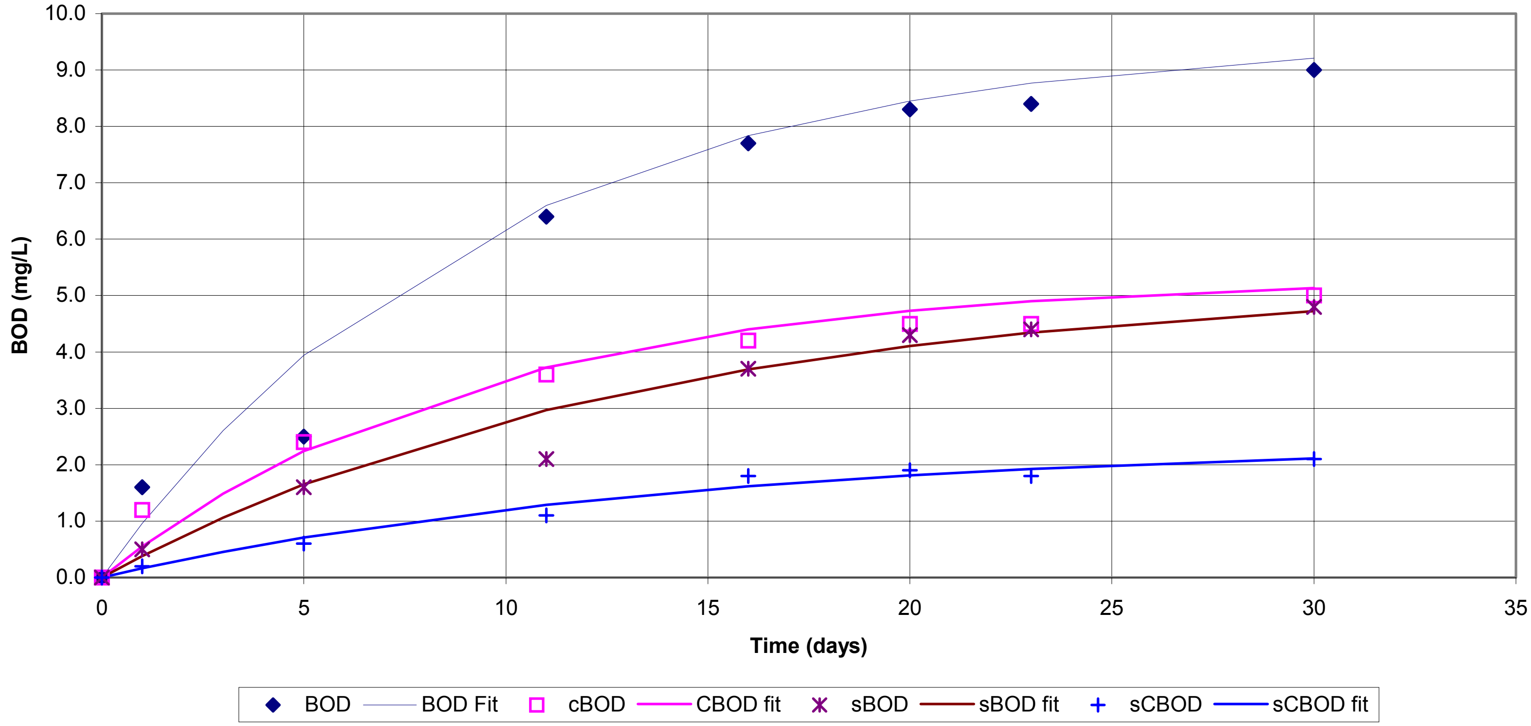


Figure III-2: Oxygen demand results and fitted curves for water collected from the Lt. 43 station on July 13, 2001 during ebb tide.

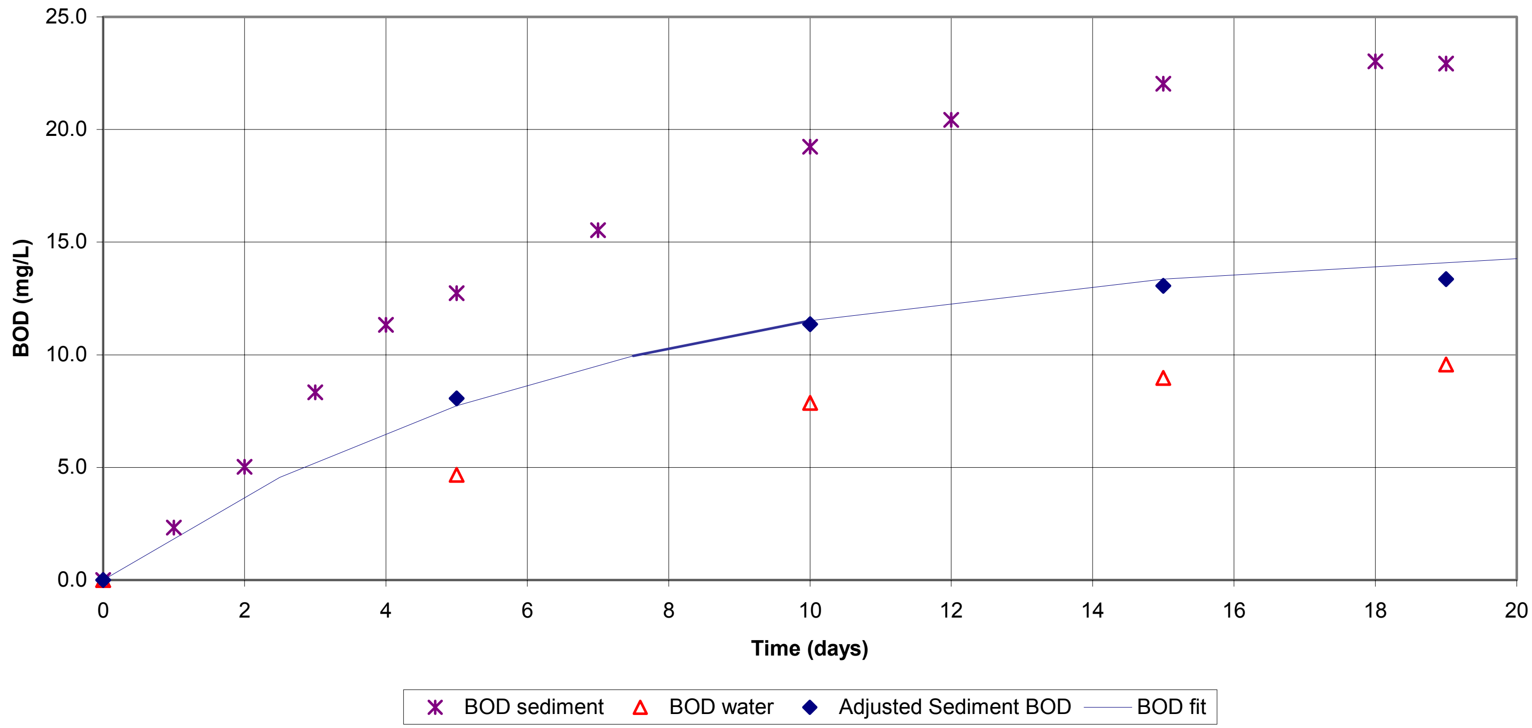


Figure III-3: Example of sediment and water oxygen demand data used to develop adjusted sediment data. Adjusted sediment data were obtained by subtracting the water BOD from the sediment BOD. Sediment and water samples were collected 2 feet above the sediment water interface at Lt. 48 on August 25, 2001.

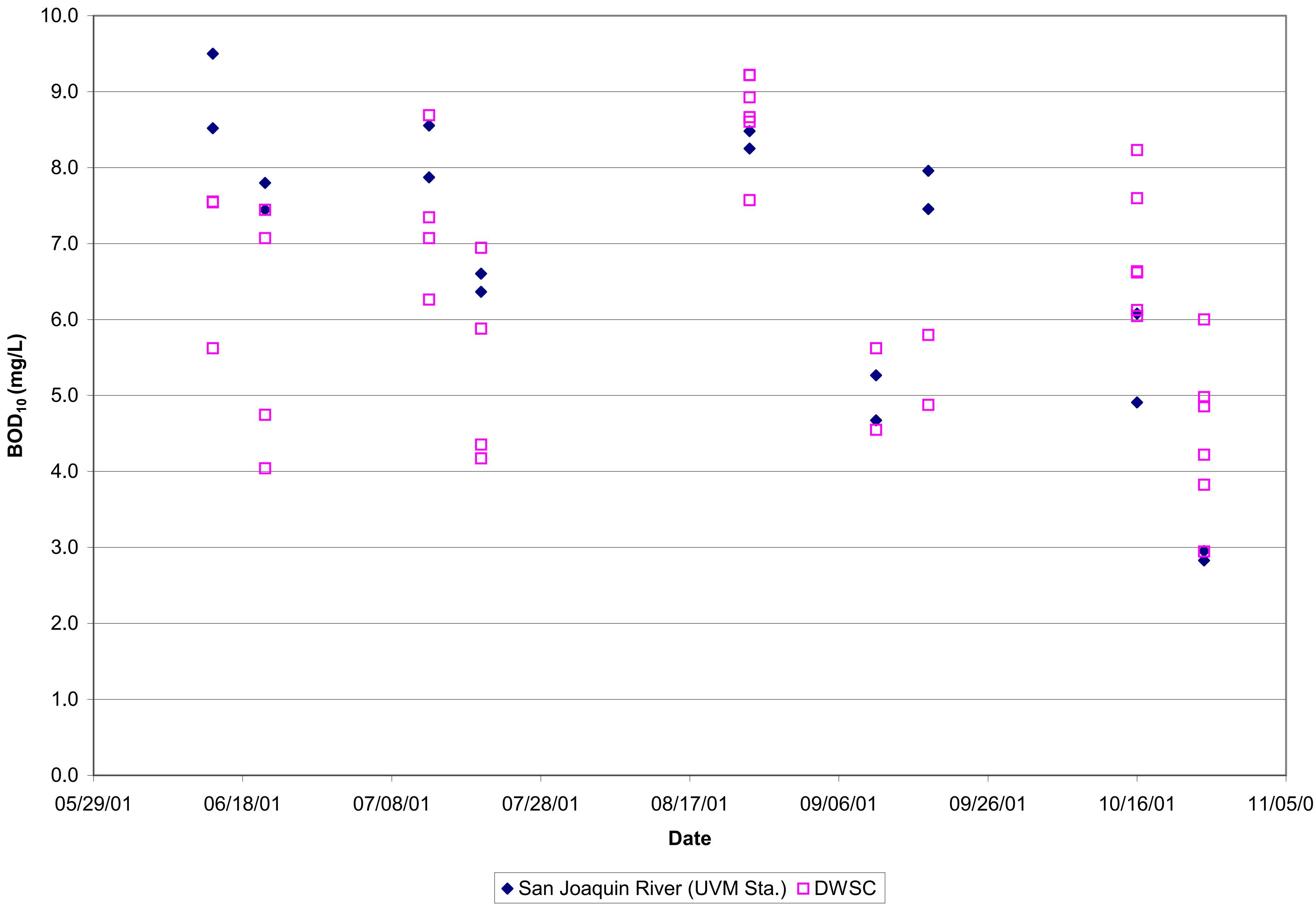


Figure III-4: Comparison of the BOD_{10} in the DWSC and entering the DWSC as measured at the USGS UVM Station on the San Joaquin River.

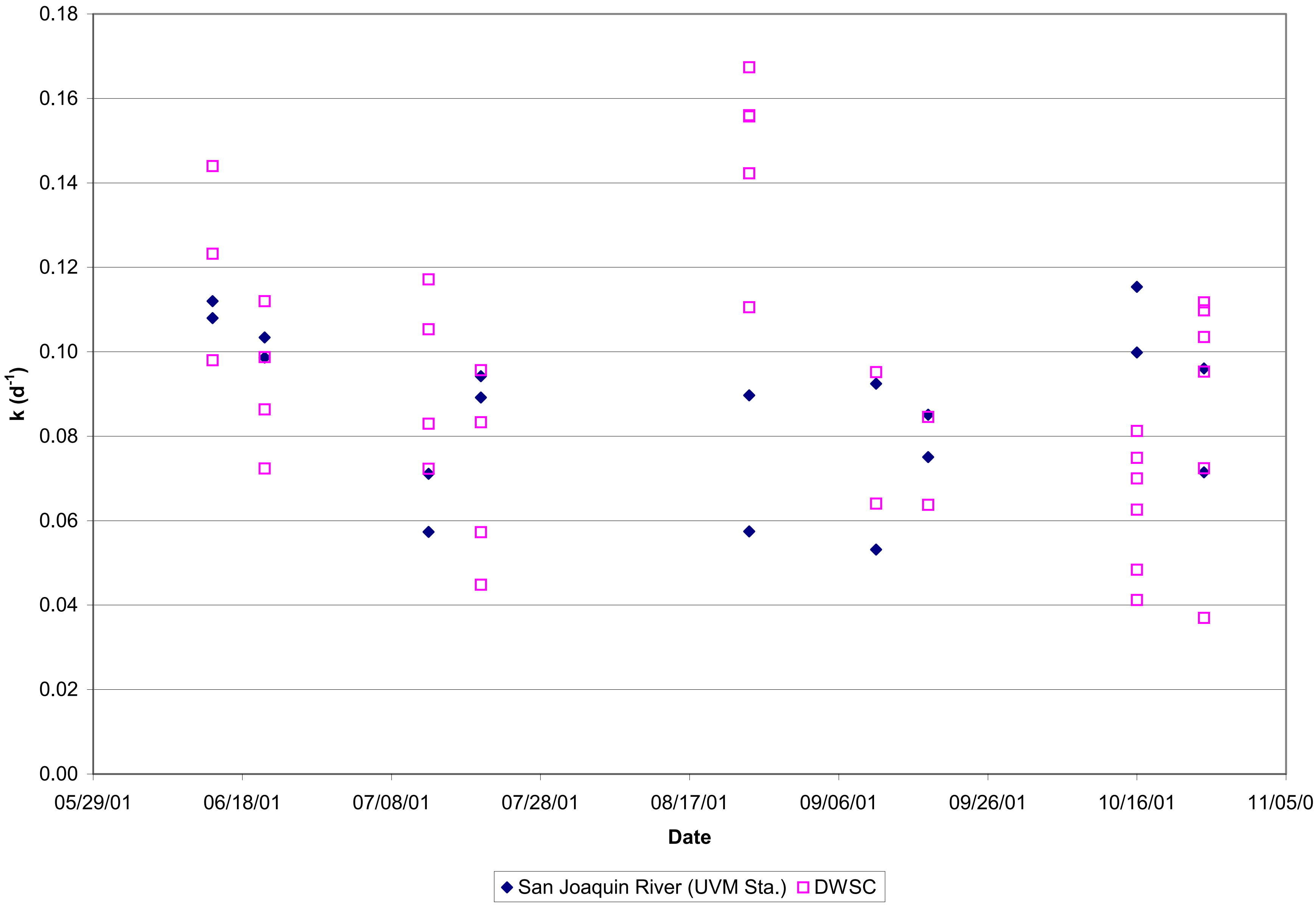


Figure III-5: Comparison of the BOD rate constant, k, in the DWSC and entering the DWSC as measured at the USGS UVM Station on the San Joaquin River.

Soluble, Particulate, Carbonaceous, and Nitrogenous BOD Fractions

The following BOD constituents were determined using 10 day values calculated with k and BOD_{ult} values determined by fitting a first-order equation to plots of

- Carbonaceous BOD (CBOD)
- Soluble BOD (sBOD)
- Soluble carbonaceous BOD (sCBOD)

Fractions of these constituents to the total BOD at 10 days were determined for the waters of the DWSC and the San Joaquin River by the linear fits shown in Figures III-7 through III-9. Note that several of the soluble tests were excluded from the average linear fits. These samples appear to be associated with high soluble fractions. A separate analysis of these cases appears later. The lines in each case were forced through the origin, thus the slopes represent the average fraction for the period of study. The fitted values are summarized in Table III-2.

Table III-2: BOD fractions in the DSWC and San Joaquin River at the USGS UVM Station.

Location	CBOD/BOD	sBOD/BOD	sCBOD/BOD
San Joaquin River	0.63	0.47	0.26
DWSC (Lt. 43)	0.58	0.45	0.28

Using these ratios, the concentrations of nitrogenous BOD, soluble NBOD, particulate BOD, particulate CBOD, and particulate NBOD can be estimated by:

NBOD = BOD - CBOD,
sNBOD = sBOD - sCBOD,
Particulate BOD = BOD - sBOD,
Particulate CBOD = CBOD - sCBOD,
Particulate NBOD = NBOD – sNBOD = BOD – CBOD – sBOD + sCBOD.

Dividing by BOD yields:

NBOD / BOD = 1 - CBOD/BOD,
sNBOD / BOD = sBOD/BOD - sCBOD/BOD,
Particulate BOD / BOD = 1 - sBOD/BOD,
Particulate CBOD / BOD = CBOD/BOD - sCBOD/BOD,
Particulate NBOD /BOD = 1 – CBOD/BOD – sBOD/BOD + sCBOD/BOD.

Table III-3 presents fractions of these constituents relative to total BOD are calculated from ratios estimated above.

Table III-3: BOD fractions in the DSWC and San Joaquin River at the USGS UVM Station.

Location	NBOD / BOD	sNBOD / BOD	pBOD / BOD	pCBOD / BOD	pNBOD / BOD
San Joaquin River	0.37	.21	.53	0.37	0.16
DWSC	0.42	.17	.55	0.30	0.25

These estimates suggest that slightly more than 50 percent of the BOD entering or in the DWSC is associated with particulate matter. These estimates also indicate that approximately 40 percent of the BOD, entering or in the DWSC, consists of NBOD. Of this soluble fraction, approximately 50 percent is nitrogenous.

A common chemical expression of algae decomposition provides estimates of its associated CBOD and NBOD:

$$\underset{\text{(algae)}}{C_{106}H_{263}O_{110}N_{16}P} + 138\ O_2 \rightarrow 106\ CO_2 + 16\ NO_3^- + HPO_4^{2-} + 122\ H_2O + 18\ H^+.$$

Each mg/L of algae will yield a theoretical oxygen demand of 1.2 mg/L. Of this 1.2 mg/L, approximately 25 percent is nitrogenous.

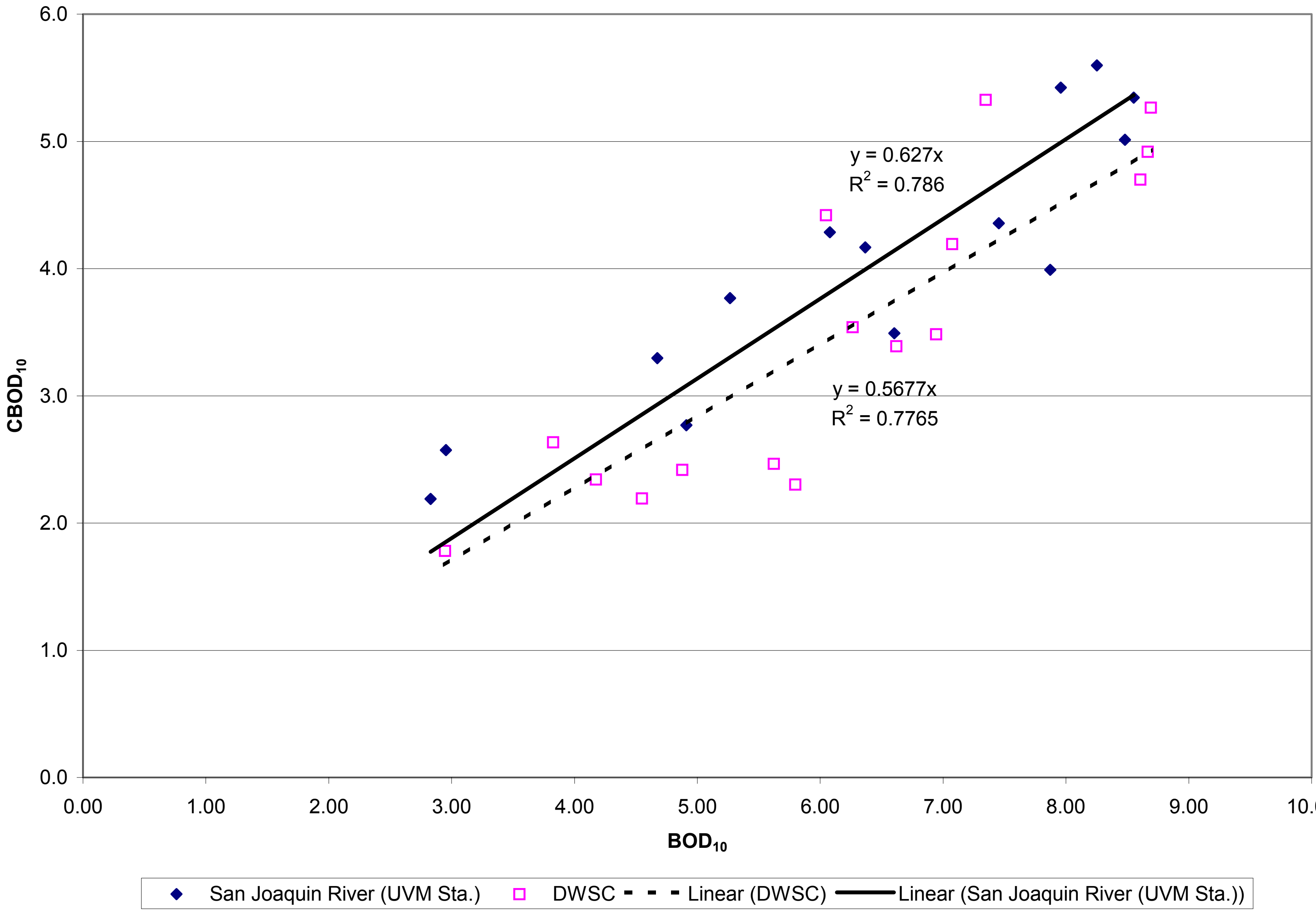


Figure III-7: Carbonaceous BOD_{10} vs. BOD_{10} for samples collected in the DWSC and San Joaquin River at the USGS UVM station.

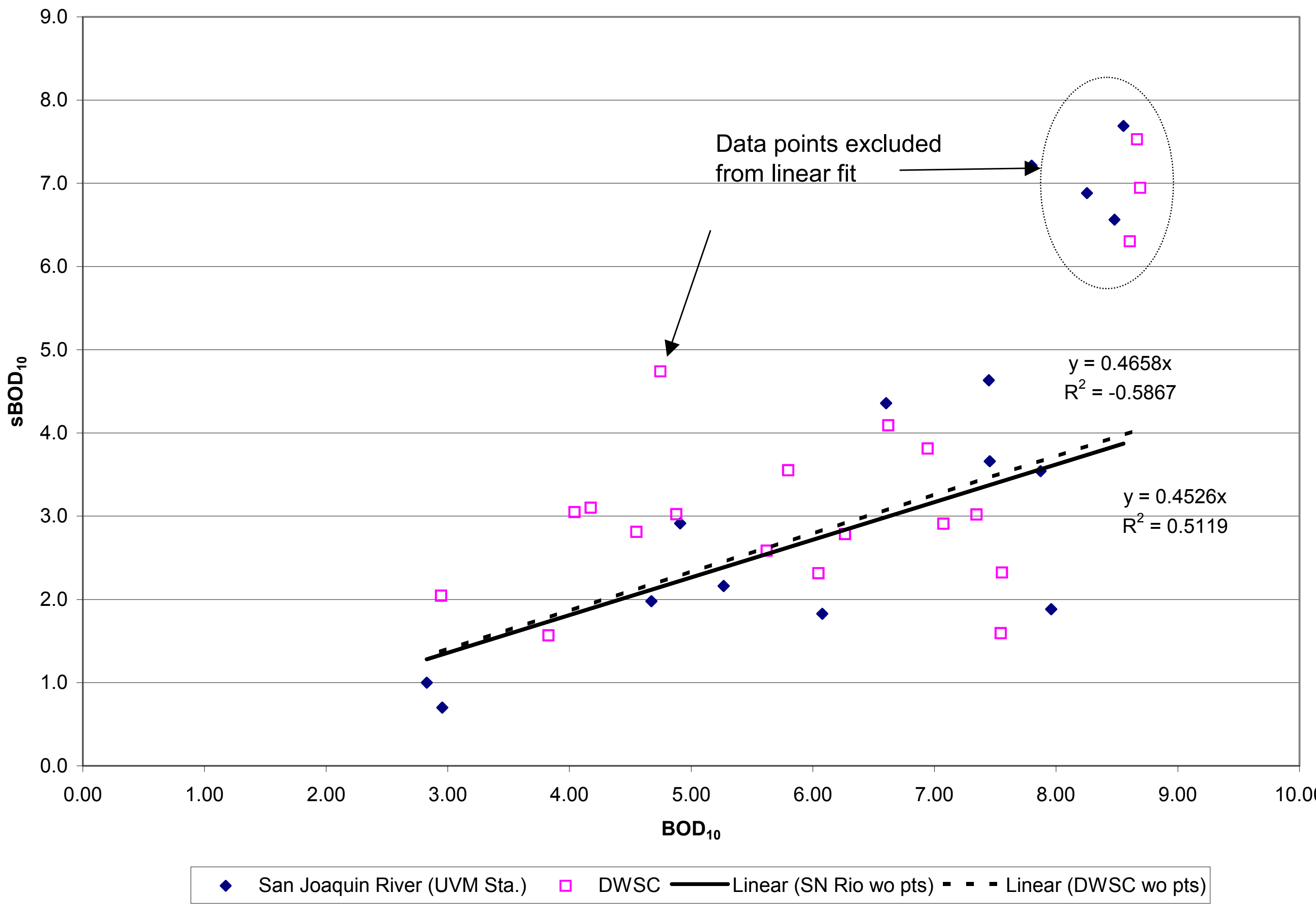


Figure III-8: Soluble BOD_{10} vs. BOD_{10} for samples collected in the DWSC and San Joaquin River at the USGS UVM station.

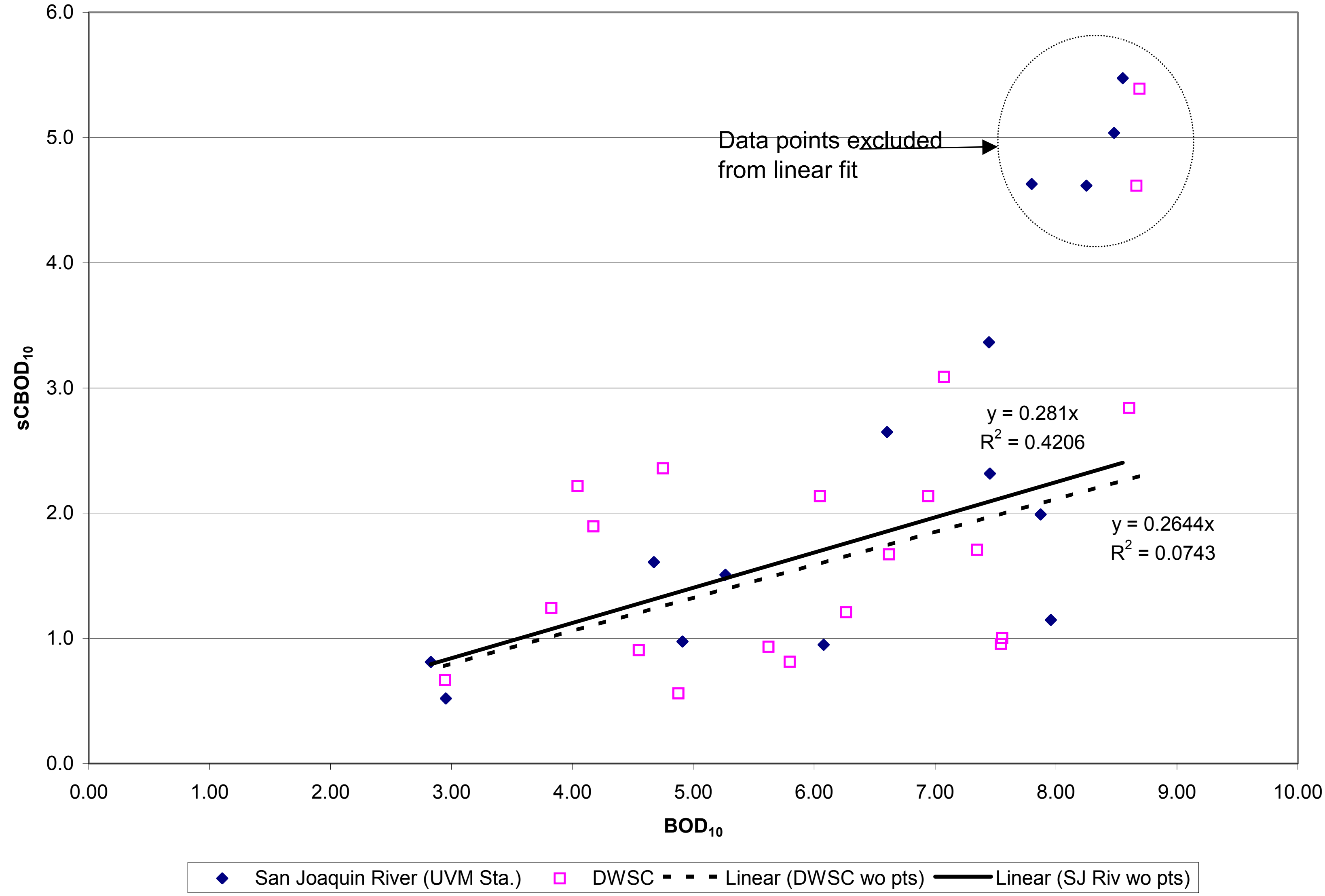


Figure III-9: Soluble carbonaceous BOD_{10} vs. BOD_{10} for samples collected in the DWSC and San Joaquin River at the USGS UVM station.

