



Can wetlands cost effectively manage nutrients?¹

Cost comparison of conventional wastewater treatment vs. wetland treatment

Wetland-based wastewater treatment would be substantially cheaper than conventional treatment, according to a study completed by The Wetlands Initiative in cooperation with the Metropolitan Water Reclamation District of Greater Chicago (MWRD). The study found that wetland treatment, compared to conventional treatment methods, could save the district 51-63% of its annual costs to achieve new water quality standards for nitrogen and phosphorus levels.

Point source nutrient control is on the horizon. The governors of Wisconsin and Minnesota have both agreed to reduce the total nitrogen load (nonpoint and point source combined) discharged to their state's waterbodies by 30 percent. Nationally, the U. S. Environmental Protection Agency (USEPA) has issued recommended criteria for nutrient levels for rivers and streams; state agencies must now establish enforceable water quality standards. Meeting these standards using standard physical, chemical, and biological nutrient controls will require extensive capital investment and increased annual operating and maintenance costs.

To consider an alternative, MWRD and The Wetlands Initiative compared the cost of water treatment at MWRD's seven water reclamation plants (WRPs) to the

potential costs of using restored wetlands in the Illinois River watershed. Cost functions were developed for the seven WRPs based on actual operating parameters and conditions. Cost functions for wetlands were based on wetland studies in Illinois and Florida. Biological nutrient control was assumed to be the advanced treatment technology utilized in upgrading the WRPs. The MWRDGC formulated the capital cost for a single WRP then applied the capital cost equations and design to its other WRPs.

For the treatment plants, the derived monthly cost functions covered a treatment capacity ranging from 3.4 to 1,200 mgd. Based on the land, pumping and restoration costs, as well as the nutrient concentrations within the Illinois River (the receiving stream), separate seasonal cost functions for nitrogen and phosphorus removal were calculated. The outfall load from the WRPs determined the area of wetlands needed to remove the excess nutrient loads for two sets of nutrient criteria (3.0 mg/L TN and 1.0 mg/L TP; 2.18 mg/L TN and 0.5 mg/L TP).

Given the physical, chemical, and biological processes governing natural systems, the winter months provide the least efficient wetland treatment and establish the minimum land area necessary to treat the monthly MWRD



Gary Sullivan, TWI

MWRD

When comparing the overall annual costs of using restored wetlands (above) to remove excess nutrients from wastewater effluent, this study found that the total is approximately 51-63% less than the cost of constructing and operating conventional wastewater treatment plants (right) to accomplish the same treatment goal.

demand. This wetland area is much larger than that required for treatment during the spring and summer seasons. As a result, surplus wetland acreage that could produce nutrient credits for other emitters, such as power plants, would be available during the warmer months. On the other hand, during periods when less nutrient removal is needed, the operating conditions and costs at treatment wetlands could be curtailed.

Based on the cost functions, the load-weighted average and marginal costs for each treatment technology to remove a ton of nutrient were determined. The average costs for the seven WRPs to remove a ton of total nitrogen was \$8,130, while the load- and season-weighted average costs to remove the same ton of total nitrogen was \$2,250 (Figure 1). Similarly, the average cost for the WRPs to remove a ton of total phosphorus was \$49,500, but only \$2,220/ton for the wetlands (Figure 1). (All costs are based on the assumption that treatment will be needed to reach the criteria of 1.0 mg/L TP and 3.0 mg/L TN.) Since the cost functions were determined to be linear, the average cost is a declining function. Consequently, the greater the load treated, the less the average cost. Still, within the conditions of the case study, the average cost of wetland treatment is substantially less than that for wastewater treatment plants.

In this study, the marginal cost, or the price of removing the last ton of nutrient, is the cost value. After the first ton of removal occurs, the average cost curve declines, while the marginal cost remains the same. Still the wetlands have a lower marginal cost by a factor of nine for phosphorus and two for nitrogen. The load-weighted marginal costs for wetlands are \$1,830/ton TP and \$1,930/ton TN, whereas the load-weighted marginal costs for the seven WRPs are \$16,000/ton TP and \$3,400/ton TN.

When comparing the overall annual costs of operating treatment wetlands (including capital costs), we find the total is approximately 51-63% less than the cost of constructing and operating conventional wastewater treatment plants. Specifically, wetland treatment would cost only \$55 million annually to remove 26,000 tons of TN (on 189,000 acres), while conventional treatment would cost an estimated \$111 million annually to remove 13,700 tons of TN (Fig. 2). Similarly, to meet the less stringent criteria for TP, wetland-based treatment would cost \$6 million annually to remove 2,600 tons, while using conventional treatment would cost \$63 million to remove 1,270 tons of TP.

Despite the seasonality of nutrient removal by wetlands, they proved to be the more efficient means of nutrient control. Wetlands also would provide other valuable benefits to the environment: flood control, wildlife habitat, recreation, and public education. Given this potential, the next step would be to develop wetland pilot projects across various eco-regions and climatic zones to verify this study's cost functions.

¹This report is based on research conducted by Donald L. Hey, Ph.D., and Jill Kostel, Ph.D., The Wetlands Initiative; Arthur P. Hurter, Ph.D., Northwestern University; and Robert H. Kadlec, Wetland Management Services, Inc. This research was conducted with the cooperation and assistance of the Metropolitan Water Reclamation District of Greater Chicago and funded by the Water Environment Research Foundation and the Gaylord and Dorothy Donnelley Foundation.



THE WETLANDS INITIATIVE

53 W. Jackson Blvd., Suite 1015 • Chicago, IL 60604

(312) 922-0777 • Fax (312) 922-1823

twi@wetlands-initiative.org • www.wetlands-initiative.org

Figure 1. Average Costs of Wetland-Based and Conventional Treatment to Meet New Nutrient Criteria

(Thousands \$/ton removed)

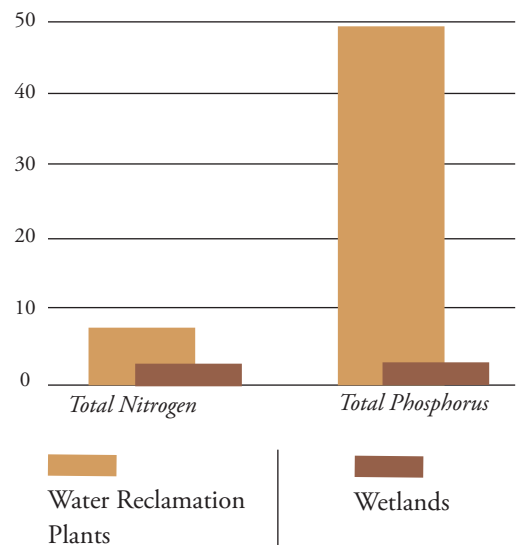


Figure 2. Total Annual Costs of Wetland-Based and Conventional Treatment to Meet New Nutrient Criteria

(Millions \$)

