SUMMARY

The oxygen dynamics studies provide a comprehensive assessment of the critical compartments associated with the dissolved oxygen regime of the lower Minnesota River during the periods of July 17-24 and August 31 - September 4, 2006. The parameters of primary interest that were measured throughout the study reach included

- Reaeration (Ka), which is the exchange rate of oxygen between the atmosphere and the river,
- Diel dissolved oxygen (DO) concentrations and DO percent saturation for assessment of total community oxygen metabolism (TCOM) and computation of community substrate oxygen demand (CSOD),
- Sediment oxygen demand (SOD), which is a measure of the bottom sediment consumption of dissolved oxygen from the water column,
- Gross primary production (GPP) by suspended phytoplankton in the water column,
- Respiration (R) associated with biological activity and chemical oxidation in the water column,
- Light transmission for delimiting the euphotic zone, defined as that portion of water column where one-percent or more of light is available for photosynthesis,
- Daily solar energy, and
- Chlorophyll-a for its potential relationship with water column production and respiration.

All of the above parameters and their associations proved to be critical considerations in evaluating the present and future DO regime of the lower Minnesota River.

Reaeration rate coefficients measured by both the noble gas krypton method and a comparable diffusion dome technique provided Ka rates throughout the study reach. Ka rates were considered typical for deep, slow moving waters at the flows investigated.

Sediment oxygen demand rates were measured and reported for the primary sediment types that are characteristic of the study reach as determined by sediment mapping. With one exception, the rates were low to moderate when compared to other SOD data bases. Receding flow between July and September appeared to have a notable influence on SOD rates at river miles 11.2 and 15, where rates increased as flow receded. This was consistent with the diver-observed increase in soft substrate at the sediment/water interface in September.

In the lower Minnesota River, light attenuation through the water column is a major factor affecting DO metabolism. Gross primary production is not possible without the benefit of photosynthesis. Visible light is an essential requirement for this process. Light transmission profiles revealed that the euphotic zone was limited to a depth of about 2.5 to 3.0 feet in July and about 2.5 to 3.5 feet in September. More importantly, the depth of the euphotic zone was limited to an average of 20 and 31 percent of the water column during the respective study periods. With reduction in flow from July to September, clarity of the water improved slightly in the lower reach of the study area. Concentrations of chlorophyll-a indicated an abundance of phytoplankton throughout the study reach, but it was in a declining mode from July to September. The chlorophyll data, particularly for the September study period, suggest that less viable forms of phytoplankton were aggregating in bottom water and settling to the sediments.

Even with declining concentrations, the magnitude of the chlorophyll-a values would indicate that the abundance of phytoplankton represented hypereutrophic conditions. However, study results relative to production-to-respiration (P:R) ratios show this not to be the case. Measured GPP rates demonstrated a significant decline occurred in production between July and September. Attendant respiration also decreased but to a lesser extent. When GPP and R rates

are viewed in terms of P:R ratios, the metabolism of the water column was progressing from an autotrophic to a heterotrophic state during the study period. P:R ratios were greater than one at two of six stations in July, while they were less than one at the other four stations in July and at all six stations in September. A ratio of one or greater indicates that the photosynthetic processes of the phytoplankton community synthesized sufficient DO and organic carbon (carbohydrates) to meet or exceed the respiration demands in the water column, hence an autotrophic state. A ratio of less than one indicates that the process of photosynthesis yields insufficient DO and organic carbon to meet the demands of respiration, hence a heterotrophic state. This change, as reported, simply indicates a normal integral response to the effects of seasonal reduction in the solar energy and associated visible light regime.

Total daily solar radiation declined significantly during the study period. Solar radiation in terms of visible light energy per day during the July sampling period was more than twice the level encountered in the September sampling period. The slight improvement in the water clarity commensurate with flow reduction was not sufficient to offset the effects of seasonal reduction in total solar radiation. The restricted depth of the euphotic zone in the study reach coupled with a decline in solar energy appeared as the factors limiting the GPP potential of the phytoplankton community. With significant reduction in the river flow and a commensurate expansion of the euphotic zone to greater depths during the annual peak period of solar radiation, a significant increase would likely occur in the phytoplankton GPP and water column R rates.