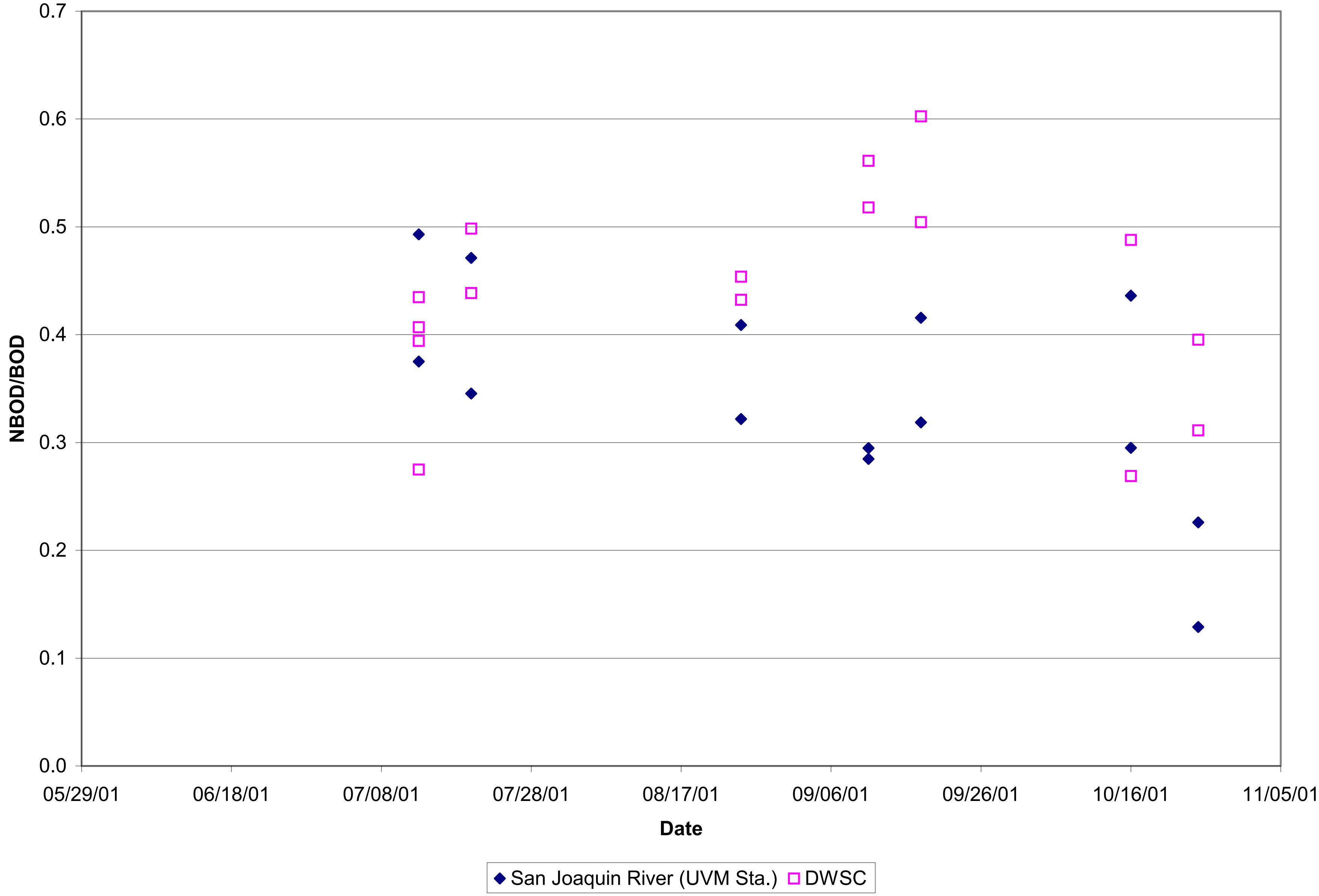


Figure III-10: Comparison of fraction of $NBOD_{10}/BOD_{10}$ in the DWSC and entering the DWSC as measured at the USGS UVM Station on the San Joaquin River.

Oxygen Demands Correlations with Water Quality Data

The TSS, VSS, and phytoplankton pigment concentrations were shown earlier to decrease with downstream distance in the DWSC. Approximately 90 percent of the decline of TSS is associated with the burial of its inorganic fraction. The remaining 10 percent is organic matter that may be lost with decay in the water column or upon settling with subsequent decay. To estimate the potential sediment oxygen demand (SOD) associated with settling matter, correlations of BOD and the constituents measured here to characterize the suspended matter concentrations were investigated.

Figures III-10 through III-13 show the BOD_{10} data was plotted against TSS, VSS, chlorophyll *a*, and chlorophyll *a* plus pheophytin *a* concentrations. As shown in Figure III-11, the BOD_{10} appears to be best correlated to VSS, especially for the San Joaquin River. The y-axis intercept of these lines represents the BOD_{10} when the VSS is zero, or in other words, the average soluble concentration of the BOD_{10}.

To assess the ratio of particulate BOD_{ult} to VSS, the y-axis intercept of the fitted line to the BOD_{ult} data was subtracted from the BOD_{ult} values. The y-axis intercepts of 5.70 and 6.44 mg/L were obtained to adjust the particulate BOD_{ult} values for the San Joaquin River and the DWSC, respectively. The intercept-adjusted particulate BOD_{ult} are plotted against VSS in Figure III-14. The slope of the fitted curves are virtually the same at 1.1 mg BOD_{ult} per 1mg of VSS. This ratio is consistent with the theoretical oxygen demand of 1.07 mg BOD_{ult} per mg of VSS if 40 percent of the VSS mass is carbon molecules.

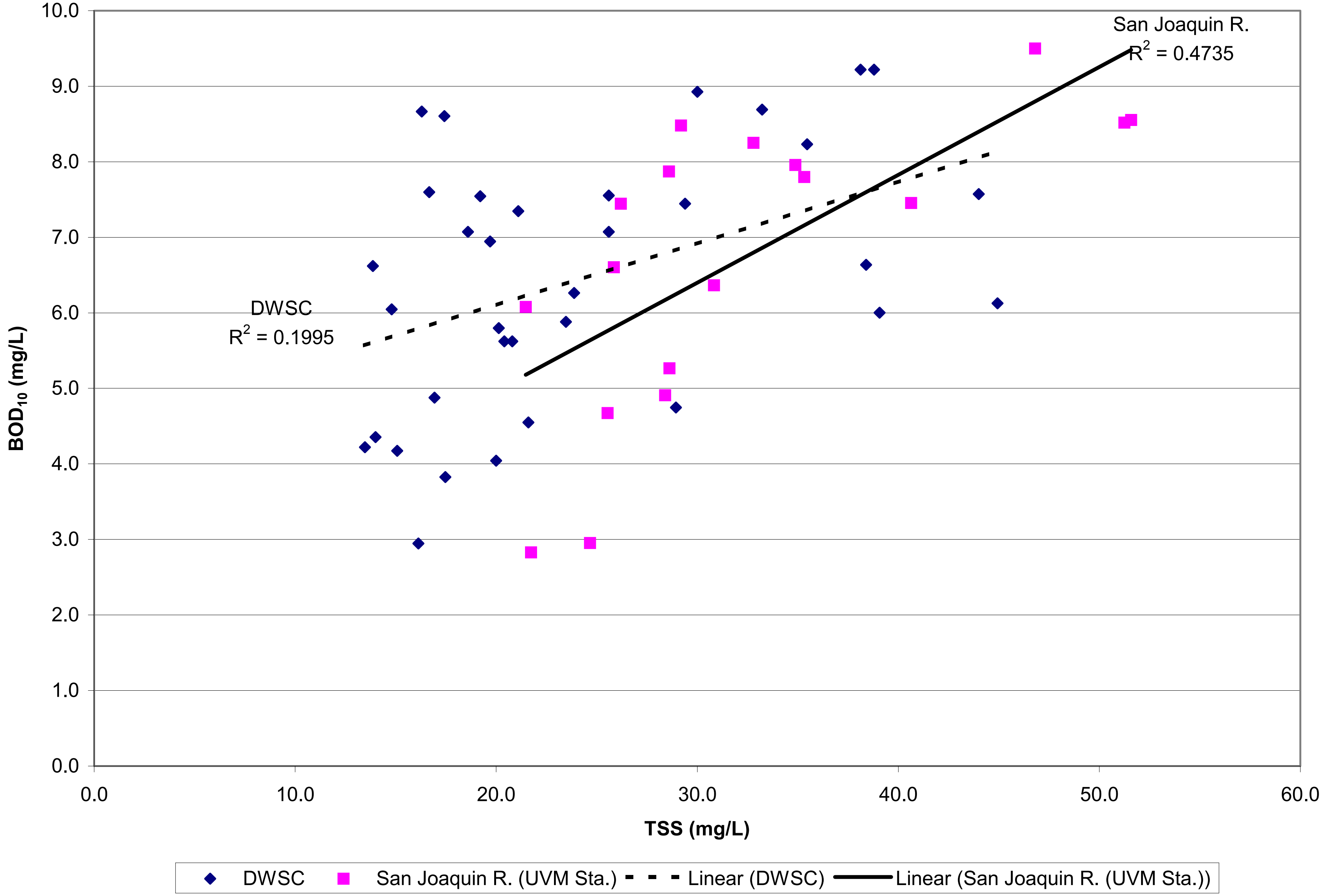


Figure III-10 : Water BOD_{10} and respective TSS concentrations.

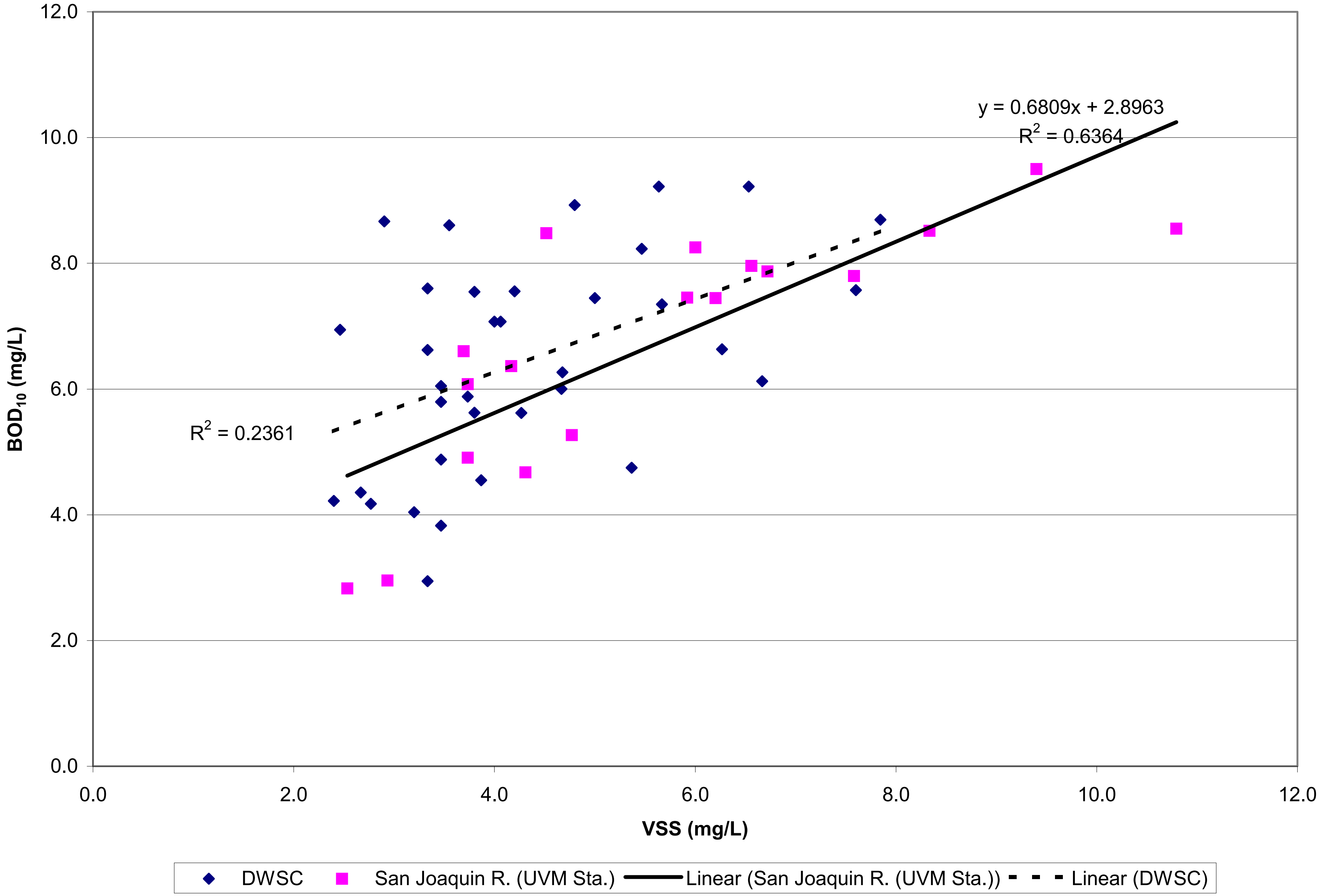


Figure III-11 : Water BOD_{10} and respective VSS concentrations.

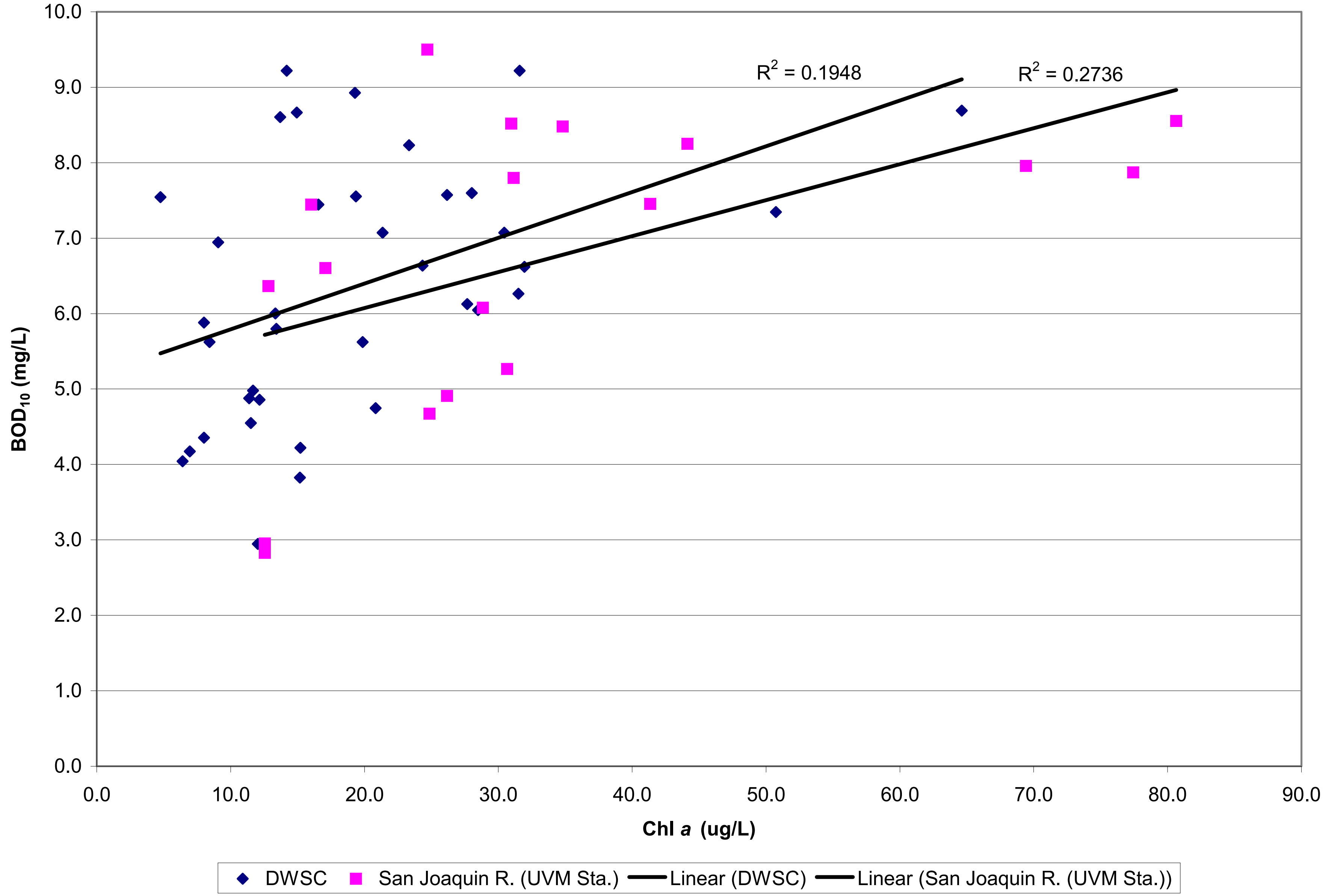


Figure III-12 : Water BOD_{10} and respective Chlorophyll *a* concentrations.

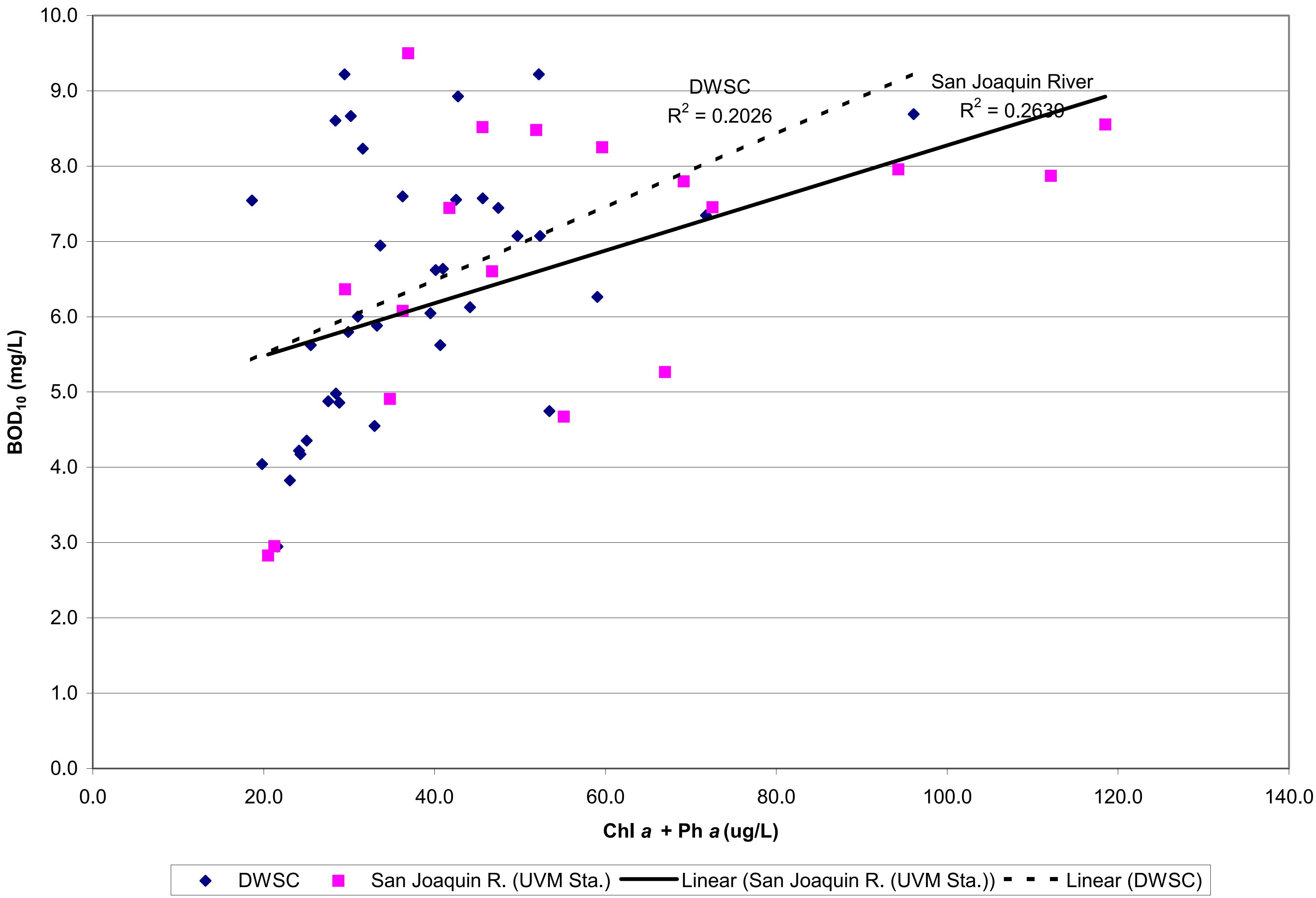


Figure III-13 : Water BOD_{10} and respective chlorophyll *a* plus pheophytin *a* concentrations

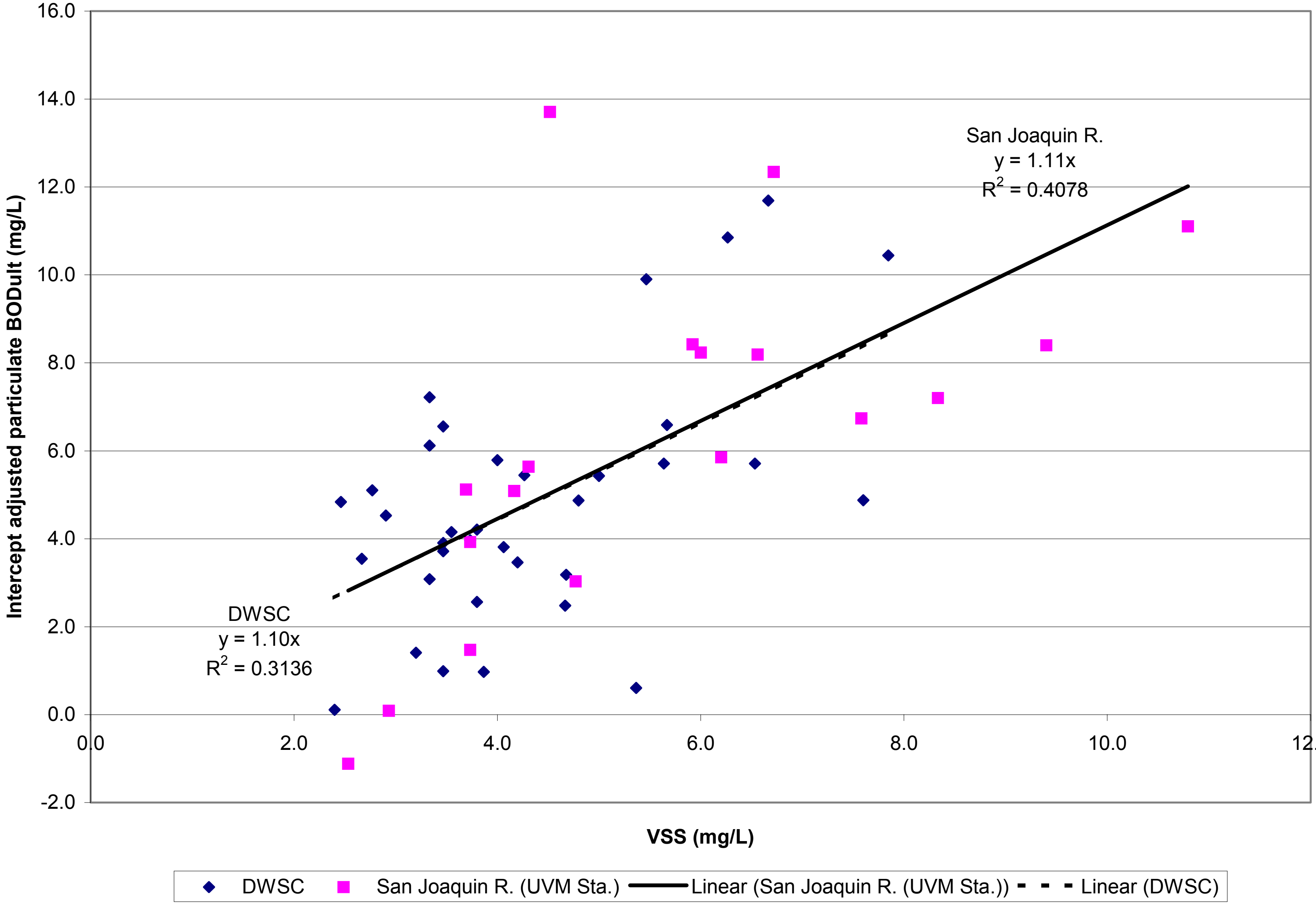


Figure III-14: Particulate BOD_{ult} and respective VSS concentrations for the San Joaquin River and the DWSC.

Trapped Sediment BOD results

The BOD of trapped sediments was estimated with bottle experiments at 20°C. As described earlier, first-order decay curves were fit to the oxygen demand of trapped sediments. All sediment BOD data were adjusted by subtracting the water contribution. The oxygen demand of the sediments were then divided by the mass of TSS, VSS, or chlorophyll *a* plus pheophytin *a* of the sediments used in the bottle experiments. These data are presented in Table D-II of Appendix D. The data are also plotted in Figures III-15 through III-17.

Similar to the water BOD results, the trapped sediments were again well correlated to their VSS mass. The data shown in Figure III-16 shows the BOD_{ult} to range from 0.1 to 0.4 mg BOD_{ult} for each mg of VSS in the trapped sediments. The average is approximately 0.25 mg BOD_{ult} per mg VSS. This is considerably less than the water ratio of particulate BOD_{ult} to VSS estimated previously to be 1.1 mg/mg. Thus, sediments that are trapped possess an oxygen demand that is approximately 3 to 4 times less than that of the particulate matter entering the San Joaquin River or collected in a water sample from the DWSC. Settling studies presented earlier indicate that the trapped sediments are comprised of fast settling aggregates. The age of the phytoplankton pigments associated with the trapped sediments also indicated that the transport of trapped sediments may be retarded approximately two times due to settling and resuspension processes. Thus, these observations for settling and resuspension rates support the low oxygen demands measured for the trapped sediments. It appears that the predominance of the matter captured in the sediment traps is relatively old and much of its oxygen has been exerted.

The first-order decay rates, k, of the trapped sediment are presented in Figure III-18. The sediment rates are more variable than the water decay rates, ranging from approximately 0.05 to 0.24 d^{-1}. The average k is approximately 0.12 d^{-1}. For many, but not all of the data sets, the highest decay rates were associated with sediments collected from the upper traps and decreased with trap depth. This may be caused by higher fractions of refractory organic matter captured in the traps near the channel bottom.

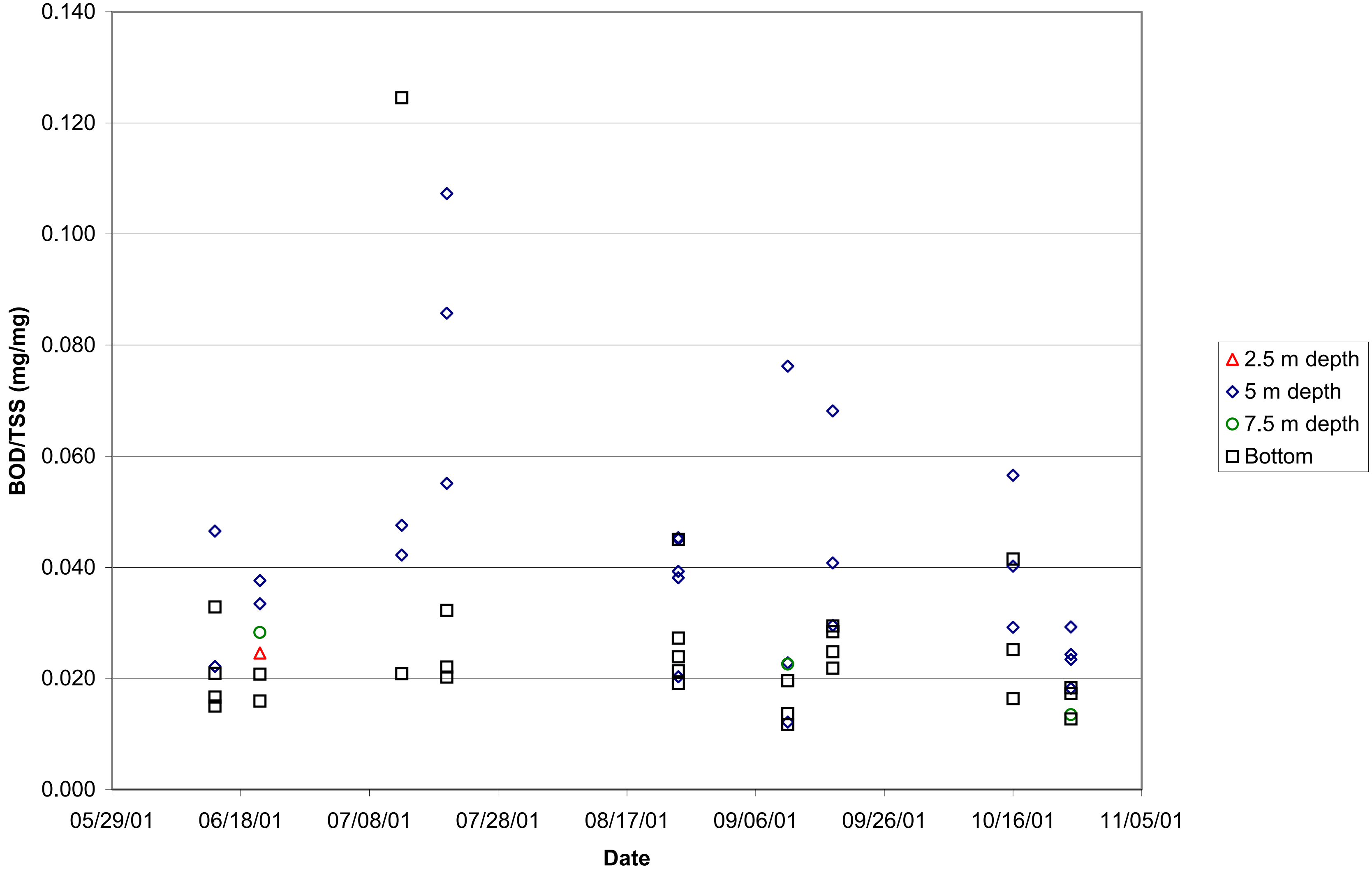


Figure III-15: Sediment mg BOD_{ult} / mg TSS in the DWSC.

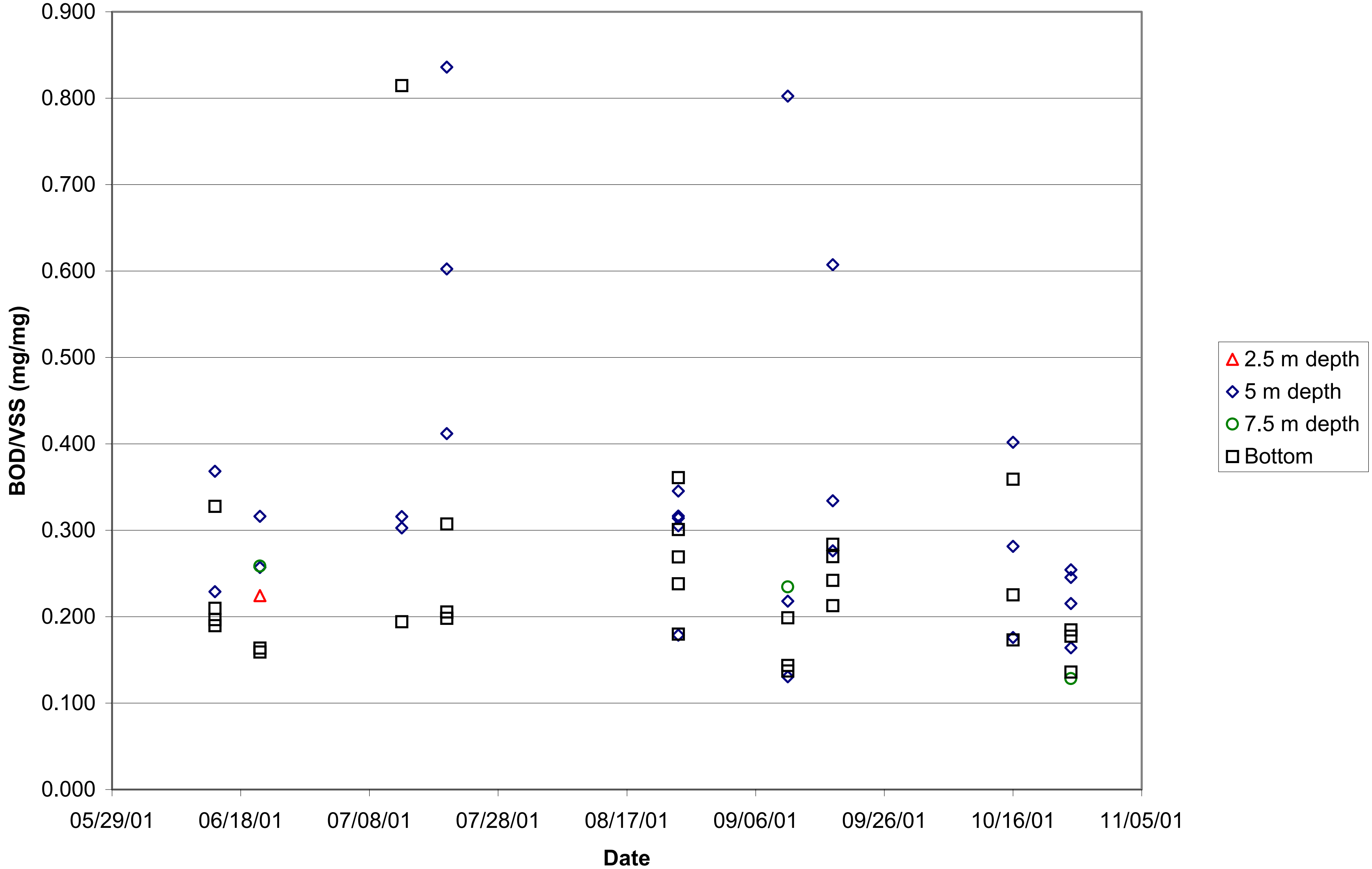


Figure III-16: Sediment mg BOD_{ult} / mg VSS in the DWSC.

