

Water Resources Center

Annual Technical Report

FY 1998

Introduction

Research Program

Research priorities that address six areas of water research were established in 1989 to guide the IWRC research program through 1998. These priorities are: groundwater quality; potential insufficiencies in water resources, including the management of water resources among competing uses; controlling pollution from nonpoint sources; the loss and degradation of water-based fish and wildlife habitat; developing and evaluating means for formulating policies that are based on limited data; and emerging issues, including other innovative research topics that are not included in the five priorities above. In addition, in 1994, the IWRC undertook a special research initiative in three areas: watershed protection, water quality and supply for small communities, and wetlands processes and management.

In 1998-99, nineteen preproposals were received by the Illinois Water Resources Center under the Water Resources Research Institutes program. Based on review by the Executive Committee, 10 full proposals were invited. The full proposals were distributed for review by peers outside the state of Illinois. Based on the peer reviews and the IWRC's announced priorities, the Executive Committee selected three projects for funding with available nonfederal resources and three for funding from the core federal grant. While no part of the core USGS grant was used to start up the nonfederally-funded projects, the core grant does provide the capacity to administer these projects and provide information transfer.

Synopses of the three individual research projects which continued in 1998 appear in the following part of this report. All of these projects received funding through the regional competition.

The Center takes a special interest in helping young scientists establish a track record in water resources research. The Water Resources Center both encourages new scientists to submit proposals and gives their proposals extra consideration. The proposals, however, must be of significant scientific merit (as determined by the reviewers and the Executive Committee) and have relevance to the total water program of Illinois to be judged worthy of funding. Virtually all projects supported by the IWRC contribute significantly to the education of students, both graduate and undergraduate, who participate in the research projects. The Student Support table lists students supported in both the internship program with the Illinois District Office of USGS and on the individual grants to faculty researchers.

The Illinois Water Resources Center also helps administer the research component of the Illinois-Indiana Sea Grant College Program in partnership with the National Oceanic and Atmospheric Administration (NOAA). This program was initiated in 1982 through the efforts of the Cooperative Extension Services at the University of Illinois and Purdue University. The research component was added in 1984. IWRC's involvement in this program has increased the Center's opportunities for coordinating research activities with other water-related programs in

the Midwest. Nine projects received continued funding in fiscal year 1998.

Basic Project Information

Basic Project Information	
Category	Data
Title	Novel Molecular-Recogniton-Based Sensors for Groundwater Quality Assessment
Project Number	C-01
Start Date	09/01/1996
End Date	08/31/1998
Research Category	Water Quality
Focus Category #1	Groundwater
Focus Category #2	Water Quality
Focus Category #3	None
Lead Institution	Other

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Joseph T. Hupp	Professor	Northwestern University	01

Problem and Research Objectives

A major post-technological/environmental issue is remediation of water sources contaminated by heavy metals, salts, polyhalogenated aromatics (including PCB's), nitroaromatics, heteroaromatics and chlorinated alkanes. Closely related are the issues of detection (sensing) of these contaminants in a complex aqueous environment (e.g., groundwater) and real-time monitoring of potential sources of additional contamination (e.g., industrial waste streams, multiple DOD and DOE containment facilities, etc.). Ideally, any sensing/detection/ monitoring strategy - whether for compliance or water quality assurance - will be selective yet versatile, tailorable, reasonably rapid, cost effective and readily applicable in remote environments. We proposed a "designed" molecular recognition approach (or "host/guest" approach) which has the potential to satisfy most or all of these criteria by exploiting both novel self-assembly chemistry and unusual light-emission properties.

Methodology

In order to detect groundwater contaminants (trace metal ions or trace organics), we proposed a strategy based on: 1) molecular or ionic guest recognition and reversible binding by rigid or semirigid hosts, and 2) quantitative modification of host photo luminescence by recognition events. To implement the approach we proposed to use new host self-assembly chemistry developed in our lab at Northwestern over the past year.

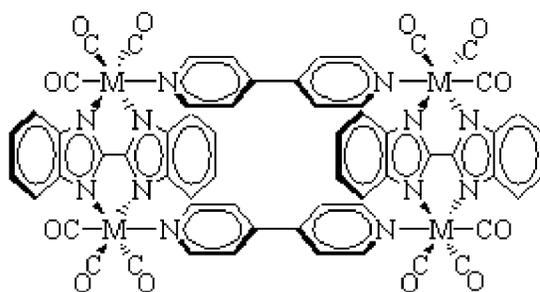
Adaptation of the host molecules for device applications such as remote sensing will entail surface immobilization and stabilization. More powerful applications, such as multicomponent sensing and selectivity enhancement, will entail spatially selective attachment of arrays of closely related hosts to surfaces.

