

Individual sewage treatment in Minnesota: *An alternative individual sewage treatment system research update*

By Jim Anderson

Individual Sewage Treatment Systems (ISTS) are used by 27 percent of Minnesota residents to treat domestic wastewater. Conventional ISTS do not adequately remove groundwater contaminants such as nitrogen, especially in geologically sensitive areas. Failing ISTS in areas with high water tables also lead to non-point source pollution



Recirculating sand filters at Lake Washington, MN.

problems such as eutrophication and impaired fisheries in lakes. The goal of this project was to develop affordable ISTS protocols for environmentally-sensitive areas.

This project builds upon a partnership formed in 1995 between the U of M, the Minnesota Pollution Control Agency, local agencies, and the private sector to construct research and demonstration facilities in LeSeuer and St. Louis counties. These facilities featured nine replicated alternative systems. Major

funding was provided by the Legislative Commission on Minnesota Resources through the Minnesota Environment and Natural Resources Trust Fund Project.

This article is the first in a series of articles that will highlight the results of the project. The first topic is an evaluation of recirculating sand filters (RSF) for use with individual residences.

A full discussion of this study can be found in the article, "Evaluation of Recirculating Sand Filters in Minnesota," available at <http://www.bae.umn.edu/~septic/LCMR/index.htm>.

Treatment process and design

Provided below is a general discussion of what happens to wastewater in a recirculating sand filter. Typically, wastewater moves from the residence into a septic tank or tanks where the gross solids settle out, resulting in some reduction in organic loading

and pathogens. From the septic tank, effluent moves by gravity to the recirculation tank where it mixes with effluent previously circulated through the sand filter (see Figure 1). Effluent is then pumped repeatedly through the lined filter and flows back by gravity to the recirculation tank. In the filter, biological treatment occurs as the effluent comes into contact with the surfaces of the filter media. Treated effluent is collected at the bottom of the filter and returned to the

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High profit cropping systems may pose greatest threat to water quality

Groundwater in the sand plains of Minnesota is extremely vulnerable to damage from agricultural chemicals.

With careful management, the sandy soils can be cropped intensively without polluting ground water.

Problems arise, however, when the highest potential profits for farmers are linked to a cropping system

that poses a significant threat to water quality, as shown in a U of M economic analysis by Mary E. Renwick and co-workers in the U of M Water Resources Center.

Five years of detailed crop production

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Application of nitrogen to a potato field under ridge tillage.

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Around the State

WATER RESOURCES UPDATES

Water Resources Center initiates new economics and water policy program

The Water Resources Center recently initiated a new program in water resources economics and policy in order to strengthen its capacity to deliver integrated research, education, and outreach. The focus of this program will be to use state-of-the-art economic valuation tools in conjunction with technical and scientific advances to guide decision-makers in formulating good investments and sound policy.

The WRC has a number of projects

underway or recently completed in the water resource economics and policy program area. One example is a joint project with the Fond du Lac Band of Ojibwe to evaluate and communicate risks and benefits to Band members of consuming aquatic-based traditional foods such as fish, wild rice, and waterfowl that may contain PCBs, and other atmospherically-deposited toxins. Another example is a project that involved an economic analysis of various cropping systems (see story on page 1).

For more information, contact Mary Renwick at the WRC at (612) 625-9798.

WRSIA monitors local resources

In Spring Semester 2001, the Water Resources Students In Action (WRSIA) group, composed of Water Resources Science graduate students, participated in two monitoring efforts. The first effort involved assisting Mora Middle School and Ogilvie High School students with their monitoring of the Groundhouse River. WRSIA members first led the students through classroom lessons designed to teach students why monitoring is important and what can be learned from monitoring efforts, and then assisted them with macroinvertebrate sampling and measuring hydrological data at the river. The monitoring project was developed three years ago by the Kanabec Soil and Water District, the Mora and Ogilvie school districts, and the WRSIA to teach students about river systems and to assess the success of restoration efforts made on the Groundhouse River by farmer Tim Fischer.

WRSIA also developed a monitoring project to assess the hydrological and water quality characteristics of the Sarita wetland, located at the southern end of the St. Paul campus. The group received grant money from the Capitol Region

Watershed District, U of M Facilities Management and Beautiful U for equipment and analytical costs to collect water samples and measure the flow of runoff that enters the Sarita wetland during spring snowmelt and summer rain events. The group will monitor the wetland throughout the summer and repeat the effort in upcoming years. Information gained from this effort will be used to assist decision-making in and assess impacts of the Sarita wetland restoration project, a project led by the Sustainable Campus Initiative, a coalition of facilities management staff, faculty, and other leaders on campus.