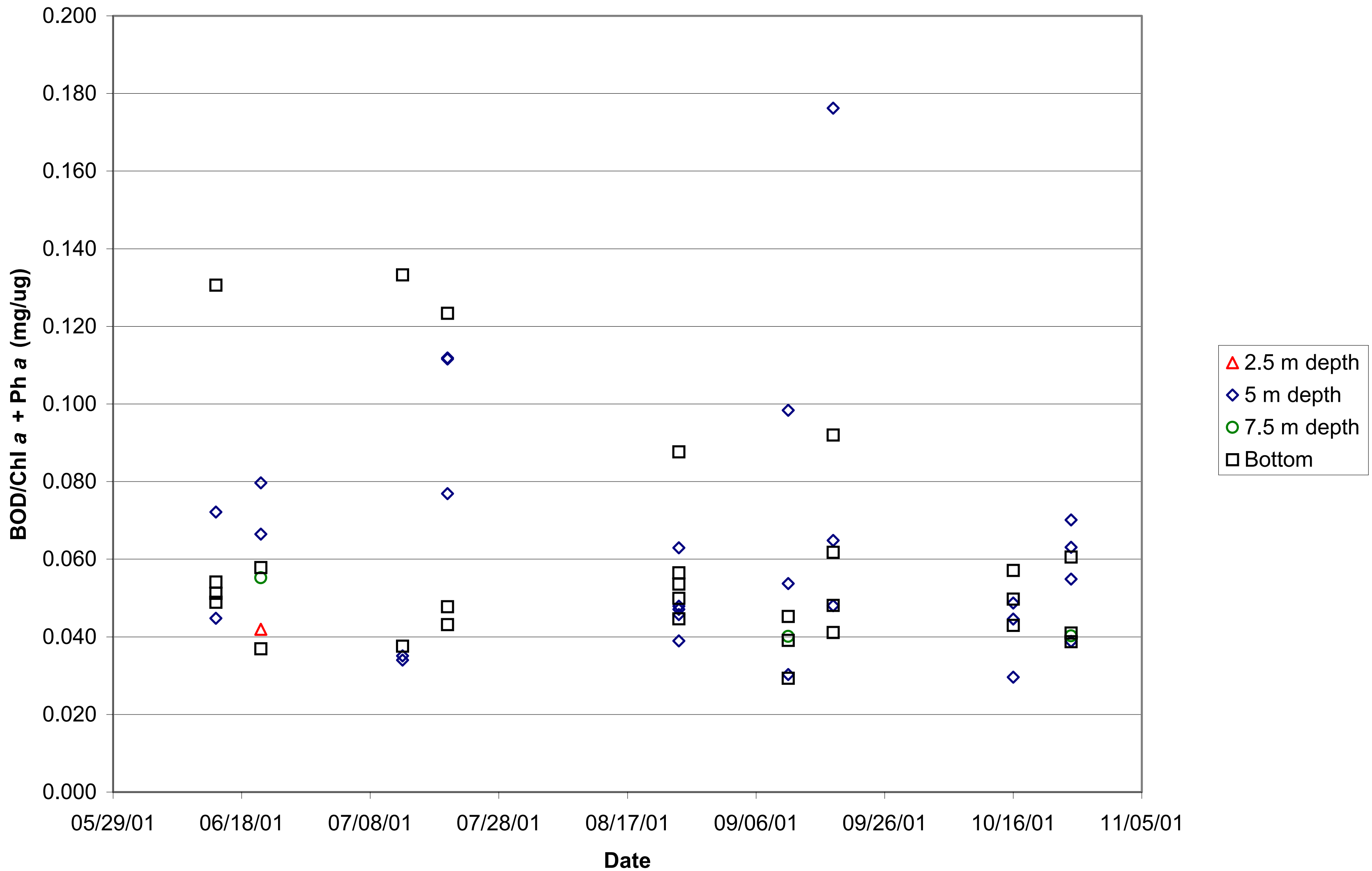


Figure III-17: Sediment mg BOD_{ult} / µg chlorophyll *a* plus pheophytin *a* in the DWSC.

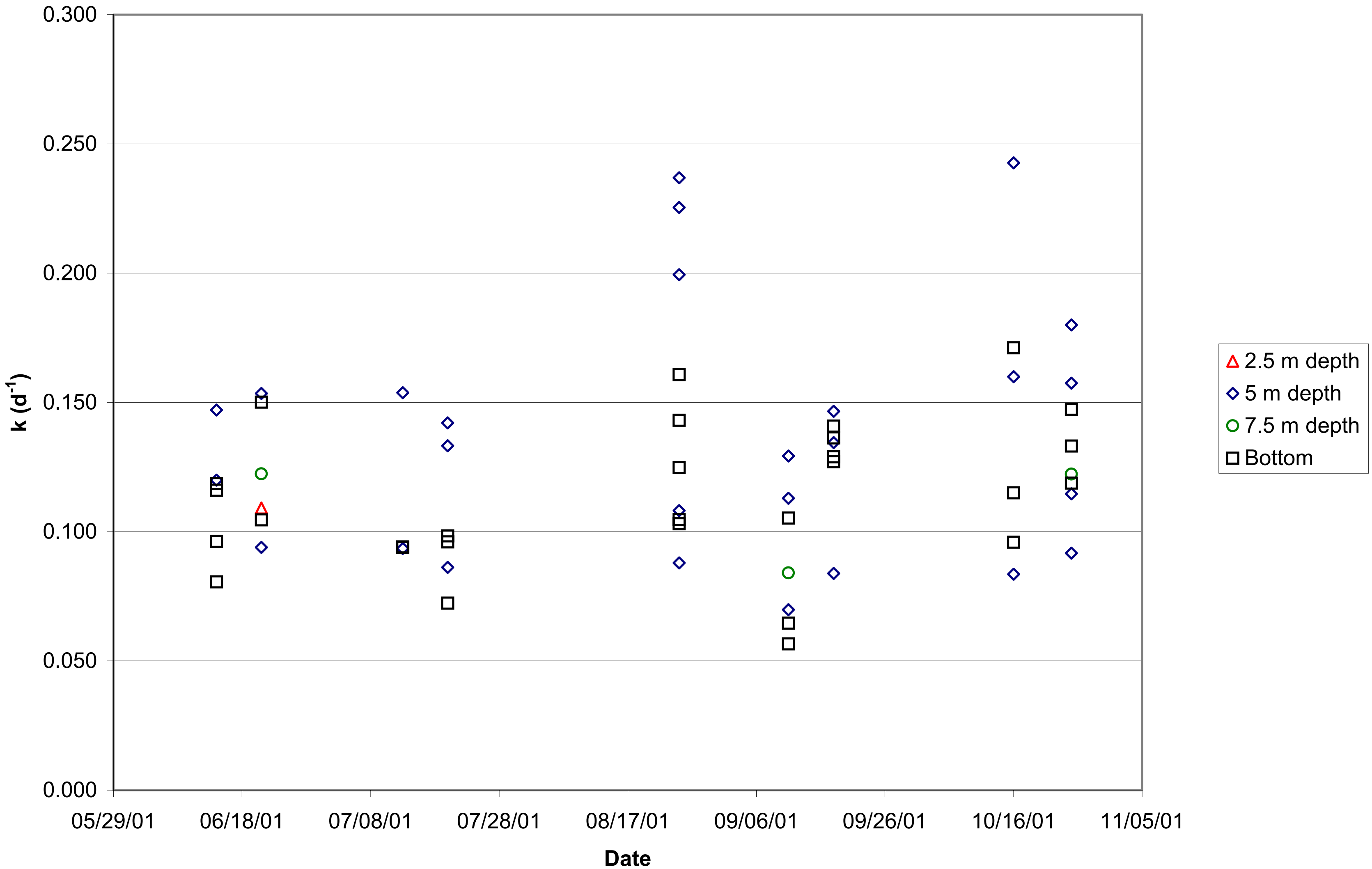


Figure III-18: First-order BOD decay constant, k, at 20°C for trapped sediments collected in the DWSC.

IV. Comparisons of Data Collected in 2000 and 2001

Depth averaged TSS water concentrations and deposition fluxes, are plotted for 2000 and 2001 in Figures IV-1 and IV-2. Depth average TSS water concentrations in the San Joaquin River above the DWSC ranged from approximately 23 to 48 mg/L in both 2000 and 2001. However, average San Joaquin River TSS concentrations were measured at levels greater than 35 mg/L on three days in 2001, but on only 1 day during 2000. Within the DWSC, TSS concentrations were fairly similar with values ranging from 20 to 35 mg/L. More variability was observed in the 2001 DWSC TSS concentrations. Depth-averaged TSS deposition fluxes in the DWSC were also similar at Lt. 38 and Lt. 43. At Lt. 48 deposition fluxes increased during 2001 while San Joaquin River concentration above the DWSC decreased, evidence that much of the turbidity in the DWSC is associated with sediment resuspension rather than the incoming sediment concentration. For 2001, the San Joaquin River concentration also exhibited a decreasing trend from June to November. However, deposition fluxes at Lt. 48 were quite variable but generally remained in the same range observed during 2000.

As shown in Figure IV-3, the depth-averaged VSS concentrations in the San Joaquin River and DWSC exhibited a declining trend during 2000. The decline appears to be correlated to the rise in the dissolved oxygen concentration in the DWSC also plotted in Figure IV-3. During 2001, the San Joaquin River VSS concentrations above the DWSC were initially high (approximately 7 to 9 mg/L) in June and early July, and then decreased to less than 3 mg/L by late October. In the DWSC, VSS concentrations did not exhibit the same decline observed in the San Joaquin River above the DWSC for 2001 and did not exhibit the same decrease observed in the DWSC during 2000.

As shown in Figure IV-3, the recovery of dissolved oxygen in the DWSC was delayed until mid September in 2001. During 2000, dissolved oxygen concentrations were initially at 5.5 mg/L and increased above 6 mg/L by late August. The late recovery of dissolved oxygen in 2001 appears to be associated with lower initial levels (approximately 4-5 mg/L) measured in June. Loads of oxygen depleting substances entering the DWSC in 2001 may have been greater than 2000. However, monitoring was not performed prior to June so the data characterizing the conditions leading to the lower dissolved oxygen levels in 2001 are not available with this work.

Depth-averaged deposition fluxes shown in Figure IV-4 indicate that the VSS flux rates were quite similar for both 2000 and 2001. Deposition rates offer little explanation for the low dissolved oxygen concentration measured in 2001 and the relatively high concentrations of 2000.

Chlorophyll *a* concentrations are plotted for 2000 and 2001 in Figure IV-5. The chlorophyll *a* concentrations in the San Joaquin River and DWSC are markedly different for the two years. The general decrease in chlorophyll *a* observed at all stations in 2000 is quite different from the highly variable concentrations measured in 2001. However the chlorophyll *a* concentrations measured at Lt. 43 and Lt. 38 are relative similar for both years. Concentrations at Lt. 48 are much more variable. Fluctuations at Lt. 48 appear to be associated with the chlorophyll *a* concentrations entering the DWSC. In Figure IV-6, deposition fluxes averaged over the water column for chlorophyll *a* also show similarity at Lt. 43 and Lt. 38, but at Lt. 48 the deposition fluxes of 2001greatly exceed 2000 measurements. While not quantified here, greater algae concentrations and associated loads seem to have arrived in 2001 compared with 2000. This is also seen in the water concentration and deposition flux plots of chlorophyll *a* plus pheophytin *a* presented in Figures IV-7 and IV-8. The water concentrations of chlorophyll *a* plus pheophytin *a* entering the DWSC from the San Joaquin River and at Lt. 48 in the DWSC are on some days much higher than measurement of 2000 as shown in Figure IV-7. Deposition fluxes of chlorophyll *a* plus pheophytin *a* at Lt. 48 were often much higher in 2001 as presented in Figure IV-8. However, the deposition fluxes at Lt. 43 are relatively similar. These comparisons suggest that higher algae loads in 2001 contributed to greater dissolved oxygen deficit, however, the lack of measurements performed prior to the onset of the DO deficit in the DWSC prevents a more quantitative analysis.

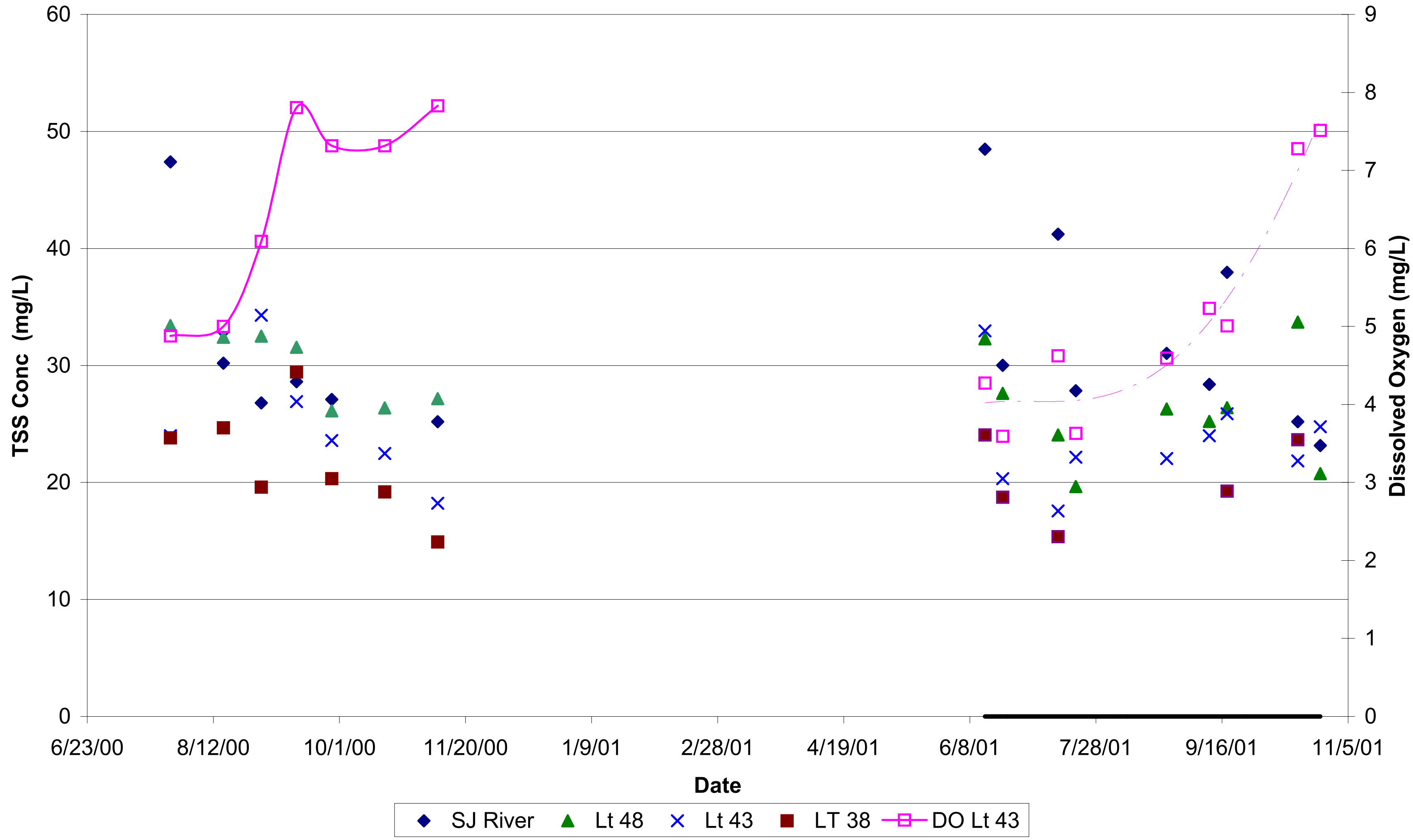


Figure IV-1: Averages TSS water concentrations in the DWSC during periods of trap deployment for 2000 and 2001.

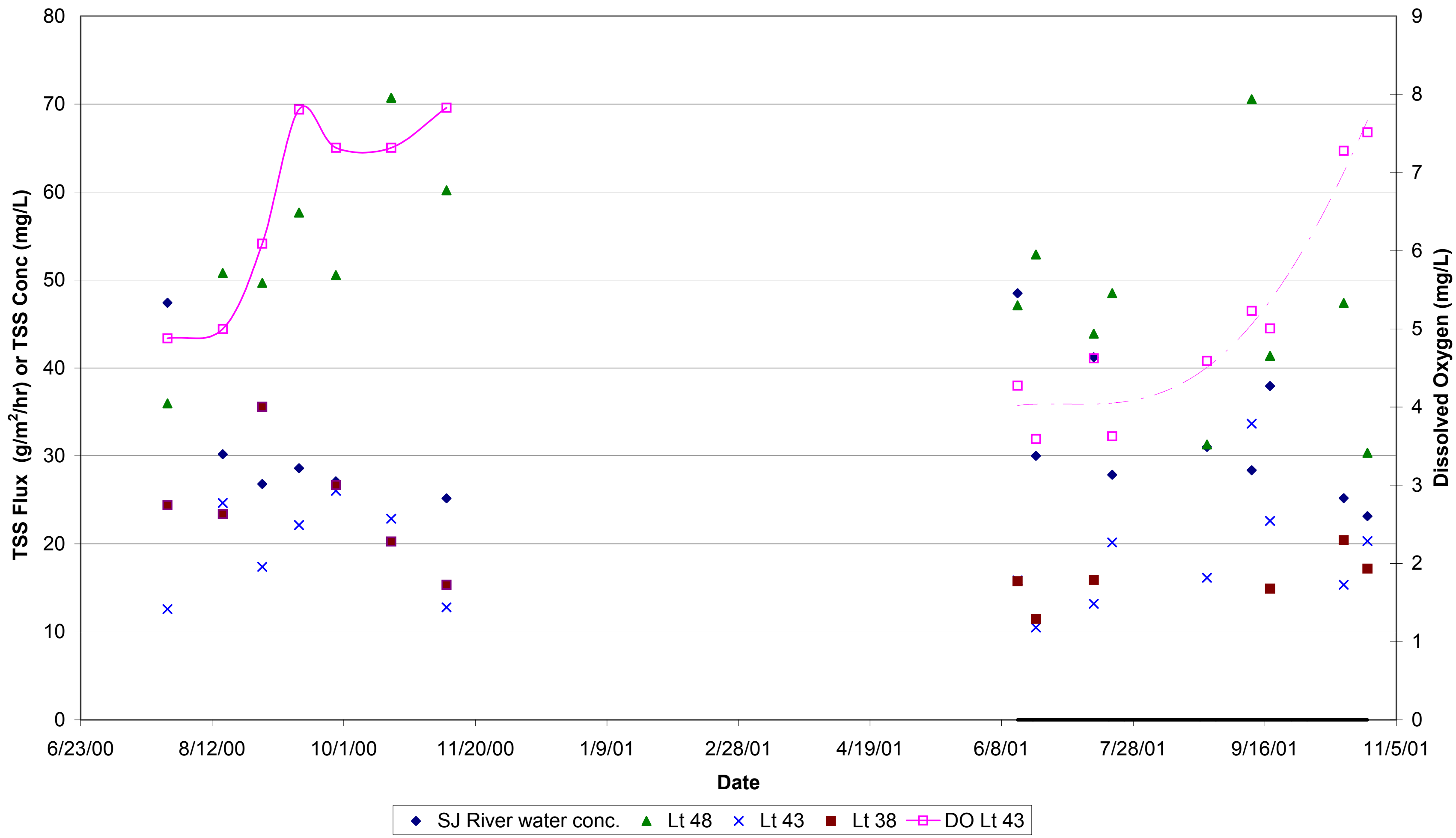


Figure IV-2: Averages TSS deposition fluxes in the DWSC during periods of trap deployment for 2000 and 2001.

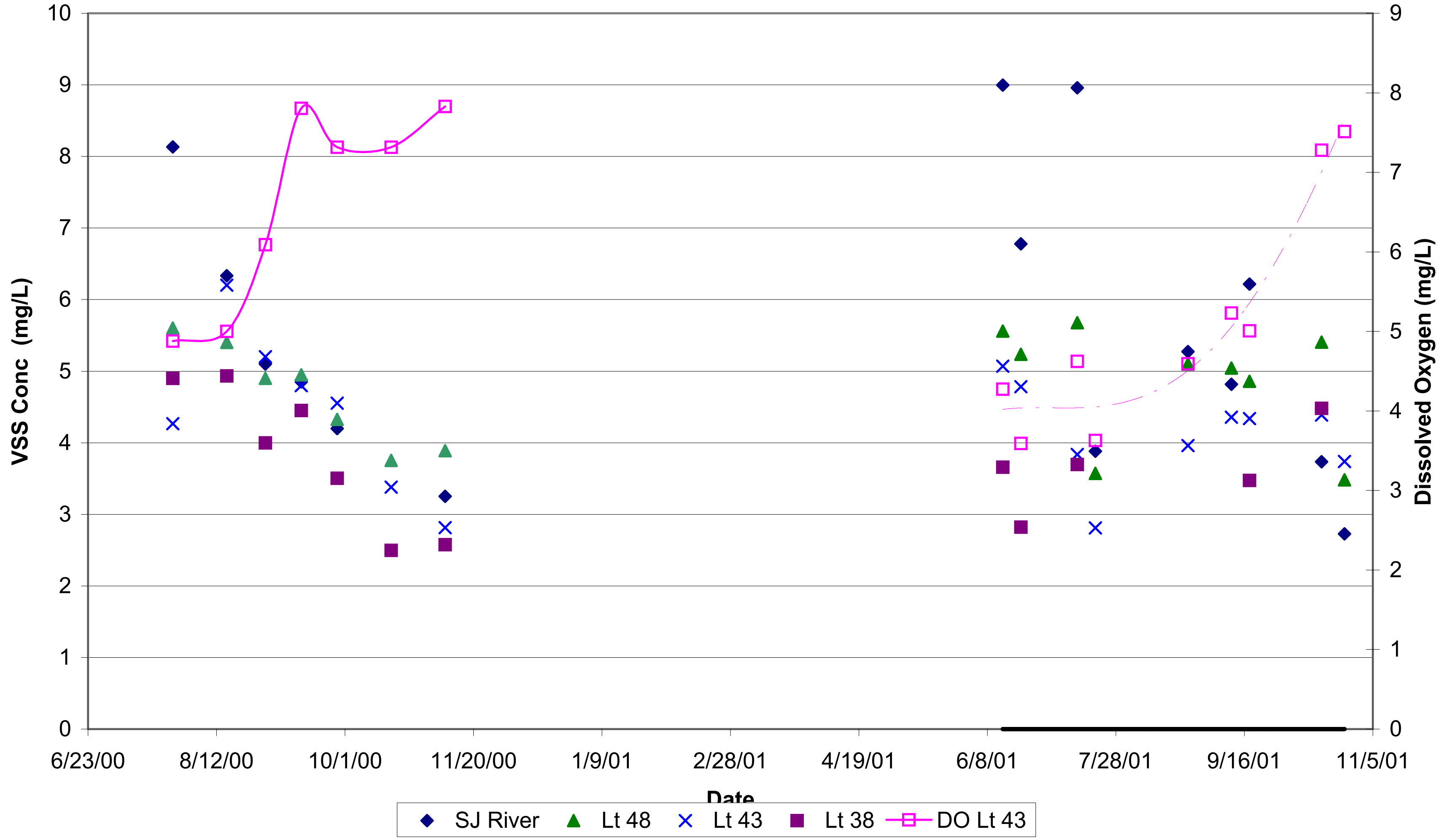


Figure IV-3: Depth-averaged VSS water concentrations in the DWSC during periods of trap deployment for 2000 and 2001.

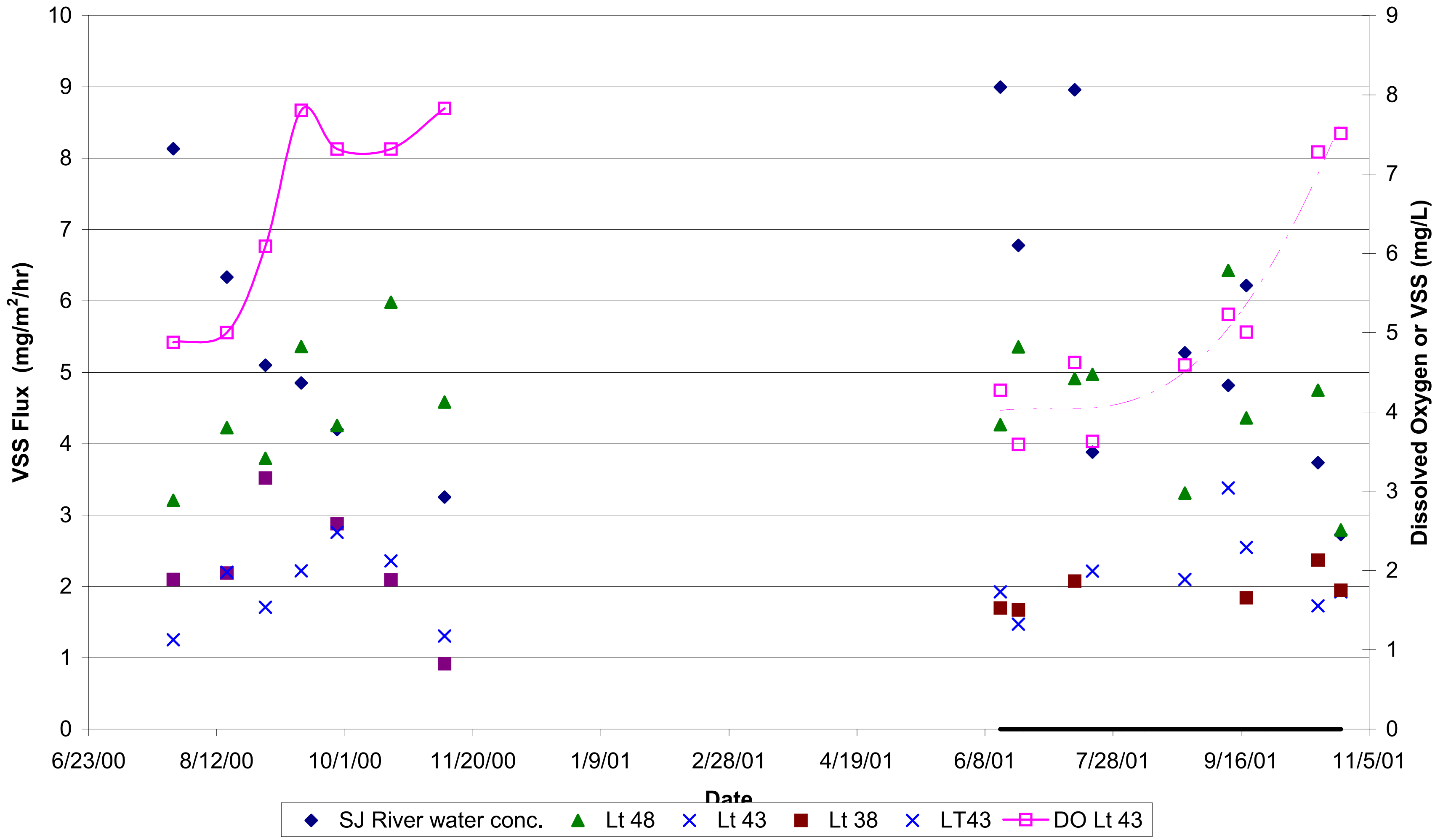


Figure IV-4: Depth-averaged VSS deposition fluxes in the DWSC during periods of trap deployment for 2000 and 2001

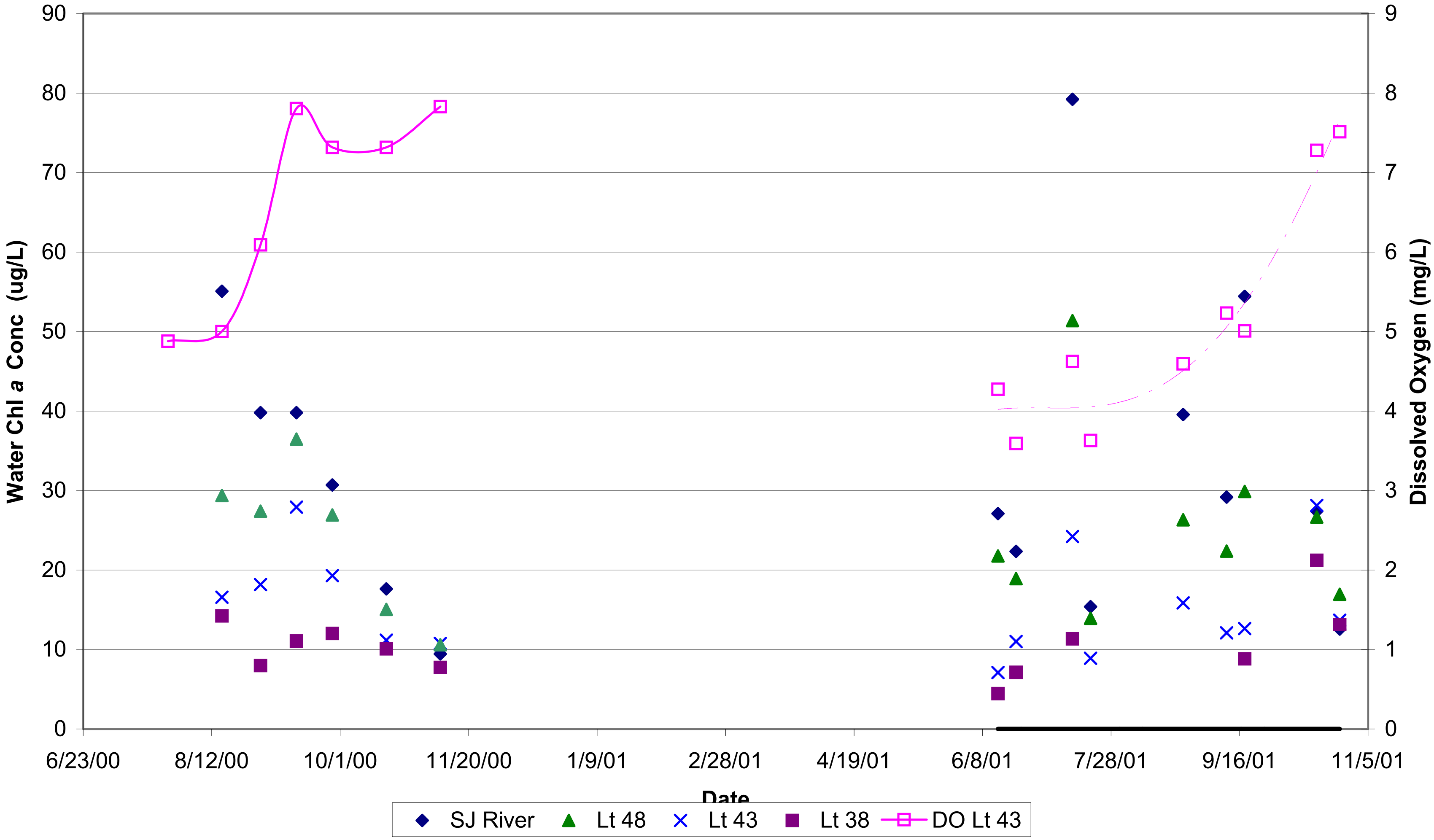


Figure IV-5: Depth-averaged chlorophyll *a* water concentrations in the DWSC during periods of trap deployment for 2000 and 2001