To summarize, in order to develop and employ a molecular sensing strategy to address a key environmental problem (groundwater quality), we proposed to use and expand current synthetic approaches to create new hosts to give a broader guest detection library and to generalize the basic molecular sensing phenomena already observed.

Principal Findings and Significance

We described in the original proposal the groundwork for using thin films of "molecular squares", developed at Northwestern, as sensors for ions and organic contaminants. We described in last year's report the successful demonstration of volatile organic chemical (VOC) sensing with these unusual materials. These molecular-recognition-based sensors rely primarily on host (square)/guest (VOC species) size complementarity to achieve chemical selectivity.

We now report the successful design and construction of improved second-generation materials capable of shape-selective recognition of molecular guests (target contaminants). The new materials are based on a "molecular rectangle" motif, as shown in the accompanying figure. We find that guest molecules of appropriate size and shape can be reversibly bound within the rectangular cavities. We further find that the binding can be detected by quartz crystal microgravimetry or, in certain cases, by changes in host luminescence, i.e. the new materials clearly can function as chemical sensors. In addition, we find that host/guest binding constants are roughly an order of magnitude larger with the rectangular materials than with the earlier square materials for similar VOC-type guests. The increases in binding constant imply a corresponding one order-of-magnitude improvement in analyte (pollutant) detection limit.



Descriptors

Groundwater Quality, Water Quality, Trace Organics

Articles in Refereed Scientific Journals

1. Benkstein, K.D.; J.T. Hupp, C.L. Stern, **1998**, "Molecular Rectangles Based Upon Rhenium (I) Coordination Chemistry" *J. Am. Chem. Soc.* (120) 12982-12983.
2. Slone, Robert V.; K.D. Benkstein, S. Belanger, J.T. Hupp, I.A. Guzei, A.L. Rheingold,

"Luminescent Transition-metal-containing Cyclophanes ("Molecular Squares"): Covalent Self-assembly, Host-guest Studies and Preliminary Nanoporous Materials Applications" *Coor. Chem. Rev.* **1998**, 171:332-354.

3. Belanger, S.; M.H. Keefe, J.L. Welch, J.T. Hupp, "Rapid Derivatization of Mesoporous Thin-Film Materials Based on Re(I) Zinc-Porphyrin "Molecular Squares": Selective Modification of Mesoporous Size and Shape by Binding of Aromatic Nitrogen Donor Ligands" *Coor. Chem. Rev.* **1999**, in press.

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

1. "Electrochemical Interrogation of Selective Molecular Transport Through New Nanoporous Inorganic Thin-Film Materials", Symposium on Electrochemistry at Nanostructured Materials, American Chemical Society National Meeting, Dallas, TX, April, 1998.
2. "Nanoporous Molecular Materials as Chemical Sensors", Gordon Research Conference on Chemical Sensors, New Hampshire, July, 1998.
3. "New Nanoporous Molecular Materials", 33rd International Conference on Coordination Chemistry, Florence, Italy, August, 1998.
4. "Synthesis and Applications of New Nanoporous Molecular Materials", Symposium on molecular functions of Electroactive Thin-Films, Electrochemical Society National Meeting, Boston, MA, November, 1998.

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	Controlling <i>Cryptosporidium</i> in Drinking Water Supply for Small Communities
Project Number	C-02
Start Date	09/01/1997
End Date	08/31/1999
Research Category	Water Quality
Focus Category #1	Water Quality
Focus Category #2	Treatment
Focus Category #3	Surface Water
Lead Institution	University of Illinois

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Benito J. Marinas	Professor	University of Illinois	02

Problem and Research Objectives

Cryptosporidium parvum (*C. parvum*) is a protozoan parasite that is known to infect humans and many animals, both wild and domesticated. The prevalence of *C. parvum* makes this pathogen difficult to control, especially in the rural communities of the North Central Region due to the high population of domesticated farm animals that inhabit the watersheds of this area. The recent interest in *Cryptosporidium parvum* is the result of an outbreak of cryptosporidiosis that occurred in the spring of 1993 in Milwaukee, WI.¹ As a result of this outbreak, more than 400,000 people became infected with cryptosporidiosis; a disease for which there is no cure.¹ Although most of the people infected recovered within two weeks, a number of people died from complications stemming from other medical conditions most notably, immune system disorders which were the result of cancer, AIDS, or organ transplant therapy.