“Building Bridges” conference a big success

“Building Bridges to Manage Minnesota’s Surface Waters” offered three days of information, networking, and camaraderie. This conference, held May 3-5 at Cragun’s Resort in Brainerd, MN, was the first joint conference sponsored by the Rivers Council of Minnesota and the Minnesota Lakes Association. It was supported by the MN Department of Natural Resources, the MN Pollution Control Agency, the MN Board of Water and Soil Resources, and the U of M Water Resources Center. With 21 breakout sessions, four special plenary sessions, two hands-on workshops, and an exhibit hall full of displays and posters, participants learned about a range of management issues facing Minnesota’s lakes and rivers. Evaluations showed that participants felt the conference was very successful. A similar joint conference is planned for April 19-21, 2002, so mark your calendars now!

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Freshwater ecologist shares knowledge with Water Resources Science students

by Brian Johnson, Water Resources Science

Water Resources Students In Action (WRSIA) and the Water Resources Sciences graduate program hosted the visit of Dr. Jack Stanford of the University of Montana this past April 16 and 17. Dr. Stanford gave the keynote speech for the Water Resources Science Spring 2001 seminar series. Dr. Stanford is



Jack Stanford spoke to Water Resources Science students about the importance of good science and their roles as future professionals in policy decision-making processes.

the director of the Flathead Lake Biological Station of the University of Montana, located in Polson, Montana, and was

named a Fellow by the American Association for the Advancement of Science for his contributions to freshwater ecology. Dr. Stanford's research focuses on the many natural factors and disturbances that interact to determine the distribution of species and productivity of food webs in aquatic and terrestrial ecosystems, as well as human influences that alter natural biogeochemical patterns.

Dr. Stanford's talk began with a brief history of the Flathead Lake Biological Station and a description of the Flathead Lake watershed. The main focus of his talk, however, was on the functions of large river floodplains on a regional scale. Dr. Stanford's definition of a river, "a constantly shifting mosaic," hints at the ecological importance of a free flowing, unregulated system. Regulated river systems may lose edge habitat as they experience large, rapid water level and flow fluctuations in response to human needs such as irrigation, flood control, and power generation. Edge habitat includes areas such as back pools and downed trees (snags). It is the loss of edge habitat, Dr. Stanford argued, that is one of the main causes of native salmon depletion in the Pacific Northwest. Young salmon use edge habitat for protection from predators. Without this habitat, the young salmon spend their time in the main channel where they are vulnerable to predation. It is the loss of edge habitat, rather than dams blocking migrating salmon, that should be the concern of fishery managers. Dr. Stanford argued that in order to restore the salmon fishery to the Pacific Northwest, edge habitat must be conserved; that is, a river needs to be managed to create and maintain this critical habitat.

After his talk, Dr. Stanford met with WRS students for about 2-1/2 hours to discuss water related issues. One of the main themes during the discussion was how budding water resources professionals can influence policy-makers in their decision-making process. Dr. Stanford stressed that one needs to rely on sound science to make effective arguments. He also advised students to get plenty of practice in presenting talks and making arguments in front of an audience. The other main theme of the discussion was pizza and cookies. We ate; we learned; our minds and stomachs became full.

WRS students awarded fellowships to study abroad

Two Water Resources Science students have been awarded fellowships to study water quality issues abroad. Brian Huser, a WRS Ph.D. student, has been awarded a Fulbright-Hays fellowship to complete his Ph.D. research at the Limnology Institute at Uppsala University in Sweden. Huser will

study how acid rain influences the movement of aluminum into lakes and its influence on nutrient cycling. More specifically, he will investigate the extent to which aluminum binds to phosphorus, a process that has useful implications for lake restoration projects as phosphorus removal limits algal growth. Huser has been working on a project funded by the Minneapolis Park Board and the MN Pollution Control Agency to determine appropriate aluminum sulfate treatments for the Minneapolis Chain of Lakes to limit algal growth.

When asked about his fellowship, Huser remarked, "[this fellowship] is an unbelievable opportunity; [receiving it] was surprising and rewarding." Huser is advised by Patrick Brezonik (Civil Engineering).