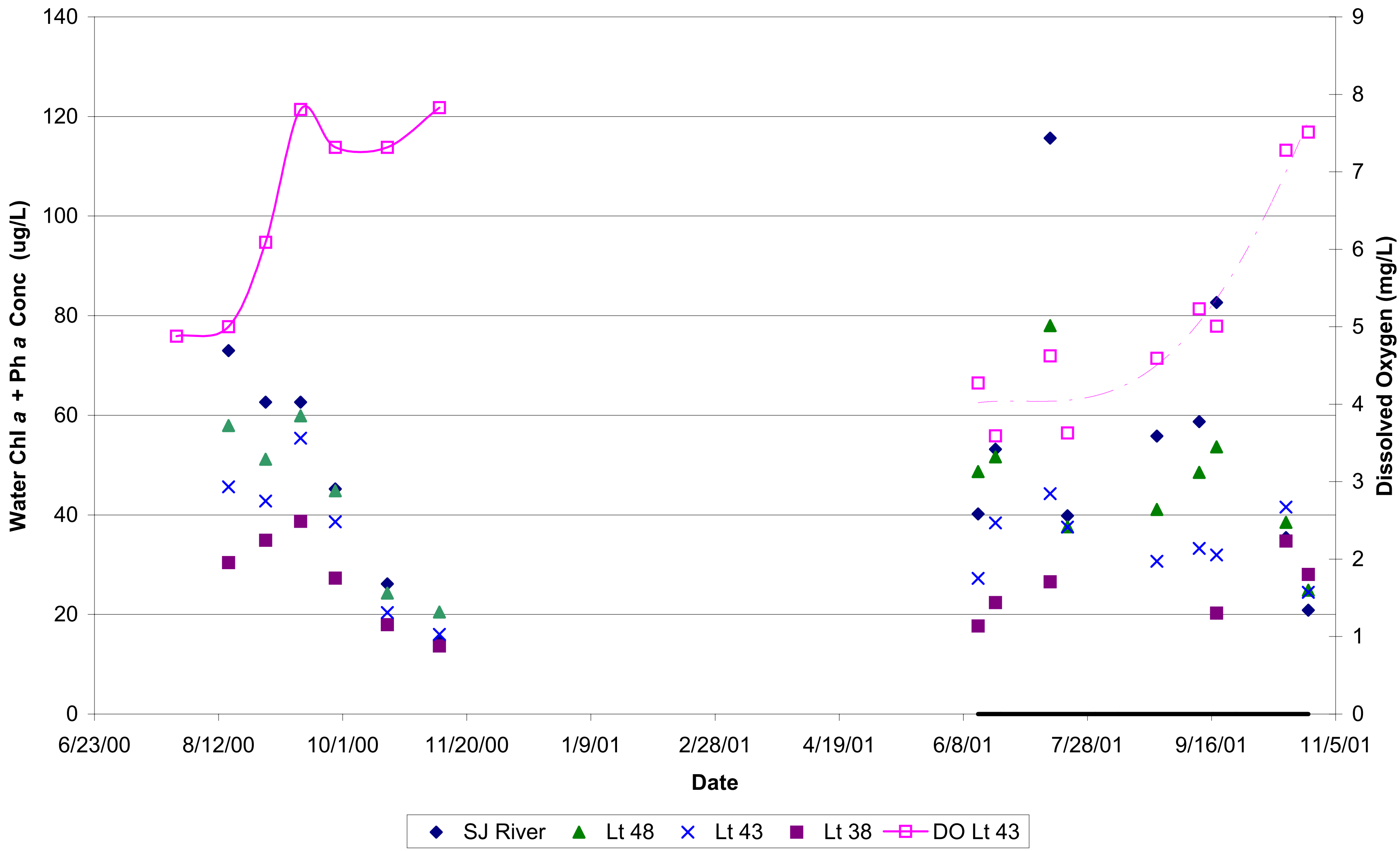


Figure IV-6: Depth-averaged chlorophyll *a* deposition fluxes in the DWSC during periods of trap deployment for 2000 and 2001.

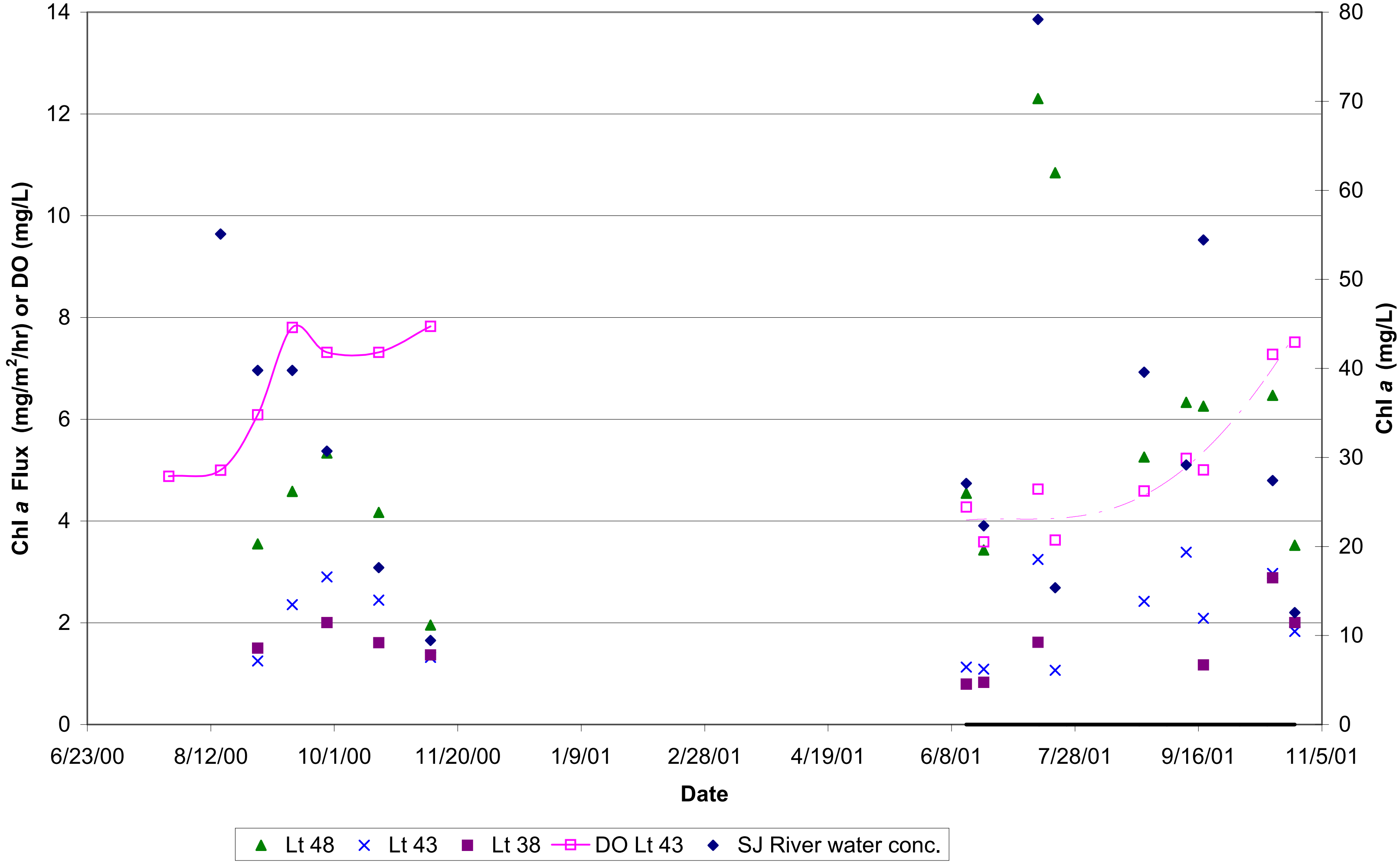


Figure IV-7: Depth averaged chlorophyll *a* + pheophytin *a* water concentrations in the DWSC during periods of trap deployment for 2000 and 2001

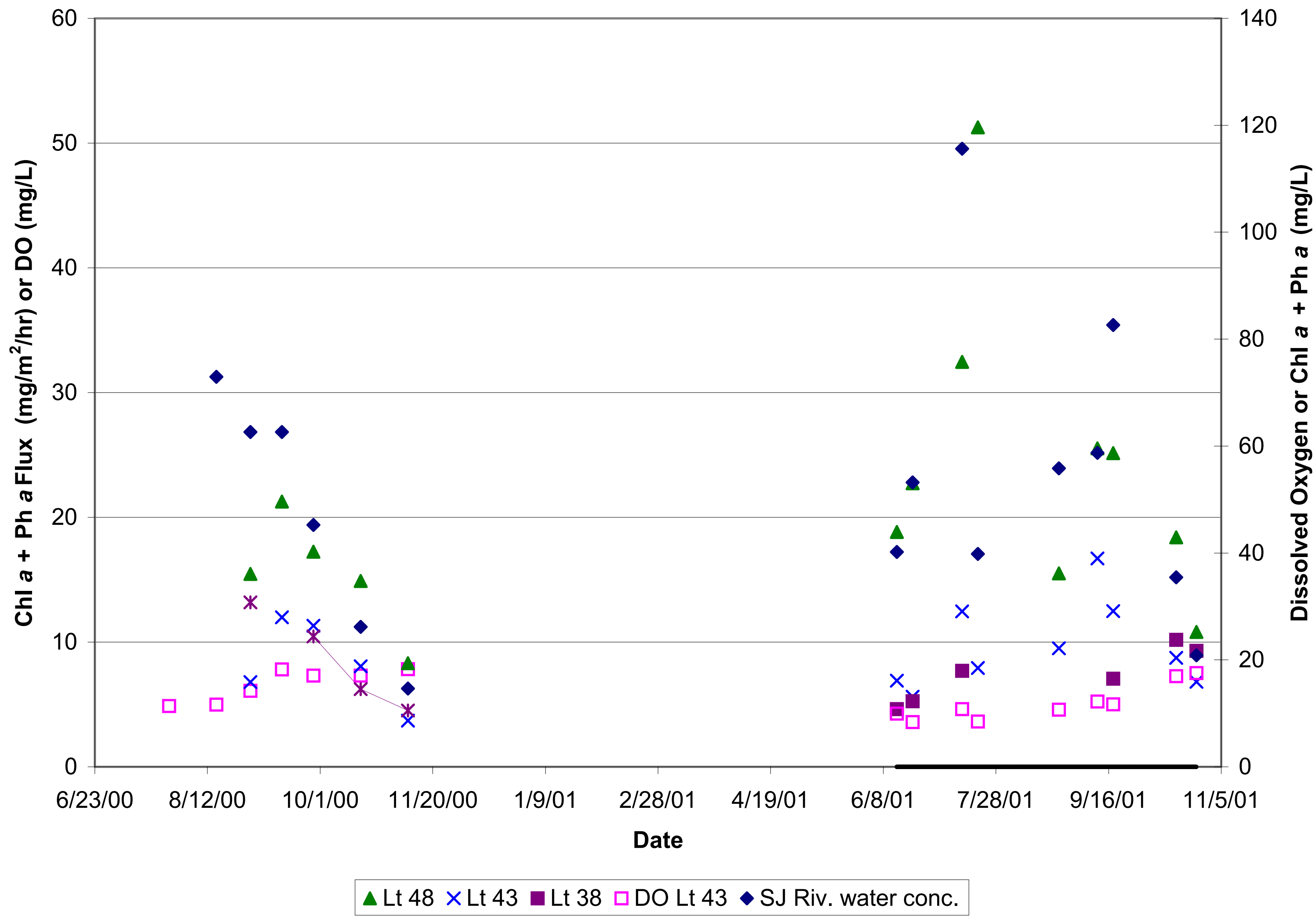


Figure IV-8: Depth averaged chlorophyll *a* + pheophytin *a* deposition fluxes in the DWSC during periods of trap deployment for 2000 and 2001.

V. Sediment Oxygen Demand Measurements

The sediment oxygen demand was measured directed with sediment cores collected at the bottom of the DWSC at Navigation Lights 38, 43, 48, and in the Turning Basin. The cores were collected in an acrylic tube from the center of the channel on the following dates during 2001:

- August 2,
- August 30,
- September 16,
- October 4,
- November 1.

<u>Materials and Methods</u>

The 8.9-cm diameter, 31-cm long sampling tube was attached to a weighted aluminum frame and lowered to the sediment water interface. The frame limited the penetration of the tube in the sediment to approximately 15 cm. Actual core depths varied from 10 to 16 cm. Once embedded in the sediments, a spring-loaded plate was released to close the top of the sampling tube. The tube was raised to the surface where another plate was fastened at the bottom prior to lifting the sediment sample from the water. The sample was then transferred to shore where a top with DO probe and water circulation fittings was attached. A schematic diagram of the sediment chamber is shown in Figure V-1 (as will be discussed later the apparatus for August 2 was slightly different). Circulation was started and the initial DO concentration was measured with a YSI 55 dissolved oxygen meter. Circulation was accomplished with a 4-channel peristaltic pump. The flow rate of 150 mL min^{-1} recirculated the water above the sediment every 6 to 9 minutes, depending on the actual volume of water overlying the sediment core. This flow rate also provided water turbidities similar to levels measured above the sediment water interface in the DWSC at the time the sediment samples were collected.

Immediately before collecting the sediment sample, the water temperature, turbidity, and DO were measured within 2 feet of the sediment-water interface. A sample of water was also collected and placed in a BOD bottle to monitor the DO depletion of the water in the absence of the sediment interface. The sediment oxygen demand (SOD) was determined by subtracting the water DO depletion rate from the chamber depletion rate and multiplying by the depth of water overlying the sediment surface in each chamber.

The chambers were tested for water and air leaks prior to conducting the field measurements. Figure V-2 presents the results of the tests conducted over a three-hour time period. These results indicate that the chamber apparatus was effectively closed from the atmosphere.

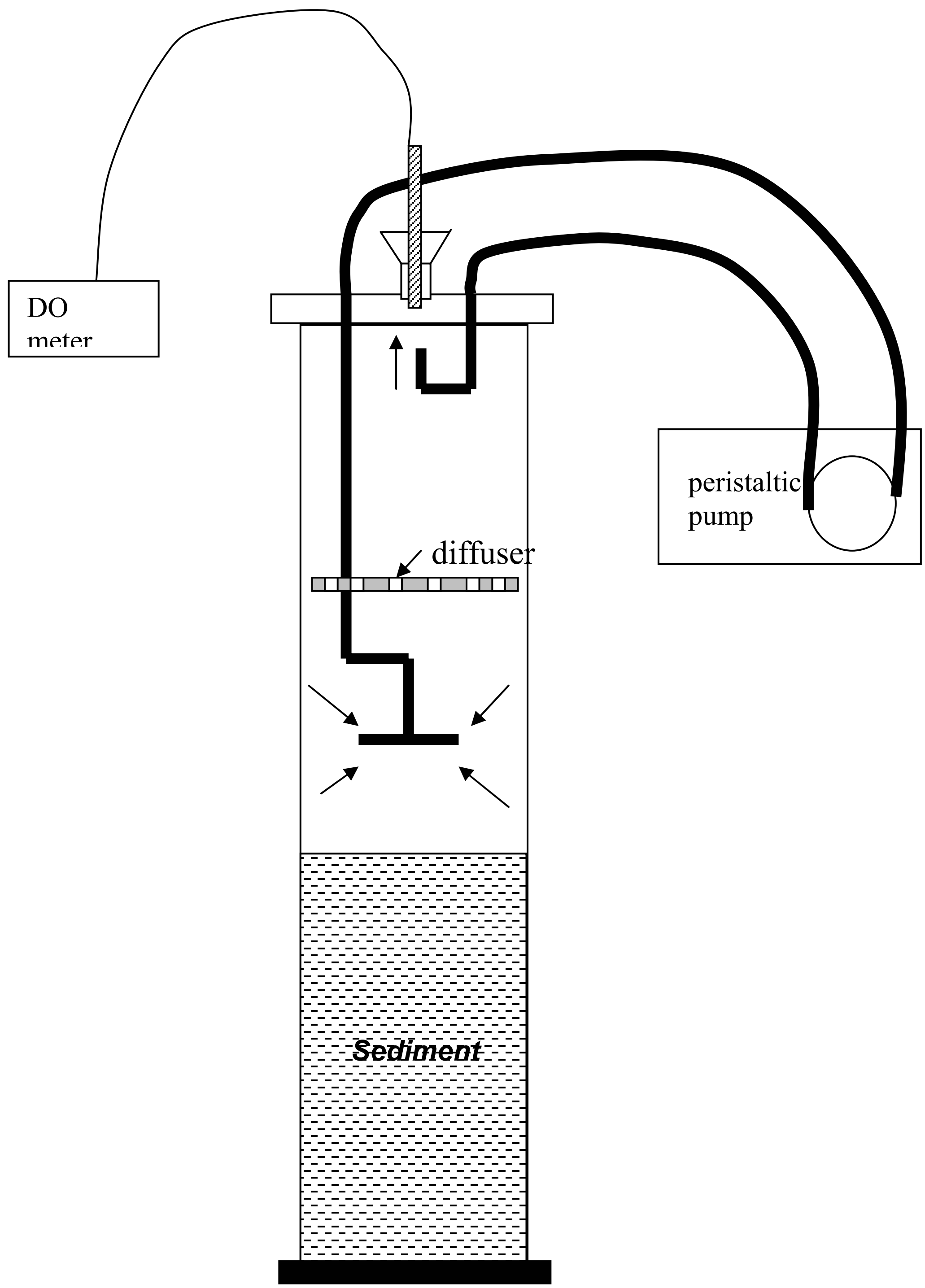


Figure V-I: Sediment Oxygen Demand Apparatus

Results and Discussion

An example of the SOD chamber results are shown for September 16 in Figure V-3. Oxygen depletion was determined by a least-squares line fit through DO concentrations measured for at least 8 hours. The slope of the lines fit to the data represent the DO depletion rate in mg $L^{-1}d^{-1}$. On September 16, two sediment samples were collected at Lt. 43 and monitored. The slopes of the fitted lines are very similar yielding SOD values of 0.70 and 0.74 g m^{-2} d^{-1}. These values were adjusted by subtracting the water from the overall chamber results shown in Figure V-3.

Table V-1 presents the results of the SOD experiments measured from August 2 to November 1, 2001. Correlation coefficients squared, R^2, were generally above 0.9 for the SOD chamber measurements. The SOD measurements generally range from 0.30 to 0.80 g m^{-2} d^{-1}. These values are consistent with many of the literature values appearing for rivers and estuaries (as compiled by Porcella, *et al.,* 1985).

Table V-I: Sediment oxygen demands measured in the DWSC.

Date and Location	Chamber Water Depth (cm)	Chamber Δ DO / Δ t (mg L^{-1} d^{-1})	Correlation Coefficient R^2	Chamber Turbidity (NTU)	Adjusted Δ DO / Δ t (mg L^{-1} d^{-1})	SOD (g m^{-2} d^{-1})
8/2/01						
Lt. 38	15	-2.2	0.77	26	-2.2	0.33
LT 43 A	15	-3.2	0.88	30	-3.2	0.49
Lt. 43 B	18	-10.3	0.94	108	-10.3	1.85
LT 48	18	-3.0	0.87	42	-2.9	0.52
8/30/01						
LT 38	14	-3.0	0.95	22	-3.0	0.42
LT 43	19	-2.2	0.95	37	-2.2	0.41
Lt. 48	18	-3.2	0.91	43	-3.2	0.56
Turning Basin	17	-0.1	0.21	25	-0.1	0.01
9/16/01						
LT 38	15	-2.8	1.00	20	-2.7	0.41
LT 43 A	20	-3.8	1.00	24	-3.7	0.74
LT 43 B	16	-4.1	0.99	28	-4.1	0.66
Lt. 48	22	-4.5	0.99	38	-3.8	0.82
10/4/01						
LT 38	18	-1.8	0.94	14	-1.2	0.22
LT 43	16	-3.7	1.00	28	-2.9	0.46
Lt. 48	18	-3.1	0.98	27	-2.5	0.46
Turning Basin	15	-2.4	0.99	25	-2.0	0.31
11/1/01						
Lt. 38	18	-1.8	0.94	21	-1.8	0.32
LT 43	18	-2.0	0.94	19	-1.8	0.32
Lt. 48	20	-2.7	0.93	21	-2.4	0.48
Turning Basin	15	-2.0	0.95	18	-1.8	0.27

Figure V-4 exhibits the SOD values measured during 2001. These results show that the SOD decreases with downstream distance in the DWSC. The measurements also indicate that relatively high values were measured on September 16, 2001. The cause of the these high values is unknown, however, high sediment deposition rates were also measured five days earlier on September 11. These high deposition rates seem to be associated with unusually high ship traffic during the morning. Perhaps the high SOD measured on September 16 at Lt. 43 and Lt. 48 were caused by similar activity prior to the collection of the sediment samples.

The SOD is dependent on the interfacial water velocity. Elevated water velocities can yield high SOD values due to the compression of the diffusion layer or the resuspension of sediments (Whittemore, 1985; Martin and Bella, 1971). Evidence of resuspension effects were observed during chamber tests conducted on August. 2The experiments performed on August 2 were conducted without the internal circulation piping shown in Figure V-1. In addition, one experiment, Lt. 43 B, was conducted without the diffuser plate. Another sediment sample was also collected at the Lt. 43 site. The results in the SOD are compared in Table V-2 below. The lack of a diffuser plate resulted in much higher chamber turbidity and associated SOD. The SOD and the turbidity for Lt. 43 B were both 3.6 times greater than the chamber turbidity. This experiment demonstrates that significant resuspension events can result in elevated oxygen demands near the sediment-water interface. However as shown later, when averaged over the entire water column the effect is relatively small.

Table V-2: Comparison of turbidity and SOD

Sample	Field Turbidity (NTU)	Chamber Turbidity (NTU)	Recirculation Flow Rate (mL/min)	SOD ($g\ m^{-2}\ d^{-1}$)
Lt. 43A	28	30	650	0.5
Lt. 43B	27	108	650	1.8

A plot of SOD vs. turbidity is presented in Figure V-5 also shows the two parameters to be relatively correlated for experiments. While the measured SOD values appear correlated with the turbidity, the variability observed in the data could also be associated with the degree of core disturbance when collecting each sample. The method used here will result in some core disturbance, regardless of the degree of care employed. Cores that were visibly disturbed were discarded until a satisfactory sample was collected as indicated by the turbidity of the water above the sediment in the core.

These results suggest that the SOD is a relatively minor contributor of the total oxygen demand in the DWSC. Using the high measurement of 0.8 $g\ m^{-2}\ d^{-1}$ the oxygen demand exerted on the water column can be estimated by multiplying the SOD by the water depth as shown:

Exerted demand in column = SOD / water depth= 0.8 $g\ m^{-2}\ d^{-1}$ / 11 m = 0.07 mg/L per day

This demand is small compared with the BOD measured in the water column. The oxygen demand for the first day entering the DWSC is often approximately 1 mg/L. Thus, the SOD contributes less than 10% of overall demand in the DWSC. Even for the extreme chamber experiment where the diffuser plate was removed and the recirculation flow was high (chamber turbidity was 108 NTU and the SOD was 1.8 g m^{-2} d^{-1}) the demand exerted in the column would be 0.16 mg/L per day or approximately 15 percent of the oxygen demand.

<u>Sediment Oxygen Demand Estimations using Water Quality Data</u>

The potential sediment oxygen demand was then estimated using a net flow, Q, of 900 cfs and the change of VSS concentrations (ΔVSS) observed between monitoring stations in the DWSC:

$$\text{Potential SOD} = Q \times \Delta VSS \times R_{BOD/VSS} / A_s \,,$$

where, $R_{BOD/VSS}$ is 1.1, and A_s is the surface area of the river reach between monitoring stations. The results of these calculations are shown in Table III-4. These estimations suggest that the average potential SOD measured in the DWSC from June through October , 2001 was 4.4 g m^{-2} d^{-1}between Lt. 48 and Lt. 43 and 3.1 g m^{-2} d^{-1} from Lt. 43 to Lt. 38.

As discussed later, the SOD chamber measurements yielded values ranging from 0.2 to 0.8 g m^{-2} d^{-1} with an average of approximately 0.4 g m^{-2} d^{-1}. The difference between these SOD estimates is probably associated with the decay of VSS in the water column while moving downstream.

Table V-3: Estimated SOD from VSS concentrations in the DWSC.

	River Segment	
	Lt. 48 to Lt. 43	Lt. 43 to Lt. 38
Average depth (ft)	24.5	24.5
Average width (ft)	590	600
Length (ft)	9,200	10,100
Average VSS at upper end (mg/L)[1]	4.85	4.15
Average VSS at lower end (mg/L)[1]	4.15	3.60
$\Delta VSS \times R_{BOD/VSS}$[1]	0.77	.60
Potential SOD (g/m^2/d)[1]	3.6	2.5

[1]$R_{BOD/VSS}$ is 1.1 as reported in Section III

Table V-4 exhibits the data used to calculate the expected loss of DO associated with the decay of VSS.

$$\text{DO depleted} = BOD_{int}^{0}\, e^{-kt} \,,$$

where BOD_{int}^0 is the ultimate BOD associated with the VSS at the upstream end of the river segment ($VSS \times R_{BOD/VSS}$), k is the decay constant (0.118 d^{-1}) for particulate BOD, and t is the travel time. As shown in Table V-4, the DO demand of the VSS while being transported in the water column is close to the expected ultimate DO demand if all the particles settle. Therefore SOD estimates using this approach are questionable and only provide an upper bound for the expected value. The adjusted SOD appearing in Table V-4 represents the lower bound of SOD values. For these cases, similarity of the potential VSS settling loss to the expected decay loss provides a range that is of little value, but does indicate that relatively low SOD levels are expected from chamber studies.

Table III-4: SOD adjusted for decay of VSS in the water column.

	River Segment	
	Lt. 48 to Lt. 43	Lt. 43 to Lt. 38
Average depth (ft)	22	22
Average width (ft)	500	500
Length (ft)	9,200	10,100
Average VSS at upper end (mg/L)[1]	4.85	4.15
Average VSS at lower end (mg/L)[1]	4.15	3.60
Average velocity (ft/s)	0.09	0.09
Travel time (d)	1.17	1.29
Potential DO demand from settling $\Delta VSS \times R_{BOD/VSS}$[1]	0.77	.60
DO demand from VSS decay in the water column	0.68	0.64
Adjusted SOD ($g/m^2/d$)[2]	0.5	-0.2

[1] $R_{BOD/VSS}$ is 1.1 as reported in Section III
[2] Assuming all the VSS that may decay in the water column occurs prior to settling.

The chamber measurements and these estimates indicate that the SOD is relatively low with a representative value being about 0.5 g DO m^{-2} d^{-1}, but certainly below 1 g DO m^{-2} d^{-1}. While there is a high potential SOD associated with settling organic matter, much of this oxygen demand appears to be exerted within the water column. The relatively low values reported here are associated with high resuspension rates that provide opportunity for some, if not most, of the oxygen demand to be exerted in the water column rather than at sediment-water interface.

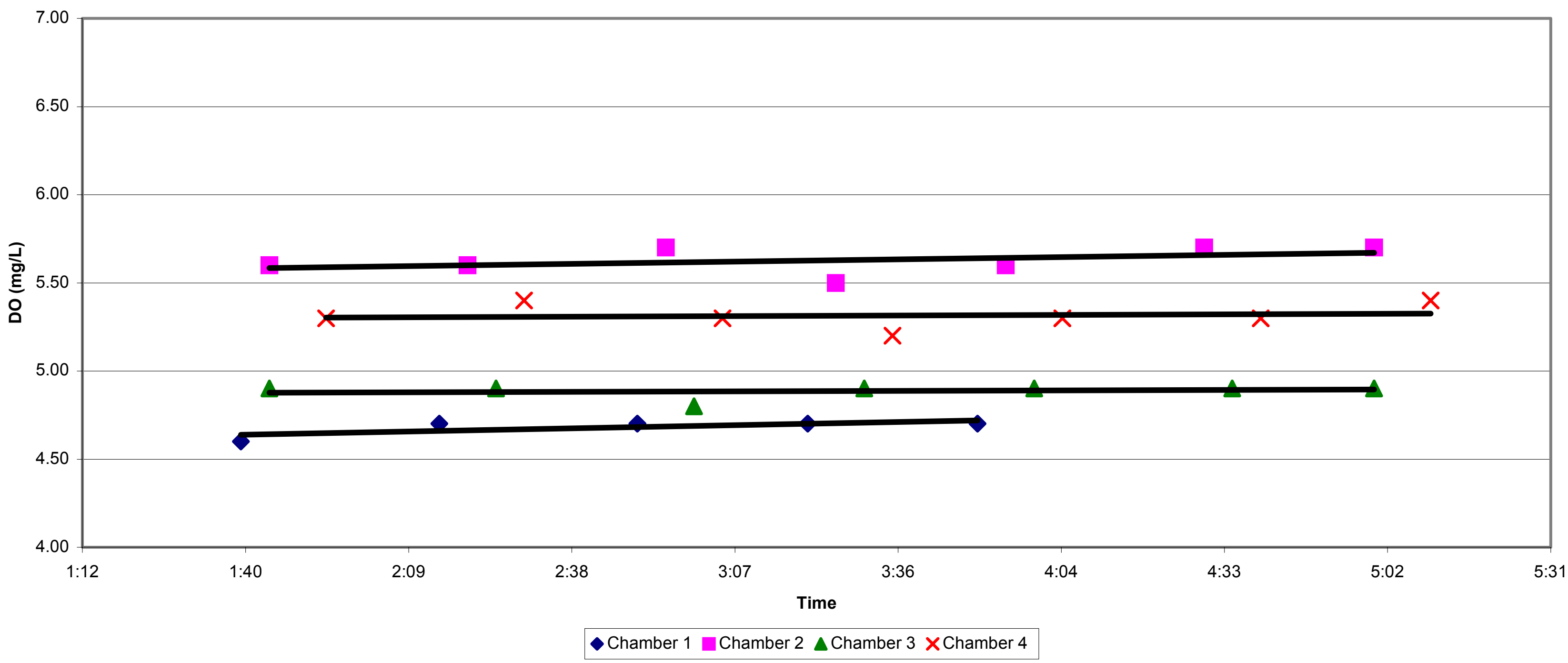


Figure V-2: Dissolved oxygen concentrations during the testing of the chamber apparatus without sediment.