C. parvum has been shown to be extremely resistant to conventional disinfection processes; as much as fifty (50) times more resistant than *Giardia lamblia*, the next most resistant pathogen. Because of this resistance, inactivation of *C. parvum* is considered by the industry to be difficult. Small utilities potentially face a greater threat from *Cryptosporidium* than large utilities because of insufficient resources that are required to train and support full-time plant operators. In addition, utilities in the North Central Region may also be more at risk due to the harsh winters associated with the area. The cold temperatures result in significantly slower inactivation kinetics observed in conventional disinfection treatment, which makes chemical disinfection much more difficult.

The main objective of this project is the development of a cost effective treatment strategy for providing safe drinking water to small communities using surface water or groundwater under the direct influence of surface water. The approaches under consideration are consistent with existing treatment systems in order to avoid high capital investment related to overall technology replacement, and to take advantage of the relative affordability of land in rural areas. The anticipated strategy is a three-step treatment process (pretreatment, holding pond, disinfection) to provide adequate disinfection of *C. parvum* oocysts.

Methodology

The inactivation of *C. parvum* oocysts was studied with both batch (free/combined chlorine) and semi-batch (ozone) reactors. Target disinfectant concentrations were 8 mg/L for free and combined chlorine and varied depending on temperature for ozone. Viability was determined by an *in vitro* excystation method. *C. parvum* oocysts treated by sequential disinfection were first pretreated with ozone at a CT (i.e. product of disinfectant concentration and contact time) sufficient to inactivate approximately 80% of the oocysts. The oocysts were then exposed to free or combined chlorine until the inactivation efficiency was greater than 99 percent.

Principal Findings and Significance

Research progress to date includes:

- Assessment of *C. parvum* oocyst inactivation with free/combined chlorine (pH 6 and 8, respectively) and temperature (4-30°C);
- Study of the effects of varying ozone pretreatment CTs on the subsequent inactivation kinetics of *C. parvum* with free or combined chlorine;
- Inactivation of the synergistic effects of sequential disinfection (ozone pretreatment-free/combined chlorine disinfection) on the inactivation of *C. parvum* oocysts in the experimental temperature range of 4-30°C.

Results obtained for the free chlorine (pH 6) disinfection experiments performed to assess the effect of temperature are presented in Figure 1. Each inactivation curve was characterized by a lag phase or shoulder region followed by pseudo-first order inactivation kinetics. Temperature had a significant effect on the resistance to *C. parvum* oocysts to free chlorine, which resulted in a longer lag phase and slower inactivation kinetics at lower temperatures. Data (not shown) indicate that the inactivation of *C. parvum* oocysts is the direct result of exposure to hypochlorous acid (HOCl) and not hypochlorite ion (OCl⁻).

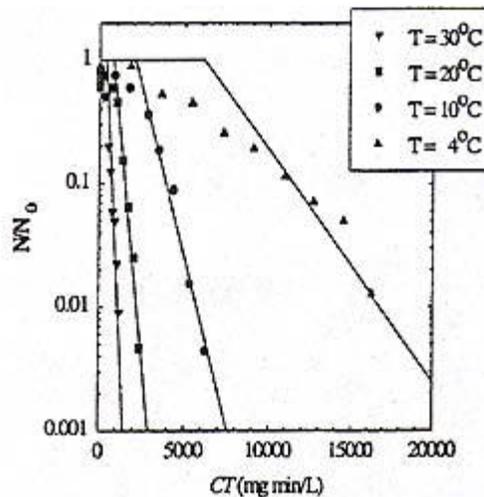


Figure 1. Effect of Temperature on the Free Chlorine Inactivation of *C. parvum* Oocysts at pH 6.