Edith Mussukuya, a WRS Master's student, was



Edith Mussukuya

awarded a fellowship from the Global International Waters Assessment (GIWA), a program led by

the United Nations Environment Program, to assess water resources in southern Africa. Mussukuya had already proposed to study the Zambezi River, a river that runs through eight countries in southern Africa, when Dag Daler, Director of



Brian Huser

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recirculation tank, where the recirculation cycle begins again. The systems evaluated were designed to recirculate the effluent

media. Holes are spaced 0.9 m apart and were 6.4 mm in diameter. It is critical that the holes face downward to assure drainage that will prevent freezing.

RSF performance and cost

All of the systems achieved secondary treatment standards but none performed as well as expected. According to design specifications, they were expected to meet 10/10/200 (BOD₅/TSS/FC) standards. They were only able to meet that standard 52% of the time for BOD₅, 50% for TSS, and 23% for FC. As a result of pretreatment, however, the problem of effluent from the individual sewage treatment systems surfacing was solved with the installation of the RSF.

The average cost for a full treatment system including a RSF and trenches is nearly \$9,000. To many residents, this is a large amount to dedicate to on-site wastewater treatment. However, an average mound system serving a three-bedroom residence costs \$6,000-\$10,000, so these numbers are comparable. Another cost component to examine is continual operation and maintenance. RSF maintenance costs are \$200-\$500 per year, which includes

periodic pumping of the septic tank, electricity, repairs, and maintenance visits. This compares to a \$100 per year average cost for maintaining a septic tank soil treatment trench system.

Overall, RSFs have proven to be a viable choice in Minnesota for on-site wastewater treatment. However, because of their inability to consistently meet the coliform standard, additional soil treatment is essential to protect public health.

Future articles will discuss the results of research on peat filters, sand filters, and constructed wetlands. For more information on this research and ISTS, visit <http://www.bae.umn.edu/~septic/>.

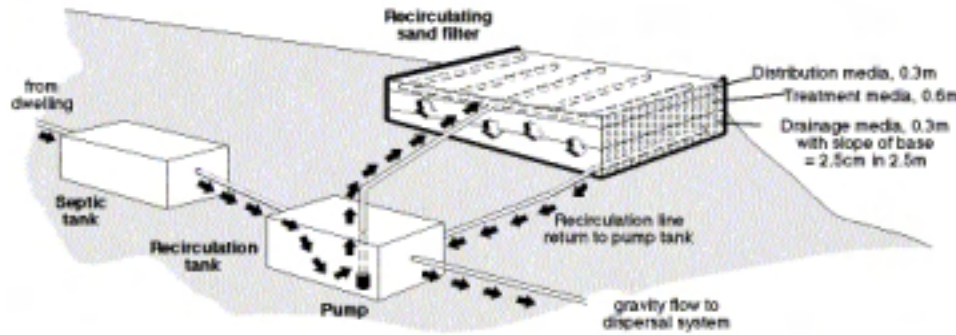


Figure 1. Septic system design using a recirculating sand filter.

five times before discharging it to a soil treatment unit for final treatment.

Filters are composed of 0.3 m of pea rock drainage media. A slotted pipe is located along the bottom of the drainage media, providing outflow from the filter. The depth of outflow is 0.3 m below the bottom of the media. Next is a 0.6-meter-thick layer of coarse sand in which a

Four RSFs were evaluated in this study. Two of them were located at the Lake Washington research site in LeSueur county. The other two were installed to serve individual residences in suburbs of the Twin Cities using demonstration funds provided by the Metropolitan Council. All systems were evaluated for their ability to reduce BOD, TSS, fecal coliform (FC), total phosphorus, total N, NH₄⁺ and NO₃⁻. The effluent from all alternative systems was directed to soil treatment trenches for final treatment. The two systems at the residences were installed to provide pretreatment to see if effluent surfacing from the soil treatment systems could be reduced or eliminated by improving effluent quality. After installation, the trenches were periodically inspected to assess how much ponding was occurring and if rejuvenation of the failing soil treatment systems was accomplished. Inspection pipes were placed at the beginning and end of each trench. Each trench was visually inspected to check if effluent was present and, if so, how much.



Dave Gustafson, Extension Educator, points out how the filter controls work.

majority of the treatment occurs. The distribution media is placed over the sand and is composed of drainfield rock. Schedule 40-distribution pipe, 1.8 cm in diameter, is placed in the distribution



A recirculating sand filter distribution system is set in place.