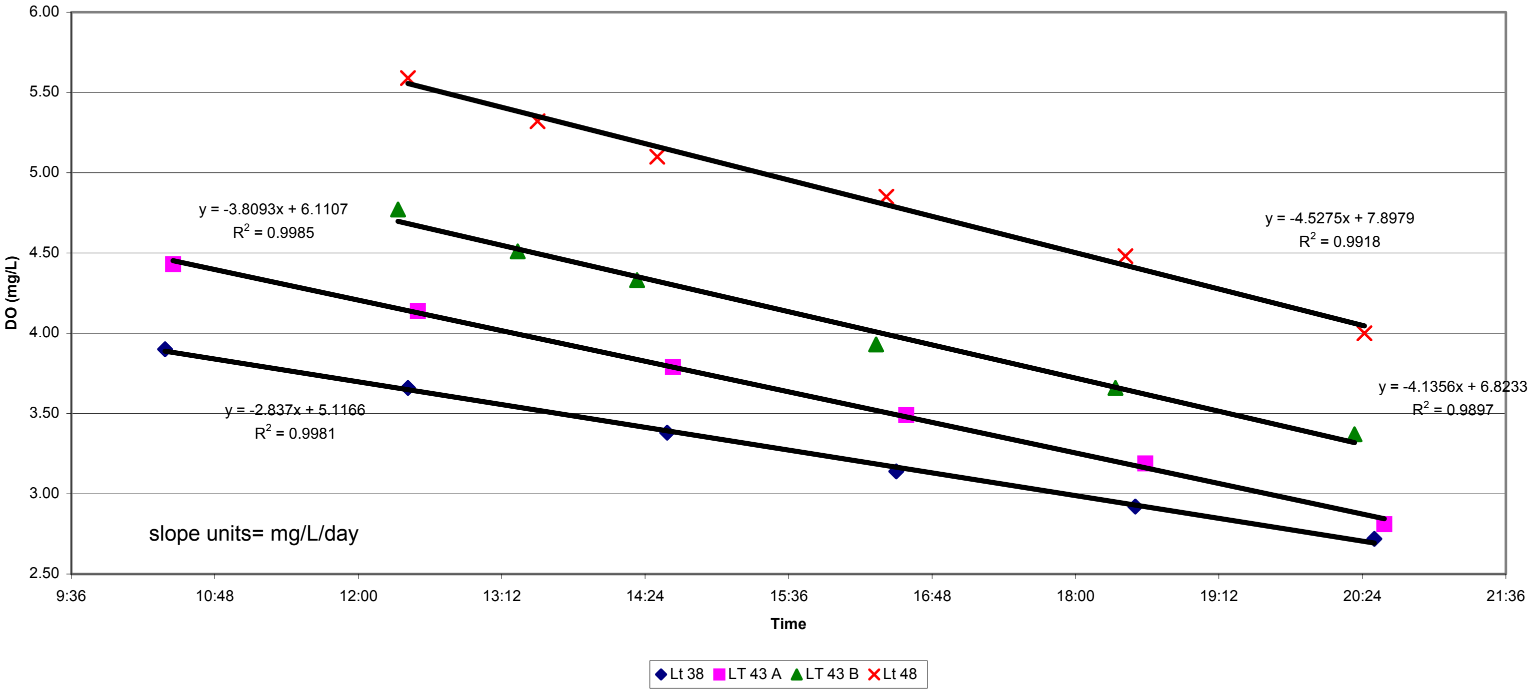


Figure V-3: Oxygen concentrations for SOD chamber experiments performed on September 16, 2001.

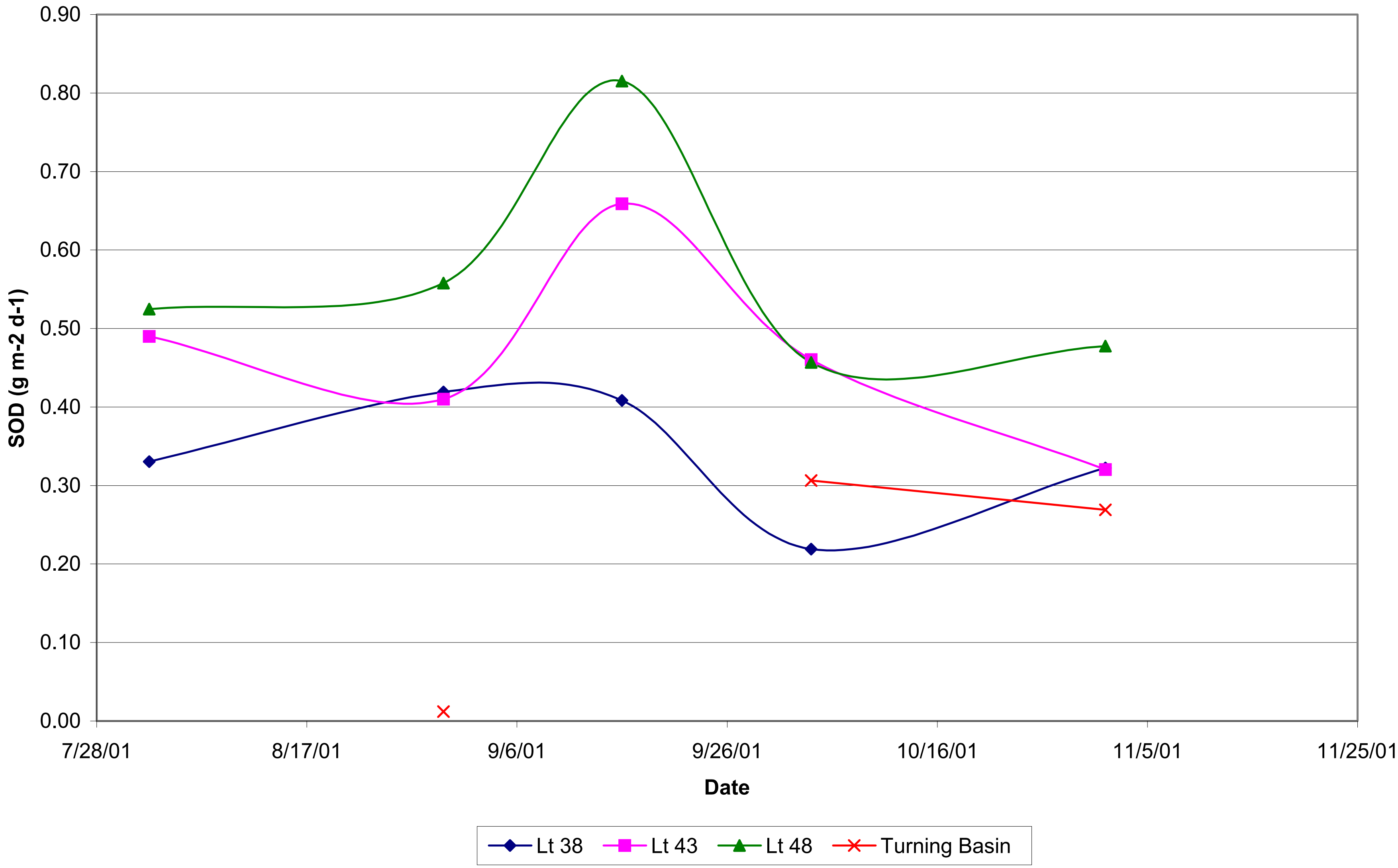


Figure V-4: SOD chamber results during 2001.

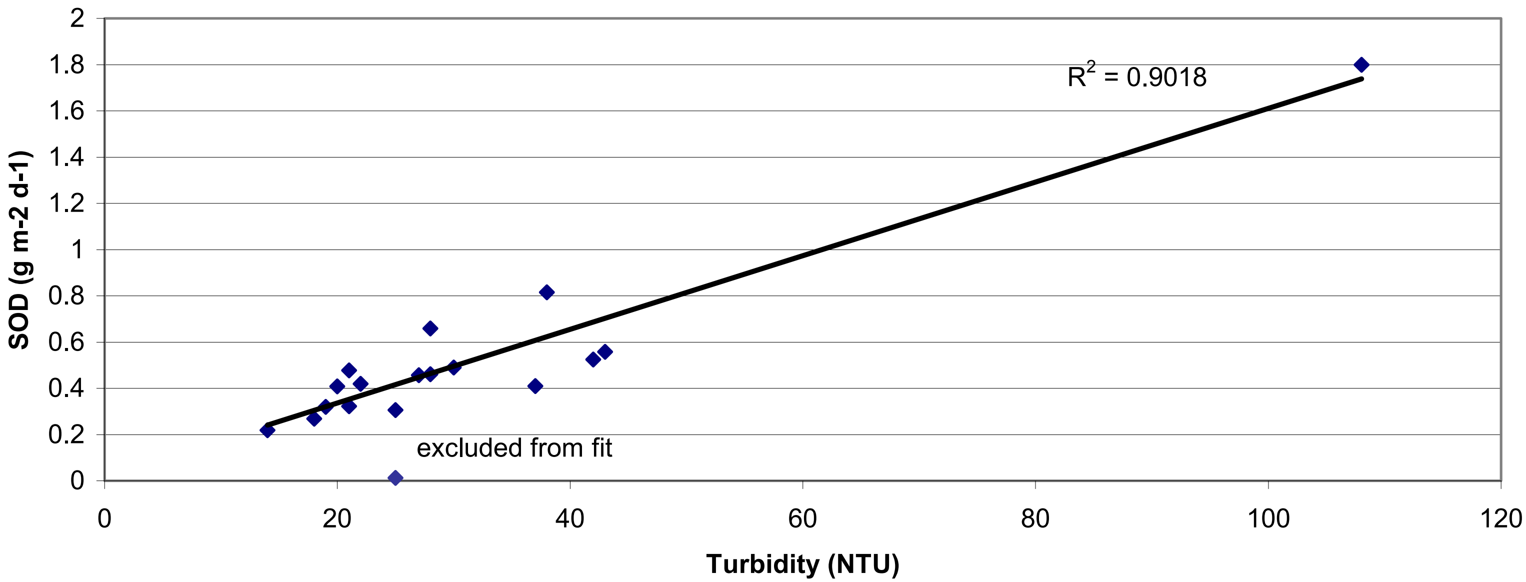


Figure V-5: Chamber SOD vs. chamber turbidity.

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VI. Appendices

Appendix A. Water quality data

Appendix B. Deposition flux data

Appendix C. Settling velocity data

Appendix A. Water quality data

Table A-1: Approximate times when field measurement were performed.

Location	Date								
	6/14/01	6/21/01	7/13/01	7/20/01[1]	8/25/01[1]	9/11/01	9/18/01	10/16/01	10/25/01
	(Neap)	(Spring)	(Neap)	(Spring)	(Neap)	(Neap + 1d)	(Spring + 1d)	(Spring)	(Neap + 1 d)
LT 38 AM Tide	*10:10/14:52*	**9:30/12:05**	*9:55/11:45*	**8:00/10:55**	*10:05/11:25*		**9:55/12:15**	**8:25/10:25**	*10:50/1:50*
LT 38 PM Tide	**17:45**	*16:40/18:15*	**16:05/18:00**	*15:50/17:55*	**14:55/16:55**		*16:15/18:20*	*15:35/17:30*	**18:00/20:40**
LT 43 AM Tide	*9:35/14:25*	**9:00/11:35**	*9:25/11:20*	**8:25/11:15**	*9:45/11:05*	*10:35/12:25*	**9:35/11:55**	**8:55/10:50**	*10:20/1:30*
LT 43 PM Tide	**17:20**	*16:10/18:00*	**15:45/17:40**	*15:35/18:20*	**14:35/16:35**	**16:00/17:05**	*15:55/17:45*	*15:15/17:10*	**17:35/20:20**
LT 48 AM Tide	*9:05/13:55*	**8:30/11:10**	*8:55/11:00*	**7:35/10:30**	*9:10/10:50*	*10:10/12:05*	**9:10/11:30**	**9:30/11:10**	*10:00/1:05*
LT 48 PM Tide	**16:55**	*15:30/17:35*	**15:15/17:20**	*15:20/17:35*	**14:15/16:20**	**15:35/16:45**	*15:40/17:25*	*14:45/16:55*	**17:10/20:00**
San Joaquin River AM Tide	*8:30/13:20*	**8:00/10:40**	*8:25/10:30*	**7:10/10:05**	*8:30/10:30*	*9:45/11:40*	**8:45/11:15**	**9:50/11:35**	*9:30/12:45*
San Joaquin River PM Tide	**16:28**	*14:53/17:15*	**14:50/16:50**	*11:50/15:00/17:15*	**13:55/16:00**	**15:10/16:30**	*15:20/17:00*	*14:25/16:35*	**16:40/19:30**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

[1] Lt Trap 38 was placed at Lt. 45.

[2] The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3] Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table A-2: Field Water Temperature °C

Location	Depth (ft)	Date 6/14/01 (Neap)	6/21/01 (Spring)	7/13/01 (Neap)	7/20/01[1] (Spring)	8/25/01[1] (Neap)	9/11/01 (Neap + 1d)	9/18/01 (Spring + 1d)	10/16/01 (Spring)	10/25/01 (Neap + 1 d)
LT 38	3.0		**25.49**	*26.17*	**24.27 / 24.4**	*24.33 / 24.5*		**22.94 / 23.37**	**19.49 / 19.54**	*17.67 / 17.92*
AM Tide	8.2	*23.4*	**25.42 / 25.51**	*25.51 / 25.53*	**24.27 / 24.26**	*24.28 / 24.36*		**22.95 / 22.99**	**19.50 / 19.46**	*17.63 / 17.76*
	16.4	*23.3*	**25.36 / 25.43**	*25.52 / 2.50*	**24.29 / 24.24**	*24.24 / 24.33*		**22.94 / 22.91**	**19.50 / 19.44**	*17.59 / 1769*
	24.6	*23.3*	**25.37 / 25.42**	*25.52 / 25.51*	**24.22 / 24.26**	*24.21 / 24.21*		**22.92 / 22.91**	**19.50 / 19.41**	*17.59 / 17.67*
	B	*23.3*	**25.37 / 25.35**	*25.54 / 25.51*	**24.12 / 24.28**	*24.11 / 24.12*		**22.93 / 22.91**	**19.50 / 19.45**	*17.56 / 17.64*
	3.0		*27.01 / 26*		*26.02 / 25.13*	**25.16 / 25.45**		*23.59 / 23.51*	*19.9 / 19.9*	**18.6 / 18.05**
LT 38	8.2	**23.70 / 23.48**	*26.53 / 26.49*	**26.35 / 26.28**	*25.54 / 24.87*	**24.58 / 25.31**		*23.34 / 23.50*	*19.76 / 19.88*	**17.94 / 18.00**
PM Tide	16.4	**23.34 / 23.33**	*25.64 / 25.7*	**25.76 / 25.9**	*24.25 / 24.27*	**24.20 / 24.40**		*23.13 / 23.14*	*19.69 / 19.82*	**17.60 / 17.57**
	24.6	**23.32 / 23.30**	*25.48 / 25.49*	**25.69 / 25.73**	*24.20 / 24.21*	**24.02 / 24.06**		*22.98 / 23.03*	*19.57 / 19.79*	**17.58 / 17.54**
	B	**23.31 / 23.30**	*25.47 / 25.48*	**25.68 / 25.72**	*24.19 / 24.21*	**23.91 / 23.81**		*22.96 / 23.01*	*19.51 / 19.57*	**17.58 / 17.48**
	3.0	*23.4*		*25.79 / 26.22*	**24.33 / 24.99**	*24.32 / 24.46*	*23.38 / 23.74*	**22.95 / 23.34**	**19.53 / 19.71**	*17.67 / 18.0*
LT 43	8.2	*23.3*	**25.6 / 26.04**	*25.79 / 25.87*	**24.31 / 24.31**	*24.25 / 24.37*	*23.33 / 23. 48*	**22.95 / 22.99**	**19.54 / 19.53**	*17.62 / 17.56*
AM Tide	16.4	*23.3*	**25.55 / 25.87**	*25.75 / 25.79*	**24.31 / 24.25**	*24.21 / 24.21*	*23 .32 / 23.32*	**22.94 / 22.97**	**19.51 / 19.50**	*17.52 / 17.51*
	24.6	*23.3*	**25.48 / 25.74**	*25.72 / 25.74*	**24.30 / 24.20**	*24.19 / 24.21*	*23. 31 / 23 .31*	**22.94 / 22.94**	**19.40 / 19.35**	*17.33 / 17.46*
	B	*23.1*	**25.43 / 25.35**	*25.61 / 25.56*	**24.27 / 24.18**	*24.12 / 24.14*	*23.23 / 23.28*	**22.92 / 22.92**	**19.26 / 19.33**	*17.32 / 17.37*
	3.0	*23.3*	*27.4 / 26.9*	**27.06 / 26.62**	*25.7*	**25.15 / 25.64**	**24.16 / 24.13**	*23.98 / 23.67*	*20.13 / 19.77*	**18.1 / 18.04**
LT 43	8.2	**23.33 / 23.39**	*26.14 / 26.73*	**26.17 / 26.22**	*24.93 / 24.86*	**24.47 / 25.06**	**23.66 / 23.90**	*23.72 / 23..40*	*19.89 / 19.75*	**17.51 / 17.33**
PM Tide	16.4	**23.30 / 23.26**	*25.85 / 26*	**25.82 / 26.08**	*24.26 / 24.26*	**24.22 / 24.19**	**23.39 / 23.38**	*23.00 / 23.15*	*19.53 / 19.65*	**17.53 / 17.24**
	24.6	**23. 28 / 23.26**	*25.7 / 25.74*	**25.78 / 25.85**	*24.22 / 24.23*	**24.13 / 24.06**	**23.35 / 23.35**	*22.97 / 22.96*	*19.40 / 19.43*	**17.14 / 16.94**
	B	**23.25 / 23.25**	*25.47 / 25.48*	**25.71 / 25.71**	*24.17 / 24.19*	**24.10 / 23.95**	**23.32 / 23.32**	*22.94 / 22.95*	*19.32 / 19.32*	**17.11 / 16.74**
	3.0		*26.1*	*25.81 / 26.23*	**24.7**	*24.05 / 24.24*	*22.84 / 23.27*	**22.95 / 23.06**	**19.31 / 19.40**	*16.53 / 17.33*
LT 48	8.2	*23.1*	**26.18 / 26.18**	*25.73 / 25.78*	**24.33 / 24.33**	*23.96 / 24.03*	*22.79 / 23.22*	**22.94 / 23.01**	**19.31 / 19.42**	*16.52 / 16.99*
AM Tide	16.4	*23.1*	**26.17 / 26.13**	*25.67 / 25.76*	**24.31 / 24.22**	*23.89 / 23.97*	*22.72 / 23.02*	**2295 / 23.00**	**19.31 / 19.39**	*16.40 / 16.70*
	24.6	*23.0*	**25.88 / 26.09**	*25.63 / 25.71*	**24.29 / 24.21**	*23.73 / 23.90*	*22.63 / 22.89*	**22.94 / 22.97**	**19.31 / 19.41**	*16.39 / 16.64*
	B	*23.1*	**25.46 / 26.02**	*25.34 / 25.56*	**24.28 / 24.11**	*23.71 / 23.69*	*22.53 / 22.50*	**22.93 / 22.95**	**19.31 / 19.39**	*16.40 / 16.55*
	3.0		*28.1*	**26.7**	*24.98 / 24.9*	**25.26 / 24.99**	**24.3 / 24.31**	*24.19 / 24.14*	*19.05 / 19.99*	**18.56 / 16.85**
LT 48	8.2	**23.44 / 23.66**	*27.01 / 27.47*	**26.48 / 26.02**	*24.30 / 24.93*	**24.68 / 24.68**	**23.53 / 23.93**	*23.17 / 23.19*	*19.62 / 19.88*	**18.52 / 16.88**
PM Tide	16.4	**23.29 / 23.51**	*26.79 / 26.59*	**25.91 / 25.77**	*24.27 / 24.39*	**24.32 / 24.41**	**23.29 / 23.27**	*22.98 / 22.95*	*19.40 / 19.50*	**17.13 / 16.74**
	24.6	**23.23 / 23.57**	*26.45 / 26.31*	**25.71 / 25.70**	*24.28 / 24.27*	**23.91 / 24.24**	**23.14 / 23.11**	*22.94 / 22.91*	*19.37 / 19.38*	**16.86 / 16.74**
	B	**22.90 / 23.45**	*26.34 / 25.93*	**25.62 / 25.65**	*24.24 / 24.16*	**23.81 / 24.06**	**22.72 / 22.67**	*22.91 / 22.91*	*19.39 / 19.41*	**16.37 / 16.69**
San Joaquin River	4.0	*22.2*	**26.01 / 26.4**	*24.22 / 24.49*	**24.09 / 23.82**	*23.35 / 23.44*	*21.91 / 22.22*	**22.70 / 22.44**	**19.22 / 19.68**	*15.62 / 16.12*
AM Tide	8.0	*22.2*	**26.01 / 26.41**	*24.22 / 24.44*	**24.09 / 23.78**	*23.33 / 23.39*	*21.88 / 22.03*	**22.69 / 22.44**	**19.25 / 19.68**	*15.62 / 15.90*
	12.0	*22.2*	**26 / 26.41**	*24.21 / 24.41*	**24.11 / 23.79**	*23.33 / 23. 39*	*21.89 / 21.95*	**22.69 / 22.44**	**19.27 / 19.68**	*15.63 / 15.86*
	16.0	*22.2*	**26 / 26.47**	*24.22 / 24.40*	**23.8**	*23 .33 / 23.39*	*21.89 / 21.94*	**22.66 / 22.43**	**19.28 / 19.69**	*15.63 / 15.83*
San Joaquin River	4.0	**22.50 / 23.40**	*27.43 / 27.7*	**25.28 / 25.10**	*23.87 / 24.55*	**23.71 / 24.23**	**22.87 / 22.81**	*23.07 / 23.20*	*19.93 / 20.05*	**16.19 / 16.48**
PM Tide	8.0	**22.56 / 23.33**	*27.43 / 27.7*	**25.22 / 25.10**	*23.78 / 24.57*	**23.56 / 24.23**	**21.96 / 21.97**	*23.04 / 23.18*	*19.88 / 20.05*	**16.16 / 16.48**
	12.0	**22.44 / 23.35**	*27.46 / 27.69*	**25.08 / 25.13**	*23.87 / 24.57*	**23.44 / 24.24**	**21.93 / 21.97**	*23.04 / 23.18*	*19.88 / 20.04*	**16.29 / 16.48**
	16.0	**22.41 / 23.36**	*27.48 / 27.69*	**25.12 / 25.15**	*23.87 / 24.56*	**23.44 / 24.24**	**21.94 / 21.90**	*23.03 / 23.16*	*19.90 / 20.04*	**16.32 / 16.48**

Table A-2: Field water temperature (°C) measurements

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table A-3: Field pH measurements in the DWSC.

Location	Depth (ft)	Date 6/14/01 (Neap)	6/21/01 (Spring)	7/13/01 (Neap)	7/20/01[1] (Spring)	8/25/01[1] (Neap)	9/11/01 (Neap + 1d)	9/18/01 (Spring + 1d)	10/16/01 (Spring)	10/25/01 (Neap + 1 d)
	3.0					*7.7 / 7.8*		**7.9 / 7.9**	**7.9 / 7.9**	*8.0 / 8.1*
LT 38	8.2					*7.8 / 7.7*		**7.9 / 7.9**	**7.9 / 7.9**	*8.0 / 8.00*
AM Tide	16.4					*7.7 / 7.7*		**7.9 / 7.9**	**7.9 / 7.9**	*8.0 / 8.0*
	24.6					*7.7 / 7.7*		**7.9 / 7.9**	**7.9 / 7.9**	*8.0 / 8.0*
	B					*7.7 / 7.7*		**7.8 / 7.8**	**7.9 / 7.9**	*8.0 / 8.0*
	3.0					**7.9 / 8.0**		*8 / 7.9*	*8 / 8.0*	**8.1 / 8.2**
LT 38	8.2					**7.8 / 7.9**		*7.9 / 7.9*	*7.9 / 7.9*	**8.0 / 8.1**
PM Tide	16.4					**7.7 / 7.7**		*7.9 / 7.9*	*7.9 / 7.9*	**8.0 / 8.0**
	24.6					**7.7 / 7.7**		*7.9 / 7.8*	*7.9 / 7.9*	**8.0 / 8.0**
	B					**7.7 / 7.7**		*7.8 / 7.8*	*7.9 / 7.9*	**8.0 / 8.0**
	3.0					*7.8 / 7.8*	*8.2 / 8.25*	**7.9 / 8.0**	**8.0 / 8.1**	*8.05 / 8.1*
LT 43	8.2					*7.7 / 7.8*	*8.2 / 8.2*	**7.9 / 7.9**	**8.0 / 8.0**	*8.0 / 8.0*
AM Tide	16.4					*7.7 / 7.7*	*8.2 / 8.2*	**7.8 / 7.9**	**7.9 / 8.0**	*8.0 / 8.0*
	24.6					*7.7 / 7.7*	*8.2 / 8.1*	**7.9 / 7.9**	**7.9 / 7.9**	*8.0 / 8.0*
	B					*7.7 / 7.7*	*8.1 / 8.1*	**7.9 / 7.9**	**7.8 / 7.8**	*8.0 / 7.9*
	3.0					**7.9 / 8.05**	**8.3 / 8.3**	*8.2 / 8.0*	*8.2 / 8.0*	**8.2 / 8.2**
LT 43	8.2					**7.7 / 8.0**	**8.2 / 8.2**	*8.0 / 7.9*	*8.1 / 8.0*	**8.1 / 8.0**
PM Tide	16.4					**7.7 / 7.8**	**8.1 / 8.2**	*7.9 / 7.9*	*8.0 / 8.0*	**8.0 / 8.0**
	24.6					**7.6 / 7.7**	**8.1 / 8.2**	*7.9 / 8.0*	*7.9 / 7.9*	**8.0 / 8.0**
	B					**7.6 / 7.8**	**8.1 / 8.1**	*7.9 / 7.9*	*7.9 / 7.9*	**7.9 / 8.0**
	3.0					*7.83 / 7.8*	*8.3 / 8.3*	**8.0 / 8.0**	**7.9 / 7.9**	*8.1 / 8.1*
LT 48	8.2					*7.77 / 7.7*	*8.3 / 8.3*	**8.0 / 8.0**	**7.9 / 7.8**	*8.0 / 8.1*
AM Tide	16.4					*7.78 / 7.7*	*8.2 / 8.2*	**8.0 / 8.0**	**7.9 / 7.8**	*8.1 / 8.0*
	24.6					*7.82 / 7.8*	*8.3 / 8.2*	**8.0 / 8.0**	**7.9 / 7.8**	*8.0 / 8.0*
	B					*7.83 / 7.8*	*8.3 / 8.3*	**8.0 / 7.9**	**7.9 / 7.8**	*8.0 / 8.0*
	3.0					**8 / 8.2**	**8.5 / 8.5**	*8.5 / 8.4*	*8 / 8.2*	**8.3 / 8.1**
LT 48	8.2					**7.8 / 8.0**	**8.3 / 8.4**	*8.2 / 8.1*	*7.9 / 8.1*	**8.2 / 8.1**
PM Tide	16.4					**7.8 / 7.9**	**8.2 / 8.3**	*8.1 / 8.1*	*7.9 / 8.0*	**8.1 / 8.1**
	24.6					**7.8 / 7.9**	**8.2 / 8.2**	*8.2 / 8.0*	*7.9 / 7.9*	**8.1 / 8.1**
	B					**7.7 / 7.8**	**8.2 / 8.2**	*8.1 / 7.9*	*7.8 / 7.8*	**8.1 / 8.0**
San Joaquin River	4.0					*8.2 / 7.9*	*8.4 / 8.4*	**8.1 / 8.5**	**8.1 / 8.1**	*8.1 / 8.2*
AM Tide	8.0					*8.17 / 7.9*	*8.4 / 8.4*	**8.0 / 8.5**	**8.0 / 8.1**	*8.1 / 8.2*
	12.0					*8.16 / 7.9*	*8.4 / 8.4*	**8.0 / 8.5**	**8.0 / 8.1**	*8.1 / 8.1*
	16.0					*8.16 / 7.9*	*8.4 / 8.5*	**8.0 / 8.5**	**8.0 / 8.1**	*8.1 / 8.1*
San Joaquin River	4.0					**8.0 / 8.4**	**8.5 / 8.5**	*8.9 / 8.7*	*8.2 / 8.05*	**8.1 / 8.2**
PM Tide	8.0					**8.0 / 8.4**	**8.4 / 8.4**	*8.9 / 8.8*	*8.2 / 8.02*	**8.2 / 8.2**
	12.0					**7.9 / 8.4**	**8.4 / 8.4**	*8.9 / 8.8*	*8.2 / 8.0*	**8.2 / 8.2**
	16.0					**7.9 / 8.4**	**8.4 / 8.4**	*8.9 / 8.8*	*8.2 / 8.0*	**8.2 / 8.2**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table A-4: Field dissolved oxygen measurements in the DWSC (mg/L).

