

**Missouri Water Resources Research Center
Annual Technical Report
FY 2008**

Introduction

Research Program Introduction

Water Resources Research Center Annual Technical Report FY 2008-2009

WATER PROBLEMS AND ISSUES OF MISSOURI

The water problems and issues in the State of Missouri can be separated into three general areas: 1) water quality, 2) water quantity, and 3) water policy. Each of Missouri's specific problems usually requires knowledge in these three areas.

Water Quality: New media attention to the occurrence of pesticides in drinking water in the Midwest has raised a serious public concern over the quality of Missouri's drinking water and how it can be protected. With the large agricultural activity in the state, non-point source pollution is of major interest. Because of several hazardous waste super-fund sites, hazardous waste is still of a concern to the public. The Centers' research has been to evaluate the quality of current waste sources and improve the methods to protect them. Areas of research for the past ten years have included (but are not limited to): erosion, non-point pollution reclamation of strip mine areas, hazardous waste disposal acid precipitation, anthropogenic effects on aquatic ecosystems and wetlands.

Water Quantity: Missouri has a history of either inadequate amounts of rainfall, or spring floods. Because of the 1987-89 drought years and the floods of 1993 and 1995, water quantity has become a major topic of concern. Research is needed to better understand droughts and flood conditions.

Water Policy: Policies and program need to be formulated that will ensure continued availability of water, as new demands are placed on Missouri's water. The social and economic costs may no longer be held at acceptable levels if water becomes a major issue in cities and rural areas. Past droughts and possible lowering of the Missouri River have raised serious questions over states rights to water and priority uses. Research areas in this program have included drought planning, legal aspects, perception and values, economic analysis, recreation, land/water use policy and legislation, and long-term effects of policy decisions.

SUMMARY OF ADVISORY COMMITTEE ACTIVITIES

The following individuals have participated in the selection and development of our 2006 research program.

UNIVERSITY OF MISSOURI FACULTY ADVISORY COMMITTEE

1. Steven Anderson, University of Missouri-Columbia, 302 Abnr Bldg.-Soil Science, Columbia, MO.
2. Patrick Osbourne, University of Missouri-St. Louis, 224 Research Building, St. Louis, MO 63121.

STATE OF MISSOURI ADVISORY COMMITTEE MEMBERS

1. John Schumacher, U.S. Geological Survey, 1400 Independence Road, Rolla, MO 65401.
2. Dr. Steve McIntosh, Water Resources Program, Department of Natural Resources, PO Box 176, Jefferson City, MO.
3. Cindy Wolken, Acting Section Chief, Watershed Protection Section, PO Box 176, Jefferson City, MO 65102
4. Dr. Jack Steiert, Biology, Southwest Missouri State University, Springfield, MO.
5. Mike McKee, Resource Scientist, Department of Conservation, Columbia, MO.
6. Robert Gale, Research Chemist/Section Leader Organic Chemistry, Columbia environmental Research Center, Biological Resources Division of USGS, Columbia, MO.
7. John Ford, Environmental Specialist, Department of Natural Resources, Jefferson City, MO.

RESEARCH PROGRAM

PROGRAM GOAL AND PRIORITIES

The Missouri Water Resources Research Centers goals are 1) establish active research programs to aid in understanding and solving Missouri's and the nations, water problems; 2) provide educational opportunities in research for students with an interest in water resources and related fields, and 3) be actively dedicated to the dissemination of water related information, using all aspects of the media.

With these goals, the Center is able to mobilize the best faculty expertise in the state to examine specific water resources problems. The Center is familiar with research needs and activities, and its goals are to help researchers avoid duplicate efforts and to serve as a link between the research community and potential users of research results such as industries, planning commissions, and state agencies.

Because Missouri's economy revolves around its water resources, the director and principal investigators have worked closely with the state in addressing their problems by providing research data which are necessary in order to solve present and future water problems. Each of the research projects forwarded for regional competition has undergone a thorough evaluation process by the water Centers Advisory Committee to determine its importance in solving Missouri's and the nation's water problems.