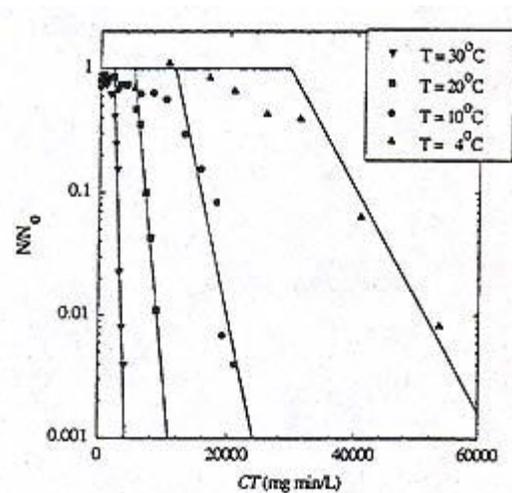


Figure 2. Effect of Temperature on the Monochloramine Inactivation of *C. parvum* Oocysts at pH 8.

Based on the results obtained for free chlorine, it was determined that *C. parvum* is resistant to this disinfectant such that impractical contact times are required to inactivate significant numbers of oocysts. A similar trend was observed for monochloramine, in which the inactivation kinetics are given by a shoulder region, followed by a first order decrease in viability. Given the CTs required to achieve significant inactivation, the use of monochloramine alone appears to be an impractical approach to treating water for *Cryptosporidium*.

Temperature dependence experiments, similar to those described above, were conducted with ozone (data not shown). The results of these experiments revealed that in addition to being much more effective at inactivating *C. parvum*, the lag phase region was significantly shorter. Given the shoulder for both disinfectants, it was hypothesized that if the shoulder region was removed with ozone, subsequent exposure with free or combined chlorine would result in an inactivation curve with no shoulder. This hypothesis was proven true, and an additional benefit of an increased rate of inactivation with both free and combined

chlorine was observed if ozone was allowed to completely remove the shoulder region.

This observation prompted the investigation of the temperature dependence of inactivation kinetics of *C. parvum* with free or combined chlorine once the shoulder region had been completely removed with ozone. The results of this effort are given in Figures 3 and 4.

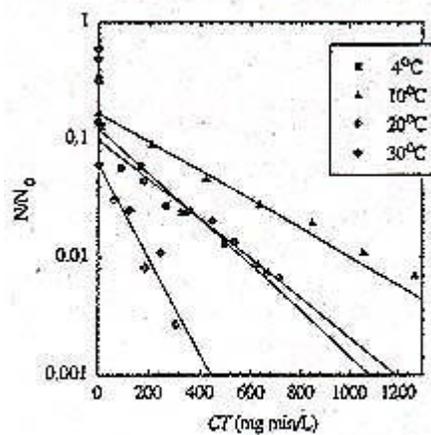


Figure 3. Effect of Temperature on the Inactivation Kinetics of *C. parvum* Oocysts with Free Chlorine (pH 6) when followed by Ozone Pretreatment.

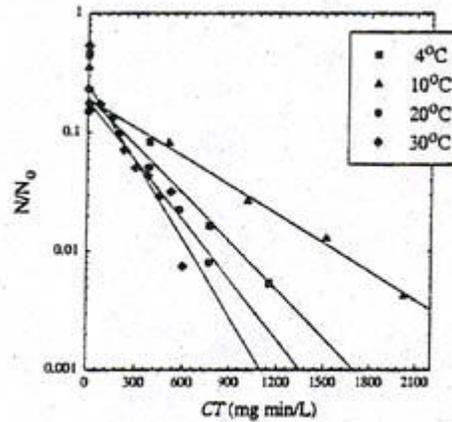


Figure 4. Effect of Temperature on the Inactivation Kinetics of *C. parvum* Oocysts with Monochloramine (pH 8) when followed by Ozone Pretreatment.

Oocysts were initially treated with ozone at a CT predetermined to inactivate approximately 80%. The oocysts were then exposed to free or combined chlorine. The rate of inactivation of the ozone/free chlorine treated oocysts was fastest at 30°C, followed by the kinetics at 4°C, 20°C, and 10°C, respectively. The rate of inactivation with free chlorine at 4°C when following ozone pretreatment was approximately 10 times faster than that for free chlorine alone at 4°C.

A similar, yet more dramatic phenomena was observed with monochloramine inactivated oocysts that were pretreated with ozone. In this case, the rate of inactivation was greatest at 30°C, followed by 20°C, 4°C, and 10°C. However, even though the inactivation rate at 4°C was the third highest, it was 15 times that observed for oocysts treated with monochloramine alone at the same temperature. This increased efficiency at low temperature not only translates into reduced cost for small utilities, but also helps to ensure that the people served will be drinking significantly safer water.