Location	Depth (ft)	Date								
		6/14/01 (Neap)	6/21/01 (Spring)	7/13/01 (Neap)	7/20/01[1] (Spring)	8/25/01[1] (Neap)	9/11/01 (Neap + 1d)	9/18/01 (Spring + 1d)	10/16/01 (Spring)	10/25/01 (Neap + 1 d)
	3.0		**4.2 / 4.3**	*4.8 / 5.5*	**3.7 / 4.3**	*5 / 4.9*		**4.4 / 5.2**	**6.7 / 6.8**	*7.7 / 7.6*
LT 38	8.2	*5.1*	**4.1 / 3.9**	*4.4 / 4.8*	**3.8 /4.0**	*5.0 /5.0*		**4.4 / 4.5**	**6.4 / 6.5**	*7.5 / 7.2*
AM Tide	16.4	*5.1*	**4.0 / 3.7**	*4.3 / 4.5*	**3.6 / 4.0**	*4.9 / 4.9*		**4.3 / 4.3**	**6.4 / 6.5**	*7.4 / 7.2*
	24.6	*5.1*	**4.0 / 3.6**	*4.2 /4.4*	**3.7 / 3.9**	*4.7 / 4.9*		**4.3 / 4.3**	**6.4 / 6.4**	*7.4 / 7.2*
	B	*5.1*	**4.0 / 3.6**	*4.2 /4.1*	**3.8 / 3.4**	*4.5 / 4.3*		**4.2 / 4.2**	**6.4 / 6.2**	*7.3 / 7.1*
	3.0		*5.4 / 5.3*	**5.7 / 6**	*5.8 / 5.2*	**6.6 / 7.4**		*5.4 / 5.4*	*7.4 / 7.0*	**8.5 / 8.7**
LT 38	8.2	**4.4 / 6.55**	*4.8 / 5.4*	**5.1 / 5.46**	*3.8 / 4.5*	**5.2 / 7.4**		*4.8 / 5.2*	*7 / 6.9*	**7.7 / 8**
PM Tide	16.4	**4.59 / 6.75**	*3.8 / 3.9*	**4.1 / 4.0**	*3.7 / 3.7*	**4.8 / 5.5**		*4.5 / 4.4*	*6.8 / 6.8*	**7.2 / 7.4**
	24.6	**4.9 / 7.06**	*3.6 / 3.5*	**3.8 / 3.7**	*3.6 / 3.6*	**4.9 / 5.0**		*4.2 / 4.2*	*6.6 / 6.8*	**7.1 / 7.2**
	B	**5.09 / 7.63**	*3.5 / 3.5*	**3.8 /3.7**	*3.3 / 3.2*	**4.7 / 5.2**		*4.2 / 4.1*	*6.6 / 6.5*	**7.1 / 7.1**
	3.0	*4.6*	**5.0**	*5 / 5.3*	**3.8 / 4.4**	*5.1 / 5.5*	*5.7 / 6.1*	**5 / 6.0**	**7.4 / 8.2**	*7.4 / 8.1*
LT 43	8.2	*4.5*	**4.0 / 5.1**	*4.5 / 4.8*	**3.7 / 3.6**	*4.6 / 4.7*	*5.5 / 5.6*	**4.9 / 5.1**	**7.3 / 7.6**	*7.4 / 7.3*
AM Tide	16.4	*4.4*	**3.8 / 4.4**	*4.3 / 4.5*	**3.7 / 3.7**	*4.4 / 4.3*	*5.4 / 5.3*	**4.9 / 5.0**	**7.3 / 7.4**	*7.4 / 7.3*
	24.6	*4.4*	**3.55 / 3.7**	*4.2 / 4.1*	**3.6 / 3.7**	*4.3 / 4.3*	*5.4 / 5.2*	**4.8 / 5.0**	**7.1 / 6.9**	*7.7 / 7.1*
	B	*4.2*	**3.1 / 2**	*4.0 / 4.1*	**3.8 / 3.5**	*4.2 / 4.3*	*5.4 / 5.2*	**4.7 / 4.8**	**6.5 / 5.9**	*7.6 / 7.6*
	3.0	*4.5*	*7.3 / 5.9*	**7.2 / 7**	*5.5 / 4.7*	**6.7 / 7.8**	**6.2 / 6.3**	*7.4 / 5.9*	*10.2 / 7.9*	**7.5 / 8.6**
LT 43	8.2	**4.45 / 4.48**	*4.6 / 5.66*	**5.3 / 5.6**	*4.4 / 4.5*	**5.0 / 6.4**	**5.6 / 5.8**	*5.7 / 5.5*	*8.9 / 7.8*	**7.5 / 7.6**
PM Tide	16.4	**4.26 / 4.53**	*3.1 / 3.64*	**4.6 / 5.2**	*3.6 / 3.6*	**4.5 / 4.7**	**5.1 / 5.2**	*5.1 / 5.1*	*8.0 / 7.7*	**7.4 / 7.6**
	24.6	**4.2 / 4.23**	*3.0 / 3.15*	**4.5 / 4.6**	*3.5 / 3.5*	**3.9 / 4.8**	**5.0 / 5.1**	*5.1 / 4.8*	*7.3 / 7.3*	**7.6 / 7.7**
	B	**3.94 / 3.82**	*2 / 2.3*	**4.5 / 4.3**	*3.3 / 3.3*	**3.8 / 4.9**	**5.0 / 4.6**	*4.9 / 4.6*	*6.8 / 6.6*	**7.6 / 7.6**
	3.0		**4.5 / 4.8**	*5.7 / 5.8*	**4.3 / 4.1**	*5.8 / 5.8*	*6.6 / 6.7*	**6.3 / 6.5**	**7.2 / 7.0**	*8.2 / 8.2*
LT 48	8.2	*4.8*	**5 / 3.8**	*5.4 / 5.8*	**4.4 / 4.1**	*5.5 / 5.9*	*6.5 / 6.7*	**6.2 / 6.2**	**7.1 / 6.8**	*8.1 / 8.0*
AM Tide	16.4	*4.8*	**4.9 / 3.7**	*5.2 / 5.2*	**4.4 / 4.0**	*5.6 / 5.2*	*6.6 / 6.4*	**6.4 / 6.2**	**7.0 / 6.8**	*8.1 / 8.0*
	24.6	*4.7*	**3.7 / 3.6**	*5.3 / 5.2*	**4.3 / 4.05**	*5.9 / 5.4*	*6.7 / 6.3*	**6.2 / 6.2**	**7.0 / 6.8**	*8.1 / 8.0*
	B	*4.7*	**2.3 / 3.5**	*5.5 / 5.3*	**4.1 / 4.1**	*5.9 / 5.6*	*6.7 / 6.6*	**5.9 / 6.4**	**7.0 / 6.7**	*8.1 / 8.1*
	3.0		*7.2*	**8.0 / 9.0**	*5.3 / 5.9*	**7.9 / 8.5**	**7.8 / 7.7**	*9.5 / 8.9*	*8.4 / 9.9*	**8.9 / 8.6**
LT 48	8.2	**4.82 / 4.38**	*4.4 / 5.6*	**6.35 / 6**	*4.7 / 5.2*	**6.0 / 6.8**	**6.2 / 7.0**	*7.6 / 6.8*	*7.8 / 9.2*	**8.4 / 8.4**
PM Tide	16.4	**4.5 / 4.21**	*4.0 / 3.7*	**6.5 / 5.9**	*4.7 / 4.2*	**5.6 / 6.4**	**5.9 / 6.3**	*7.2 / 7.0*	*7.3 / 8.1*	**7.8 / 8.5**
	24.6	**4.46 / 4.19**	*3.6 / 3.5*	**6.8 / 6.5**	*4.5 / 4.1*	**5.6 / 6.0**	**6.1 / 6.1**	*7.5 / 6.3*	*7.2 / 7.1*	**8.0 / 8.5**
	B	**4.42 / 4.27**	*3.3 / 2.7*	**6.8 / 7.1**	*4.2 / 3.9*	**5.5 / 7.5**	**6.2 / 6.0**	*7.2 / 6.2*	*7.8*	**8.0 / 8.4**
San Joaquin River	4.0	*8.4*	**4.1 / 4.44**	*7.11 / 7.3*	**5.5/4.2/5.05**	*7.2 / 7.21*	*7.45 / 7.75*	**6.9 / 8.6**	**7.4 / 8.2**	*8.7 / 8.2*
AM Tide	8.0	*8.4*	**4.0 / 4.0**	*7.0 / 7.1*	**5.5/4.2/5.0**	*7.14 / 7.0*	*7.5 / 7.5*	**6.8 / 8.6**	**7.4 / 8.2**	*8.6 / 8.1*
	12.0	*8.3*	**4.0 / 4.0**	*7.0 / 7.0*	**5.5/4.2/5.05**	*7.08 / 7.0*	*7.5 / 7.4*	**6.8 / 8.6**	**7.4 / 8.2**	*8.6 / 8.1*
	16.0	*8.5*	**4.0 / 3.9**	*6.9 / 6.9*	**5.5/4.2/5.05**	*7.03 / 7.0*	*7.5 / 7.3*	**6.9 / 8.6**	**7.5 / 8.2**	*8.6 / 8.1*
San Joaquin River	4.0	**8.46 / 10.22**	*5.16 / 5.3*	**9.3 / 8.3**	*6.05 / 5.95*	**8.65 / 8.9**	**8.9 / 8.45**	*10.3 / 9.7*	*8.6 / 8.6*	**8.8 / 8.8**
PM Tide	8.0	**8.44 / 10.06**	*5.4 / 5.2*	**9.0 / 8.3**	*5.9 / 6.0*	**7.4 / 8.8**	**7.5 / 7.2**	*9.9 / 9.6*	*8.4 / 8.5*	**8.8 / 8.7**
	12.0	**7.7 / 9.93**	*5.4 / 5.2*	**8.7 / 8.3**	*5.9 / 5.9*	**7.1 / 8.8**	**7.1 / 7.1**	*9.6 / 9.6*	*8.4 / 8.5*	**8.8 / 8.7**
	16.0	**7.51 / 9.87**	*5.3 /5.1*	**8.7 / 8.3**	*5.9 / 5.9*	**7.0 / 8.6**	**7.0 / 7.0**	*9.8 / 9.6*	*8.4 / 8.4*	**8.9 / 8.6**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.
[1]Lt Trap 38 was placed at Lt. 45.
[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.
[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table A-5: Field measurements of turbidity in the DWSC (NTU)

Location	Depth	Date								
	(ft)	6/14/01 (Neap)	6/21/01 (Spring)	7/13/01 (Neap)	7/20/01[1] (Spring)	8/25/01[1] (Neap)	9/11/01 (Neap + 1d)	9/18/01 (Spring + 1d)	10/16/01 (Spring)	10/25/01 (Neap + 1 d)
	3.0			*15 / 15*	**18 / 18**	*14 / 14*		**19 / 14**	**15 / 12**	*18 / 21*
LT 38	8.2	*28*	**20 / 21**	*14 / 15*	**19 / 14**	*19 / 18*		**16 / 16**	**20 / 16**	*20 / 19*
AM Tide	16.4	*27*	**22 / 23**	*16 /16*	**23 / 15**	*24 / 19*		**17 / 20**	**20 / 16**	*21 / 23*
	24.6	*31*	**24 / 24**	*16 /16*	**25 / 15**	*31 / 24*		**23 / 21**	**29 / 19**	*21 / 23*
	B	*33*	**24 / 26**	*18 / 19*	**24 / 28**	*38 / 42*		**24 / 25**	**34 / 26**	*26 / 28*
	3.0	*21*		**14 / 14**	*14 / 15*	**13 / 13**		*14 / 14*	*17 / 16*	**17 / 14**
LT 38	8.2	**25 / 26**		**14 / 14**	*14 / 12*	**16 / 15**		*15 / 14*	*15 / 16*	**16 / 13**
PM Tide	16.4	**26 / 27**		**19 / 15**	*13 / 14*	**19 / 16**		*15 / 16*	*17 / 15*	**16 / 15**
	24.6	**29 / 30**		**19 / 21**	*16 / 16*	**27 / 17**		*18 / 16*	*19 / 15*	**23 / 17**
	B	**29 / 30**		**28 / 21**	*23 / 20*	**52 / 41**		*21 / 19*	*20 / 20*	**26 / 23**
	3.0	**22**		*16 / 15*	**22 / 18**	*15 / 14*	*16 / 15*	**21 / 14**	**10.0 / 15**	*16 / 16*
LT 43	8.2	*28*	**20 / 15**	*15 / 15*	**20 / 15**	*17 / 17*	*20 / 16*	**21 / 18**	**12.0 / 13**	*16 / 16*
AM Tide	16.4	*34*	**20 / 17**	*15 / 14*	**22 / 16**	*16 / 17*	*21 / 21*	**20 / 19**	**11.0 / 14**	*14 / 15*
	24.6	*32*	**20 / 20**	*16 / 15*	**24 / 17**	*21 / 18*	*21 / 21*	**22 / 22**	**14 / 20**	*22 / 20*
	B	*39*	**27 / 29**	*20 / 20*	**22 / 22**	*31 / 27*	*30 / 25*	**41 / 40**	**40 / 46**	*31 / 35*
	3.0	*25*		**14 / 14**	*15 / 17*	**14 / 16**	**15 / 15**	*14 / 14*	*15 / 14*	**15 / 13**
LT 43	8.2	**31 / 23**		**14 / 13**	*14 / 15*	**14 / 14**	**16 / 15**	*15 / 14*	*13 / 15*	**15 / 14**
PM Tide	16.4	**/ 28**		**14 / 15**	*14 / 16*	**15 / 17**	**18 / 17**	*18 / 15*	*37241.0*	**17 / 14**
	24.6	**34 / 39**		**17 / 19**	*16 / 16*	**24 / 19**	**18 / 18**	*19 / 19*	*20 / 19*	**19 / 16**
	B	**41 / 53**		**23 / 19**	*24 / 18*	**43 / 26**	**28 / 37**	*31 / 25*	*34 / 29*	**30 / 24**
	3.0			*16 / 18*	**22 / 17**	*19 / 15*	*16 / 13*	**18 / 17**	**19.0 / 14**	*20 / 12*
LT 48	8.2	*31*	**17 / 29**	*17 / 17*	**14 / 20**	*20 / 17*	*20 / 16*	**19 / 18**	**25 / 23**	*18 / 18*
AM Tide	16.4	*28*	**17 / 29**	*18 / 16*	**14 / 20**	*21 / 18*	*23 / 18*	**19 / 19**	**26 / 24**	*20 / 20*
	24.6	*29*	**18 / 32**	*20 / 17*	**15 / 21**	*27 / 21*	*23 / 18*	**22 / 20**	**29 / 25**	*20 / 26*
	B	*31*	**23 / 32**	*29 / 20*	**22 / 24**	*31 / 35*	*33 / 30*	**45 / 26**	**40 / 30**	*27 / 35*
	3.0			**15 / 15**	*21 / 16*	**11.0/18.0**	**15 / 16**	*14 / 13*	*14 / 13*	**12.0 / 16**
LT 48	8.2	**28 / 30**		**16 / 13**	*24 / 15*	**13 / 20**	**18 / 17**	*20 / 16*	*14 / 14*	**13 / 15**
PM Tide	16.4	**24 / 31**		**18 / 15**	*22 / 16*	**15 / 22**	**19 / 20**	*24 / 20*	*15 / 13*	**17 /17**
	24.6	**26 / 31**		**20 / 20**	*22 / 17*	**19 / 24**	**21 / 19**	*29 / 22*	*16 / 14*	**18 / 16**
	B	**37 / 51**		**28 / 26**	*23 / 19*	**30 / 35**	**28 / 35**	*29.0*	*36 / 28*	**23 / 19**
San Joaquin River	4.0	*39*	**19 / 28**	*22 / 24*	**16 / 23**	*32 / 27*	*26 / 21*	**26 / 35**	**26 / 24**	*29 / 20*
AM Tide	8.0	*39*	**24 / 28**	*26 / 27*	**16 / 25**	*33 / 27*	*24 / 23*	**23 / 33**	**27 / 26**	*30 / 20*
	12.0	*37*	**21 / 33**	*28 / 26*	**16 / 25**	*31 / 27*	*28 / 24*	**27 / 32**	**24 / 25**	*30 / 19*
	16.0	*37*	**22 / 32**	*27 / 26*	**15 / 25**	*32 / 28*	*32 / 26*	**24 / 31**	**25 / 26**	*31 / 20*
San Joaquin River	4.0	**34 / 47**		**30 / 44**	*26 / 60*	**24 / 40**	**21 / 21**	*32 / 28*	*25 / 17*	**19 / 24**
PM Tide	8.0	**29 / 47**		**32 / 42**	*26 / 36*	**23 / 37**	**21 / 24**	*21 /29*	*24 / 18*	**19 / 21**
	12.0	**30 / 45**		**38 / 40**	*26 / 38*	**24 / 36**	**25 / 23**	*28 / 30*	*22 / 17*	**18 / 23**
	16.0	**37 / 48**		**35 / 42**	*25 / 46*	**30 / 36**	**27 / 24**	*29 / 30*	*22 / 18*	**18 / 21**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.
[1]Lt Trap 38 was placed at Lt. 45.
[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment. Equipment failure on 6/14.
[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table A-6: Secchi depth measurements in the DWSC.

Location	Date								
	6/14/01	6/21/01	7/13/01	7/20/01[1]	8/25/01[1]	9/11/01[2]	9/18/01	10/16/01	10/25/01
	(Neap)	(Spring)	(Neap)	(Spring)	(Neap)	(Neap + 1d)	(Spring + 1d)	(Spring)	(Neap + 1 d)
LT 38 AM Tide	*1.5*	**1.8 / 1.8**	*2 / 2.2*	**1.5 / 2.1**	*2.0 /2.0*		**2.0 / 2.4**	**2.0 / 2.0**	*2.0 / 2.2*
LT 38 PM Tide	**1.6 / 1.5**	*1.6 / 1.5*	**2 / 2.2**	*2.3 / 2.0*	**2.3 / 2.0**		*2.2 / 2.3*	*2.0 / 1.9*	**2.0**
LT 43 AM Tide	*1.5*	**1.7 / 2**	*1.9 / 1.7*	**1.6 / 2.0**	*2.4 / 2.1*	*2.1 / 2.3*	**1.8 / 2.5**	**2.2 / 2.0**	*2.0 / 2.4*
LT 43 PM Tide	**1.4 / 1.6**	*1.8 / 1.6*	**2.5 / 2.2**	*2.3 / 1.7*	**2.2 / 2.0**	**2.5**	*2.3 / 2.2*	*2.1 / 2.0*	**2.2**
LT 48 AM Tide	*1.6*	**2 / 1.8**	*1.9 / 2.3*	**2.0 / 1.8**	*1.8 / 1.8*	*1.9 / 1.9*	**1.9 / 2.0**	**1.6 / 1.7**	*2.0 / 2.0*
LT 48 PM Tide	**1.5**	*1.7 / 1.4*	**1.8 / 1.9**	*1.5 / 2.0*	**2.0 / 2.0**	**2.0 / 2.5**	*1.8 / 2.0*	*2.0 / 2.0*	**1.8**
San Joaquin River[3] AM Tide	*1.0*	**1.5 / 1.5**	*1.4 / 1.4*	**1.5 / 1.4**	*1.4 / 1.5*	*1.6 / 1.5*	**1.6 / 1.4**	**1.7 / 1.6**	*1.5 / 2.0*
San Joaquin River[3] PM Tide	**1.2**	*1.3 /1.4*	**1.5 / 1**	*1.4 / 1.3*	**1.5 / 1.3**	**1.8 / 1.8**	*1.4 / 1.3*	*1.8 / 1.8*	**1.6**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table A-7: TSS concentrations (mg/L) in the DWSC and San Joaquin River at the USGS UVM Station.

Location	Depth (ft)	Date 6/14/01 (Neap)	6/21/01 (Spring)	7/13/01 (Neap)	7/20/01[1] (Spring)	8/25/01[1] (Neap)	9/11/01 (Neap + 1d)	9/18/01 (Spring + 1d)	10/16/01 (Spring)	10/25/01 (Neap + 1 d)
LT 38	8.2	*21.4*	**14.8**	*15.6*	**18.4**	*18.4*	*NA*[2]	**16.8**	**20.1**	*NA*[3]
AM Tide	16.4	*22.2*	**20.0**	*16.7*	**20.7**	*21.3*	*NA*	**19.7**	**20.1**	*NA*[3]
	24.6	*27.6*	**21.6**	*15.7*	**20.3**	*30.9*	*NA*	**21.1**	**28.5**	*NA*[3]
	B	*34.0*	**23.6**	*29.1*	**29.2**	*39.9*	*NA*	**28.5**	**42.5**	*NA*[3]
LT 38	8.2	**19.2**	*14.1*	**14.3**	*14.5*	**15.7**	**NA**	*12.2*	*16.8*	**13.7**
PM Tide	16.4	**25.0**	*17.7*	**19.3**	*14.0*	**18.5**	**NA**	*14.6*	*17.1*	**15.5**
	24.6	**24.0**	*15.6*	**19.5**	*16.5*	**22.9**	**NA**	*18.0*	*18.7*	**19.1**
	B	**22.6**	*20.5*	**23.8**	*23.5*	**61.3**	**NA**	*21.8*	*22.5*	**26.3**
LT 43	8.2	*27.9*	**14.9**	*13.2*	**16.7**	*16.6*	*18.9*	**19.4**	**12.7**	*14.8*
AM Tide	16.4	*29.4*	**15.7**	*13.7*	**19.7**	*17.4*	*21.6*	**20.1**	**13.9**	*13.5*
	24.6	*30.0*	**19.6**	*16.7*	**26.3**	*19.3*	*23.7*	**23.7**	**19.1**	*21.5*
	B	*40.5*	**29.6**	*20.8*	**26.3**	*38.1*	*33.2*	**54.8**	**48.4**	*39.1*
LT 43	8.2	**20.8**	*16.0*	**14.3**	*13.6*	**13.2**	**15.2**	*13.7*	*15.2*	**13.1**
PM Tide	16.4	**25.1**	*17.2*	**18.6**	*15.1*	**16.3**	**17.6**	*16.9*	*14.8*	**16.1**
	24.6	**35.2**	*21.6*	**18.4**	*16.0*	**25.5**	**18.9**	*19.8*	*19.5*	**16.8**
	B	**53.2**	*28.6*	**23.9**	*23.5*	**30.0**	**35.6**	*31.8*	*30.0*	**51.2**
LT 48	8.2	*33.1*	**25.6**	*17.9*	**14.0**	*19.6*	*20.7*	**20.2**	**35.6**	*20.3*
AM Tide	16.4	*24.0*	**28.9**	*20.0*	**16.5**	*21.2*	*22.9*	**20.8**	**35.5**	*22.4*
	24.6	*32.9*	**29.4**	*24.1*	**17.4**	*26.7*	*23.2*	**22.8**	**37.5**	*30.9*
	B	*31.3*	**32.4**	*29.9*	**24.9**	*38.8*	*40.1*	**44.0**	**44.9**	*38.3*
LT 48	8.2	**25.6**	*20.7*	**17.1**	*20.7*	**17.9**	**17.3**	*15.7*	*16.1*	**13.5**
PM Tide	16.4	**27.8**	*23.0*	**21.1**	*21.5*	**18.5**	**20.4**	*23.5*	*16.7*	**17.5**
	24.6	**31.0**	*25.8*	**24.8**	*20.8*	**23.6**	**18.2**	*30.9*	*17.6*	**16.5**
	B	**49.6**	*32.6*	**33.2**	*24.8*	**44.0**	**36.1**	*32.3*	*38.4*	**22.5**
San Joaquin River	AM	*51.3*	**26.2**	*28.6*	**25.8**	*29.2*	*30.3*	**40.6**	**28.4**	*24.7*
	PM	**46.8**	*35.3*	**51.6**	*30.8*	**32.8**	**25.5**	*34.9*	*21.5*	**21.7**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

na: data not available.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table A-8**:** VSS concentrations (mg/L) in the DWSC.

Location	Depth	Date								
	(ft)	6/14/01	6/21/01	7/13/01	7/20/01[1]	8/25/01[1]	9/11/01	9/18/01	10/16/01	10/25/01
		(Neap)	(Spring)	(Neap)	(Spring)	(Neap)	(Neap + 1d)	(Spring + 1d)	(Spring)	(Neap + 1 d)
LT 38	8.2	*3.2*	**2.4**	*3.2*	**2.5**	*3.9*	*NA*[2]	**3.1**	**4.4**	*NA*[3]
AM Tide	16.4	*3.2*	**3.2**	*3.6*	**2.9**	*4.3*	*NA*	**3.5**	**4.0**	*NA*[3]
	24.6	*4.0*	**3.2**	*3.3*	**3.1**	*5.6*	*NA*	**3.8**	**5.1**	*NA*[3]
	B	*4.8*	**2.9**	*5.5*	**4.0**	*6.9*	*NA*	**4.8**	**6.7**	*NA*[3]
LT 38	8.2	**3.8**	*1.7*	**2.9**	*2.8*	**3.9**	**NA**	*2.8*	*3.7*	**3.3**
PM Tide	16.4	**3.7**	*2.7*	**3.7**	*2.7*	**3.5**	**NA**	*2.9*	*3.9*	**2.8**
	24.6	**3.8**	*3.1*	**3.6**	*2.7*	**3.5**	**NA**	*3.1*	*3.6*	**2.8**
	B	**3.0**	*3.2*	**3.8**	*3.7*	**8.5**	**NA**	*3.5*	*4.1*	**4.5**
LT 43	8.2	*4.5*	**3.5**	*3.8*	**2.5**	*4.0*	*4.0*	**3.5**	**3.7**	*1.9*
AM Tide	16.4	*4.6*	**3.5**	*2.9*	**2.5**	*3.5*	*3.9*	**3.5**	**3.3**	*2.4*
	24.6	*4.3*	**4.4**	*3.7*	**3.3**	*3.8*	*4.5*	**3.7**	**4.1**	*2.8*
	B	*5.2*	**6.0**	*4.0*	**3.3**	*5.6*	*5.5*	**8.0**	**7.3**	*4.7*
LT 43	8.2	**3.8**	*5.3*	**3.5**	*2.7*	**3.1**	**3.3**	*3.2*	*4.3*	**2.5**
PM Tide	16.4	**4.5**	*5.2*	**4.1**	*2.8*	**2.9**	**3.5**	*3.5*	*3.5*	**3.3**
	24.6	**4.4**	*5.2*	**3.9**	*2.8*	**4.1**	**3.3**	*3.7*	*3.6*	**3.3**
	B	**8.6**	*6.0*	**4.7**	*3.7*	**4.8**	**5.7**	*5.0*	*5.1*	**6.8**
LT 48	8.2	*5.5*	**4.0**	*3.9*	**2.7**	*4.3*	*4.8*	**4.0**	**5.3**	*3.2*
AM Tide	16.4	*4.8*	**5.4**	*4.7*	**2.9**	*3.9*	*4.8*	**4.5**	**5.5**	*3.1*
	24.6	*5.5*	**5.0**	*4.9*	**3.1**	*5.6*	*4.4*	**4.6**	**5.7**	*4.4*
	B	*3.9*	**5.0**	*5.4*	**4.0**	*6.5*	*7.1*	**6.8**	**6.7**	*5.1*
LT 48	8.2	**4.2**	*6.0*	**4.8**	*4.3*	**4.5**	**4.7**	*3.7*	*4.7*	**3.9**
PM Tide	16.4	**5.3**	*5.4*	**5.7**	*4.1*	**4.0**	**4.3**	*4.5*	*3.3*	**3.5**
	24.6	**6.4**	*5.4*	**6.4**	*3.7*	**4.4**	**3.4**	*4.9*	*3.5*	**3.2**
	B	**8.0**	*6.4*	**7.8**	*4.3*	**7.6**	**6.5**	*5.7*	*6.3*	**3.3**
San Joaquin River	AM	*8.3*	**6.2**	*6.7*	**3.7**	*4.5*	*5.2*	**5.9**	**3.7**	*2.9*
	PM	**9.4**	*7.6*	**10.8**	*4.2*	**6.0**	**4.3**	*6.6*	*3.7*	**2.5**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

na: data not available.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table A-9: Chlorophyll *a* concentrations (mg/L) in the DWSC.

	(ft)	6/14/01	6/21/01	7/13/01	7/20/01[1]	8/25/01[1]	9/11/01	9/18/01	10/16/01	10/25/01
		(Neap)	(Spring)	(Neap)	(Spring)	(Neap)	(Neap + 1d)	(Spring + 1d)	(Spring)	(Neap + 1 d)
LT 38	8.2	*4.1*	**7.5**	*11.7*	**9.1**	*17.1*	*NA*[2]	**8.7**	**20.6**	*14.3*
AM Tide	16.4	*4.0*	**6.4**	*10.7*	**8.5**	*20.0*	*NA*	**9.2**	**20.3**	*12.2*
	24.6	*5.6*	**5.9**	*9.6*	**8.0**	*18.4*	*NA*	**8.6**	**21.1**	*11.7*
	B	*5.4*	**5.9**	*10.1*	**8.0**	*18.8*	*NA*	**8.1**	**20.7**	*11.0*
LT 38	8.2	**4.8**	*12.8*	**16.6**	*9.6*	**30.6**	**NA**	*12.3*	*24.3*	**18.3**
PM Tide	16.4	**4.0**	*7.5*	**9.6**	*8.0*	**26.9**	**NA**	*8.5*	*23.0*	**12.6**
	24.6	**4.6**	*6.4*	**11.7**	*6.9*	**16.1**	**NA**	*7.3*	*21.5*	**12.8**
	B	**4.9**	*5.9*	**10.1**	*8.0*	**26.5**	**NA**	*8.0*	*18.5*	**12.2**
LT 43	8.2	*7.0*	**15.0**	*21.9*	**9.6**	*15.2*	*12.5*	**13.4**	**35.2**	*16.6*
AM Tide	16.4	*7.0*	**10.1**	*16.0*	**9.1**	*13.7*	*11.5*	**13.4**	**32.0**	*15.2*
	24.6	*6.4*	**6.4**	*12.3*	**10.1**	*15.2*	*13.1*	**12.2**	**24.8**	*14.7*
	B	*6.3*	**6.4**	*15.0*	**8.0**	*14.2*	*14.4*	**12.4**	**21.3**	*13.4*
LT 43	8.2	**8.4**	*26.2*	**29.9**	*9.1*	**22.1**	**12.7**	*16.2*	*41.3*	**13.3**
PM Tide	16.4	**6.7**	*9.6*	**30.4**	*6.9*	**15.0**	**10.7**	*11.4*	*28.5*	**12.0**
	24.6	**8.5**	*8.5*	**31.0**	*5.9*	**12.0**	**11.0**	*10.4*	*21.7*	**12.2**
	B	**5.6**	*8.5*	**31.5**	*5.9*	**19.3**	**12.6**	*11.1*	*19.8*	**12.8**
LT 48	8.2	*15.0*	**21.4**	*43.8*	**8.0**	*23.8*	*24.6*	**28.9**	**25.9**	*22.8*
AM Tide	16.4	*15.8*	**20.8**	*39.5*	**NA**	*23.3*	*22.8*	**30.7**	**23.3**	*14.1*
	24.6	*14.0*	**16.6**	*41.1*	**10.1**	*26.5*	*22.8*	**25.1**	**26.4**	*14.1*
	B	*19.9*	**13.4**	*48.1*	**11.7**	*31.6*	*22.0*	**29.5**	**27.7**	*15.3*
LT 48	8.2	**19.4**	*30.4*	**46.5**	*16.6*	**30.7**	**26.1**	*32.3*	*38.7*	**22.5**
PM Tide	16.4	**24.7**	*20.8*	**50.7**	*17.6*	**28.0**	**19.9**	*32.2*	*28.0*	**15.2**
	24.6	**24.0**	*17.6*	**60.3**	*14.4*	**20.6**	**19.7**	*32.2*	*23.5*	**16.1**
	B	**33.4**	*11.7*	**64.6**	*15.0*	**26.2**	**19.7**	*30.7*	*24.3*	**15.3**
San Joaquin River	AM	*31.0*	**16.0**	*77.4*	**17.1**	*34.8*	*31.5*	**41.3**	**26.2**	*12.6*
	PM	**24.7**	*31.2*	**80.6**	**12.8**	**44.1**	**25.8**	*69.4*	*28.8*	**12.6**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

na: data not available.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table A-10: Chlorophyll *a* and Pheophytin *a* concentrations in the DWSC.

