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Constructed Marshes for Nitrate Removal

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Large numbers of free water surface treatment wetlands are in use for nitrate reduction. Target applications are field runoff, river and stream improvement, and enhancement of wastewater treatment plants. In total, an extensive database now exists, in many publications and operating reports. Microcosms and mesocosms are not included here because of the lack of transferability to design. A first-order areal model is appropriate, to be implemented with appropriate temperature, hydraulic efficiency, and flow pattern. Annual average rate constants at 20°C have a median of 25 m/year. Performance is better at higher water temperatures, with a modified Arrhenius temperature factor of 1.106. Measured values of the tanks-in-series (TIS) parameter average N = 4.4 TIS. Higher rate coefficients are associated with emergent soft tissue vegetation, and lower efficiencies with submergent vegetation, unvegetated open water, and forested wetlands. Carbon availability can limit denitrification at high nitrate loadings; however, wetlands produce carbon in sufficient quantities to support typical municipal and agricultural loads. Design may be for load reduction or concentration reduction, with the latter requiring larger wetlands. Significant ancillary benefits of ecological diversity and wildlife habitat are certain to accompany the project. A small negative greenhouse gas penalty, which accrues to all new wetlands, is not an important factor. Economic issues may include land cost and pumping cost. Constructed marshes are an ecologically and economically attractive method for reducing nitrate levels in surface waters.

KEYWORDS: design, economics, hydrology, nitrate, performance, treatment marshes

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