References:

1. Fox, K.R.; Lytle, D.A. (1996) "Milwaukee's Crypto Outbreak: Investigation and Recommendation", *Journal of the American Water Works Association*, 88(9), 87-94.

Descriptors

Cryptosporidium parvum oocysts, disinfection, ozonation, protozoa, small communities, surface water, water quality control, water treatment

Articles in Refereed Scientific Journals

1. K.M. Ruffell; J.L. Rennecker; B.J. Mariñas (2000) "Inactivation of *Cryptosporidium parvum* Oocysts with Chlorine Dioxide". *Water Research*, 34(1), (in press).
2. A.M. Driedger, J.L. Rennecker, B.J. Mariñas, "Sequential Inactivation of *Cryptosporidium parvum* Oocysts with Ozone and Free Chlorine", *Water Research* (submitted).

Book Chapters

Dissertations

1. Kristen M. Ruffell, M.S.E.E., 1999, Inactivation of *Cryptosporidium parvum* with Chlorine Dioxide and Potassium Permanganate.

Water Resources Research Institute Reports

Conference Proceedings

1. K.M. Ruffell; J.L. Rennecker; B.J. Mariñas (1998) "Inactivation Kinetics of *Cryptosporidium parvum* Oocysts with Chlorine Dioxide." *Proceedings of the American Water Works Association Water Quality Technology Conference*, San Diego, CA, November 1-5, 1998.
2. J.L. Rennecker, S.A. Rubin, B.J. Mariñas "Synergistic Effects of Sequential Disinfection Schemes with Ozone/Monochloramine and Ozone/Free Chlorine," *Proceedings of the 1999 American Water Works Association Annual Conference*, Chicago, IL, June 20-24, 1999.
3. A.M. Driedger, S.A. Rubin, J.L. Rennecker, B.J. Mariñas "Inactivation of *Cryptosporidium parvum* Oocysts with Free Chlorine and Monochloramine," *Proceedings of the 1999 American Water Works Association Annual Conference*, Chicago, IL, June 20-24, 1999.
4. B. Corona-Vasquez, J.L. Rennecker, B.J. Mariñas, "Inactivation of *C. parvum* with Chlorine Dioxide/Free Chlorine and Chlorine Dioxide/Monochloramine," accepted for presentation and publication in the *Proceedings of the 1999 American Water Works Association Water Quality Technology Conference*, Tampa, Florida, October 31-November 4, 1999.
5. A.M. Driedger, J.L. Rennecker, B.J. Mariñas, "Optimization of *C. parvum* Inactivation with Ozone/Free Chlorine and Ozone/Monochloramine," accepted for presentation and publication in the *Proceedings of the 1999 American Water Works Association Water Quality Technology Conference*, Tampa, Florida, October 31-November 4, 1999.

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	Cost-Effective Monitoring Design for Intrinsic Bioremediation
Project Number	C-03
Start Date	09/01/1998
End Date	08/31/2000
Research Category	Ground-water Flow and Transport
Focus Category #1	Groundwater
Focus Category #2	None
Focus Category #3	None
Lead Institution	University of Illinois

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Albert J. Valocchi	Professor	University of Illinois	03
Barbara S. Minsker	Assistant Professor	University of Illinois	03

Problem and Research Objectives

A recent Environmental Protection Agency report (U. S. EPA, 1997) reported that over 217,000 sites in the United States currently need to be remediated under existing regulations, at a predicted cost of \$186 billion. Over 70 percent of these sites have contaminated groundwater requiring remediation (U. S. EPA, 1997). During remediation, whether by natural attenuation or active remediation technologies, monitoring wells must be sampled to track the progress of remediation. Large, complex sites may have hundreds of monitoring wells that were installed for site characterization and long-term sampling from all of these wells can cost millions of dollars per year. The objective of this research is to develop a methodology for designing cost-effective long-term monitoring plans and to demonstrate the methodology's capabilities by applying it at a field site.

Methodology

The method developed combines three primary components: a groundwater fate-and-transport simulation, several plume interpolation techniques, and a genetic algorithm. The fate-and-transport simulation model, RT3D, is used to predict concentrations at all existing monitoring wells in future monitoring periods. These concentrations are then used with one of several plume interpolation techniques, including inverse distance weighting, kriging, and a hybrid of both methods, to obtain a global estimate of contaminant mass remaining in the groundwater. The genetic algorithm then searches through possible sampling plans using a process analogous to natural selection to identify sampling plans that provide reasonably accurate mass estimates at the least cost.