Location	Depth	Date								
	(ft)	6/14/01	6/21/01	7/13/01	7/20/01[1]	8/25/01[1]	9/11/01	9/18/01	10/16/01	10/25/01
		(Neap)	(Spring)	(Neap)	(Spring)	(Neap)	(Neap + 1d)	(Spring + 1d)	(Spring)	(Neap + 1 d)
LT 38	8.2	*15.3*	**18.7**	*25.0*	**26.5**	*31.6*	*NA*[2]	**19.7**	**36.2**	*28.5*
AM Tide	16.4	*14.0*	**19.8**	*23.5*	**31.0**	*34.6*	*NA*	**19.7**	**34.1**	*28.9*
	24.6	*15.4*	**20.6**	*20.9*	**26.5**	*37.1*	*NA*	**20.2**	**35.8**	*28.5*
	B	*14.7*	**21.7**	*23.9*	**35.5**	*46.6*	*NA*	**22.7**	**34.8**	*31.1*
LT 38	8.2	**18.6**	*24.7*	**29.2**	*23.9*	**39.8**	**NA**	*20.9*	*34.8*	**29.3**
PM Tide	16.4	**16.5**	*25.0*	**31.0**	*25.0*	**32.2**	**NA**	*19.1*	*35.5*	**26.0**
	24.6	**20.2**	*25.0*	**25.8**	*30.7*	**32.0**	**NA**	*18.9*	*33.7*	**25.8**
	B	**21.5**	*26.9*	**30.7**	*33.3*	**64.7**	**NA**	*20.6*	*32.9*	**26.6**
LT 43	8.2	*22.4*	**35.9**	*37.8*	**29.2**	*27.0*	*31.6*	**32.3**	**45.2**	*26.5*
AM Tide	16.4	*24.6*	**31.8**	*32.5*	**33.6**	*28.4*	*33.0*	**29.9**	**40.1**	*24.1*
	24.6	*22.8*	**31.0**	*31.8*	**35.9**	*29.9*	*33.7*	**31.6**	**36.6**	*27.1*
	B	*25.4*	**34.4**	*32.1*	**33.6**	*29.5*	*38.0*	**42.1**	**45.1**	*31.0*
LT 43	8.2	**25.5**	*49.7*	**45.2**	*22.4*	**33.4**	**27.7**	*27.1*	*49.8*	**21.5**
PM Tide	16.4	**28.2**	*44.9*	**52.3**	*24.3*	**30.2**	**27.3**	*27.6*	*39.5*	**21.6**
	24.6	**37.1**	*43.7*	**55.7**	*26.9*	**24.1**	**30.8**	*27.6*	*36.3*	**20.4**
	B	**26.7**	*45.2*	**59.1**	*34.4*	**42.8**	**38.5**	*34.0*	*39.4*	**27.3**
LT 48	8.2	*40.6*	**49.7**	*66.5*	**27.3**	*35.7*	*50.2*	**45.1**	**36.6**	*24.3*
AM Tide	16.4	*37.7*	**53.5**	*75.1*	**NA**	*41.5*	*47.1*	**49.6**	**31.6**	*23.8*
	24.6	*30.6*	**47.5**	*63.2*	**35.1**	*39.5*	*48.0*	**52.4**	**40.2**	*26.0*
	B	*45.4*	**53.5**	*80.4*	**41.9**	*52.2*	*57.1*	**60.6**	**44.1**	*28.5*
LT 48	8.2	**42.5**	*55.7*	**62.4**	*39.6*	**40.2**	**45.6**	*51.7*	*47.3*	**29.7**
PM Tide	16.4	**55.6**	*51.6*	**71.8**	*40.7*	**40.6**	**40.7**	*55.2*	*36.3*	**23.1**
	24.6	**49.5**	*51.6*	**87.1**	*37.8*	**33.4**	**43.1**	*54.4*	*33.3*	**22.5**
	B	**72.9**	*51.2*	**96.1**	*41.5*	**45.6**	**52.6**	*63.7*	*41.0*	**24.8**
San Joaquin River	AM	*45.6*	**41.7**	*112.1*	**46.7**	*51.9*	*61.8*	**72.5**	**34.8**	*21.2*
	PM	**36.9**	*69.2*	**118.5**	**29.5**	**59.6**	**54.2**	*94.3*	*36.3*	**20.5**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

na: data not available.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Appendix B. Trapped Sediment Deposition Fluxes.

Table B-1: TSS Deposition fluxes in the DWSC.

Location	Depth	Date								
	(ft)	6/14/01	6/21/01	7/13/01	7/20/01[1]	8/25/01[1]	9/11/01	9/18/01	10/16/01	10/25/01
		(Neap)	(Spring)	(Neap)	(Spring)	(Neap)	(Neap + 1d)	(Spring + 1d)	(Spring)	(Neap + 1 d)
LT 38	8.2	*12.0*	**6.2**	*10.3*	**11.6**	*7.6*	*NA*[2]	**9.0**	**7.2**	*15.5*
AM Tide	16.4	*19.8*	**10.6**	*16.1*	**19.3**	*12.5*	*NA*	**11.6**	**10.7**	*18.2*
	24.6	*27.5*	**15.3**	*23.6*	**32.9**	*22.5*	*NA*	**17.8**	**16.5**	*35.2*
	B	*33.1*	**23.2**	*31.9*	**na**	*51.6*	*NA*	**35.9**	**49.9**	*na*
LT 38	8.2	**3.9**	*3.8*	**3.2**	*4.1*	**4.0**	**NA**	*2.2*	*8.5*	**5.1**
PM Tide	16.4	**8.8**	*5.8*	**8.2**	*7.6*	**7.2**	**NA**	*3.1*	*12.2*	**10.2**
	24.6	**15.2**	*9.5*	**13.4**	*11.4*	**13.0**	**NA**	*7.1*	*18.1*	**18.5**
	B	**17.3**	*13.6*	**23.9**	*16.0*	**49.6**	**NA**	*30.5*	*40.0*	**17.8**
LT 43	8.2	*9.8*	**4.2**	*7.8*	**5.2**	*5.7*	*15.1*	**9.0**	**3.7**	*4.2*
AM Tide	16.4	*12.6*	**6.0**	*10.9*	**8.6**	*8.7*	*31.9*	**12.6**	**5.2**	*6.3*
	24.6	*18.6*	**9.6**	*17.2*	**14.3**	*15.6*	*62.2*	**18.9**	**11.6**	*15.5*
	B	*24.6*	**17.3**	*22.8*	**79.6**	*39.5*	*na*	**67.1**	**45.6**	*na*
LT 43	8.2	**3.6**	*5.1*	**3.6**	*3.3*	**3.0**	**na**	*4.9*	*5.0*	**2.7**
PM Tide	16.4	**8.3**	*8.9*	**6.6**	*7.5*	**6.9**	**7.1**	*7.0*	*6.3*	**10.1**
	24.6	**17.9**	*13.6*	**16.8**	*12.2*	**17.3**	**15.2**	*12.7*	*11.2*	**28.8**
	B	**32.2**	*21.5*	**20.9**	*18.4*	**32.7**	**57.1**	*40.7*	*33.4*	**47.4**
LT 48	8.2	*10.5*	**28.3**	*9.8*	**29.7**	*12.3*	*29.7*	**23.6**	**40.4**	*17.6*
AM Tide	16.4	*21.3*	**56.4**	*19.4*	**51.2**	*22.4*	*56.9*	**31.7**	**55.9**	*32.0*
	24.6	*39.2*	**76.5**	*31.3*	**66.8**	*41.9*	*86.1*	**43.9**	**67.4**	*50.1*
	B	*81.8*	**100.7**	*na*	**na**	*83.1*	*213.6*	**89.3**	**79.8**	*na*
LT 48	8.2	**11.8**	*15.5*	**na**	*9.2*	**7.1**	**6.2**	*11.4*	*6.5*	**14.7**
PM Tide	16.4	**24.6**	*31.3*	**17**	*19.9*	**11.4**	**15.6**	*16.5*	*9.4*	**23.7**
	24.6	**39.9**	*38.4*	**37**	*29.9*	**23.1**	**33.8**	*28.2*	*14.2*	**29.3**
	B	**135.0**	*54.3*	**113**	*80.6*	**50.3**	**75.7**	*74.7*	*26.1*	**37.8**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

na: data not available.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table B-2: Deposition Flux (g/ m^{2}hr)of VSS in the DWSC.

Location	Depth	Date								
	(ft)	6/14/01	6/21/01	7/13/01	7/20/01[1]	8/25/01[1]	9/11/01	9/18/01	10/16/01	10/25/01
		(Neap)	(Spring)	(Neap)	(Spring)	(Neap)	(Neap + 1d)	(Spring + 1d)	(Spring)	(Neap + 1 d)
LT 38	8.2	*1.3*	**1.0**	*1.4*	**1.4**	*1.1*	*NA*[2]	**1.2**	**0.8**	*1.7*
AM Tide	16.4	*2.0*	**1.6**	*2.2*	**2.2**	*1.7*	*NA*	**1.6**	**1.2**	*2.2*
	24.6	*3.0*	**2.1**	*3.4*	**3.3**	*2.9*	*NA*	**2.2**	**1.9**	*3.7*
	B	*3.3*	**2.9**	*4.2*	**NA**	*6.3*	*NA*	**4.3**	**5.3**	*NA*
LT 38	8.2	**0.6**	*0.8*	**0.5**	*0.6*	**0.7**	**NA**	*0.3*	*1.1*	**0.7**
PM Tide	16.4	**1.0**	*1.4*	**1.1**	*1.1*	**1.1**	**NA**	*0.4*	*1.5*	**1.4**
	24.6	**1.6**	*1.6*	**1.6**	*1.5*	**1.9**	**NA**	*0.9*	*2.4*	**2.2**
	B	**1.7**	*1.7*	**2.8**	*1.7*	**5.8**	**NA**	*3.5*	*4.8*	**1.9**
LT 43	8.2	*1.5*	**0.7**	*1.1*	**0.6**	*0.8*	*1.6*	**1.1**	**0.6**	*0.7*
AM Tide	16.4	*1.7*	**1.1**	*1.7*	**1.2**	*1.2*	*3.3*	**1.5**	**0.7**	*0.9*
	24.6	*2.5*	**1.5**	*3.6*	**1.6**	*2.4*	*6.0*	**2.2**	**1.4**	*1.9*
	B	*2.8*	**2.2**	*3.2*	**8.3**	*4.5*	**NA**	**7.3**	**4.3**	*NA*
LT 43	8.2	**0.6**	*0.8*	**0.7**	*0.3*	**0.5**	**NA**	*0.7*	*0.7*	**0.4**
PM Tide	16.4	**1.1**	*1.2*	**1.0**	*1.0*	**0.9**	**0.7**	*0.9*	*1.0*	**0.9**
	24.6	**2.1**	*1.9*	**2.2**	*1.6*	**2.3**	**1.7**	*1.5*	*1.3*	**1.8**
	B	**3.4**	*2.5*	**3.2**	*1.9*	**4.1**	**5.6**	*4.2*	*3.7*	**4.4**
LT 48	8.2	*1.1*	**3.1**	*1.3*	**3.1**	*1.5*	*2.9*	**2.7**	**4.0**	*1.7*
AM Tide	16.4	*2.5*	**6.0**	*2.3*	**5.2**	*2.5*	*5.3*	**3.4**	**5.5**	*2.8*
	24.6	*4.3*	**8.4**	*3.6*	**6.6**	*4.6*	*7.7*	**4.6**	**6.5**	*4.4*
	B	*8.0*	**10.1**	*NA*	**NA**	*8.8*	*18.2*	**9.1**	**7.6**	*NA*
LT 48	8.2	**1.2**	*1.6*	**NA**	*1.2*	**1.0**	**0.8**	*1.4*	*1.2*	**1.4**
PM Tide	16.4	**2.4**	*2.9*	**2**	*2.1*	**1.4**	**1.8**	*1.8*	*1.3*	**2.3**
	24.6	**3.5**	*3.3*	**4**	*3.2*	**2.7**	**3.7**	*3.2*	*1.9*	**2.7**
	B	**10.7**	*4.9*	**12**	*8.2*	**4.0**	**7.2**	*7.5*	*3.0*	**3.5**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

na: data not available.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table B-3: Chlorophyll *a* deposition fluxes (mg/m^2 hr) the DWSC.

Location	Depth	Date								
	(ft)	6/14/01	6/21/01	7/13/01	7/20/01[1]	8/25/01[1]	9/11/01	9/18/01	10/16/01	10/25/01
		(Neap)	(Spring)	(Neap)	(Spring)	(Neap)	(Neap + 1d)	(Spring + 1d)	(Spring)	(Neap + 1 d)
LT 38	8.2	*0.7*	**0.7**	*1.4*	**1.1**	*2.0*	*NA*[2]	**0.9**	**1.9**	*1.4*
AM Tide	16.4	*0.7*	**1.0**	*1.4*	**1.3**	*2.9*	*NA*	**0.9**	**2.1**	*1.8*
	24.6	*1.0*	**1.0**	*2.1*	**2.5**	*3.3*	*NA*	**1.4**	**3.0**	*2.4*
	B	*1.4*	**0.9**	*1.6*	**NA**	*5.1*	*NA*	**1.8**	**3.8**	*NA*
LT 38	8.2	**0.5**	*0.7*	**1.4**	*1.0*	**2.9**	**NA**	*0.8*	*2.5*	**1.5**
PM Tide	16.4	**0.7**	*0.8*	**1.5**	*1.1*	**2.5**	**NA**	*0.9*	*2.6*	**1.3**
	24.6	**0.6**	*0.6*	**1.7**	*1.3*	**3.3**	**NA**	*0.9*	*2.9*	**1.8**
	B	**0.4**	*0.9*	**1.8**	*1.7*	**4.0**	**NA**	*1.7*	*4.6*	**2.9**
LT 43	8.2	*1.0*	**1.3**	*2.7*	**0.5**	*1.7*	*2.0*	**1.2**	**2.4**	*1.4*
AM Tide	16.4	*1.5*	**1.2**	*2.6*	**1.0**	*1.9*	*2.6*	**1.9**	**2.4**	*1.4*
	24.6	*1.4*	**1.7**	*2.5*	**1.2**	*1.7*	*9.0*	**2.2**	**3.1**	*1.4*
	B	*1.5*	**1.1**	*2.3*	**1.8**	*3.5*	**NA**	**3.4**	**3.4**	*2.6*
LT 43	8.2	**0.6**	*0.5*	**3.4**	*0.7*	**2.4**	**NA**	*1.4*	*2.9*	**1.7**
PM Tide	16.4	**1.0**	*1.1*	**3.6**	*1.4*	**2.1**	**1.5**	*1.5*	*2.7*	**1.2**
	24.6	**0.9**	*0.9*	**5.1**	*1.1*	**2.6**	**2.0**	*2.0*	*2.8*	**1.7**
	B	**1.5**	*0.5*	**3.2**	*1.1*	**3.5**	**3.6**	*3.0*	*4.2*	**2.9**
LT 48	8.2	*2.8*	**2.7**	*7.8*	**3.0**	*3.4*	*3.5*	**4.1**	**4.1**	*2.0*
AM Tide	16.4	*2.6*	**3.9**	*10.0*	**4.7**	*4.3*	*5.6*	**5.4**	**4.5**	*2.6*
	24.6	*3.0*	**5.0**	*11.1*	**5.9**	*5.9*	*2.7*	**5.9**	**4.9**	*3.1*
	B	*5.3*	**5.0**	*NA*	**NA**	*7.3*	*14.5*	**8.2**	**6.9**	*NA*
LT 48	8.2	**3.1**	*2.8*	**NA**	*2.7*	**4.1**	**3.5**	*5.6*	*10.7*	**2.9**
PM Tide	16.4	**4.0**	*2.2*	**9**	*2.4*	**4.1**	**5.8**	*5.9*	*8.0*	**1.8**
	24.6	**4.7**	*2.9*	**12**	*2.5*	**5.1**	**5.6**	*6.9*	*9.9*	**4.1**
	B	**9.2**	*1.5*	**21**	*10.7*	**7.9**	**9.0**	*8.7*	*10.9*	**5.8**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

na: data not available.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table B-4: Chlorophyll *a* and pheophytin *a* fluxes (mg/m^{2}hr) the DWSC.

Location	Depth (ft)	Date 6/14/01 (Neap)	6/21/01 (Spring)	7/13/01 (Neap)	7/20/01[1] (Spring)	8/25/01[1] (Neap)	9/11/01 (Neap + 1d)	9/18/01 (Spring + 1d)	10/16/01 (Spring)	10/25/01 (Neap + 1 d)
LT 38	8.2	*4.0*	**3.6**	*5.5*	**8.3**	*6.1*	*NA*[2]	**4.8**	**4.6**	*5.6*
AM Tide	16.4	*5.1*	**5.0**	*7.2*	**10.2**	*8.1*	*NA*	**6.7**	**6.4**	*7.6*
	24.6	*6.8*	**6.7**	*9.9*	**17.3**	*13.5*	*NA*	**8.8**	**9.2**	*11.8*
	B	*8.8*	**8.3**	*12.4*	**NA**	*24.3*	*NA*	**14.8**	**20.5**	*NA*
LT 38	8.2	**1.9**	*2.4*	**3.3**	*3.4*	**5.6**	**NA**	*2.1*	*5.4*	**4.0**
PM Tide	16.4	**3.3**	*4.6*	**5.7**	*5.8*	**6.3**	**NA**	*2.1*	*7.5*	**5.5**
	24.6	**4.9**	*3.7*	**7.2**	*5.6*	**10.3**	**NA**	*3.6*	*9.8*	**8.3**
	B	**5.1**	*6.7*	**11.0**	*8.2*	**23.6**	**NA**	*12.5*	*18.2*	**15.9**
LT 43	8.2	*4.5*	**5.3**	*8.0*	**3.2**	*4.4*	*8.9*	**5.9**	**4.5**	*2.8*
AM Tide	16.4	*5.3*	**6.0**	*9.9*	**6.2**	*6.2*	*13.5*	**7.9**	**4.7**	*3.8*
	24.6	*7.2*	**7.8**	*13.5*	**8.3**	*8.5*	*35.0*	**10.8**	**7.3**	*6.5*
	B	*8.3*	**9.2**	*15.4*	**20.8**	*19.1*	**NA**	**32.0**	**17.4**	*11.3*
LT 43	8.2	**2.4**	*1.9*	**6.6**	*2.1*	**4.7**	**NA**	*3.9*	*5.4*	**3.0**
PM Tide	16.4	**5.4**	*3.9*	**9.3**	*7.2*	**6.5**	**5.5**	*5.5*	*6.2*	**3.3**
	24.6	**8.1**	*5.0*	**16.9**	*5.9*	**9.7**	**8.2**	*8.9*	*7.7*	**5.7**
	B	**13.2**	*3.3*	**19.5**	*7.8*	**16.8**	**24.7**	*21.7*	*16.9*	**14.7**
LT 48	8.2	*7.4*	**16.6**	*16.0*	**17.9**	*8.6*	*14.2*	**15.2**	**14.1**	*5.9*
AM Tide	16.4	*12.3*	**28.4**	*22.4*	**27.2**	*11.7*	*22.8*	**19.5**	**17.2**	*9.7*
	24.6	*18.1*	**39.2**	*29.9*	**31.2**	*20.5*	*21.9*	**25.0**	**20.7**	*13.8*
	B	*30.4*	**43.5**	*NA*	**NA**	*29.6*	*63.9*	**46.0**	**27.8**	*NA*
LT 48	8.2	**8.5**	*6.9*	**NA**	*7.7*	**7.0**	**7.2**	*11.3*	*13.4*	**5.9**
PM Tide	16.4	**12.2**	*8.7*	**21**	*8.8*	**9.5**	**10.7**	*15.2*	*10.9*	**7.6**
	24.6	**17.8**	*13.2*	**29**	*17.3*	**13.4**	**18.9**	*20.9*	*14.9*	**10.0**
	B	**41.5**	*9.5*	**63**	*48.4*	**24.1**	**35.2**	*45.4*	*19.0*	**16.9**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

na: data not available.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Appendix C. Settling Velocities of Trapped Sediment.

Table C-1. Settling velocities of TSS (m/hr) in the DWSC.

Location	Depth (ft)	Date 6/14/01 (Neap)	6/21/01 (Spring)	7/13/01 (Neap)	7/20/01[1] (Spring)	8/25/01[1] (Neap)	9/11/01 (Neap + 1d)	9/18/01 (Spring + 1d)	10/16/01 (Spring)	10/25/01 (Neap + 1 d)
LT 38	8.2	*0.56*	**0.42**	*0.66*	**0.63**	*0.41*	*NA*[2]	**0.53**	**0.36**	*NA*[3]
AM Tide	16.4	*0.89*	**0.53**	*0.96*	**0.94**	*0.59*	*NA*	**0.59**	**0.53**	*NA*[3]
	24.6	*0.99*	**0.71**	*1.50*	**1.62**	*0.73*	*NA*	**0.84**	**0.58**	*NA*[3]
	B	*0.97*	**0.98**	*1.10*	**NA**	*1.29*	*NA*	**1.26**	**1.17**	*NA*[3]
LT 38	8.2	**0.20**	*0.27*	**0.22**	*0.28*	**0.25**	**NA**	*0.18*	*0.50*	**0.37**
PM Tide	16.4	**0.35**	*0.33*	**0.42**	*0.54*	**0.39**	**NA**	*0.21*	*0.71*	**0.66**
	24.6	**0.63**	*0.61*	**0.69**	*0.69*	**0.57**	**NA**	*0.39*	*0.97*	**0.97**
	B	**0.76**	*0.66*	**1.00**	*0.68*	**0.81**	**NA**	*1.40*	*1.77*	**0.68**
LT 43	8.2	*0.35*	**0.28**	*0.59*	**0.31**	*0.35*	*0.80*	**0.47**	**0.29**	*0.28*
AM Tide	16.4	*0.43*	**0.38**	*0.80*	**0.44**	*0.50*	*1.48*	**0.63**	**0.37**	*0.47*
	24.6	*0.62*	**0.49**	*1.03*	**0.54**	*0.81*	*2.62*	**0.80**	**0.61**	*0.72*
	B	*0.61*	**0.58**	*1.10*	**3.03**	*1.04*	**NA**	**1.22**	**0.94**	*NA*
LT 43	8.2	**0.17**	*0.32*	**0.25**	*0.24*	**0.23**	**NA**	*0.36*	*0.33*	**0.20**
PM Tide	16.4	**0.33**	*0.52*	**0.36**	*0.50*	**0.42**	**0.40**	*0.41*	*0.43*	**0.63**
	24.6	**0.51**	*0.63*	**0.91**	*0.76*	**0.68**	**0.80**	*0.64*	*0.58*	**1.71**
	B	**0.61**	*0.75*	**0.87**	*0.78*	**1.09**	**1.60**	*1.28*	*1.11*	**0.92**
LT 48	8.2	*0.32*	**1.11**	*0.55*	**2.12**	*0.63*	*1.44*	**1.17**	**1.13**	*0.87*
AM Tide	16.4	*0.89*	**1.95**	*0.97*	**3.10**	*1.05*	*2.48*	**1.53**	**1.58**	*1.43*
	24.6	*1.19*	**2.60**	*1.30*	**3.83**	*1.57*	*3.71*	**1.93**	**1.80**	*1.62*
	B	*2.62*	**3.11**	*NA*	**NA**	*2.14*	*5.32*	**2.03**	**1.78**	*NA*
LT 48	8.2	**0.46**	*0.75*	**NA**	*0.45*	**0.40**	**0.36**	*0.73*	*0.40*	**1.09**
PM Tide	16.4	**0.88**	*1.36*	**0.81**	*0.93*	**0.62**	**0.76**	*0.70*	*0.57*	**1.36**
	24.6	**1.29**	*1.49*	**1.48**	*1.44*	**0.98**	**1.86**	*0.91*	*0.81*	**1.77**
	B	**2.72**	*1.67*	**3.41**	*3.25*	**1.14**	**2.09**	*2.31*	*1.17*	**1.68**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

na: data not available.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table C-2: Settling velocities (m/hr) of VSS in the DWSC

Location	Depth (ft)	Date 6/14/01 (Neap)	6/21/01 (Spring)	7/13/01 (Neap)	7/20/01[1] (Spring)	8/25/01[1] (Neap)	9/11/01 (Neap + 1d)	9/18/01 (Spring + 1d)	10/16/01 (Spring)	10/25/01 (Neap + 1 d)
LT 38	8.2	*0.42*	**0.41**	*0.43*	**0.55**	*0.29*	*NA[2]*	**0.38**	**0.18**	*NA[3]*
AM Tide	16.4	*0.64*	**0.48**	*0.60*	**0.74**	*0.39*	*NA*	**0.45**	**0.31**	*NA[3]*
	24.6	*0.75*	**0.65**	*1.03*	**1.09**	*0.52*	*NA*	**0.58**	**0.37**	*NA[3]*
	B	*0.69*	**1.00**	*0.76*	**NA**	*0.91*	*NA*	**0.90**	**0.79**	*NA[3]*
LT 38	8.2	**0.16**	*0.45*	**0.16**	*0.22*	**0.19**	**NA**	*0.11*	*0.29*	**0.21**
PM Tide	16.4	**0.28**	*0.51*	**0.29**	*0.41*	**0.31**	**NA**	*0.15*	*0.39*	**0.49**
	24.6	**0.42**	*0.53*	**0.44**	*0.56*	**0.55**	**NA**	*0.29*	*0.65*	**0.79**
	B	**0.58**	*0.52*	**0.74**	*0.46*	**0.68**	**NA**	*0.99*	*1.16*	**0.42**
LT 43	8.2	*0.34*	**0.20**	*0.29*	**0.25**	*0.20*	*0.41*	**0.31**	**0.15**	*0.35*
AM Tide	16.4	*0.38*	**0.33**	*0.60*	**0.47**	*0.35*	*0.86*	**0.44**	**0.22**	*0.38*
	24.6	*0.57*	**0.35**	*0.98*	**0.49**	*0.63*	*1.32*	**0.61**	**0.34**	*0.66*
	B	*0.54*	**0.37**	*0.80*	**2.50**	*0.80*	**NA**	**0.92**	**0.59**	*NA3*
LT 43	8.2	**0.16**	*0.14*	**0.19**	*0.13*	**0.18**	**NA**	*0.20*	*0.17*	**0.16**
PM Tide	16.4	**0.24**	*0.23*	**0.26**	*0.35*	**0.31**	**0.19**	*0.25*	*0.30*	**0.26**
	24.6	**0.47**	*0.36*	**0.58**	*0.57*	**0.58**	**0.52**	*0.41*	*0.35*	**0.55**
	B	**0.40**	*0.42*	**0.68**	*0.50*	**0.85**	**0.98**	*0.84*	*0.74*	**0.65**
LT 48	8.2	*0.19*	**0.78**	*0.33*	**1.18**	*0.35*	*0.60*	**0.66**	**0.76**	*0.53*
AM Tide	16.4	*0.53*	**1.11**	*0.47*	**1.78**	*0.66*	*1.10*	**0.76**	**1.01**	*0.92*
	24.6	*0.77*	**1.67**	*0.73*	**2.13**	*0.83*	*1.76*	**1.00**	**1.13**	*0.99*
	B	*2.07*	**2.01**	*NA*	**NA**	*1.35*	*2.58*	**1.35**	**1.14**	*NA3*
LT 48	8.2	**0.29**	*0.27*	**NA**	*0.27*	**0.23**	**0.18**	*0.37*	*0.25*	**0.36**
PM Tide	16.4	**0.45**	*0.53*	**0.40**	*0.52*	**0.36**	**0.42**	*0.41*	*0.40*	**0.66**
	24.6	**0.55**	*0.62*	**0.66**	*0.85*	**0.61**	**1.09**	*0.65*	*0.54*	**0.85**
	B	**1.34**	*0.76*	**1.55**	*1.93*	**0.53**	**1.10**	*1.31*	*0.79*	**1.06**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

na: data not available.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table C-3: Chlorophyll *a* settling velocities (m/hr) in the DWSC.

	(ft)	6/14/01 (Neap)	6/21/01 (Spring)	7/13/01 (Neap)	7/20/01[1] (Spring)	8/25/01[1] (Neap)	9/11/01 (Neap + 1d)	9/18/01 (Spring + 1d)	10/16/01 (Spring)	10/25/01 (Neap + 1 d)
LT 38	8.2	*0.16*	**0.10**	*0.12*	**0.12**	*0.12*	*NA*[2]	**0.10**	**0.09**	*0.10*
AM Tide	16.4	*0.19*	**0.15**	*0.13*	**0.16**	*0.15*	*NA*	**0.10**	**0.10**	*0.14*
	24.6	*0.18*	**0.17**	*0.22*	**0.31**	*0.18*	*NA*	**0.17**	**0.14**	*0.21*
	B	*0.27*	**0.15**	*0.16*	**NA**	*0.27*	*NA*	**0.22**	**0.18**	*NA*
LT 38	8.2	**0.11**	*0.05*	**0.09**	*0.11*	**0.10**	**NA**	*0.06*	*0.10*	**0.08**
PM Tide	16.4	**0.17**	*0.10*	**0.15**	*0.13*	**0.09**	**NA**	*0.11*	*0.11*	**0.11**
	24.6	**0.14**	*0.10*	**0.15**	*0.18*	**0.20**	**NA**	*0.13*	*0.13*	**0.14**
	B	**0.08**	*0.15*	**0.18**	*0.22*	**0.15**	**NA**	*0.21*	*0.25*	**0.24**
LT 43	8.2	*0.14*	**0.08**	*0.12*	**0.05**	*0.11*	*0.16*	**0.09**	**0.07**	*0.08*
AM Tide	16.4	*0.21*	**0.12**	*0.16*	**0.11**	*0.14*	*0.22*	**0.14**	**0.07**	*0.09*
	24.6	*0.21*	**0.26**	*0.20*	**0.12**	*0.11*	*0.69*	**0.18**	**0.12**	*0.10*
	B	*0.23*	**0.17**	*0.16*	**0.23**	*0.25*	**NA**	**0.27**	**0.16**	*0.19*
LT 43	8.2	**0.07**	*0.02*	**0.11**	*0.07*	**0.11**	**NA**	*0.09*	*0.07*	**0.13**
PM Tide	16.4	**0.15**	*0.11*	**0.12**	*0.21*	**0.14**	**0.14**	*0.13*	*0.10*	**0.10**
	24.6	**0.10**	*0.11*	**0.16**	*0.20*	**0.21**	**0.18**	*0.20*	*0.13*	**0.14**
	B	**0.27**	*0.06*	**0.10**	*0.18*	**0.18**	**0.29**	*0.27*	*0.21*	**0.23**
LT 48	8.2	*0.19*	**0.13**	*0.18*	**0.38**	*0.14*	*0.14*	**0.14**	**0.16**	*0.09*
AM Tide	16.4	*0.16*	**0.19**	*0.25*	**NA**	*0.18*	*0.25*	**0.18**	**0.19**	*0.18*
	24.6	*0.21*	**0.30**	*0.27*	**0.58**	*0.22*	*0.12*	**0.23**	**0.19**	*0.22*
	B	*0.27*	**0.38**	*NA*	**NA**	*0.23*	*0.66*	**0.28**	**0.25**	*NA*
LT 48	8.2	**0.16**	*0.09*	**NA**	*0.16*	**0.13**	**0.14**	*0.17*	*0.28*	**0.13**
PM Tide	16.4	**0.16**	*0.11*	**0.17**	*0.14*	**0.15**	**0.29**	*0.18*	*0.28*	**0.25**
	24.6	**0.20**	*0.17*	**0.19**	*0.23*	**0.25**	**0.28**	*0.22*	*0.42*	**0.26**
	B	**0.27**	*0.13*	**0.32**	*0.72*	**0.30**	**0.46**	*0.28*	*0.45*	**0.38**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

na: data not available.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Table C-4: Settling velocities of chlorophyll *a* and pheophytin *a* (m/hr) in the DWSC.