Development of Membrane Aerated Reactor Processes for Nitrogen and Phosphorus Removal from Wastewater

Basic Information

Title:	Development of Membrane Aerated Reactor Processes for Nitrogen and Phosphorus Removal from Wastewater
Project Number:	2007MO70B
Start Date:	3/1/2007
End Date:	2/28/2009
Funding Source:	104B
Congressional District:	9
Research Category:	Water Quality
Focus Category:	Water Quantity, Nitrate Contamination, Treatment
Descriptors:	
Principal Investigators:	Zhiqiang Hu

Publication

1. Liang, Z. H., Nguyen, H. Hu, Z. Q. 2008. Nutrient removal in on-site wastewater treatment systems using membrane-aerated bioreactor techniques. Proceedings at the Missouri MWEA/AWWA 2008 Joint Annual Meeting, March 31 - April 2, 2008, Tan-Tar-A Resort, Osage Beach, Missouri.
2. Jia, Y., Das, A., Dolan, E. M., and Hu, Z. Q. Ammonia-oxidizing archaea involved in nitrogen removal. Water Research 2009, 43, 1801-1809.

Development of Membrane Aerated Reactor Processes for Nitrogen and Phosphorus Removal from Wastewater

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Nature, Scope and Objectives of Research

Due to the excess input of nitrogen and phosphorus into the aquatic systems, nutrient contamination is one of the serious water quality problems in the United States. In the state of Missouri, particularly, eutrophication of recreational lakes because of the nutrient enrichments continues to be a concern. Symptoms of eutrophication include low dissolved oxygen (hypoxia) in the water and the occurrence of nuisance and toxic algal blooms, which decrease the water resource value for drinking water, recreation, fishing, and other uses.

Under the federal Clean Water Act (Section 303), the Missouri total maximum daily load (TMDL) program provides a framework for identifying and cleaning up impaired water bodies. Since nutrient runoff mainly comes from wastewater treatment plants, septic tank systems, animal waste, and fertilizers, the TMDL program requires significant cut of nutrient loads from point sources in order to meet the concentration limits (total phosphorus < 0.075 mg/L; total nitrogen < 1.5 mg/L) for some of the impaired water bodies (2001). Correspondently, a mandatory discharge limit of 0.5 mg P/L is enforced to many wastewater treatment facilities in Missouri. However, these facilities were mostly designed for removal of organic matter and solids only. In an attempt to meet new permits, the US Environmental Protection Agency and local governments are investing multi-million dollars to upgrade or build new wastewater treatment facilities for biological nutrient removal (BNR). Unfortunately, many facilities that have already installed BNR processes are still experiencing intermittent and extended periods of higher levels of nutrient in their discharges than the mandatory permits.

The objective of this research was to develop a membrane aerated reactor system for efficient nitrogen and phosphorus removal from domestic wastewater through biotic and/or abiotic reactions. In this research, a gas-permeable membrane was applied as a carrier for aeration and nitrifying biofilm formation, and further, metallic iron materials will be introduced in anoxic basins to promote abiotic denitrification and chemical phosphorus precipitation.

Summary

Nutrient removal from on-site wastewater treatment systems remains a challenging issue. To efficiently remove organic compounds and nitrogen from wastewater, two types of bioreactors using membrane-aerated biofilm reactor (MABR) and microbial fuel cell (MFC) techniques were examined for simultaneous nitrification and denitrification in lab-scale septic tanks. During more than 250 days of continuous flow reactor operation, both reactors showed consistently high COD removal (>86%). Under the shock nitrogen loading conditions (influent NH_4^+ -N concentrations >150 mg/L), more than two-thirds of the total N was accumulated in the form of NH_4^+ -N and NO_3^- -N in the MABR and the MFC-based reactor, respectively. Afterwards, at an influent NH_4^+ -N concentration of 30 mg/L N, the average effluent NH_4 -N concentrations were 6.2 and 0.5 mg/L N for MABR and MFC reactor, respectively, corresponding to overall total N removal efficiencies of 64% and 36%. Consistent with the effluent nitrogen concentrations, there was no detectable nitrifying activity of the sludge from the MABR while a specific oxygen uptake rate of 0.1 g O_2 /g VSS/day was detected in the MFC-based reactor due to ammonia oxidation. Terminal restriction fragment length polymorphism (T-RFLP) analysis demonstrated relatively high abundance of *Nitrosomonas europaea* in the MFC-based reactor and the biofilm on nonwoven fabric of the MABR, and *Nitrobacter* in both reactors, confirming that *Nitrosomonas europaea* and *Nitrobacter* may out-compete *Nitrospira* and *Nitrospira* spp. at high substrate and oxygen concentrations. An analysis of the advantages and disadvantages of each technique suggested that MABR coupled with MFC techniques could be an attractive method for improved nitrogen removal and reduced sludge production in on-site wastewater treatment systems.

