VII. Summary

1. New algal production was an important contributor to the oxygen demand in the DWC. Algal load from new production in the DWC could be 100 kg/day and was equivalent to the algal load from upstream during August and September.

2. Daily oxygen demand from algal biomass in the DWC was between 2 mg/L and 4 mg/L. The actual contribution of algal biomass to oxygen demand in the DWC cannot be measured accurately with the standard light/dark bottle productivity measurement because it measures a community response that includes both algal and bacterial respiration and bacterial respiration in the DWC is probably high. Calculated production rates using production and respiration equations developed for San Francisco Bay where nitrification is low suggest algal biomass contributed at most about 2 mg/L to the daily oxygen demand. This demand is small compared with the total deficit in the DWC, but may be significant when high water temperature drives saturation levels to 8 mg/L. A low oxygen demand from carbon sources was supported by carbonaceous BOD measurements that were consistently about 1-2 mg/L at all stations.

3. Nitrogenous BOD comprised most of the total 10 day BOD in the DWC. Carbonaceous BOD comprised about 30% of the total total BOD that reached 6 mg/L. The correlation coefficient between ammonia and either total BOD or nitrogenous BOD was 0.90 at Turner Cut and Rough and Ready Island in the DWC. In addition, total Kjeldahl nitrogen was significantly correlated with total BOD, but the correlation was lower than for ammonia except at Turner Cut. Total 10 day BOD was not significantly correlated with chlorophyll *a*, phaeophytin or volatile suspended solids. Even carbonaceous BOD was not significantly or poorly correlated with chlorophyll *a*, phaeophytin or volatile suspended solids. These patterns were not observed in the Turning Basin where algae comprise the majority of the organic matter and ammonia concentration is low.

   Direct application of the BOD test results to the in situ demand in the DWC requires consideration of ecosystem processes. The CBOD test is a 10 day incubation in the dark where all of the carbonaceous material is decomposed by bacteria. This is an overestimate of the carbonaceous demand in the river where algae produce oxygen through photosynthesis. In addition, all BOD tests are conducted at 20^{o}C that underestimated the oxygen demand in September when water temperature was near 25^{o}C and overestimated the oxygen demand in November when water temperature was near 15^{o}C. More effort is needed to quantify the relative importance of the carbon versus nitrogen components of the BOD at the ambient water temperature in the DWC.

4. Nitrogenous material that contributed to the nitrogenous BOD include the discharge of ammonia from the City of Stockton RWCF between September and November and non-ammonia Kjeldahl nitrogen load from upstream (the non-ammonia load does not include nitrate and nitrite). The non-ammonia nitrogenous load from upstream at Mossdale and Channel Point could be high and was sometimes many times higher than the ammonia load.

5. A potentially small contribution of algal biomass to the total oxygen demand in the DWC during 2000 was supported by historical data. Chlorophyll *a* concentration in the DWC and load from Vernalis upstream decreased by a factor of 4 over time. This suggests algal biomass may not be as important today as in the 1970s when chlorophyll *a* concentration in the DWC was over 100 ug/L.

6. The oxygen demand from algal growth was far less than maximum because the algae in the DWC and upstream are light limited by high suspended material concentration in the water column. Suspended material restricts the photic zone to the upper 2 m where algae receive only 18% of the surface irradiance and attain commomly 25 % of their maximum growth.

7. Algae from different input sources did not significantly alter the algal production rates in the DWC. The similarity of response was probably a function of the similarity of algal species composition, the presence of excess nutrient and the overriding effect of light limitation.

8. Upstream load into the DWC was poorly estimated by Vernalis or Mossdale load. Upstream algal load at station 51 near the entrance to the DWC was at times 100 kg/day to 300 kg/day lower than estimates made using Vernalis or Mossdale data. The loss of algal biomass was accompanied by loss of all suspended materials including TSS and VSS and total BOD when ammonia load was low. The cause of this material loss is unknown, but vertical settling, benthic and planktonic grazing and agricultural diversion are possible factors.

9. Seasonal average load suggest the DWC is a sink for total and volatile suspended solids and a source of algal detritus and BOD. Material in the DWC is imported on ebb tide from upstream and the retention of material despite tidal exchange may be due to high residence time and rapid settling.

10. Discrete and continuous monitoring systems demonstrated the relatively good dissolved oxygen conditions in the DWC during 2000 a cool-wet year compared with 1999 a warm-dry year. Dissolved oxygen concentration decreased to below the 5 mg/L and 6 mg/L standard only in August and September in a small section of the study reach and vertical stratification was weak. In contrast dissolved oxygen concentration was below 5 mg/L from Disappointment Slough to the Turning Basin and was characterized by a strong vertical gradient for most of fall 1999. The lower dissolved oxygen concentration in 1999 than 2000 was probably a function of a suite of factors. Algal biomass and ammonia concentration were

somewhat higher in 1999 and were accompanied by 2-3°C higher sustained water temperature that combined exerted a greater oxygen demand on the river.

11. The enhanced continuous monitoring program was a valuable tool for determining the spatial and temporal variation of dissolved oxygen and direct sources of oxygen demand. Continuous monitoring demonstrated a 4 mg/L diel variation in dissolved oxygen concentration that could affect compliance with standards and a higher frequency of dissolved oxygen depression than obtained by infrequent mid-day shipboard sampling by the DWR Channel Program. Continuous monitoring was also able to verify the absence of direct oxygen demand from upstream where dissolved oxygen concentrations were continually saturated despite high algal biomass. Bottom monitors verified that dissolved oxygen concentration could be below standard near the bottom but not at the surface but confirmed the absence of a severe oxygen depression during the night.