Principal Findings and Significance

Progress report: The methodology has been completed and published in Patrick Reed's thesis (Reed, 1999), with an application to a relatively simple site from the literature. The thesis will be submitted to a journal for publication this fall. Research is ongoing to apply the methodology to a field site. Although we had planned to apply the methodology to Wurtsmith Air Force Base, we had difficulties obtaining the data required for the analysis. Representatives from Williams Air Force Base, who viewed a poster presentation on the methodology at the Bioremediation Symposium in April 1999, offered to provide data for an application at their site. We have received the data and are currently fitting the fate and transport model to it. Brett Schmidt will be completing his thesis during the Summer of 2000, completing the application and the project.

The methodology developed in this project has the potential to produce substantial cost savings at numerous sites in the U.S. We presented the work at several professional conferences and interest in the method has been substantial. The University of Illinois issued a press release on the method in August and several articles have been written or are in press in popular environmental industry journals such as *Pollution Engineering*. Several requests for more information and the software have already been received and more are expected to come as the articles in press are published.

References:

1. United States Environmental Protection Agency, Office of Solid Waste and Emergency Response, Technology Innovation Office, 1997, *Cleaning Up the Nation's Waste Sites: Markets and Technology Trends*, EPA 542-R-96-005.
2. Reed, Patrick, 1999, *Cost Effective Long-term Groundwater Monitoring Design using a Genetic Algorithm and Global Mass Interpolation*, M. S. dissertation, Department of Civil and Environmental Engineering, College of Engineering, University of Illinois, Urbana, IL, 54 pages.

Descriptors

Water quality monitoring, sampling plans, groundwater modeling, optimization, plume interpolation

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

1. Reed, Patrick, 1999, *Cost Effective Long-term Groundwater Monitoring Design using a Genetic Algorithm and Global Mass Interpolation*, M. S. dissertation, Department of Civil and Environmental Engineering, College of Engineering, University of Illinois, Urbana, IL, 54 pages.

Water Resources Research Institute Reports

Conference Proceedings

1. Reed, Patrick, Barbara Minsker and Albert Valocchi, 1999, Cost-Effective Long-Term Monitoring Design for Intrinsic Bioremediation, in Proceedings of the 26th Annual Water

- Resources Planning and Management Conference (ISBN 0-7844-0430-5), ed. Erin M. Wilson, Session 2B: Natural Attenuation Management Issues, Tempe, AZ, CD-ROM proceedings available from American Society of Civil Engineers, Washington, DC.
2. Reed, Patrick, Barbara Minsker and Albert Valocchi, 1999, Cost-Effective Long-Term Monitoring Design for Intrinsic Bioremediation, in Proceedings of the 5th International In Situ and On-site Bioremediation Symposium (Bruce C. Alleman and Andrea Leeson, eds.), San Diego, CA , pp. 301-306.

Other Publications

Information Transfer Program

The major functions of the Water Resources Center are to oversee a research program and convey the results of the research and development within the water resources field to specialists and the interested public. To accomplish this, the Center uses many vehicles of communication, including publishing a newsletter circulated to over 700 addresses, publishing research reports, consulting with government agencies, service on state advisory committees, sponsoring conferences and preparing conference proceedings. These and other activities are discussed below.

ILLINOIS RIVER ACTIVITIES: The Illinois River, a major recreational and economic resource for Illinois (more than 90 percent of the state's population lives in this basin of 30,000 square miles), is rapidly deteriorating. The Center has played an important role in efforts to reverse this deterioration. The Center Director served on the Lt. Governor's Team that developed a consensus-based Integrated Management Plan for the Illinois River. The Plan led to a joint state-USDA initiative of \$429 million to restore and preserve the watershed, including measures to reduce soil erosion and sedimentation, improve water quality, and enhance wildlife habitat. At the Director's suggestion, a Science Advisory Committee (SAC) was created in 1998 to assist in the implementation of the Plan and in the assessment of progress, and the Director was invited to serve on the SAC. Both the Director and the Editor served on the planning committee for the 1999 Governor's Conference on the Management of the Illinois River System.