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and water quality data for three farming systems were analyzed in the study. The farming systems were:

- Field corn/soybean annual rotation under ridge tillage and split nitrogen and banded herbicide applications.
- Sweet corn/potato annual rotation under a conventional full-width tillage with split nitrogen applications and banded herbicide applications for sweet corn and broadcast applications for potatoes.

- Field corn under continuous, conventional full-width tillage and split nitrogen application with broadcast herbicide applications.

Study results showed:

- No atrazine was detected in the corn/soybean ridge tillage system and atrazine metabolites were detected



Irrigated corn at the MSEA research site.

only occasionally. These detections were less frequent for the corn/soybean ridge tillage system compared to both the conventional full-width tillage continuous corn and sweet corn/potato systems.

- Grain yields for corn were higher for the corn/soybean rotation than under the continuous corn system.
- Nitrate-N concentrations in the upper one-meter saturated zone were least under a corn/soybean rotation

and greatest under the sweet corn/potato rotation.

- When best management practices



Dan Rosemore of the USGS collects groundwater samples from a study farm system.

were used on the irrigated sandy soils, nitrate-N concentrations did not increase in the groundwater table.

These results suggest that ridge tillage corn/soybean continuous corn production provides a viable and more environmentally benign alternative to a full-width continuous corn production system, Renwick and co-workers wrote in their report.

However, the economic analysis suggests that the sweet corn/potato production system is potentially most profitable. Renwick says, "The sweet corn/potato rotation that poses the most significant threat to ground water quality yields the largest potential profits.

"This is a disturbing finding," Renwick says.

"Producers may be reluctant to adopt the environmentally benign practices unless they have economic incentives or mandates to do so."

"The sweet corn/potato production system is subject to substantial risk due to year-to-year variability in yield, prices, and inputs," Renwick says. "This risk worked to curb the expansion of the sweet corn/potato system."

The analysis relied on data from the Management Systems Evaluation Area

High-tech water education project receives new funding

The U of M Duluth and Lake Superior College have received an \$800,000 grant from the National Science Foundation's Advanced Technological Education Program for the project, "Training Water Science Technicians for the Future—A National Online Curriculum Using Advanced Technologies and Real-Time Data." This funding will expand the scope and reach of an existing Internet-based water resources curriculum project, Water on the Web (<http://wow.nrri.umn.edu>), to community colleges and undergraduate institutions across the country.

"We are excited to be able to take Water on the Web from basic Internet-based science lessons to a year-long water resources management course that will address issues important to each region," said Bruce Munson, Minnesota Sea Grant marine educator and associate professor with the U of M Duluth's Department of Education.

Through an on-line curriculum, students will learn and apply their knowledge and skills to problems using real-world, real-time data collected by Remote Underwater Sampling Station (RUSS) units deployed in lakes in their region. The RUSS units provide water quality

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(MSEA) on the outwash sand plains near Princeton, MN. The MSEA project is a joint U of M, USDA, and USGS partnership undertaken to develop management systems that protect groundwater while allowing a viable agricultural enterprise. Other project researchers included John A. Lamb, James L. Anderson, Robert H. Dowdy and Carrie A. Laboski.

For more information, contact Mary Renwick at the WRC at (612) 625-9798.



Minnesota Water Community News

Jeffrey Schuldt, Lucinda Johnson, George Host, and Carl Richards (MN Sea Grant) recently received an EPA grant to: 1) apply an *a priori* classification system to Great Lakes coastal ecosystems, 2) quantitatively identify reference sites within classification units using widely available spatial data bases, 3) define reference biological conditions for classification units, 4) use biological data to test the efficacy of reference classifications, and 5) determine whether degraded biological conditions differ from reference conditions in a subset of classification units.

Jeff Gunderson, Paul Tucker, and Carl Richards, (MN Sea Grant) received a grant from Minnesota Technology, Inc. for the project, "Improving Economically-Viable Baitfish Culture Technology." They will explore aquaculture techniques for golden shiners and other high-value baitfish species.

Barb Liukkonen, (WRC, MN Sea Grant), **Cindy Hagley, Bruce Munson**, (MN Sea Grant), **John Barten** (Hennepin Regional Park District), **George Host, Richard Axler** (NRRI), and **Chris Owen** (Apprise Technologies, Inc.) received an EPA grant for the project, "Managing Urban Runoff Using Real-Time Community-Based Monitoring." The project will examine the consequences of using phosphorus-free fertilizers on a broad scale within an urban watershed with the support of community residents and advanced environmental monitoring technology.