Location	Depth (ft)	Date								
		6/14/01 (Neap)	6/21/01 (Spring)	7/13/01 (Neap)	7/20/01[1] (Spring)	8/25/01[1] (Neap)	9/11/01 (Neap + 1d)	9/18/01 (Spring + 1d)	10/16/01 (Spring)	10/25/01 (Neap + 1 d)
LT 38	8.2	*0.26*	**0.19**	*0.22*	**0.31**	*0.19*	*NA*[2]	**0.25**	**0.13**	*0.20*
AM Tide	16.4	*0.37*	**0.25**	*0.31*	**0.33**	*0.23*	*NA*	**0.34**	**0.19**	*0.26*
	24.6	*0.44*	**0.32**	*0.47*	**0.65**	*0.36*	*NA*	**0.44**	**0.26**	*0.41*
	B	*0.60*	**0.38**	*0.52*	**NA**	*0.52*	*NA*	**0.65**	**0.59**	*NA*
LT 38	8.2	**0.10**	*0.10*	**0.11**	*0.14*	**0.14**	**NA**	*0.10*	*0.15*	**0.14**
PM Tide	16.4	**0.20**	*0.19*	**0.18**	*0.23*	**0.19**	**NA**	*0.11*	*0.21*	**0.21**
	24.6	**0.24**	*0.15*	**0.28**	*0.18*	**0.32**	**NA**	*0.19*	*0.29*	**0.32**
	B	**0.24**	*0.25*	**0.36**	*0.25*	**0.37**	**NA**	*0.61*	*0.55*	**0.60**
LT 43	8.2	*0.20*	**0.15**	*0.21*	**0.11**	*0.16*	*0.28*	**0.18**	**0.10**	*0.10*
AM Tide	16.4	*0.22*	**0.19**	*0.31*	**0.18**	*0.22*	*0.41*	**0.27**	**0.12**	*0.16*
	24.6	*0.32*	**0.25**	*0.42*	**0.23**	*0.28*	*1.04*	**0.34**	**0.20**	*0.24*
	B	*0.33*	**0.27**	*0.48*	**0.62**	*0.65*	**NA**	**0.76**	**0.38**	*0.36*
LT 43	8.2	**0.10**	*0.04*	**0.15**	*0.09*	**0.14**	**NA**	*0.14*	*0.11*	**0.14**
PM Tide	16.4	**0.19**	*0.09*	**0.18**	*0.29*	**0.22**	**0.20**	*0.20*	*0.16*	**0.15**
	24.6	**0.22**	*0.11*	**0.30**	*0.22*	**0.40**	**0.27**	*0.32*	*0.21*	**0.28**
	B	**0.49**	*0.07*	**0.33**	*0.23*	**0.39**	**0.64**	*0.64*	*0.43*	**0.54**
LT 48	8.2	*0.18*	**0.33**	*0.24*	**0.66**	*0.24*	*0.28*	**0.34**	**0.39**	*0.24*
AM Tide	16.4	*0.33*	**0.53**	*0.30*	**NA**	*0.28*	*0.48*	**0.39**	**0.55**	*0.41*
	24.6	*0.59*	**0.83**	*0.47*	**0.89**	*0.52*	*0.46*	**0.48**	**0.51**	*0.53*
	B	*0.67*	**0.81**	*NA*	**NA**	*0.57*	*1.12*	**0.76**	**0.63**	*NA*
LT 48	8.2	**0.20**	*0.12*	**NA**	*0.20*	**0.18**	**0.16**	*0.22*	*0.28*	**0.20**
PM Tide	16.4	**0.22**	*0.17*	**0.29**	*0.22*	**0.23**	**0.26**	*0.27*	*0.30*	**0.40**
	24.6	**0.36**	*0.26*	**0.33**	*0.33*	**0.40**	**0.44**	*0.38*	*0.45*	**0.45**
	B	**0.57**	*0.18*	**0.65**	*1.17*	**0.53**	**0.67**	*0.71*	*0.46*	**0.68**

Italic values denote flood tide sampling. Bold face values denote ebb tide sampling.

na: data not available.

[1]Lt Trap 38 was placed at Lt. 45.

[2]The Lt. 38 sediment trap was destroyed by a ship 30 minutes after morning deployment.

[3]Location at the USGS stream velocity gage station above Stockton wastewater outfall.

Appendix D: Long-Term Oxygen Demand Experimental Data

Table D-1: BOD fitting parameters and oxygen demands for water samples collected in the DWSC and San Joaquin River at the USGS UVM Station.

Sample	Date	R^2	K	L_o	BOD_5	BOD_{10}	BOD_{20}
			d^{-1}	mg/L	mg/L	mg/L	mg/L
SJ River - Ebb	06/14/01	0.955	0.112	14.1	6.0	9.5	12.6
SJ River - Flood	06/14/01	0.977	0.108	12.9	5.4	8.5	11.4
BOD LT 48 - 5 - Ebb	06/14/01	0.977	0.144	9.9	5.1	7.6	9.3
sBOD LT 48 - 5 - Ebb	06/14/01	0.995	0.045	6.5	1.3	2.3	3.8
sCBOD LT 48 - 5 - Ebb	06/14/01	0.906	0.155	1.3	0.7	1.0	1.2
BOD LT 43 - 5 - Ebb	06/14/01	0.953	0.098	9.0	3.5	5.6	7.7
sCBOD LT 43 - 5 - Ebb	06/14/01	0.940	0.052	3.6	0.8	1.4	2.3
BOD LT 38 - 5 - Ebb	06/14/01	0.980	0.123	10.7	4.9	7.5	9.7
sCBOD LT 38 - 5 - Ebb	06/14/01	0.932	0.091	1.6	0.6	1.0	1.3

BOD SJ River - Ebb	06/21/01	0.995	0.103	11.6	4.7	7.4	10.1
sBOD SJ River - Ebb	06/21/01	0.988	0.059	10.4	2.7	4.6	7.2
sCBOD SJ River - Ebb	06/21/01	0.694	0.075	6.4	2.0	3.4	5.0
BOD SJ River - Flood	06/21/01	0.975	0.099	12.4	4.8	7.8	10.7
sBOD SJ River - Flood	06/21/01	0.803	0.086	12.5	4.4	7.2	10.3
sCBOD SJ River - Flood	06/21/01	0.907	0.063	9.9	2.7	4.6	7.1
BOD LT 48 - 5 - Ebb	06/21/01	0.999	0.072	7.8	2.4	4.0	6.0
sBOD LT 48 - 5 - Ebb	06/21/01	0.373	0.027	13.1	1.6	3.1	5.4
sCBOD LT 48 - 5 - Ebb	06/21/01	0.879	0.074	4.3	1.3	2.2	3.3
BOD LT 38 - 5 - Ebb	06/21/01	0.949	0.112	7.0	3.0	4.7	6.3
sBOD LT 38 - 5 - Ebb	06/21/01	0.960	0.045	13.0	2.6	4.7	7.8
sCBOD LT 38 - 5 - Ebb	06/21/01	0.983	0.077	4.4	1.4	2.4	3.4
BOD LT 48 - 2.5 - Ebb	06/21/01	0.969	0.086	12.2	4.3	7.1	10.1
BOD LT 48 - 7.5 - Ebb	06/21/01	0.953	0.099	11.9	4.6	7.4	10.2

BOD SJ River - Flood	07/13/00	0.465	0.057	18.0	4.5	7.9	12.3
CBOD SJ River - Flood	07/13/00	0.995	0.067	8.2	2.3	4.0	6.0
sBOD SJ River - Flood	07/13/00	0.788	0.063	7.6	2.0	3.5	5.4
sCBOD SJ River - Flood	07/13/00	0.964	0.104	3.1	1.2	2.0	2.7
BOD SJ River - Ebb	07/13/00	0.984	0.071	16.8	5.0	8.6	12.8
CBOD SJ River - Ebb	07/13/00	0.990	0.072	10.4	3.2	5.3	7.9
sBOD SJ River - Ebb	07/13/00	0.955	0.084	13.5	4.6	7.7	11.0
sCBOD SJ River - Ebb	07/13/00	0.913	0.055	13.0	3.1	5.5	8.6
BOD LT 48 - 5.0 - Ebb	07/13/00	0.989	0.083	13.0	4.4	7.3	10.6
CBOD LT 48 - 5.0 - Ebb	07/13/00	0.983	0.104	8.2	3.3	5.3	7.2
sBOD LT 48 - 5.0 - Ebb	07/13/00	0.747	0.041	9.0	1.7	3.0	5.0
sCBOD LT 48 - 5.0 - Ebb	07/13/00	0.612	0.040	5.1	0.9	1.7	2.8
BOD LT 48 -B - Ebb	07/13/00	0.980	0.072	16.9	5.1	8.7	12.9
CBOD LT 48 - B - Ebb	07/13/00	0.987	0.113	7.8	3.4	5.3	7.0
sBOD LT 48 - B - Ebb	07/13/00	0.898	0.088	11.9	4.2	6.9	9.8
sCBOD LT 48 - B - Ebb	07/13/00	0.970	0.087	9.3	3.3	5.4	7.6
BOD LT 43 - 5.0 - Ebb	07/13/00	0.964	0.117	10.2	4.5	7.1	9.3
CBOD LT 43 - 5.0 - Ebb	07/13/00	0.967	0.124	5.9	2.7	4.2	5.4
sBOD LT 43 - 5.0 - Ebb	07/13/00	0.923	0.061	6.4	1.7	2.9	4.5
sCBOD LT 43 - 5.0 - Ebb	07/13/00	0.875	0.112	4.6	2.0	3.1	4.1

Sample	Date	R^2	K	L_o	BOD_5	BOD_{10}	BOD_{20}
BOD LT 43 - B - Ebb	07/13/00	0.770	0.105	9.6	3.9	6.3	8.4
CBOD LT 43 - B - Ebb	07/13/00	0.983	0.109	5.3	2.2	3.5	4.7
sBOD LT 43 - B - Ebb	07/13/00	0.777	0.075	5.3	1.7	2.8	4.1
sCBOD LT 43 - B - Ebb	07/13/00	0.849	0.069	2.4	0.7	1.2	1.8
BOD SJ River - Flood	07/20/01	0.945	0.089	10.8	3.9	6.4	9.0
CBOD SJ River - Flood	07/20/01	0.978	0.103	6.5	2.6	4.2	5.7
BOD SJ River - Ebb	07/20/01	0.919	0.094	10.8	4.1	6.6	9.2
CBOD SJ River - Ebb	07/20/01	0.964	0.100	5.5	2.2	3.5	4.8
sBOD SJ River - Ebb	07/20/01	0.941	0.049	11.2	2.4	4.4	7.0
sCBOD SJ River - Ebb	07/20/01	0.959	0.096	4.3	1.6	2.6	3.7
BOD LT 43 - 5.0 - Ebb	07/20/01	0.954	0.096	11.3	4.3	6.9	9.6
CBOD LT 43 - 5.0 - Ebb	07/20/01	0.970	0.103	5.4	2.2	3.5	4.7
sBOD LT 43 - 5.0 - Ebb	07/20/01	0.941	0.067	7.8	2.2	3.8	5.8
sCBOD LT 43 - 5.0 - Ebb	07/20/01	0.987	0.118	3.1	1.4	2.1	2.8
BOD LT 43 - 5.0 - flood	07/20/01	0.927	0.045	11.5	2.3	4.2	6.8
CBOD LT 43 - 5.0 - flood	07/20/01	0.986	0.088	4.0	1.4	2.3	3.3
sBOD LT 43 - 5.0 - flood	07/20/01	0.695	0.028	12.6	1.7	3.1	5.4
sCBOD LT 43 - 5.0 - flood	07/20/01	0.966	0.089	3.2	1.2	1.9	2.7
BOD LT 45-5.0-Flood	07/20/01	0.886	0.057	10.0	2.5	4.4	6.8
BOD Lt. 45-B-Flood	07/20/01	0.984	0.083	10.4	3.5	5.9	8.4

BOD SJ River - Flood	08/25/01	0.936	0.057	19.4	4.8	8.5	13.3
CBOD SJ River - Flood	08/25/01	0.990	0.134	6.8	3.3	5.0	6.3
sBOD SJ River - Flood	08/25/01	0.926	0.102	10.3	4.1	6.6	8.9
sCBOD SJ River - Flood	08/25/01	0.999	0.135	6.8	3.3	5.0	6.3
BOD SJ River - Ebb	08/25/01	0.966	0.090	13.9	5.0	8.3	11.6
CBOD SJ River - Ebb	08/25/01	0.999	0.127	7.8	3.7	5.6	7.2
sBOD SJ River - Ebb	08/25/01	0.953	0.113	10.2	4.4	6.9	9.1
sCBOD SJ River - Ebb	08/25/01	0.969	0.114	6.8	2.9	4.6	6.1
BOD LT 43 - 5.0 - Flood	08/25/01	0.976	0.167	10.6	6.0	8.6	10.2
CBOD LT 43 - 5.0 - Flood	08/25/01	0.997	0.138	6.3	3.1	4.7	5.9
sBOD LT 43 - 5.0 - Flood	08/25/01	0.999	0.132	8.6	4.2	6.3	8.0
sCBOD LT 43 - 5.0 - Flood	08/25/01	1.000	0.168	3.5	2.0	2.8	3.4
BOD LT 43 - 5.0 - Ebb	08/25/01	0.990	0.156	11.0	5.9	8.7	10.5
CBOD LT 43 - 5.0 - Ebb	08/25/01	0.998	0.166	6.1	3.4	4.9	5.9
sBOD LT 43 - 5.0 - Ebb	08/25/01	0.950	0.110	11.3	4.8	7.5	10.0
sCBOD LT 43 - 5.0 - Ebb	08/25/01	0.988	0.087	7.9	2.8	4.6	6.5
BOD LT 43 - B - Flood	08/25/01	0.996	0.142	12.1	6.2	9.2	11.4
BOD LT 43 - B - Ebb	08/25/01	0.998	0.156	11.3	6.1	8.9	10.8
BOD LT 48 - B - Flood	08/25/01	0.996	0.142	12.1	6.2	9.2	11.4
BOD LT 48 - B - Ebb	08/25/01	0.989	0.111	11.3	4.8	7.6	10.1

BOD SJ River - Flood	09/11/01	0.997	0.092	8.7	3.2	5.3	7.4
CBOD SJ River - Flood	09/11/01	0.987	0.108	5.7	2.4	3.8	5.0
sBOD SJ River - Flood	09/11/01	0.963	0.049	5.6	1.2	2.2	3.5
sCBOD SJ River - Flood	09/11/01	0.993	0.119	2.2	1.0	1.5	2.0
BOD SJ River - Ebb	09/11/01	0.996	0.053	11.3	2.6	4.7	7.4
CBOD SJ River - Ebb	09/11/01	0.991	0.106	5.0	2.1	3.3	4.4
sBOD SJ River - Ebb	09/11/01	0.526	0.014	15.2	1.0	2.0	3.7
sCBOD SJ River - Ebb	09/11/01	0.986	0.119	2.3	1.0	1.6	2.1

Sample	Date	R^2	K	L_o	BOD_5	BOD_{10}	BOD_{20}
BOD LT 48 - 5.0 - Ebb	09/11/01	0.997	0.064	11.9	3.3	5.6	8.6
CBOD LT 48 - 5.0 - Ebb	09/11/01	0.996	0.094	4.0	1.5	2.5	3.4
sBOD LT 48 - 5.0 - Ebb	09/11/01	0.990	0.045	7.1	1.4	2.6	4.2
sCBOD LT 48 - 5.0 - Ebb	09/11/01	0.978	0.077	1.7	0.6	0.9	1.4
BOD LT 43 - 5.0 - Flood	09/11/01	0.998	0.095	7.4	2.8	4.5	6.3
CBOD LT 43 - 5.0 - Flood	09/11/01	0.997	0.099	3.5	1.4	2.2	3.0
sBOD LT 43 - 5.0 - Flood	09/11/01	0.924	0.047	7.4	1.6	2.8	4.6
sCBOD LT 43 - 5.0 - Flood	09/11/01	0.903	0.065	1.9	0.5	0.9	1.4
BOD SJ River - Ebb	09/18/01	0.963	0.075	14.1	4.4	7.5	11.0
CBOD SJ River - Ebb	09/18/01	0.968	0.116	6.3	2.8	4.4	5.7
sBOD SJ River - Ebb	09/18/01	0.917	0.027	15.4	2.0	3.7	6.5
sCBOD SJ River - Ebb	09/18/01	0.999	0.062	5.0	1.3	2.3	3.6
BOD SJ River - Flood	09/18/01	0.989	0.085	13.9	4.8	8.0	11.4
CBOD SJ River - Flood	09/18/01	0.964	0.116	7.9	3.5	5.4	7.1
sBOD SJ River - Flood	09/18/01	0.932	0.027	7.9	1.0	1.9	3.3
sCBOD SJ River - Flood	09/18/01	0.872	0.071	2.3	0.7	1.1	1.7
BOD LT 43 - 5.0 - Ebb	09/18/01	0.994	0.085	10.2	3.5	5.8	8.3
CBOD LT 43 - 5.0 - Ebb	09/18/01	0.935	0.107	3.5	1.5	2.3	3.1
sBOD LT 43 - 5.0 - Ebb	09/18/01	0.998	0.082	6.4	2.1	3.6	5.1
sCBOD LT 43 - 5.0 - Ebb	09/18/01	0.882	0.090	1.4	0.5	0.8	1.1
BOD LT 43 - 5.0 - flood	09/18/01	0.973	0.064	10.3	2.8	4.9	7.5
CBOD LT 43 - 5.0 - flood	09/18/01	0.947	0.099	3.8	1.5	2.4	3.3
sBOD LT 43 - 5.0 - flood	09/18/01	0.995	0.065	6.3	1.8	3.0	4.6
sCBOD LT 43 - 5.0 - flood	09/18/01	0.718	0.078	1.0	0.3	0.6	0.8
BOD SJ River - Ebb	10/16/01	0.985	0.115	7.2	3.1	4.9	6.5
CBOD SJ River - Ebb	10/16/01	0.945	0.130	3.8	1.8	2.8	3.5
sBOD SJ River - Ebb	10/16/01	0.951	0.091	4.9	1.8	2.9	4.1
sCBOD SJ River - Ebb	10/16/01	0.978	0.075	1.8	0.6	1.0	1.4
BOD SJ River - Flood	10/16/01	0.986	0.100	9.6	3.8	6.1	8.3
CBOD SJ River - Flood	10/16/01	0.964	0.145	5.6	2.9	4.3	5.3
sBOD SJ River - Flood	10/16/01	0.972	0.029	7.2	1.0	1.8	3.2
sCBOD SJ River - Flood	10/16/01	1.000	0.080	1.7	0.6	0.9	1.4
BOD LT 43 - 5.0 - Ebb	10/16/01	0.960	0.075	12.6	3.9	6.6	9.8
CBOD LT 43 - 5.0 - Ebb	10/16/01	0.982	0.111	5.0	2.2	3.4	4.5
sBOD LT 43 - 5.0 - Ebb	10/16/01	1.000	0.085	7.1	2.5	4.1	5.8
sCBOD LT 43 - 5.0 - Ebb	10/16/01	0.981	0.090	2.8	1.0	1.7	2.4
BOD LT 43 - 5.0 - Flood	10/16/01	0.964	0.063	13.0	3.5	6.0	9.3
CBOD LT 43 - 5.0 - Flood	10/16/01	0.975	0.147	5.7	3.0	4.4	5.4
sBOD LT 43 - 5.0 - Flood	10/16/01	0.975	0.103	3.6	1.5	2.3	3.1
sCBOD LT 43 - 5.0 - Flood	10/16/01	0.988	0.109	3.2	1.4	2.1	2.9
BOD LT 48 - 5.0 - Ebb	10/16/01	0.957	0.070	16.3	4.8	8.2	12.3
BOD LT 48 - B - Ebb	10/16/01	0.913	0.041	18.1	3.4	6.1	10.2
BOD LT 48 - 5.0 - Flood	10/16/01	0.981	0.081	13.7	4.6	7.6	11.0
BOD LT 48 - B - Flood	10/16/01	0.959	0.048	17.3	3.7	6.6	10.7
BOD SJ River - Flood	10/25/01	0.964	0.071	5.8	1.7	3.0	4.4
CBOD SJ River - Flood	10/25/01	0.958	0.110	3.9	1.6	2.6	3.4
sBOD SJ River - Flood	10/25/01	0.830	0.046	1.9	0.4	0.7	1.1

Sample	Date	R^2	K	L_o	BOD_5	BOD_{10}	BOD_{20}
sCBOD SJ River - Flood	10/25/01	0.707	0.033	1.9	0.3	0.5	0.9
BOD SJ River - Ebb	10/25/01	0.955	0.096	4.6	1.7	2.8	3.9
CBOD SJ River - Ebb	10/25/01	0.955	0.105	3.4	1.4	2.2	3.0
sBOD SJ River - Ebb	10/25/01	0.928	0.057	2.3	0.6	1.0	1.6
sCBOD SJ River - Ebb	10/25/01	0.934	0.046	2.2	0.5	0.8	1.3
BOD LT 48 - 5.0 - Ebb	10/25/01	0.968	0.072	7.4	2.3	3.8	5.7
CBOD LT 48 - 5.0 - Ebb	10/25/01	0.963	0.126	3.7	1.7	2.6	3.4
sBOD LT 48 - 5.0 - Ebb	10/25/01	0.027	0.017	10.3	0.8	1.6	2.9
sCBOD LT 48 - 5.0 - Ebb	10/25/01	0.979	0.081	2.2	0.7	1.2	1.8
BOD LT 43 - 5.0 - Ebb	10/25/01	0.866	0.037	9.5	1.6	2.9	5.0
CBOD LT 43 - 5.0 - Ebb	10/25/01	0.982	0.078	3.3	1.1	1.8	2.6
sBOD LT 43 - 5.0 - Ebb	10/25/01	0.927	0.059	4.6	1.2	2.0	3.2
sCBOD LT 43 - 5.0 - Ebb	10/25/01	0.952	0.050	1.7	0.4	0.7	1.1
BOD LT 38 - 5.0 - Flood	10/25/01	0.995	0.110	7.3	3.1	4.9	6.5
BOD LT 38 - 7.5 - Flood	10/25/01	0.971	0.095	8.1	3.1	5.0	6.9
BOD LT 43 - 5.0 - Flood	10/25/01	0.994	0.103	6.5	2.6	4.2	5.7
BOD LT 43 - B - Flood	10/25/01	0.984	0.112	8.9	3.8	6.0	8.0

Table D-2. : BOD fitting parameters and oxygen demands for sediments trapped in the DWSC.

		Fitting Statistics			mg BOD_{ult}/ mg sediment parameter				mg BOD_{10}/ mg sediment parameter			
Sample	Date	R^2	K	L_o	TSS	VSS	Chl a	Chl a+ Pha	TSS	VSS	Chl a	Chl a+ Pha
LT 48 - 5 - Ebb	06/14/01	0.977	0.120	8.21	0.022	0.229	0.135	0.045	0.015	0.160	0.094	0.031
LT 43 - 5 - Ebb	06/14/01	0.983	0.147	5.96	0.047	0.368	0.387	0.072	0.036	0.284	0.298	0.056
LT 48 - B - Ebb	06/14/01	0.929	0.081	33.79	0.017	0.210	0.245	0.054	0.009	0.116	0.135	0.030
LT 48 - B - Ebb	06/14/01	0.975	0.096	30.53	0.015	0.190	0.221	0.049	0.009	0.117	0.137	0.030
LT 43 - B - Ebb	06/14/01	0.969	0.116	10.4	0.021	0.197	0.438	0.051	0.014	0.135	0.301	0.035
LT 38 - B - Ebb	06/14/01	0.958	0.119	10.32	0.033	0.328	1.623	0.131	0.023	0.228	1.127	0.091
BOD LT 48 - 2.5 - Ebb	06/21/01	0.960	0.109	11.328	0.025	0.224	0.257	0.042	0.016	0.149	0.171	0.028
BOD LT 48 - 5.0 - Ebb	06/21/01	0.924	0.094	29.851	0.033	0.316	0.481	0.066	0.020	0.192	0.293	0.040
BOD LT 48 - 7.5 - Ebb	06/21/01	0.938	0.122	34.170	0.028	0.258	0.430	0.055	0.020	0.182	0.304	0.039
BOD LT 48 - B - Ebb	06/21/01	0.936	0.105	25.458	0.016	0.159	0.318	0.037	0.010	0.103	0.206	0.024
BOD LT 38 - 5.0 - Ebb	06/21/01	0.973	0.153	6.361	0.038	0.257	0.413	0.080	0.030	0.201	0.324	0.063
BOD LT 38 - B - Ebb	06/21/01	0.951	0.150	7.733	0.021	0.164	0.534	0.058	0.016	0.127	0.415	0.045
BOD LT 43 - 5.0 - Ebb	07/13/01	0.941	0.154	6.003	0.048	0.303	0.087	0.034	0.037	0.238	0.068	0.027
BOD LT 43 - B - Ebb	07/13/01	0.933	0.094	36.941	0.125	0.815	0.801	0.133	0.076	0.497	0.488	0.081
BOD LT 48 - 5.0 - Ebb	07/13/01	0.970	0.094	6.398	0.042	0.316	0.083	0.035	0.026	0.192	0.050	0.021
BOD LT 48 - B - Ebb	07/13/01	0.912	0.094	31.920	0.021	0.194	0.115	0.038	0.013	0.118	0.070	0.023
BOD LT 45 - 5.0 - Flood	07/20/01	0.944	0.133	7.504	0.086	0.602	0.608	0.112	0.063	0.443	0.448	0.082
BOD LT 45 - B - Flood	07/20/01	0.959	0.098	4.113	0.022	0.206	0.205	0.043	0.014	0.129	0.129	0.027
BOD LT 43 - 5.0 - Flood	07/20/01	0.944	0.142	9.320	0.107	0.836	0.560	0.112	0.081	0.634	0.425	0.085
BOD LT 43 - B - Flood	07/20/01	0.822	0.096	4.194	0.020	0.198	0.349	0.048	0.013	0.122	0.215	0.029
BOD LT 43 - 5.0 - Ebb	07/20/01	0.991	0.086	8.123	0.055	0.412	0.456	0.077	0.032	0.238	0.264	0.044
BOD LT 43 - B - Ebb	07/20/01	0.941	0.072	43.770	0.032	0.307	1.389	0.123	0.017	0.158	0.715	0.064
BOD LT 43 - 5.0 - Flood	08/25/01	0.842	0.088	4.399	0.045	0.317	0.207	0.063	0.026	0.185	0.121	0.037
BOD LT 43 - B - Flood	08/25/01	0.999	0.125	11.567	0.027	0.238	0.307	0.056	0.019	0.170	0.219	0.040
BOD LT 43 - 5.0 - Ebb	08/25/01	0.965	0.237	3.686	0.045	0.346	0.148	0.048	0.041	0.313	0.134	0.043
BOD LT 43 - B - Ebb	08/25/01	0.970	0.103	17.361	0.045	0.361	0.423	0.088	0.029	0.232	0.272	0.056

BOD LT 48 - 5.0 - Flood	08/25/01	0.996	0.199	5.479	0.020	0.179	0.106	0.039	0.018	0.154	0.091	0.034
BOD LT 48 - B - Flood	08/25/01	0.978	0.161	18.400	0.019	0.180	0.218	0.054	0.015	0.144	0.175	0.043
BOD LT 48 - 5.0 - Ebb	08/25/01	0.983	0.225	6.543	0.039	0.314	0.109	0.047	0.035	0.281	0.098	0.042
BOD LT 48 - B - Ebb	08/25/01	0.999	0.143	15.129	0.024	0.301	0.152	0.050	0.018	0.229	0.116	0.038
BOD LT 48 - 5.0 - Ebb (not stirred)	08/25/01	0.991	0.108	6.359	0.038	0.305	0.106	0.046	0.025	0.202	0.070	0.030
BOD LT 48 - B - Ebb (not stirred)	08/25/01	0.989	0.105	13.532	0.021	0.269	0.136	0.045	0.014	0.175	0.088	0.029
BOD LT 43 - 5.0 - Flood	09/11/01	0.880	0.070	8.434	0.023	0.218	0.284	0.054	0.011	0.110	0.143	0.027
BOD LT 43 - 7.5 - Flood	09/11/01	0.982	0.084	16.183	0.023	0.234	0.156	0.040	0.013	0.133	0.089	0.023
BOD LT 43 - 5.0 - Ebb	09/11/01	0.846	0.129	4.840	0.076	0.802	0.365	0.098	0.055	0.582	0.264	0.071
BOD LT 43 - B - Ebb	09/11/01	0.998	0.057	10.312	0.020	0.199	0.310	0.045	0.008	0.086	0.134	0.020
BOD LT 48 - 5.0 - Flood	09/11/01	0.971	0.113	8.768	0.012	0.131	0.123	0.030	0.008	0.088	0.083	0.020
BOD LT 48 - B - Flood	09/11/01	0.961	0.105	31.997	0.012	0.137	0.172	0.039	0.008	0.089	0.112	0.025
BOD LT 48 - 5.0 - Ebb	09/11/01	Sediment trap concentration too low										
BOD LT 48 - B -Ebb	09/11/01	0.930	0.065	9.069	0.014	0.144	0.114	0.029	0.006	0.068	0.054	0.014
BOD LT 43 - 5.0 - Ebb	09/18/01	0.997	0.084	7.655	0.041	0.334	0.267	0.065	0.023	0.190	0.151	0.037
BOD LT 43 - 5.0 - flood	09/18/01	Sediment trap concentration too low										
BOD LT 43 - B - Ebb	09/18/01	0.960	0.129	28.822	0.029	0.269	0.590	0.062	0.021	0.195	0.427	0.045
BOD LT 43 - B - Flood	09/18/01	0.945	0.141	9.240	0.022	0.213	0.300	0.041	0.017	0.161	0.227	0.031
BOD LT 48 - 5.0 - Ebb	09/18/01	0.927	0.134	13.508	0.030	0.276	0.173	0.048	0.022	0.204	0.128	0.036
BOD LT 48 - B - Ebb	09/18/01	0.963	0.127	32.054	0.025	0.242	0.270	0.048	0.018	0.174	0.194	0.035
BOD LT 48 - 5.0 - Flood	09/18/01	0.982	0.147	10.628	0.068	0.607	0.660	0.176	0.052	0.467	0.508	0.136
BOD LT 48 - B - Flood	09/18/01	0.980	0.136	20.680	0.028	0.284	0.671	0.092	0.021	0.211	0.499	0.068
BOD LT 43 - 5.0 - Ebb	10/16/01	0.957	0.084	2.861	0.040	0.282	0.089	0.045	0.023	0.159	0.050	0.025
BOD LT 43 - B - Ebb	10/16/01	0.984	0.096	10.312	0.016	0.173	0.221	0.043	0.010	0.107	0.136	0.026
BOD LT 43 - 5.0 - Flood	10/16/01	0.958	0.160	2.100	0.029	0.176	0.067	0.030	0.023	0.140	0.054	0.024
BOD LT 43 - B - Flood	10/16/01	0.932	0.115	9.555	0.025	0.225	0.200	0.050	0.017	0.154	0.137	0.034
BOD LT 48 - 5.0 - Ebb	10/16/01	Delayed uptake then unlimited uptake for 30 d										
BOD LT 48 - B - Ebb	10/16/01	Delayed uptake then unlimited uptake for 30 d										
BOD LT 48 - 5.0 - Flood	10/16/01	0.995	0.243	3.013	0.057	0.402	0.067	0.049	0.052	0.366	0.061	0.044
BOD LT 48 - B - Flood	10/16/01	0.976	0.171	6.257	0.042	0.359	0.100	0.057	0.034	0.294	0.082	0.047

BOD LT 43 - 5.0 - Flood	10/25/01	0.977	0.092	2.0	0.023	0.164	0.105	0.039	0.014	0.099	0.063	0.023
BOD LT 43 - B - Flood	10/25/01	0.987	0.119	9.2	0.018	0.178	0.264	0.061	0.013	0.123	0.183	0.042
BOD LT 43 - 5.0 - Ebb	10/25/01	0.922	0.180	2.4	0.018	0.215	0.158	0.055	0.015	0.180	0.132	0.046
BOD LT 43 - B - Ebb	10/25/01	0.958	0.147	8.3	0.013	0.136	0.204	0.041	0.010	0.105	0.158	0.032
BOD LT 38 - 5.0 - Flood	10/25/01	0.952	0.115	7.0	0.029	0.245	0.303	0.070	0.020	0.167	0.207	0.048
BOD LT 38 - 7.5 - Flood	10/25/01	0.987	0.122	6.0	0.013	0.128	0.196	0.040	0.009	0.090	0.138	0.028
BOD LT 48 - 5.0 - Ebb	10/25/01	0.978	0.157	7.4	0.024	0.254	0.154	0.063	0.019	0.202	0.122	0.050
BOD LT 48 - B - Ebb	10/25/01	0.958	0.133	8.8	0.017	0.185	0.112	0.039	0.013	0.136	0.082	0.029