MIDWEST TECHNOLOGY ASSISTANCE CENTER (MTAC): MTAC is a cooperative effort of the ten states of the Midwest (congruent with USEPA regions 5 and 7), led by the Illinois State Water Survey and the Illinois Water Resources Center. The participation of each state in MTAC is led by the Director of their Water Resources Institute. Following a national competition, the Midwest Technology Assistance Center (MTAC) was established 1 October 1 1998 to provide assistance to small public water systems throughout the Midwest with funding from the United States Environmental Protection Agency (USEPA) under the 1996 amendments to the Safe Drinking Water Act.

The mission of MTAC is to assist small community water systems and Native American community water systems in the assessment, evaluation, and implementation of technological solutions to their drinking water problems. MTAC is funding several competitively selected projects to address those needs. The results of a Benchmark Investigation of Small Public Water System Economics funded by MTAC should help small systems with financial planning so they can afford to implement solutions to future problems. MTAC will sponsor a series of workshops that employ Native American educational organizations and speakers to address issues such as laboratory methods, regulatory requirements, monitoring needs and methodology, wellhead protection, and public awareness of drinking water issues. The study on Corrosion Control in Small Public Water Systems will address the interaction of some corrosion control chemistries and disinfection with chlorine in steel, copper, and lead pipes. MTAC has

also initiated the production of a Public Water System Emergency Planning Interactive Guide in cooperation with the Illinois section of the American Water Works Association (AWWA). The guide will be used to aid small community water systems in the development an emergency response plan. More than two hundred small community water systems participated in a Technical Needs Assessment conducted by MTAC. This information will be used to help focus the efforts of MTAC in the future so that the most critical needs of small systems will be addressed.

WORKSHOP ON STREAM RESTORATION IN RAPIDLY URBANIZING AREAS: The "collar" counties around Chicago, including Kane County, are among the fastest developing areas in Illinois. Management of stormwater and preservation of green space are important issues as rural land is developed. Restoration of green space and streams are important issues in the same counties as brownfields and former industrial areas are redeveloped. The Center Director helped plan a workshop, *Stream Geomorphology & Restoration Techniques in Northeastern Illinois*, that will introduce principles for understanding, valuing, and improving streams to an audience of consultants, developers, city and state officials, and representatives from environmental organizations.

WATERSHED MANAGEMENT: The Center Director organized a workshop for leaders from "pilot" watersheds in Illinois that are developing watershed management plans and seeking innovative solutions to problems that cannot be addressed by controls on point sources. The workshop was supported by the Illinois Department of Natural Resources.

IWRC DISPLAY: The display which describes the activities of the Center is used at conferences (including the Illinois River Conference mentioned above) and other public events to highlight the Center's accomplishments.

NEWSLETTER: The Water Resources Center's newsletter, News and Announcements, is the Center's primary means of informing its 700 subscribers of research results, publications, grant information, conferences and workshops, personnel changes, and other water resources news. Each issue highlights a new water research project or a major issue in water resources. Two issues were produced in 1998-99, with major stories on the Technology Assistance Center and Water '98, a statewide water resources conference organized by the Center.

IWRC ON THE WEB: The IWRC is on the World Wide Web. The page may be accessed at the following internet address: (<http://w3.aces.edu/IWRC/>). It provides links to other information through the national Institutes for Water Resources (<http://wrri.nmsu.edu/niwr/index.html>). Among the resources available from the NIWR page are all 54 State Water Research Institute's home pages, the Universities Council on Water Resources' database of experts (UWIN), and the National Oceanic and Atmospheric Association's home page (<http://www.noaa.gov/>). The Illinois-Indiana Sea Grant home page at (<http://ag/ansc.purdue.edu/il-in-sg/home.htm>) can be accessed from IWRC's page.

Publications from core funds during 1998-1999

News and Announcements, Volume 27, Number 1, May 1998; Volume 27, Number 2, August 1998, Alesia Strawn, Editor.

Illinois Water '98 Conference Program. 16-17 November 1998, Urbana, Illinois, Alesia Strawn, Editor. 12p.

Illinois Water '98 Technical Session & Poster Abstracts. 16-17 November 1998, Urbana, Illinois, Alesia Strawn, Editor. 33p.