Relation Between Spatial Variation of Bed-Shear Stress Distribution and the Statistical Characterization of Bed Material in the Missouri River

Basic Information

Title:	Relation Between Spatial Variation of Bed-Shear Stress Distribution and the Statistical Characterization of Bed Material in the Missouri River
Project Number:	2007MO71B
Start Date:	3/1/2007
End Date:	2/28/2009
Funding Source:	104B
Congressional District:	9
Research Category:	Water Quality
Focus Category:	Sediments, Methods, Hydrology
Descriptors:	
Principal Investigators:	Jerry Richardson, Richard Geekie

Publication

Relation between Spatial Variation of Bed-Shear Stress Distribution and Statistical
Characterization of Bed

Jerry Richardson, Associate Professor

UMKC

1. Data analyses have been conducted with the USGS bed samples collected from the Missouri River between 1991 and 2001. Statistics such as mean, median, standard deviation, skew and kurtosis have been completed and analyzed.
2. Similar analysis of the median grain size has been plotted for the lower 500 miles of the Missouri River. These data are the results of the Corps of Engineers data sampling program which is conducted every four to six years. These two data sets (USGS and Corps) provide clues as to what the relationship between sediment supply from upstream and local shear stress distributions have with the changing local bed-material composition
3. Various software were reviewed, specifically the STORM model from the Geomorphology and Sediment Transport Laboratory of the USGS in Golden, Colorado and the CCHE2D Two-Dimensional Flow and Sediment Transport Model developed at University of Mississippi, National center for Computational Hydroscience and Engineering
4. River curvature, using ArcView© map of sailing line of the lower 500 miles of the Missouri River, was used to relate the spatial variation of gradation curves and bed-shear stress.
5. Draft of dissertation documenting how bed-material composition changes with changes in the upstream sediment supply and local shear stress distributions. This study is different from others in that the scale of the study is not much longer than the length of a dune

Information Transfer Program Introduction

The Missouri Water Resources Research Center's objectives are: 1) to establish active research programs to aid in understanding and solving Missouri's and the Nation's water problems, 2) to provide education opportunities in research for students with an interest in water resources and related fields, and 3) to be actively dedicated to the dissemination of information through all aspects of the media.

The technology assistance program goal is to meet objective 3, dissemination of information through all aspects of the media.

During FY2009 the Center maintained an active information transfer program that included:

Water Board Training and Community Outreach in cooperation with Northwest Missouri State University and MU Extension. -Training course for drinking water. The Water Partnership Team members elected officials, agency representatives and service providers. Instruction was designed to develop core competencies required for effective drinking water system management and planning. Assistance in the organization of statewide conferences. Coordination of local seminar program. Interaction with state and federal water agencies. Cooperation with University extension personnel (they are represented on advisory committee). Director serves on various national and local water related boards, organizations and committees. Continued cooperation with district USGS office (representative on advisory committee). Maintenance and expansion of comprehensive web site. Making available of Center's publications. Continue to respond to public requests and questions for information.

Tech Transfer - USGS Water Resources Research Center

Basic Information

Title:	Tech Transfer - USGS Water Resources Research Center
Project Number:	2007MO72B
Start Date:	3/1/2007
End Date:	2/28/2009
Funding Source:	104B
Congressional District:	9th
Research Category:	Not Applicable
Focus Category:	Management and Planning, None, None
Descriptors:	
Principal Investigators:	Thomas E. Clevenger, Thomas E. Clevenger

Publication

The Missouri Water Resources Research Center's objectives are: 1) to establish active research programs to aid in understanding and solving Missouri's and the Nation's water problems, 2) to provide education opportunities in research for students with an interest in water resources and related fields, and 3) to be actively dedicated to the dissemination of information through all aspects of the media.

The technology assistance program goal is to meet objective 3, dissemination of information through all aspects of the media.

The Center will continue to maintain an active information transfer program that will include:

- Assistance in the organization of statewide conferences
- Coordination of local seminar program
- Publishing of annual newsletter
- Interaction with state and federal water agencies
- Cooperation with University extension personnel (they are represented on advisory committee)
- Director serves on various national and local water related boards, organizations and committees
- Continued cooperation with district USGS office (representative on advisory committee)
- Maintenance and expansion of comprehensive web site
- Making available of Center's publications
- Responding to public requests and questions
- Meeting with advisory committee to improve information transfer activities

USGS Summer Intern Program

None.

Student Support					
Category	Section 104 Base Grant	Section 104 NCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	1	0	0	0	1
Masters	0	0	0	0	0
Ph.D.	2	0	0	0	2
Post-Doc.	0	0	0	0	0
Total	3	0	0	0	3

Notable Awards and Achievements