WATER RESOURCES RESEARCH GRANT PROPOSAL

TITLE: Use of Constructed Wetlands to Improve Water Quality

DURATION: September 1, 1997 to August 31, 1999

FEDERAL FUNDS REQUESTED: $50,000

NON-FEDERAL FUNDS: $124,904

PRINCIPAL INVESIGATORS:

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CONGRESSIONAL DISTRICT: 15th

STATEMENT OF CRITICAL REGIONAL OR STATE WATER PROBLEMS:

Water quality is an issue of major concern in the Mississippi River watershed where nitrate loading is known to result in phytoplankton blooms that cause severe hypoxic conditions in the Gulf of Mexico. In addition to the hypoxia problems, many midwest ern municipalities derive their drinking water from reservoirs that frequently exceed the maximum contaminant level (MCL) for nitrate. The majority of NPS derived pollutants entering midwestern streams can be attributed to agricultural practices (USEPA, 1 992). In 1986 it was estimated that 50 to 70% of the assessed U.S. surface waters were adversely affected by agricultural NPS pollution (USEPA 1986). In addition, state NPS assessment reports identified agriculture as the greatest NPS pollution problem in the U.S. (CAST, 1992). Illinois water quality data reflected this same trend. Of the surface waters surveyed, 54% of the streams and 88% of the lake acreage did not meet full use support criteria with 41%and 91% of all use impairments in streams and lake s, respectively, derived from agriculture (IEPA, 1992). In a recent study on the Embarras River, Champaign County, Illinois (David et al. 1997), 96% of the annual nitrate load was derived from agriculture. Similar results were found in an Iowa study (Keen ey and Deluca, 1993).

resulted in a 1992 IEPA directive to the city of Bloomington, Illinois (authorized by the USEPA) to reduce its maximum drinking water nitrate contaminant levels to below 10 ppm. Although some progress has been made, the city will not meet the directive 's dead line of June 1997. A major issue **is** the cost of engineered systems designed to remove nitrates from drinking water. At the present ion exchange, the most cost effective treatment available to remove nitrate, is still quite expensive. Estimated cost ofinitial construction for **a** 20 mgd plant is $ 8million with $ 1million for yearly maintenance and brine disposal. In addition, the construction of treatment facilities is not in keeping with the recen t EPA goal of "source water protection" (a watershed approach). Presently, Bloomington and other Illinois municipalities (Danville, Decatur and Peoria) seek less expensive more ecologically sound watershed based approaches to remove nitrate from water sup ply reservoirs. These including the potential use of wetlands as a method to remove agricultural pollutants before they enter drinking water reservoirs and fertilizer input management.

Excessive concentrations of nutrients in streams draining agricultural areas can be attributed to agricultural systems that characteristically "leak" nutrients (Loucks, 1979) because N fertilizer is ineffectively taken up by monoculture cropping (Keene y, 1982; Simonis, 1988). These leaky systems are further exacerbated in the Midwest by extensive tile drainage. On 37% of these agricultural lands, tile drainage has decoupled wetland systems from the wetland/riverine interface, shunting contaminated upla nd drainage water directly to main river channels (Fausey et al., 1995).

In a recent study on the Embarras River at Camargo, Illinois, we have shown that drainage files are the major source of nitrate entering the river causing concentrations to repeatedly exceed EPA suggested MCLs for nitrate (David et al., 1997). Improvem ents in surface water quality will require the implementation of strategies and management practices that reverse these effects by directly reducing nitrate application through fertilizer management and, by reducing nitrate output from tile drainage syste ms to streams using techniques such as constructed wetlands. Constricted wetlands may prove to be a practical, economical, and effective method to reduce surface water nitrate contamination. These "wetlands" are formed by berming an area adjacent to a str eam and forming a small detention basin or holding pond that intercepts file drainage water before it enters the stream. The basin acts to reduce transport of nitrate in drainage water through plant uptake and microbial transformation and degradation. Fol lowing

wetland treatment", drainage water is slowly released to the stream, through regulated flow. Research on constructed wetlands addresses the IWRC interest areas of watershed protection, water quality and supply for small communities, and wetlands proces ses and management; and may provide new methodologies to resolve associated water contaminant problems.

STATEMENT OF RESULTS OR BENEFITS:

Constructed wetlands dearly have the potential to improve and sustain water quality throughout the Midwestern agricultural region. We propose an inexpensive and sustainable method to reduce nitrate input to Lake Bloomington. Through the use of input/ou tput budgets, our research will document the effectiveness of constructed wetlands in removing nitrate from agricultural tile drainage waters, before entering Lake Bloomington. We will also determine the rate of subsurface leakage and its effect on N remo val efficiencies of the constructed wetlands. This work will be conducted seasonally over at least two growing seasons. A multi-seasonal approach is important because tile drainage inputs to the wetlands is weather dependent and is expected to vary greatl y from year to year. In previous work we have found that large flows over a few days can provide most of the year's input of nitrate. Wetland function (denitrification) is thought to be highly temperature dependent, so that the timing of these inputs may be critical to nitrate removal. We do not know at this time how the wetlands will function at various times of the year. Without this understanding, it is not possible to generalize about their effectiveness.

Once we obtain several years of detailed information from the Bloomington constructed wetlands, we will be able to make recommendations to the municipality, landowners and farmers. The results of this work may potentially have a large and sustained imp act on farming systems throughout the Midwest We expect to be able to recommend an inexpensive, yet functional wetland ecosystem that can be added to many, if not most, farming systems that include tile drainage. Our recommendations would include the size of wetlands needed per acre of tile drainage. This system could be demonstrated and recommended to towns and cities in Illinois that depend on surface water supplies for drinking water. Constructed wetlands could provide sustained treatment of tile drain age waters, cleanup surface waters, and provide the many benefits of wetlands that are currently absent in most Midwestern agricultural ecosystems.