Ray Newman (Fisheries, Wildlife, and Conservation Biology) was named the College of Natural Resources Professor of the Semester for Spring semester 2001. Voting criteria were based on Newman's overall teaching ability and his ability to interest and motivate students.

James Cooper (Fisheries, Wildlife, and Conservation Biology) has retired from the College of Natural Resources after 28 years of service. Cooper's research focused on the behavior, survival, and management of Canada geese.

Alicia Urban (Civil Engineering) received a Doctoral Dissertation Fellowship from the Graduate School. She will use the fellowship to complete her thesis, "The Influence of Hydraulic Structures on Total Dissolved Gas Concentrations." Urban is advised by **John Gulliver** (St. Anthony Falls Laboratory).

Steven Daley Laursen (Associate Dean, College of Natural Resources), **Charlie Blinn** (Forest Resources), **Ray Newman, Jim Cooper** (Fisheries, Wildlife, and Conservation Biology), **Mark Paulson** and **Daisy Ritter** (Center for Environmental Learning and Leadership) recently were presented a Secretary's Honor Award by the United States Department of Agriculture for the White Earth Reservation Science and Math Program, a program sponsored by the College of Natural Resources and the University of Minnesota Extension Service. This program was credited for "brightening the future of American Indian youth by teaching math and science skills while nurturing environmental and cultural appreciation."

Edith Mussukuya (Water Resources Science) was awarded a UM Alumni award in April from the Center for Women. This scholarship is awarded to women returning to school after extended periods of time. Mussukuya worked as an environmental consultant for several years before returning to school to study the Zambezi River in Africa (see story on page 3). She is advised by **Jim Perry** (Fisheries, Wildlife, and Conservation Biology).

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GIWA, gave a lecture on the St. Paul campus about the GIWA initiative. Mussukuya approached Daler about incorporating her research into the GIWA initiative. She applied for funds and was granted a fellowship to study the economic activities that occur within the Zambezi basin, interactions between land-use, water quality and water supply; how upstream activities impact the downstream environment and countries; and the institutional goals of the Zambezi River Action Plan (formulated by UNEP and ratified by the South African Countries in 1987). Mussukuya also plans to use the data she collects in models to predict future water demand that would result from various water plans. "This information is important to help policy-makers and planners plan pro-actively, making [water quality] decisions before pollution reaches a crises point," said Mussukuya. In June, she will also serve as a GIWA program officer in Kalmar, Sweden, for a GIWA implementation meeting.

When asked about her fellowship, Mussukuya replied, "I had been worried about securing funding for my project, and when the GIWA opportunity came out of the blue, I was very excited. I thought it was a true blessing." She is advised by **Jim Perry** (Fisheries, Wildlife, and Conservation Biology).



Upcoming Events

June 1-July 13. **Minnesota: Rivers and Fields.** This 13-part series on the history of the Minnesota River Valley will be broadcast on Fridays at 12:30 pm and 1 pm (back-to-back episodes) on Pioneer Public Television, Appleton. The series was produced by Media Services.

July 11-13. **The Inaugural Conference of the United States Society for Ecological Economics.** Duluth, MN. The USSEE is the most recently formed Regional Chapter of the International Society for Ecological Economics (ISEE). Ecological Economics is an interdisciplinary field of study aimed at the design and implementation of socially and ecologically sustainable economic development. Conference themes will be the social and ecological dimensions of a sustainable and just global economy. This event will showcase the work of over 200 ecological economists representing academia, government agencies, non-profit organizations and the business community. Visit the conferences website at <http://www.ussee.org/> for more information.

July 15-18. **Aquatic Plant Management Society 41st Annual Meeting.** Minneapolis, MN. This conference will focus on aquatic plant management and education challenges. For more information, visit <http://www.apms.org/>.

July 28. **Minnesota On-site Sewage Treatment Contractors Association (MOSTCA) Summer Tour.** Mankato, MN. Participants will tour the Lake Washington Research site as well as look at soil, investigate sewage treatment problems, and learn about new technology and how a lakeshore community solved their sewage treatment problem. For more information, contact MOSTCA at (651) 265-7843 or (888) 810-4178.

September 12-14. **Working at a Watershed Level Training Course.** St. Cloud, MN. This three-day course is designed for managers as well as technical specialists, and covers all facets of watershed work including public involvement strategies, outreach program development, stream ecology, system dynamics, assessment and analysis, planning methods, and management techniques. Speakers will represent both state and national agencies and organizations. For more information, contact Larry Gunderson at larry.gunderson@pca.state.mn.us.

November 8-10. **Working Landscapes in the Midwest: Creating Sustainable Futures for Agriculture, Forestry, and Communities.** Deleva, WI. This conference will explore practices and policies that promote land-based economic activity to sustain families, communities, and ecosystems, while also providing multiple benefits to society. For more information, contact Marin Bryne, Institute for Agriculture and Trade Policy, at (612) 870-3436 or E-mail: marin@iatp.org.

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information such as pH, the amount of oxygen in the water, temperature, electrical conductivity, and turbidity. RUSS technology was developed in Duluth, MN, where the units are manufactured. Curriculum materials will be developed with the help of instructors from two- and four-year institutions in the Pacific Northwest, Southwest, Southeast, Northeast, and Midwest. Each region will be associated with real-time water quality data delivered to the Water-on-the-Web site in partnership with an associated water management agency or university. The project's efforts will be

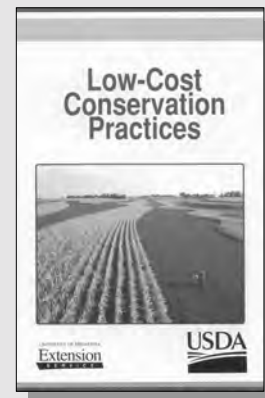
guided by a national panel representing industry, agencies, and higher education.

Project collaborators are Munson, Cindy Hagley, and Carl Richards with Minnesota Sea Grant; Rich Axler and George Host of the Natural Resources Research Institute; Glenn Merrick of Lake Superior Community College; and Chris Owen of Apprise Technologies, Inc.

Minnesota Sea Grant News Release

New "Low-Cost Conservation Practices" brochure available

The USDA Natural Resources Conservation Service (NRCS) and the U of M Extension Service have recently published a new brochure highlighting low-cost conservation practices for agricultural producers. The brochure also describes the types of support (incentive payments, cost-share, etc.) that producers can receive for implementing such practices. For a free copy, contact the WRC at (612) 625-2282 or your local USDA NRCS office, or visit <http://wrc.coafes.umn.edu/EQIP/conservation.pdf>.





New Publications

Alien Invasive Species and Biological Pollution of the Great Lakes Basin Ecosystem. Great Lakes Water Quality Board. 2001. This white paper focuses on the discharge of ballast water from shipping vessels coming from outside the U.S. and Canada and makes recommendations to the International Joint Commission regarding implementation and enforcement of bi-national ballast water discharge standards; evaluation of the effectiveness of alternative technologies to achieve ballast water discharge standards for use in the long-term, as well as the use of chemical treatment as a short-term, emergency measure while this evaluation effort is proceeding; implementation of best management practices for sediment control in shipping vessels; shipping vessel design modifications; and monitoring and contingency plans for future invasions of alien species. Available at <http://www.ijc.org/boards/wqb/ais01may.html>.

Water Sourcebook Series. EPA. 2001. This series consists of four volumes,

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appropriate for Grades K-2, 3-5, 6-8, & 9-12, that explain how the water management cycle affects every aspect of the environment. The curriculum provides strong science and math content, but also links these subject areas to social studies and language arts. Each Water Sourcebook contains hands-on activities and investigations, fact sheets, reference materials, and a glossary of terms. Available at <http://www.epa.gov/safewater/kids/exper.html>.

Financing Stormwater Management. Center for Urban Policy and the Environment at Indiana University-Purdue University Indianapolis (IUPUI), and Watershed Management Institute, Inc. This website includes an annotated bibliography of existing stormwater finance materials; an archive that contains selected previously published materials concerning stormwater finance; a manual that discusses the financing options available to communities for stormwater management programs; a set of case studies that describe successful

finance mechanisms that have been used in seven communities around the country; and a group of links to other useful web sites about stormwater management. Visit <http://stormwaterfinance.urbancenter.iupui.edu/>

Wetland Functions and Values. EPA. 2001. This web-based training module reviews the extraordinary contributions that wetlands make to water quality, economy, recreation, environmental health, and other areas. Visit <http://www.epa.gov/watertrain/wetlands/>.

The Impacts of Tourism. Glenn Kreag. 2001. This publication tabulates 87 tourism impacts within seven categories to provide an unbiased framework for discussions, directions, and development, and is designed for individuals and groups interested in the potential results of tourism development. Available from Minnesota Sea Grant at (218) 726-6191, E-mail: seagr@d.umn.edu, reference item T 13.

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