Basic Project Information

Basic Project Information	
Category	Data
Title	Illinois River Activities
Description	Scientific Advisory Committee to the Coordinating Council that Implements the Integrated Master Plan for the Illinois River
Start Date	03/01/1998
End Date	02/28/1999
Type	Conferences
Lead Institution	Illinois Water Resources Center

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Richard E. Sparks	Professor	Illinois Water Resources Center	01

Problem and Research Objectives

Methodology

Principal Findings and Significance

Committee provides scientific advice on restoration of the Illinois River, whose basin of 30,000 square miles is home to 90% of the state's population.

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	Midwest Technology Assistance Center (MTAC)
Description	MTAC is a cooperative effort of Water Resources Institutes in ten states of the Midwest to provide assistance to small public water systems (USEPA funded).
Start Date	03/01/1998
End Date	12/31/2000
Type	Conferences
Lead Institution	Illinois Water Resources Center

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Kent Smothers	Professional Staff	Illinois State Water Survey	01
John Braden	Professor	Environmental Council, University of Illinois	02
Richard E. Sparks	Professor	Illinois Water Resources Center	03

Problem and Research Objectives

Methodology

Principal Findings and Significance

Most of the violations of drinking water standards in the Midwest occur in small community water systems. MTAC provides technical assistance, including financial planning, so these small systems can supply safe water.

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	Stream Geomorphology and Restoration Techniques in Northeastern Illinois
Description	Planning a conference to introduce principles for understanding, valuing, and improving streams in rapidly urbanizing areas.
Start Date	03/01/1998
End Date	02/28/1999
Type	Conferences
Lead Institution	Illinois Water Resources Center

Principal Investigators

Problem and Research Objectives

Methodology

Principal Findings and Significance

Conference concept is that stormwater management can be combined with preservation of green space to enhance the quality of life and property values in rapidly urbanizing areas.

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	Watershed Management
Description	A workshop for leaders from watershed planning groups.
Start Date	03/01/1998
End Date	02/28/1999

Type	Conferences
Lead Institution	Illinois Water Resources Center

Principal Investigators

Problem and Research Objectives

Methodology

Principal Findings and Significance

Effectiveness of community-led watershed planning improved when appropriate technical assistance, including leadership development, is provided.

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	IWRC Display
Description	A display which describes the activities of the Center is used at conferences and other public events to highlight the Center's accomplishments.
Start Date	03/01/1998
End Date	02/28/1999
Type	Audio-Visual Productions
Lead Institution	Illinois Water Resources Center

Principal Investigators

Problem and Research Objectives

Methodology

Principal Findings and Significance

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	IWRC on the Web
Description	Website
Start Date	03/01/1998
End Date	02/28/1999
Type	Newsletter
Lead Institution	Illinois Water Resources Center

Principal Investigators

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Water Resources Research Institute Reports

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Other Publications

Basic Project Information

Basic Project Information	
Category	Data
Title	News and Announcements
Description	Newsletter--Vol. 27, No.1, March 1998; Vol. 27, No. 2, August 1998
Start Date	03/01/1998
End Date	02/28/1999
Type	Newsletter
Lead Institution	Illinois Water Resources Center

Principal Investigators**Problem and Research Objectives****Methodology****Principal Findings and Significance****Articles in Refereed Scientific Journals****Book Chapters****Dissertations****Water Resources Research Institute Reports****Conference Proceedings****Other Publications**

Basic Project Information

Basic Project Information	
Category	Data
Title	The Illinois River--Responsible Management for the New Millennium
Description	Planning the 1999 Governor's Conference on the Management of the Illinois River System
Start Date	03/01/1998
End Date	02/28/1999
Type	Conferences
Lead Institution	Illinois Water Resources Center

Principal Investigators

Principal Investigators			
Name	Title During Project Period	Affiliated Organization	Order
Stephen P. Havera	Professional Staff	University of Illinois	01
Robert Frazee	Professional Staff	University of Illinois	02

Problem and Research Objectives

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Water Resources Research Institute Reports

Conference Proceedings

Conference Proceedings will be available early next year.

Other Publications

USGS Internship Program

Student Support

Student Support					
Category	Section 104 Base Grant	Section 104 RCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	N/A	N/A	4	N/A	N/A
Masters	N/A	6	N/A	N/A	N/A
Ph.D.	N/A	3	N/A	N/A	N/A
Post-Doc.	N/A	N/A	N/A	N/A	N/A
Total	N/A	N/A	N/A	N/A	N/A

Awards & Achievements

Publications from Prior Projects

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications