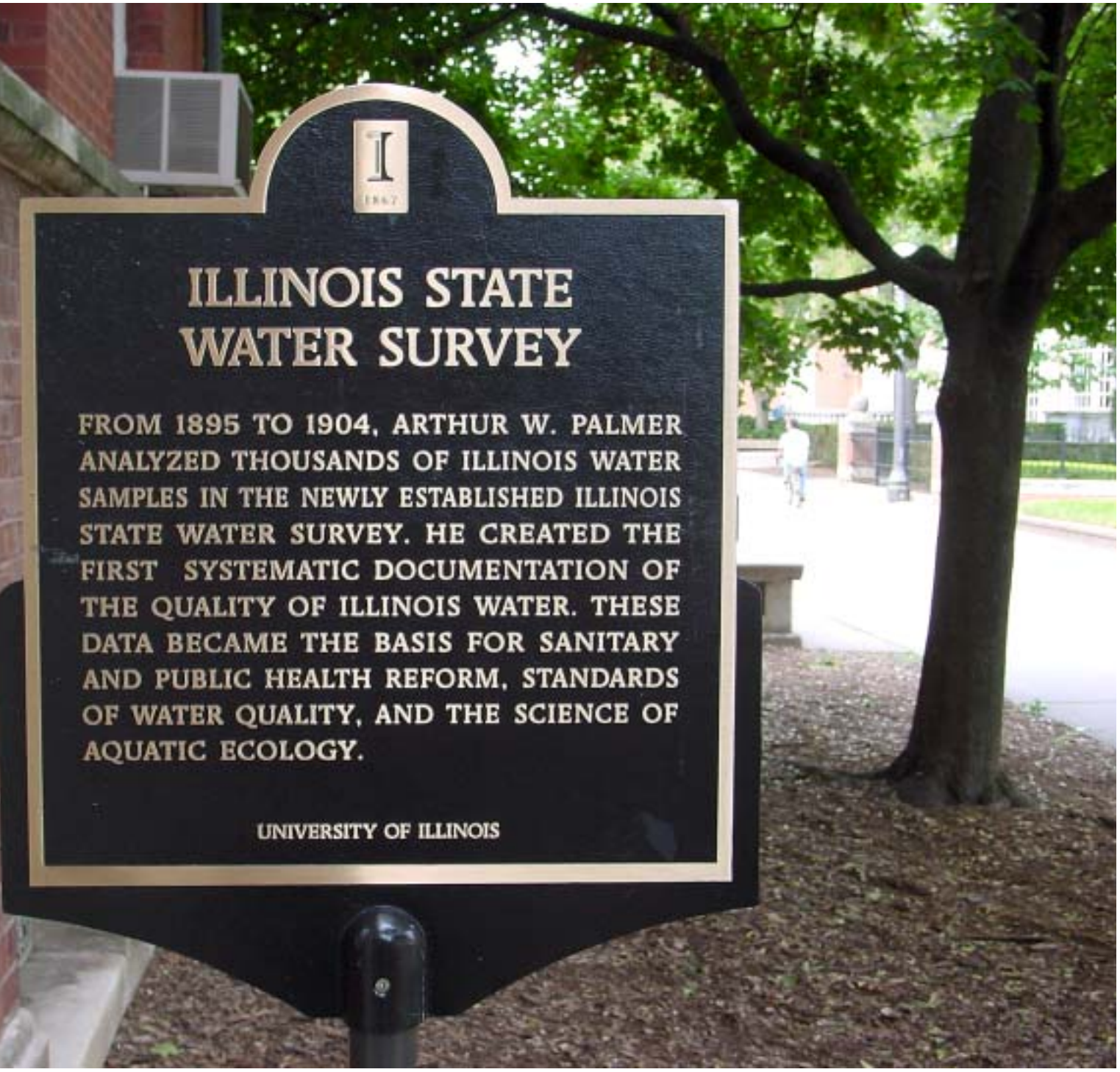


# Illinois State Water Survey
# **Annual Report 2001–2002**

# Illinois State Water Survey Annual Report

## July 1, 2001 – June 30, 2002

**2204 GRIFFITH DRIVE**
**CHAMPAIGN, ILLINOIS 61820-7495**

**2002**

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All uncredited photographs provided by Water Survey staff

**Front Cover:** The University of Illinois has erected this sign outside the north entrance to Noyes Laboratory where the Illinois State Water Survey was established and located from 1895 to 1904.

Page 29: Modified from NIPC Strategic Plan for Water Resources Management, 2001.

ILLINOIS
DEPARTMENT OF
NATURAL
RESOURCES

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# From the Chief's Desk

The Illinois State Water Survey (ISWS) does not manage water supplies but rather provides scientific data and information that planners and managers require to make wise decisions related to the provision of adequate, reliable, and clean supplies of water. In preparing a recent paper on ISWS history, it struck me that Illinois has been talking about the need for improved planning and management of water supplies for at least 80 years. That we are still talking about this at the beginning of the 21st Century is an indication that much remains to be done.

At the heart of legal, political, and social issues relating to water supplies in Illinois is the right of an individual to make reasonable use of these supplies unhampered by government regulation. This common law is rooted in riparian rights. When water supplies are abundant and there is little competition among users, allocating water according to the principle of reasonable use works well. However, when water disputes and shortages arise, often as a result of competition and drought, the courts usually decide what constitutes reasonable and beneficial allocation of scarce water resources. Already projections of water shortages in Illinois have been made, competition for scarce supplies is increasing, future droughts will occur, and determination of what is reasonable will be questioned more than ever.

Over the decades in Illinois, a strong constituency has represented those who want to preserve the reasonable use of water supplies without undue government regulation. This raises some important questions. Does improved management have to be equated with tighter government regulations? Can communities band together voluntarily to protect water supplies for present and future generations, to allocate these supplies to meet diverse demands, and to handle increasing competition effectively?

The Water Authorities Act already provides a mechanism for some of these actions locally, and a few, albeit small, water authorities exist in some parts of Illinois. To provide a sound basis for statewide water protection and management, however, current laws probably would require substantial revision. Another option would be to move toward the western system of private ownership of water rights and to allocate scarce resources efficiently through a market-trading system. However, any attempt to appropriate water rights in Illinois would likely be met with a stiff challenge.

On 22 April 2002, Governor Ryan issued an Executive Order requiring the Interagency Coordinating Committee on Groundwater (ICCG), chaired by the Illinois Environmental Protection Agency, to report each January on progress in establishing a water-quantity planning procedure. Initially, an ICCG sub-committee chaired by the Illinois Department of Natural Resources is to produce an integrated water resources agenda (groundwater and surface water) and an assessment report. The sub-committee is preparing an agenda and that report.

*Derek Winstanley is Chief of the Illinois State Water Survey.*

As a member of this sub-committee, I am making the following recommendations for consideration.

1. Planning and management should be science based.
   a. Large amounts of existing scientific data and information first should be marshaled as a basis for statewide planning and management of water supplies.
   b. Scientific research and monitoring activities that fill important data gaps need to be adequately supported and conducted to provide an improved basis for planning and management.

2. Planning and management should be iterative and adaptive, based on progress made, understanding gained, evolving priorities and science, and changing needs.

3. Given the great regional diversity of water supply and demand in Illinois, there should be an emphasis on regional planning and management with appropriate roles for state, county, and local governments, and interest groups.

4. Watersheds and aquifers should be the core natural regions for the conjunctive and optimal planning and management of water supplies, including water conservation and reuse.

Water planning and management are necessary to protect water supplies and to provide reliable supplies of clean water at reasonable cost for current and future generations and for fish and wildlife. Over the next year, Illinois has yet another opportunity to take appropriate actions that demonstrate its interest and commitment to achieving this goal.

Derek Winstanley, Chief

# "Governor's Conference on Energy and the Illinois Environment"


*Chief Derek Winstanley introduces IDNR Director Brent Manning (far left) and opening session moderator Mitch Beaver, Illinois Department of Commerce and Community Affairs.*

Deregulation of the electric utility industry in Illinois, concern over greenhouse gas emissions, possible decommissioning of nuclear power plants, economic factors, and air- and water-quality regulations all will play a role in evaluating the energy sources that are most viable for Illinois in upcoming decades. In conjunction with the UIUC Division of Conferences and Institutes, the Scientific Surveys hosted the "Governor's Conference on Energy and the Illinois Environment" on November 7–8, 2001 in Springfield.

The program included invited oral presentations and a poster session. Major topics covered patterns of current energy use in Illinois, plausible scenarios of energy use during the next 20–30 years, and environmental impacts of various energy production and use scenarios.

*Richard Cirillo (left), Argonne National Laboratory, and Dave Kolaz, Illinois Environmental Protection Agency, share their views on state and national energy policies.*

*Carol Werner, Environmental Energy and Study Institute, describes alternative sources for long-term energy sustainability.*

*Arlene Juracek, ComEd, delivers opening remarks before introducing the first speaker.*

*Eric Brenner, Office of the Governor, unveils Governor George Ryan's new state energy policy.*


*Charlie Wheeler, University of Illinois at Springfield, leads a discussion on planning a secure energy future for Illinois. Panelists (left to right) include Bill Shilts, Illinois State Geological Survey; Phil Amick, Global Energy, Inc.; Bob Lieberman, Center for Neighborhood Technology; Eric Brenner, Office of the Governor; Mark Burger, Spire Solar Chicago; and Arlene Juracek, ComEd.*

Among the 180 attendees at the Springfield Renaissance Hotel were individuals from the private and public sector who are interested in energy issues and associated environmental impacts in Illinois. Factors that may affect energy sources used in Illinois were examined, and environmental issues associated with different energy use scenarios were reviewed. Keynote speaker Karl Rabago of the Rocky Mountain Institute also provided a thought-provoking lecture on energy trends. Materials from conference presentations are available on the Web (http://www.sws.uiuc.edu/hilites/confpast.asp).

*Conference attendees enjoy an elegant evening reception at the Old State Capitol as docents in period attire describe building history and former occupants, including Abraham Lincoln.*

*Chief Derek Winstanley (right) discusses the future of Illinois' coal industry with Taylor Pensoneau (left), Illinois Coal Association, and Roger Dennison (center), Turris Coal Company.*

*Laura Green, Cambridge Environmental, discusses health effects of airborne particulate matter.*

*Keynote speaker Karl Rabago, Rocky Mountain Institute, describes three energy innovations that will shape the 21st Century.*


*Two attendees study one of many posters on display during the conference.*

*Luncheon speaker William Keese, California Energy Commission, provides background information on the California energy crisis.*

*Ken Kunkel (right), ISWS, answers a question on climate change with session moderator Rob Finley, Illinois State Geological Survey.*

*Mike Murphy (left), Illinois Department of Commerce and Community Affairs; Roger Dennison (center), Turris Coal Company; and Taylor Pensoneau (right), Illinois Coal Association, discuss the importance of Illinois coal to the state's economy and energy supply.*

# OFFICE OF THE CHIEF

## Extension and Education Activities

*Jason Curl (far right), 2001 W.C. Ackermann scholarship recipient, is shown with Mark Peden, Bill Ackermann, and Mrs. Margaret Ackermann.*

### *William C. Ackermann Scholarship Recipient*

Jason M. Curl of Centralia was the 2002 recipient of the W.C. Ackermann scholarship. Curl is working on his M.S. degree in civil and environmental engineering at the University of Illinois at Urbana-Champaign (UIUC) from which he also earned his B.S. degree with highest honors. Curl plans to be an engineering consultant, concentrating on drinking water treatment using synthetic membrane technology.

Both Illinois State Water Survey (ISWS) Chief Derek Winstanley and Nicholas Schneider, Executive Director of the Nature of Illinois Foundation, presented the scholarship during a ceremony held in conjunction with annual ISWS staff service awards. Also in attendance were Mrs. Margaret Ackermann, widow of former ISWS Chief William C. Ackermann, and their son Bill. Curl is the ninth recipient of the scholarship, which was established in memory of Dr. Ackermann, ISWS Chief Emeritus and UIUC professor of engineering from 1956–1979.

### *"Environmental Horizons 2002"*

On April 1–2, the Scientific Surveys participated in "Environmental Horizons 2002" at the Illini Union to highlight the breadth and diversity of environmental research being conducted on the UIUC campus. The University Environmental Council sponsors this annual conference, which is organized by a campuswide planning committee that also includes members from the Scientific Surveys.

Technical symposia, a poster session, a career fair, and art and performance exhibits provided an excellent forum for ISWS staff to share their scientific and artistic talents with University faculty and students and to create new opportunities for future collaborations. The ISWS organized a technical symposium that focused on mercury in the environment, including mercury removal from Illinois coal, mercury in rainfall, health effects of mercury, and efforts by the UIUC campus to reduce the use of mercury-containing devices. Eileen Claussen, conference keynote speaker and President of the Pew Center on Global Climate Change, discussed global climate change and the need for coordinated international efforts to effectively address the issue.

### *ISWS Introduces Hydro-House at State Fair*

The ISWS Hydro-House made its debut at the Illinois State Fair in Springfield on August 10–19, 2001. This new attraction let fair-goers experience a summer rain provided by overhead misters as they viewed colorful panels representing different aspects of the hydrologic cycle. Mid-80s daytime temperatures made Hydro-House quite popular, particularly with young children.

Staff volunteers encouraged attendees to "Take the $H_2O$ Challenge" by comparing the



*Illinois State Fair: Hydro-House was a hit (top photos), as was the water taste test conducted by Kent Smothers (bottom left).*

taste of distilled water with water from the Springfield municipal supply. This activity provided the opportunity to share some basic facts about Illinois drinking water supplies with both children and their parents.

Distribution of more than 250 raingages generated interest in the weather of Illinois. Each gage also included instructions and the ISWS Web site address so that rainfall information collected could be added to a statewide database. Other educational displays presented information on swine odor research and global climate change.

## Peoria's Clean Water Celebration a Success

On March 18, 2002, ISWS staff and representatives from more than 40 other organizations participated in the Peoria Clean Water Celebration, an annual science event for elementary through high school students. The Peoria Civic Center arena was filled to capacity, primarily with students from local middle schools. Attending students and teachers learned about the role of water in our environment and the importance of a clean water supply.

The ISWS displayed the "Monitor" work boat with equipment used for lake and stream measurements. A floodplain model helped teach students about 50- and 100-year flood frequencies. Staff members also conducted a series of presentations on drinking water, a new feature added at the request of teachers.

## Natural Resources Quiz Bowl

Scientists from the Scientific Surveys returned to Champaign's Jefferson Middle School on October 11 to celebrate Earth Week by hosting the fourth annual Natural Resources Quiz Bowl for grades 6–8. Four participants from 14 eight-member teams answered questions during each 12-minute session. Survey scientists provided written study materials and natural resources information available via the Internet, but the students had no advance knowledge of actual questions that would be asked.

More than 600 students either were team members or cheered their "home team" to victory. The Quiz Bowl provides science education in a game show format enjoyed by students and teachers alike. Local media coverage noted the students' interest in science education and highlighted the effective partnership between the Scientific Surveys and the students.

## Illinois Science Olympiad State Finals

The State Tournament for the Illinois Science Olympiad was held on the UIUC campus on Saturday, April 6, 2002. More than 1,200 students on teams from 36 junior highs and 30 high schools participated in more than 20 events to see which teams would take home medals and trophies. Participants earned a spot at the State Tournament based on their performance at regional events.

*More than 1,200 students competed for medals and trophies at Science Olypiad 2002.*

Water Survey staffers organized the water-quality section of the tournament, prepared test materials, and monitored all 66 teams during four 50-minute sessions at historic Noyes Laboratory. The three-part tests included a written test, identification of biological species, and testing of water chemistry. Winning teams received awards at a ceremony in Huff Hall. Top teams then went on to the national finals.

## Geographic Information Systems

Geographic Information Systems (GIS) software upgrades to the latest Environmental Systems Research Institute versions and completion of the transition from UNIX workstations to a Windows server and workstations now provide interested staff members with direct computer access to GIS software and data. As part of these upgrades, a point and click interface makes some GIS functions and data available to Internet users.

For example, the alternative crops suitability project for the Web (http://www.sws.uiuc.edu/data/altcrops/) allowed GIS staff to demonstrate GIS technology by building Internet maps. Previous GIS work for the National Atmospheric Deposition Program and the Illinois Rivers Decision Support System at the Illinois State Water Survey (ISWS) provided some background on mapping for the Internet.

Additional three-dimensional landscape visualizations of Illinois streams being developed will augment modeling research of ISWS scientists for presentation to multi-disciplinary or lay audiences. These visualizations are based on data from ISWS and other agencies.

Such projects that build on the work of others at ISWS will continue as GIS becomes more accessible to the public. The GIS staff also work with individual scientists and researchers on GIS maps and analysis and interpretation of spatial data. Some of these maps appear as illustrations in publications. Additional information about GIS is available at (http://www.sws.uiuc.edu/chief/gis/).

*A computer was used to recreate Lower Peoria Lake in 1902 (top) and today (bottom).*

# Long-Term Resources Monitoring

The Water and Atmospheric Resources Monitoring (WARM) Program (http://www.sws.uiuc.edu/warm/) continues to expand its Web-based data for the general public. With the addition of new components and regular updates to current pages, this site is constantly evolving. Among the new materials this year are daily updated Illinois Climate Network (ICN) maps of soil temperatures and weather data, soil moisture maps and observations, information on provisional monthly flow data for selected Illinois rivers and streams, and data from the Benchmark Sediment Monitoring Program.

Through a grant from the Illinois Department of Agriculture Fertilizer Research and Education program, farmers now have access to a Web tool that provides assistance with timing of post-harvest nitrogen (N) fertilizer application. Fall soil temperatures determine when ammonium that contains N fertilizer may be applied without excessive nitrification. Daily maps of 4-inch bare soil temperatures represent a guide to general soil temperatures within a given region and are indicative of current temperature trends during periods when fertilizer applications can be considered.

The maps are based on observations from selected ICN sites across the state. They are intended for use in conjunction with regular monitoring of soil temperatures in individual fields and short- to long-term weather forecasts before fall application of N fertilizer. The information displayed is representative of actual locations where observations were made, and an algorithm has been developed to estimate data at the remaining sites from continuous temperature sensors that have been installed at all sites.

In addition, maps of numerous other ICN weather observations include weather data for several parameters: maximum and minimum air temperatures, average and maximum wind speeds, average wind direction, average dew point temperatures, solar radiation, precipitation, and potential evapotranspiration. A six-day archive of soil temperature and weather data also has been added.

Bi-weekly soil moisture maps, primarily in support of the agricultural community, are now available on the Web. These maps provide information on current trends in soil moisture conditions, suggesting adequate or insufficient moisture availability. These data also are very important during times of precipitation extremes because they can provide early indications of droughts and floods and their impacts on the state's other water resources.

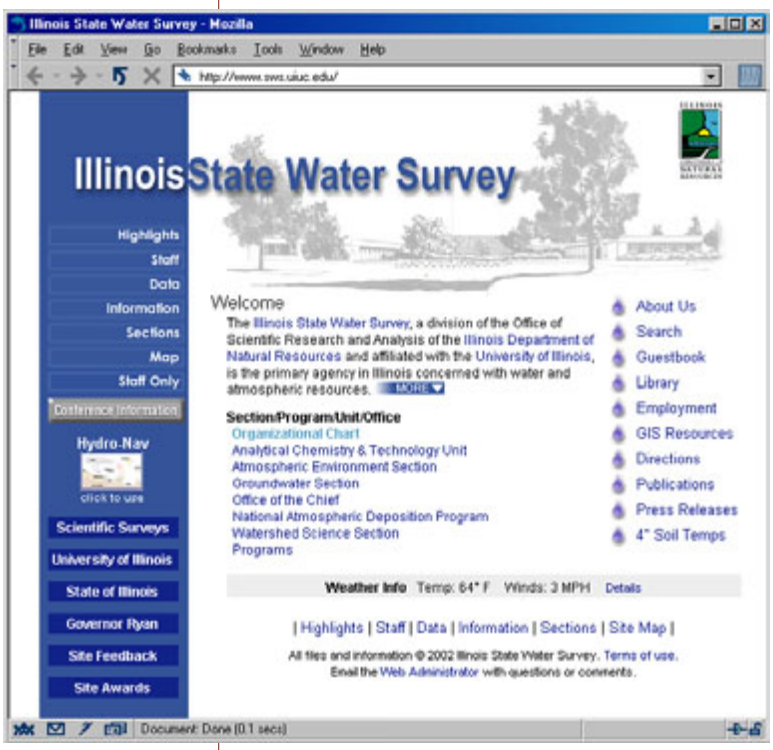
Provisional, monthly mean flow graphs and tables now appear on the Web for 26 U.S. Geological Survey gaging stations on rivers and streams throughout Illinois. Data for these vital water resources in Illinois appear for the month just ending and for the preceding water year to allow comparisons of station flows with flows the past year. Highest streamflows typically occur in spring, and lowest flows occur in summer and fall. Long-term average monthly flows and other statistics computed from historical records for each calendar month provide a climatological context for comparison.

The Benchmark Sediment Monitoring Program presents data from suspended sediment samples collected at 15 sampling sites throughout Illinois. These samples are analyzed at the Water Survey Sediment Laboratory in Champaign to determine suspended sediment concentration and suspended sediment particle sizes. Data users can download this information for each site.

Future Web pages in support of weather and agriculture include hourly time series of selected weather parameters and archives of hourly historic data. In addition, a comparison analysis between data from new continuous soil moisture sensors installed at ICN sites and values from the former collection method is underway to normalize the coincident data between the two collection methods.

Subsequent to this analysis, the former collection method will be terminated, and the current bi-weekly soil moisture maps will be converted to daily figures. Further value-added observations of ICN data are planned, such as daily updates on heat unit accumulations during the growing season. Farmers will be able to track the expected status of crop and pest development using a series of crop/pest degree-day computations at ICN sites.

# What's New on the Web




Web use at the Illinois State Water Survey (ISWS) continues to rise. New additions to the Web site include a record number of press releases and other highlights, new publications, and downloadable data.

The Library Web site was redesigned for compatibility with the main ISWS Web site. Users now can find information more easily, and regular updates keep the information current.

The WARM site for provisional monthly streamflow data for 26 U.S. Geological Survey gaging stations is significant because it uses dynamic tools recently installed on the main Web server that generate graphs "on the fly" from data housed at different Web sites.

Since September 11, 2001, some ISWS data became sensitive information. Security measures put in place safeguard this information, yet still allow Web access. Improved security measures also were implemented for other Web equipment.

An alternate crops Web site lists climate and soil requirements for alternative and traditional crops. Users may search by geographic location or by crop name, and then refine the search using various parameters. The resulting list of potentially suitable crops should help the agricultural community. Eventually the site will be expanded to include information for other states.

All Web servers were totally redesigned, including installation of newer, faster versions of all software packages, which improved performance for site areas that provide downloadable data. Hardware upgrades resulted in substantially more storage space for ongoing projects, and the latest technology for users. As site usage grows, faster hardware and software are being phased in to accommodate increased traffic on ISWS equipment.

Web operations for the ISWS Web Group surpassed 8 million hits during this fiscal year, an increase of more than 30 percent, with 841, 817 user sessions. This is a new high for the fourth consecutive year, with substantial gains each year. The Web Group includes the ISWS (http://www.sws.uiuc.edu/), the Midwestern Regional Climate Center (http://mrcc.sws.uiuc.edu/), the National Atmospheric Deposition Program (http://nadp.sws.uiuc.edu/), and the Illinois Rivers Decision Support System (http://ilrdss.sws.uiuc.edu/), among other sites.

Ongoing efforts to increase the ISWS presence in popular search engines such as Google, AltaVista, Yahoo!, and many others has resulted in increased exposure. Searches for the ISWS Web site usually rank in the top 10 results in most popular search engines. More than 1,000 search engines now contain the ISWS Web site, and Web searches usually return it in the top 25 results or higher.

Many additions were made to the Intranet site for ISWS employees. Informational pages added now include emergency information. The site also provides day-to-day information that changes frequently, such as forms, phone lists, and other documents.

## Program Planning and Management

The Water Survey's Strategic Plan is the framework for program planning within the Water Survey and an information source for those outside the organization who have an interest in the organization's current and future activities. The strategic plan focuses on future direction and changes needed to achieve specified goals. Each year, the Water Survey updates the plan and determines action items to be achieved during the current fiscal year. All planning documents are developed in the context of current conditions and emerging trends; therefore, the program planning process remains fluid and allows for unforeseen changes.

The Water Survey's strategic planning process is incorporated into the Department of Natural Resources' Strategic Plan and the Annual Management Plan (AMP) completed for the Office of Strategic Management in the Bureau of the Budget. The AMP is designed as a planning document for the following fiscal year and provides subprogram goals and objectives that may be quantified and used for budgeting purposes. Performance Measures target goals are the final link in the process and, once determined, can be used to measure the quantity of services provided.

## Planning and Managing Water Supplies

A decade ago, budget cuts resulted in the loss of 30 ISWS State-funded positions—about one third of the total. These cuts and the closing of the ISWS office in Batavia greatly reduced ISWS capabilities for research, monitoring, and provision of important services related to water supplies. Recognizing the increasing importance of planning and managing water supplies, the ISWS prepared *A Plan for Scientific Assessment of Water Supplies in Illinois* (http://www.sws.uiuc.edu/pubdoc/IEM/ISWSIEM2001-03.pdf). The plan outlines important water-supply issues facing Illinois and recommends scientific studies necessary to address them. Studies proposed include reducing uncertainties associated with projections of future climate and water availability, quantifying groundwater supplies in aquifers and minimum in-stream flows in rivers and streams, improving data on water withdrawals, measuring sedimentation and water capacity in reservoirs, and developing a decision support system.

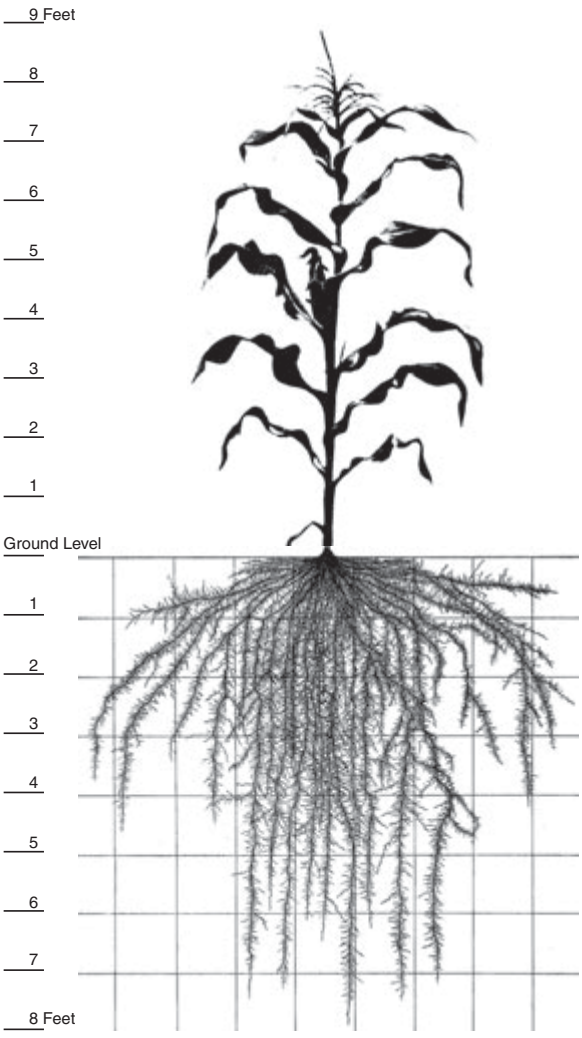

*Decision support is needed for comprehensive water resources planning and management.*

# Biogeochemical Cycles

Biogeochemical cycles associated with water integrate diverse ISWS units and programs. These cycles provide a scientific perspective from the top of the atmosphere to deep within the earth: from minerals to living things. Water is a unifying theme for all these things. It physically cycles throughout our planet and reacts with all living and nonliving things. The majority of living biomass is water, and most of the rest is organic matter. Of the four major elements that make up organic matter—carbon (C), hydrogen (H), oxygen (O), and nitrogen (N)—H and O come from water ($H_2O$). And C and N are bound in combinations ranging from methane ($CH_4$) to carbon dioxide ($CO_2$) and ammonium ($NH_4$) to nitrate ($NO_3$) with H and O from water. Water physically and chemically breaks down rocks and then transports and disperses the dissolved nutrients and other mineral substances that are released.

Our popular Nitrogen Cycles Web site (www.sws.uiuc.edu/nitro/), which presents one such biogeochemical cycle, had almost half a million hits during the past fiscal year. For a deeper look into the biogeochemical nitrogen cycle, see the "Terrestrial Nitrogen Cycle" paper of Krug and Winstanley, published in *The Science of the Total Environment* (2002), which is available online (www.sws.uiuc.edu/docs/journals.asp).

The ISWS is conducting other significant research on the biogeochemical carbon cycle. A report due to be published at the end of 2002 will discuss the impacts of human activities and the biogeochemical cycles of water, nitrogen, sulfur, and mineral nutrients on the biogeochemical carbon cycle and the amount of carbon stored in soils. Carbon storage in soils is a possible, important way to reduce the concentration of carbon dioxide in the atmosphere.




*Growing corn removes carbon dioxide (a greenhouse gas) from the atmosphere. Grain carbon is harvested. Leaves, stalks, and roots decompose to carbon dioxide and soil humus. If nitrogen, phosphorus, and other nutrients are added, more of the decomposing plant stays in the soil as humus and less returns to the atmosphere as a greenhouse gas.*

# ANALYTICAL CHEMISTRY & TECHNOLOGY UNIT

## Science for Planning and Managing Water Resources

The Analytical Chemistry and Technology Unit provides training and technological services for small public water systems in Illinois and the Midwest; help with solving water problems of private citizens, communities, state facilities, and utilities in Illinois; and analytical support and research data for the scientific community.

### *Midwest Technology Assistance Center for Small Public Water Systems*

The Midwest Technology Assistance Center (MTAC) for Small Public Water Systems (http://mtac.sws.uiuc.edu/) funds priority research, develops and distributes financial and training tools and products, and sponsors training on critical issues. The goal of USEPA-funded MTAC is to enhance the technical, managerial, and financial capacity of small systems, better enabling them to produce and deliver safe drinking water at a reasonable cost. Several MTAC projects have impacts on local water resources planning and management.

Two projects funded by competitive grants focus on arsenic in Illinois groundwater supplies and will increase our knowledge about arsenic concentration and variability in Illinois aquifers, including the relationship between arsenic concentration and other water-quality parameters. Methods that optimize operation of water plants to increase their effectiveness in removing arsenic from raw water supplies also are being studied.

Operators of small systems need help setting rates that cover their operating expenses and planning for future infrastructure needs. Financial tools being developed will give them the assistance they need.

Operators also will be able to develop protection plans for source water using an interactive CD-ROM being developed. Upon completion, this training tool will be distributed statewide to operators of all water systems in Illinois, and eventually to those in surrounding states.

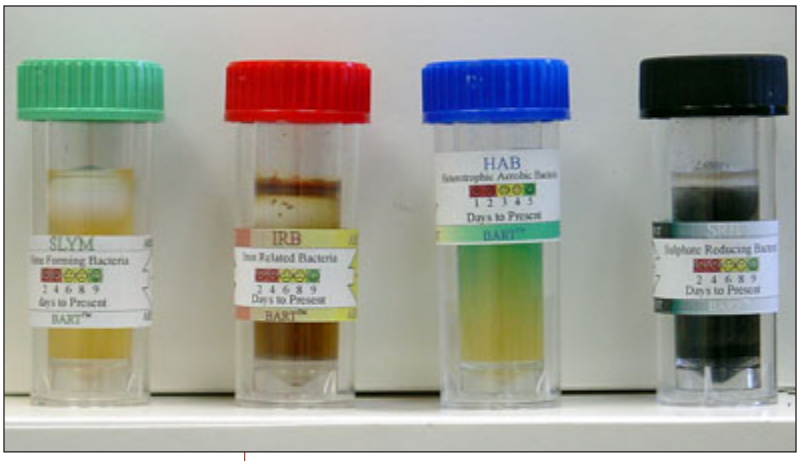
Several MTAC-sponsored training programs were held, and others are scheduled. There were two workshops by the Illinois Rural Water Association on emergency preparedness and planning. Long-distance learning workshops on chloramine addition and control were presented at 12 community colleges across Illinois in spring 2002. A series of fall workshops will offer training on financial planning (see sidebar) and arsenic.

In conjunction with the Illinois Section of the American Water Works Association, MTAC is working on interactive CD-ROM programs that will provide guidance on testing, identifying, and controlling bacteria and other microbes in drinking water, and on performing system self-evaluations to identify potential problem areas that need to be addressed prior to Illinois Environmental Protection Agency system audits.

### *Institutional Water Treatment Program*

The Institutional Water Treatment Program or IWTP (http://www.sws.uiuc.edu/chem/iwt/) provides unbiased, professional water treatment advice for more than 100 state facilities throughout Illinois. As a result of the program, the State of Illinois and participating facilities realize substantial annual savings in costs of chemicals, fuel, water, and maintenance of industrial and potable water systems.

*Sofia Lazovsky prepares the autotitration system for pH/alkalinity determinations.*




*The IWTP staff routinely evaluates open and closed cooling systems for potential microbial contamination. Biological growths can result in corrosion or fouling problems in addition to causing potential health risks.*

Among services provided are on-site training and seminars, chemical specifications, and recommendations concerning a comprehensive water treatment program to control corrosion, mineral scale formation, and biological growths. Participating facilities receive detailed written recommendations and specifications for recommended equipment, chemicals, and corrosion-resistant materials for use in construction.

The IWTP, the Illinois Department of Natural Resources (IDNR), the University of Illinois at Urbana-Champaign, and other state agencies also cosponsor an annual workshop for Illinois Institutional Chief Engineers. Now in its 55th year, the workshop also provides supervisory and administrative staff at individual institutions with information on pending regulations and water treatment developments.

State facilities pay a fee so that the IWTP can recover a portion of costs associated with making 3–6 routine visits, recommendations, consultations, and sample analyses to facilitate compliance with state and federal water-quality guidelines for drinking water and wastewater discharge. Program staff also make more that 400 annual site visits to evaluate chemical treatment programs, answer questions, solve problems, and analyze samples. Last year, there were almost 3,000 field analyses and 950 complete laboratory analyses.

## Public Service Laboratory Program

The Public Service Laboratory (PSL) Program analyzes water samples from private wells for inorganic parameters (metals, anions, dissolved solids, pH, and alkalinity). Staff analyzed more than 450 samples and responded to more than 300 requests for information and referrals last year. Additional information, including contact information for water testing, can be found on the Web (http://www.sws.uiuc.edu/chem/psl/).

Staff members also participate in outreach activities. For example, they work at the IDNR booth at the Illinois State Fair in Springfield, discussing water-quality problems and general water issues. They help host the water-quality section of Illinois Science Olympiad State Finals, judge school science fairs, and participate in career workshops. Memberships in professional organizations also allow staff to make technical contributions related to educational issues, methods development, and quality assurance practices.

Public interest in the measurement of arsenic increased because the Safe Drinking Water Act required the U.S. Environmental Protection Agency (USEPA) to revise the existing arsenic standard of 50 micrograms per liter (µg/L). On February 22, 2002, the arsenic in drinking water rule took effect, and a more stringent standard (10 µg/L) was set for community water systems. The target implementation date for all systems is 2006. Although this rule does not apply to private wells, the exposure concerns are still valid. The USEPA Web site (http://www.epa.gov/safewater/arsenic.html) contains updated information about arsenic in drinking water and links to other sites with information concerning drinking water issues.

Last February the PSL began using graphite furnace atomic absorption spectroscopy for routine measurements of arsenic concentrations in all water samples submitted from wells. Limited initial data indicate that a significant number of private wells have arsenic concentrations that exceed the 10 µg/L standard. Because complete mineral analyses, well logs, and historical records for these samples are available, there is a unique opportunity for further research with Groundwater Section staff on factors that affect arsenic occurrence, concentrations, mobility, and removal.

## Internal Analytical Services

Staff provide laboratory services required to analyze research samples and advice on sample collection, preservation, and quality assurance. Available analyses include metals, anions, dissolved solids, pH, alkalinity, nutrients, nonvolatile organic carbon, pesticides, and volatile organic compounds. This combination of expertise and analytical capabilities allows analysts to work closely with researchers to customize services that

achieve project goals. For example, sampling routines and analysis schedules for many watershed monitoring projects underway need to accommodate sporadic storm events. A review of data for other projects may indicate a need to change sampling protocol or parameters mid-project, which laboratory staff are able to accommodate.

Staff are contributing to several research projects. These include: sediment and water-quality monitoring (Vermilion River and Little Vermilion River watersheds); spatial and temporal variability of nutrients in Illinois streams; sediment and nutrient monitoring to evaluate Conservation Reserve Enhancement Program effectiveness (select watersheds within the Illinois River watershed); water-quality monitoring (Hurricane Creek); watershed monitoring for Illinois Council of Food and Agricultural Research Water Quality Strategic Research Initiatives or WQ - SRI (Upper Sangamon); shallow groundwater flow and mass flux of nitrogen and phosphorous (Big Ditch watershed); watershed monitoring (Lake Decatur watershed); hydrologic, sediment, and nutrient monitoring for the Interagency Pilot Watershed Program; improved quantification of water and nitrogen balances (WQ-SRI best management practices field site); dewatering well assessment (East St. Louis area highway drainage system); application of nitrogen and oxygen isotopes of nitrate to identify sources; compiling and interpreting hydrologic and geologic data (State Nature Preserves and Natural Areas); sulfur in oil analyses in cooperation with the Waste Management Research Center; arsenic assessment (Pt. Byron area); water quality (Mammoth Hot Springs); corrosion control monitoring and control systems for heating and cooling applications; metals analysis for IWTP; Mahomet Aquifer assessment; and project assistance for University scientists and graduate students.

## Financial Workshops for Managers of Small Water Systems

Because small water systems do not benefit from the same economies of scale available to their larger counterparts, it is critical that their financial health is measured. Only then will it be possible to develop a rate structure that meets existing operating and maintenance expenses and formulate realistic plans for any immediate or future infrastructure upgrades. A series of four MTAC-sponsored workshops will introduce managers and operators of small systems to financial benchmark tools that will allow them to do just that.

Several financial indicators can be used as benchmarks to compare the financial performance of individual water systems. The workshops will be offered in tandem with other major conferences and training events.

The workshops have five objectives:

- Introduce benchmark concepts and demonstrate their use in monitoring financial and managerial performance.
- Help participants develop a more businesslike management approach.
- Develop participant knowledge of critical financial information and its use.
- Compare participants' system performance with that of other systems in MTAC's Benchmark Economic Study.
- Provide opportunities for peer interaction and encourage development of networks for information exchange and problem solving.

Developing sound fiscal practices is a necessary precursor to the long-term viability of any small public water system, and MTAC provides the necessary training tools and expertise so that small systems can continue to provide consumers with safe drinking water at a reasonable price.

*Red water, a common complaint of Illinois citizens and institutions, is caused by oxidation of dissolved iron in well water or corrosion of the steel in the piping system.*

# ATMOSPHERIC ENVIRONMENT SECTION

## Science for Planning and Managing Water Resources

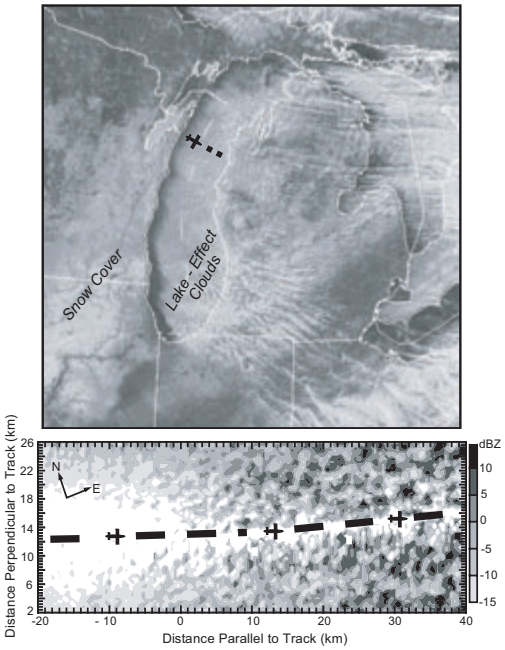
Atmospheric processes are a critical component of the hydrologic cycle. Precipitation within Illinois and in surrounding regions is the source of water that is used within the state. Evapotranspiration represents an important loss of water as much of this water exits the state. Research within the Atmospheric Environment Section seeks to understand the nature and causes of variability in these processes to anticipate possible changes in the future from natural or human-induced (anthropogenic) forces.

### *Understanding Climate*

The ISWS has a long history of studying the climate of Illinois, which has resulted in a wealth of data and knowledge. A project to develop a climate atlas for Illinois will provide convenient, comprehensive access to key aspects of these studies for water managers, scientists, high school and university students, and the general public. Large portions of a draft have been completed and cover precipitation, temperature, humidity, climate extremes, storms, wind, energy budgets, special local climates, air quality, outstanding events of the 20th Century, and synoptic climatology. More than 400 maps and graphs document diverse aspects of Illinois' climate, including spatial patterns and temporal variations and changes. Although the atlas primarily is based on past work, many updated analyses include more recent data.

Both natural and anthropogenic climate change pose a challenge to future water supplies, but there remains great uncertainty about the magnitude of such potential changes. To address this issue, the ISWS is developing a regional climate model that will be used to develop plausible scenarios of the future climate of Illinois. Continual improvements are increasing credibility in model results. For example, improvements made to the model representation of the interaction of clouds and radiation and the interfaces for land surfaces and oceans were evaluated to determine if they resulted in better simulations of past events than previous simulations using the model. The enhancements substantially improved simulations of the 1988 drought and the 1993 flood, two periods with the most severe seasonal precipitation anomalies of the past 60 years.

Water withdrawals from Lake Michigan are an absolutely critical component of the water supplies in northeastern Illinois. Water levels in Lake Michigan are affected not only by processes in this basin, but also by water supplies in Lakes Superior and Huron. During fall and winter months, water from the lakes evaporates, often resulting in lake-effect snowstorms. This evaporated water is blown far downwind in moistened air masses,




*This GOES-8 satellite image taken on 13 January 1998 during the Lake-ICE project shows lake-effect clouds over and downwind of Lake Michigan. At the time, snow was falling along the western shore of Lake Michigan. The figure shows the approximate path of the research aircraft across the lake.*

deposited over near-shore land areas as snowstorms, or returned to the lakes as precipitation. As part of an ongoing research effort on such storms, observations from field experiments were used to understand how lake-effect snowstorms evolve across Lake Michigan. It was found that a quarter to a third of the evaporated water was returned to the lake during several lake-effect events.

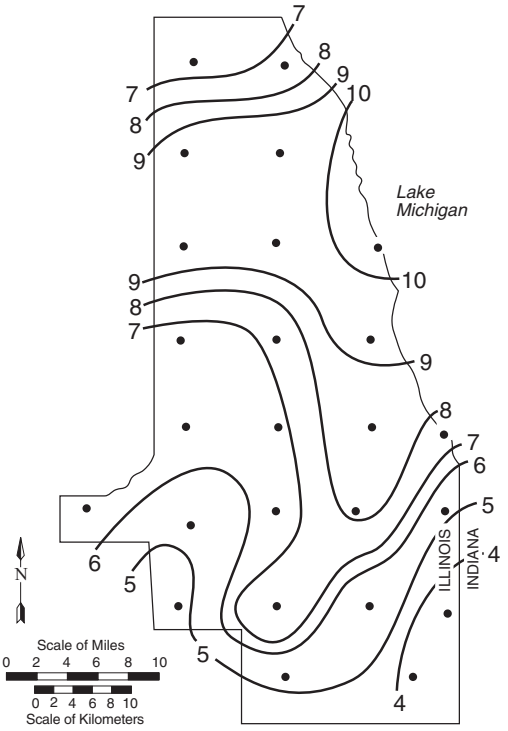
The ISWS raingage network in Chicago sampled eight severe rainstorms in 2001— a record number—and analysis revealed that this was likely a continuation of a trend toward increasing heavy rains across the state that began 50 years ago. Comparison of heavy rainstorms in networks operated in central and southern Illinois revealed not only more storms in southern Illinois, but also more intense rains of longer duration. This difference is a major factor in heavier average precipitation across southern Illinois.

Past climate history also provides valuable information about the magnitude of possible variability in water supplies. However, a full understanding of climate variability often is hampered by lack of high-quality, long-term records. Survey scientists are playing key roles in national efforts to improve availability of such records (see sidebar). The ISWS has the lead role in quality control and analysis of daily precipitation and temperature data for the first half of the 20th Century that were recently entered into a database and in helping to design procedures to do this for 19th Century data. The availability of such data will contribute to a better understanding of temperature and precipitation variability, particularly in extreme events.

## The Atmosphere and Its Effects

Several other studies were undertaken to better understand the atmosphere and its effects on Illinois. These studies include modeling air quality; identifying alternative crops and mapping their suitability for Illinois conditions; monitoring airborne, inhalable fine particles that have adverse effects on human health; providing climate information; planning a new field program on warm rain; and studying the impacts of using deicing salt on road surfaces.

A three-month simulation of air quality used a modeling system consisting of a regional climate model, an emissions model, and an air-quality model. Results, presented at the November 2001 Governor's Energy Conference, demonstrated the suitability of this system for studies of the effects of climate variability and change on air quality.




*The August 2001 Cook County Precipitation Network average of 7.01 inches was about 174 percent of the 11-year (1990–2000) August network average of 4.03 inches. These data are used for Lake Michigan diversion accounting.*

Difficult economic conditions challenge agricultural producers to grow traditional crops more efficiently or to select and grow alternative crops. During the past year, 414 traditional and alternative crops for Illinois were identified, and maps indicating suitable areas for growing each crop were developed (http://www.sws.uiuc.edu/data/altcrops/).

The Illinois Environmental Protection Agency (IEPA) supported a study that monitored and chemically characterized airborne, inhalable fine particulate matter (PM-2.5) at the Bondville Environmental and Atmospheric Research Site, a representative rural site in Illinois. These particles are responsible for adverse human health effects, and elevated levels have been measured throughout Illinois. The U.S. Environmental Protection Agency recently set new national ambient air-quality standards for PM-2.5. Project information will help ISWS scientists better understand PM-2.5 levels, seasonal variation, and sources in Illinois. It also will help the IEPA develop PM-2.5 control strategies in the future.

The State Climatologist responded to 975 e-mail and phone requests and 140 media requests for climate information. Periodic press releases and monthly summaries of conditions in Illinois were issued. Information distributed through the ISWS Web site included current conditions,

historical records, climate-related issues, such as heat and drought, and on-line, monthly climate data.

As part of an effort to develop plans and acquire funding for a new research program on warm rain, Section scientists organized and chaired a meeting of interested scientists from numerous U.S. and foreign organizations to formulate program plans. While precipitation typically first forms by this process in summer clouds in Illinois, forecast models used to predict Illinois weather and climate do not properly take into account numerous clouds in the Northern Hemisphere that precipitate solely through warm processes. Because of this deficiency, forecast models misrepresent the effects of radiation and latent heat exchange when describing the energy balance in the atmosphere.

Tentative plans call for a field program using several instrumented aircraft and advanced weather radars. Materials from the meeting are being used in preparing a scientific overview document for review by federal funding agencies.

The impact of road deicing salt on surface waters, groundwater, soils, and vegetation near roads (within 200 meters) has been studied for many years. However, the atmospheric transport pathway, which can distribute salt over much greater distances, has not been studied. Consequently, a multi-year field study is examining emission of road salt to the atmosphere and measuring and modeling salt deposition at distances from 300 meters to 6 kilometers from salted roads. The study has shown that emission of dry salt residue from roads is probably greater than the emission of salt droplets due to traffic on the wet roads. Measurements from several winters at six sites near Lemont, Illinois, will be available in late 2002.

## Increasing Availability of Historical Climate Data

With funding appropriated by Congress, the National Climatic Data Center has undertaken a massive project to create a database for climate data hitherto available only in paper or microfiche/microfilm form. This effort is providing digital data from the 19th and first half of the 20th Centuries. Well over 100,000,000 data values already have been entered into the database, and this effort continues.

Wider availability of these data will provide new opportunities to better understand past climate variability and change. Newly available hourly data (1900–1948) will facilitate definitive studies of past rainstorms to assess the relationship between rainfall magnitude and wind directions and speeds (important aspects of building design), and the occurrence of freezing rain with winds and heavy rain that create damage. Temperature and precipitation data for the 19th Century will help to better define the climate trends and probabilities of extreme events and whether they have changed significantly from the 19th to the 20th Centuries.

The ISWS has been a pioneer in the area of climate impacts, particularly in assessing economic impacts. To fully assess the consequences of potential climate change, there is a need and an opportunity to broaden this effort and develop an even better assessment of climate impacts on various economic sectors in Illinois, such as retail sales, home construction, government activities, and rail and air transportation.

Spring 2002 was very wet, and serious flooding occurred in some parts of Illinois. This event affords an opportunity to define conditions that produced the flooding and to determine whether similar conditions have occurred before, rainfall and flooding magnitudes, the extent of erosion of soils and fertilizers, and the impacts on water quality and Illinois agriculture. Such studies are being conducted, and knowledge obtained can be used to help citizens of Illinois better protect themselves from future flooding events.

The terrorists' attack on September 11 has raised concerns about future attacks using windborne chemical or biological agents that target people or agricultural crops. The complex transport of such agents would be very dependent on local conditions, including topography and land use.

A new atmospheric circulation model being developed by several groups, including the ISWS, is capable of modeling wind patterns at resolutions of less than 1000 feet. Such improved resolution may make it possible to determine the

patterns of windborne chemical and biological agents and find solutions for the effects of urban heat islands, topography, land use, and geography on dispersion patterns over a city. Because monitoring such releases is critical, there may be an opportunity to establish a denser network of weather stations that not only monitor wind, temperature, humidity, solar radiation, and precipitation but also house instruments with air filters to trap airborne chemicals and pathogens. Continued routine monitoring of weather variables plus filters could provide an early warning system that detects airborne threats and also has capabilities for tracing chemical pathogen origins and predicting their spread locally or nationally.

# GROUNDWATER SECTION

## Science for Planning and Managing Water Resources

Groundwater is an economically important, renewable resource and contributes to base flow in rivers, streams, and wetlands. Illinois uses more than one billion gallons daily for drinking water, agriculture, industry, and power generation. Although Illinois aquifers have an estimated, combined potential yield of seven billion gallons per day, those aquifers are neither uniformly distributed nor homogeneous in their physical and chemical properties. Through scientific data collection and analysis, the Groundwater Section evaluates management options for the use and protection of these resources, and presently is giving special attention to several regions of Illinois.

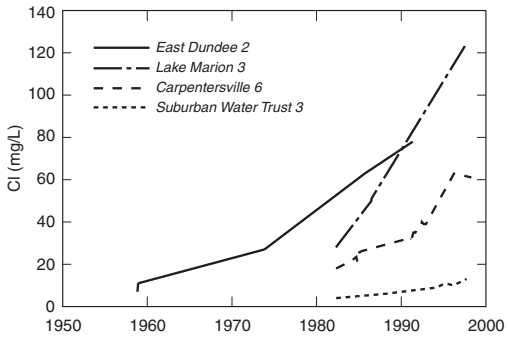
### *Northeastern Illinois: Kane County*

The deep bedrock Cambrian-Ordovician aquifer system underlies all of northeastern Illinois and has contributed greatly to industrial and population expansion in the area. Until Lake Michigan water became available to collar counties in the early 1980s, yearly pumpage since the late 1950s exceeded the estimated 65-million-gallon-per-day (mgd) sustainable yield estimated under ideal pumping conditions. Studies have shown that artesian heads fell more than 850 feet at some heavy pumping centers since the 1860s.

As a result of Lake Michigan water diversions and consequent reductions in water withdrawals from the deep bedrock aquifers, water withdrawals from the deep bedrock aquifers are currently only slightly more than the estimated sustainable yield, and recovery of water levels has been observed in some areas (see sidebar). Continued heavy pumpage in collar counties causes some water-level declines in these counties, however. Historical data also suggest that water quality in the deep bedrock system may degrade as lowered groundwater levels cause groundwater containing undesirable concentrations of dissolved radium, barium, and chlorides to move into the system from adjacent geologic units.

To further complicate matters, Illinois has used or exceeded its annual allotment of Lake Michigan water in recent years, and an increased allocation is extremely unlikely. The most viable source alternatives are shallow aquifers and the Fox, Des Plaines, and Kankakee Rivers. Shallow groundwater resources and surface streams are hydraulically connected, and withdrawals from these shallower systems may reduce the amount of water in streams and wetlands. Consequently, conjunctive use of groundwater and surface water must be examined using scenarios based on field data and computer modeling. Shallow aquifers also are vulnerable to surface-derived contaminants, and ISWS studies have shown degraded quality of some shallow groundwater (see graph).

These constraints create a challenge for managing water resources that was clearly articulated in the Northeastern Illinois Planning Commission's *Strategic Plan for Water*




*Change in chloride concentrations in four municipal wells (<200 feet deep) in Kane County.*

*Resources Management*. Kane County's 2020 *Land Resource Management Plan* recognized the vulnerability of the county's economy on abundant water resources and the need for a scientific basis for their management.

With funding from Kane County, the ISWS and the Illinois State Geological Survey (ISGS) jointly initiated a five-year investigation that will provide the necessary technical support for policies to manage Kane County's water resources. Section scientists will conduct hydrological field studies and records searches, construct databases, map groundwater surfaces, and model groundwater flow.

As part of the planning process for this long-term study, the two Surveys developed and conducted a workshop for the Kane County Development Department to educate officials from 27 municipalities and other interested parties about water resources and water protection. Presentations, posters, and workshop notes also were developed. Approximately 160 local government officials and others attended, a record for the yearly "Making It Work!" workshops by the Kane County Board and the DuKane Valley Council.

## East-Central Illinois

Many east-central Illinois communities, industries, and irrigators depend on the Mahomet aquifer for their water supply. Estimated municipal use exceeds 30 mgd, and withdrawals for irrigation, principally in Mason and Tazewell Counties, often exceed 100 mgd during the summer. While estimates of groundwater availability from the entire Mahomet aquifer exceed 400 mgd, concerns have been raised over water availability, particularly in the Champaign area. Long-term observations of groundwater levels at Champaign have shown a decline of 50 feet since 1950, a result of increasing water demand in the Champaign-Urbana area.

Similar, perhaps greater, declines can be expected in other developing areas as aquifer use increases. Projections suggest that those served by the Mahomet aquifer may increase by 100,000 people by 2020. New users include a hog processor (Rantoul), a large dairy (Bellflower), a peaker power plant (DeLand), and a water bottling facility (Paxton). Additional demands may result as several central Illinois communities currently using surface water reservoirs (e.g., Springfield and Bloomington) look to the Mahomet to alleviate reservoir capacity and water-quality problems.

Section scientists are modeling the aquifer to examine water availability and the effects of increased development. Because computer models require volumes of data, Section scientists are acquiring new data to complement historical data. Recent modeling studies suggest a possible direct connection between the Sangamon River and the Mahomet aquifer near Monticello for which drilling and testing are planned. Similar "windows" from shallow sources to the deeper Mahomet aquifer found during studies in McLean and Tazewell Counties have significant implications for groundwater availability in the Mahomet system.

Water within the Mahomet aquifer is generally of good quality, although arsenic has been found in many Mahomet aquifer wells, often exceeding the new standard for drinking water, 10 micrograms per liter. Section scientists are examining arsenic occurrence in the Mahomet aquifer and overlying aquifers, geochemical and geologic reasons for its occurrence, and the effectiveness of water treatment for removal. With an increased understanding of why arsenic occurs in certain portions of the aquifer, transport models can be created to predict the effects of large-scale withdrawals on arsenic movement in the aquifer.

## Southwestern Illinois

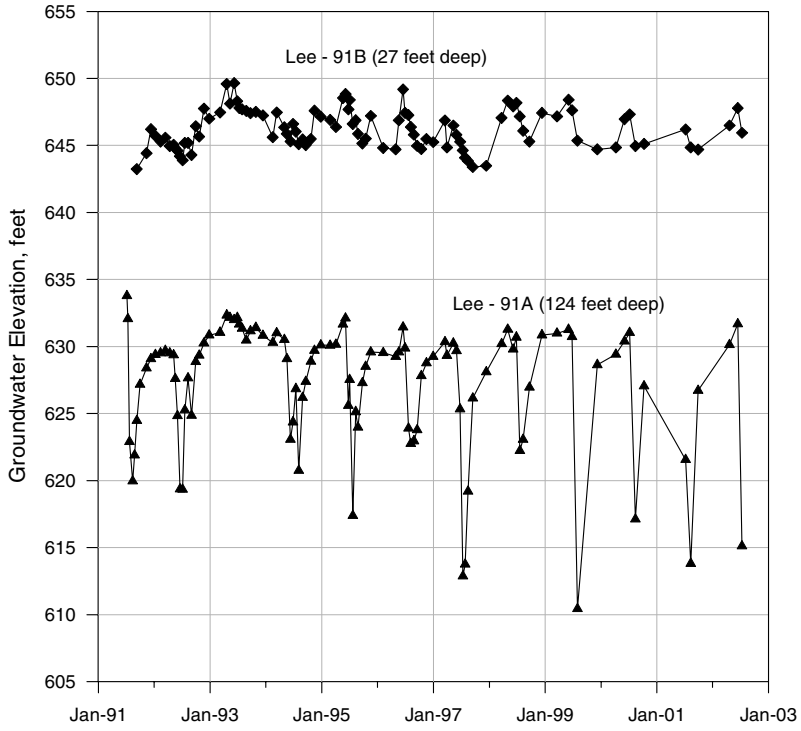
The American Bottoms in southwestern Illinois includes the communities of Alton, Wood River, Granite City, Collinsville, East St. Louis, and Cahokia. This heavily populated, industrialized area also contains substantial areas devoted to agriculture, particularly production of specialty crops such as horseradish and vegetables. The sand-and-gravel aquifer underlying the area was developed extensively into the 1960s for industrial, agricultural irrigation, and municipal use. Estimated withdrawals from wells increased from 2 mgd in 1900 to a peak of 111 mgd in 1956. Such large withdrawals coupled with the prolonged 1952–1956

drought caused groundwater levels to recede to record lows.

Concern over the alarming groundwater-level recessions led water users to shift demands to the Mississippi River. As a result, groundwater levels rose dramatically, damaging highways, foundations, basements, and sewer and gas lines. Water-level data indicate a rising trend of groundwater levels since 1965 due to an overall decrease in groundwater use. The Illinois Department of Transportation (IDOT) currently pumps more than 20 mgd just to keep groundwater levels below highway surfaces in regions of the American Bottoms.

Groundwater is typically an economic asset, not a liability. In the American Bottoms, however, high groundwater levels are due to drastic reductions in groundwater use. Construction of major underground infrastructure without fully understanding the groundwater system set the stage for destruction from rebounding groundwater levels.

The American Bottoms has been of major interest to the ISWS for more than 50 years. As a result, a network of 19 observation wells was created, and five wells are monitored continuously. Section scientists also have been working with IDOT to monitor groundwater levels and maintain dewatering well performance since 1983. Construction of a planned new Mississippi River bridge by IDOT and termination of some dewatering facilities would continue to alter groundwater conditions in this region, changes that Section scientists plan on monitoring.




*Hydrographs of nested wells in Lee County show effects of irrigation from the deeper artesian Sankoty aquifer and little response in the shallow Tampico aquifer.*

## Northwestern Illinois

Like the Havana Lowlands in central Illinois, the Sankoty aquifer beneath Lee and Whiteside Counties in northwestern Illinois provides a significant source of water for irrigation. Approximately 19 mgd is pumped from this artesian system for crop irrigation; about 3.5 mgd is withdrawn for municipal water supplies. Section scientists began detailed data collection on groundwater levels in this area in 1991.

Hydrographs of two adjacent wells completed in two distinct aquifers show the influence of irrigation pumpage on water levels in the deeper Sankoty aquifer versus seasonal influences on the shallower Tampico aquifer (see graph). Annual irrigation drawdown cycles of 10 feet or more in deeper water levels clearly can be seen. The lack of irrigation drawdowns during the 1993 flood also is obvious. Water levels recovered completely during nonirrigation seasons and deepened during 1994–1999 irrigation seasons. Seasonal influences on the shallow water table also are evident.

The lowering of water levels during consecutive irrigation seasons indicate increasing withdrawals of water from the Sankoty aquifer. Long-term monitoring and modeling of aquifer systems such as this are essential to understanding and projecting the impacts of groundwater development for resource management.

## Statewide Issues

Additional study of other regional and local aquifers in Illinois is needed. Often these aquifer systems represent the sole source of water for many communities, agriculture, and industries. In areas without appreciable aquifers, many rural residents rely on large-diameter bored or dug wells for water supplies. Not only are these wells sensitive to drought conditions, Survey studies have shown they also are highly vulnerable to contamination. Recent expansion of regional water systems will help to alleviate such problems in parts of rural Illinois, but those systems will place additional demands on available groundwater and surface water.

Several computer databases maintained by ISWS contain valuable information on groundwater quality, aquifer hydraulic properties, and water use for resource managers statewide. Because data access is critical,

especially for other state agencies, the IEPA recently provided funding for upgrades to make these databases available via the Internet.

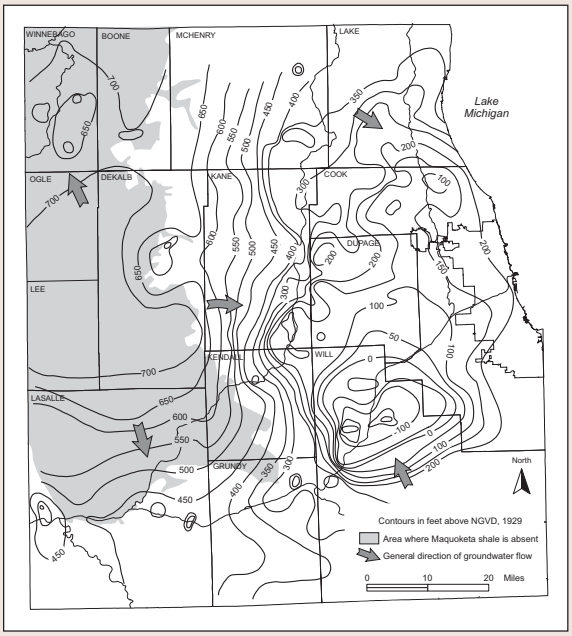
Regardless of aquifer size or location, new demands are being placed on groundwater resources daily. Centralized livestock facilities, peak power generation and ethanol production, increased irrigation due to climate variability and market changes, and increasing population growth warrant greater attention to water availability and quality, increased reliance on a scientific understanding of groundwater resources, and more sharing of data and expertise.

## Potentiometric Surface Mapping in Northeastern Illinois

The potentiometric surface of an aquifer describes the level to which groundwater will rise in wells penetrating the aquifer. An aquifer's potentiometric surface can be mapped by contouring water-level elevations measured in wells open to the aquifer. Just as surface water moves from topographically high to low areas, so too flows groundwater along flow paths perpendicular to potentiometric contours. Pumping reduces groundwater levels in the vicinity of operating wells. Therefore, potentiometric surface maps can be used to show directions of groundwater flow, to show where and how deep cones of depression have developed in response to pumping, and to determine the effects of groundwater development.

To evaluate the impact of groundwater development on the deep bedrock aquifer system beneath northeastern Illinois, the Groundwater Section has measured groundwater levels in deep sandstone wells periodically since the early 20th Century. The most recent measurement was in 2000, when water-level elevations from 367 wells were plotted and contoured. The resulting map shows the recharge area of the deep bedrock aquifer as a potentiometric high beneath areas where the impermeable cover of the Maquoketa Group shales is absent (shaded in gray) and the large cone of depression surrounding Joliet. Groundwater withdrawals at Joliet (the largest public water system using deep bedrock aquifers), Plainfield, Romeoville, and in the industrial corridor along the Des Plaines River contribute to the Joliet cone.

As a result of rapidly declining artesian heads in deep bedrock aquifers, Lake Michigan water was diverted to many Chicago-area communities beginning in the 1980s and early 1990s, which greatly reduced demand on the deep bedrock system. Potentiometric surface maps show heads rose more than 250 feet at Villa Park and Elmhurst (DuPage County) between 1980 and 2000. Recoveries exceeding 100 feet were observed over a large area of Cook, DuPage, and Lake Counties since 1980. However, the rate of recovery is slowing markedly. Artesian heads recovered less than 25 feet in large portions of northeastern Illinois from 1995 to 2000. Largest recoveries since 1995 were observed at Des Plaines, Bellwood, Western Springs, Prospect Heights, and around Elgin, while declines continue at Aurora and at a developing pumping center in northern Kendall County.




*Potentiometric surface of the deep bedrock aquifers in northeastern Illinois, fall 2000.*

Scientific mapping clearly demonstrates the success of the Lake Michigan diversion in alleviating aquifer stresses, and the need for future management of the deep bedrock as a long-term water resource. Section scientists and engineers will continue providing a scientific basis for decisions about managing water resources.

# NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

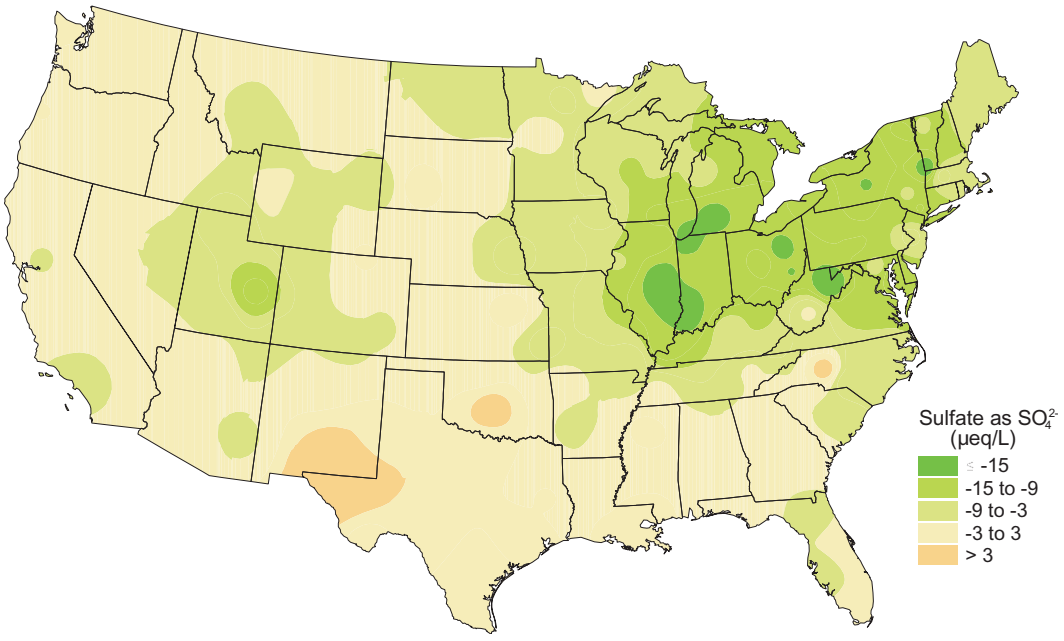
## Science for Planning and Managing Water Resources

The National Atmospheric Deposition Program (NADP) provides regional and national data and information on chemicals deposited by precipitation. Scientists use NADP data to study the effects of atmospheric deposition on the productivity of managed and natural ecosystems and the chemistry of ground and surface waters, including estuaries. Policy-makers use this information in planning and management decisions. Supporting science for water resources planning and management is among the principal NADP goals.

The NADP operates the ~240-site National Trends Network (NTN) to characterize geographic patterns and temporal trends in the deposition of acidic compounds, nutrients, and base cations in precipitation. Network data have shown 10–25 percent reductions in sulfate concentrations in precipitation in and downwind of the Ohio River valley since 1990, with similar decreases in acidic deposition. Scientists have shown that sulfate deposition alters the acidity in some of the streams and catchments where soils have little neutralizing capacity.

Much of the sulfate reduction occurred in the mid-1990s, when many power plants in the Ohio River valley reduced sulfur dioxide emissions consistent with requirements of the 1990 Clean Air Act Amendments. Title IV of this Act aims to reduce the adverse effects of acidic deposition through reductions in sulfur dioxide emissions for which it set new lower limits in an innovative "cap-and-trade system." The Act set a sulfur dioxide emissions cap and specified emissions allowances equal to it. Each sulfur dioxide source could meet its allowance, reduce emissions below its allowance and sell or bank the balance, or exceed its allowance and pay a fine or buy emissions allowances from another source. By allowing sources to choose from several options, this system has proven to be cost-effective in reducing sulfur dioxide emissions. Data from NTN have shown that these reductions have decreased sulfur and acidic deposition.

*The cap-and-trade system has proven to be a cost-effective approach for reducing sulfur dioxide emissions and ultimately to reduce the adverse effects of sulfur and acidic deposition. Data from NTN have shown that these reductions have decreased sulfate concentration and deposition and acidity in Illinois.*




*This map shows changes in sulfate concentrations in precipitation, 1990–2000.*

Based on cap-and-trade system successes, U.S. President George Bush announced the Clear Skies initiative in February 2002, which targets new mandatory emissions caps for sulfur dioxide, nitrogen oxides, and mercury. To further reduce adverse health and environmental impacts of these pollutants, power plants are expected to lower emissions beyond the reductions specified in Title IV of the 1990 Clean Air Act Amendments. Environmental Protection Agency (EPA) Administrator Christine Todd Whitman sent Congress the Clear Skies Act of 2002, a draft bill based on the President's initiative. It establishes cap-and-trade programs for power plant emissions of nitrogen oxides and mercury, and further lowers the sulfur dioxide emissions cap.

Much as sulfur dioxide leads to sulfate in precipitation, nitrogen oxides lead to nitrate, which also contributes to acidic deposition.

*Unlike the downward trend in sulfate evident in NTN data over the last decade, there are no consistent changes in nitrate concentrations or deposition.*

Unlike sulfate concentration in precipitation, NTN data show that nitrate concentration in precipitation has not decreased regionally or nationally over the last decade. A consequence of level nitrate and lower sulfate concentrations is that the contribution of nitrate to acidic deposition has grown. Acidic deposition speeds the weathering of monuments, buildings, and other stone and metal surfaces, one of the reasons cited for the Clear Skies Act cap on nitrogen oxides emissions. Sulfur is needed by crops, and sulfur deposition is generally beneficial for agriculture.

Nitrogen oxides also affect air quality, by contributing to fine particle and ozone formation in the lower atmosphere, and water quality, particularly in estuaries, by contributing to eutrophication. Nitrogen is a nutrient, and nutrients can degrade water quality by stimulating excessive growth of microscopic plants and animals (eutrophication). As these plants and animals die and decay, dissolved oxygen is consumed, sometimes leading to low-oxygen (hypoxia) or no-oxygen (anoxia) conditions that some organisms cannot survive. Plant and animal growth often is nitrogen-limited in estuaries or coastal areas where freshwater from streams and rivers meets salt water from the sea. Eutrophication, a natural phenomenon, often is triggered by nitrogen from runoff or other sources, including precipitation, which deposits nitrogen derived from nitrogen oxides and other nitrogen-containing compounds.

Ammonium, another nitrogen-containing compound in precipitation, is measured routinely in NTN samples. Other inorganic and organic nitrogen-containing compounds in precipitation are not. Many researchers, including ISWS scientists at the NADP Central Analytical Laboratory (CAL), are investigating the amount and nature of these compounds. Preliminary CAL estimates indicate that nitrogen from sources other than nitrate and ammonium may account for a significant portion of the total nitrogen in precipitation. Consequently, the NADP is contemplating routine measurements of total nitrogen in samples from its Atmospheric Integrated Research Monitoring Network (AIRMoN).

A recent National Academy of Sciences (NAS) report, entitled *Clean Coastal Waters, Understanding and Reducing the Effects of Nutrient Pollution,* used NTN and AIRMoN data to evaluate the role of atmospheric nitrogen deposition as a cause of excess nutrients in estuarine systems. The report indicates that atmospheric deposition contributes from 10 to 40 percent of the total nitrogen input to many estuaries along the eastern U.S. seaboard and Gulf Coast. Report authors cited NADP data as crucial to the development of airshed and watershed models such as those being used to support planning and management decisions in Florida's Tampa Bay.

*A recent National Academy of Sciences report cited NADP data as crucial to the development of airshed and watershed models already being used for planning and management decisions.*

The Clear Skies initiative also proposes the first national cap on mercury emissions to lower health risks from mercury-contaminated fish and wildlife. The EPA would allocate mercury emissions allowances to power plants in a cap-and-trade system similar to that used to reduce acid rain in the 1990 Clean Air Act Amendments. Forty-three states, including Illinois, have advisories warning people, particularly pregnant women and young children, to limit consumption of fish and wildlife from certain water bodies because of mercury contamination.

*The NADP Mercury Deposition Network is the only network measuring total mercury in precipitation on a regional scale in the United States and Canada.*

Mercury in fish and wildlife can come from many processes, including precipitation. The connection between mercury in precipitation

and mercury in fish and wildlife is under study. The NADP Mercury Deposition Network (MDN) is the only network measuring total mercury in precipitation on a regional scale in the United States and Canada. The MDN seeks to expand its current coverage (70 stations in 20 states, including Illinois, and 6 Canadian Provinces) to include the entire United States. Since joining the NADP in 1996, the MDN has more than tripled in size.

Researchers can use MDN data to evaluate the role of mercury deposition as a source of mercury in fish and wildlife and in water bodies. In 2001, annual average total mercury concentrations ranged from 5 to 30 nanograms per liter and 10.5 ng/L in Illinois. By contrast, sulfate concentrations in U.S. precipitation were 3,000 to 600,000 times higher. What makes even these tiny mercury concentrations important, however, is that mercury accumulates up the food chain. Mercury from all sources in water bodies can occur in an extremely toxic organic form, methylmercury, which concentrates in fish tissue. Concentrations reach levels one million times the initial concentration in larger predator fish. Humans consuming fish containing such high concentrations of mercury can experience nervous system disorders or impaired motor and cognitive skills. Much work needs to be done to understand the conditions that lead to mercury methylation and to track the mercury sources that enter this biological cascade, and MDN data provide an important contribution to these efforts.

The NADP is a cooperative program involving more than 250 federal, state, local, and tribal government agencies, universities, State Agricultural Experiment Stations, and nongovernmental organizations. It is among the nation's premier research support projects. The NADP strives to support informed decisions on air-quality issues, particularly as they relate to water resources planning and management, while also remaining responsive to emerging issues.

## Environmental Monitoring for National Security

The United States and the world were shocked by the terrorist attacks on September 11, 2001. These attacks and subsequent anthrax-related sicknesses and deaths caused many people to question the safety of the air we breathe and the security of water supplies. Residents of cities, suburbs, and even rural areas began realizing their potential vulnerability to harmful or even deadly effects from possible widespread releases of toxic chemicals, biological agents, or radioactive particles. To stem this threat, a new priority of many federal and state agencies is to ensure the security of water supplies and the safety of the air we breathe.

Government agencies responsible for responding to security threats need to know quickly what has been released, when, and where. They also have specific roles in confirming and tracking disease outbreaks and the movement of harmful substances, reducing and removing the threat, and restoring normalcy.

It is vital to have an early warning system in place to detect the chemical, biological, or radioactive agents quickly and economically. Existing environmental monitoring programs currently meet some of these requirements and, with some modifications, could meet all of them. One such program, the NADP, measures precipitation chemistry at regionally representative U.S. sites. The ISWS has operated the NADP CAL since the program began in 1978, and has been the home for the NADP Program Office since 1997.

With three networks of more than 300 monitoring sites spanning the continental United States, Alaska, Hawaii, Puerto Rico, and Canada, the NADP offers regional coverage of precipitation chemistry at rural and suburban locations across the country. Each NADP site is equipped to measure precipitation amounts and collect samples 24 hours a day, seven days a week. Site operators follow standard operating procedures and send samples to a central laboratory for analysis in accordance with strict quality control practices.

Presently, samples are collected once a week at NADP NTN and Mercury Deposition Network sites and daily when precipitation occurs at Atmospheric Integrated Research Monitoring sites. An increase of

sampling and analysis schedules may be necessary to meet early warning criteria. The NADP routinely reports chemical concentrations of acidic compounds, nutrients, mercury, and base cations in precipitation. Clearly, other analyses are needed and, perhaps, could be provided by laboratories specializing in target chemical, biological, and/or radiological measurements using NADP precipitation samples. Additional sites also may be required, although other monitoring programs may satisfy the need for an early warning network in urban areas.

Among NADP's greatest assets are its stable base of funding, existing infrastructure, and 24 years of experience. With coordination and communications systems already in place, adapting all or a subset of existing NADP sites for national surveillance could be done more quickly and more economically than installing a wholly new network. The NADP has adapted its sampling platform for special purposes in the past.

- **Particles**. Sudden eruption of Mount St. Helens in May 1980 dispersed volcanic ash widely across many western states. Ash particles were reported in NADP samples from northwestern Washington to east-central California, and as far east as southern Minnesota and southern Illinois. Ash reports accompanied eruptions in May–August 1980.
- **Radionuclides.** After the Chernobyl nuclear accident in the Ukraine in April 1986, there was a need to determine whether rain was depositing radioactive elements on U.S. soil. Thus, portions of NADP precipitation samples were sent for analysis to the U.S. Department of Energy's Environmental Measurements Laboratory in New York City. Scientists could use these samples to better map distribution and estimated amounts of radioactive elements that fell across the United States.
- **Pesticides.** In 1990–1991, the NADP and U.S. Geological Survey scientists measured NADP precipitation samples for commonly used herbicides, such as atrazine and alachlor. This study encompassed 80 sites in 26 states from the upper Midwest to the East Coast.

With its extensive experience, scientific expertise, and strong track record, the NADP has the potential to contribute to an enhanced national security effort and to ease concerns about the contents of our air and water.

# WATERSHED SCIENCE SECTION

## Science for Planning and Managing Water Resources

The ISWS always has been a leader in developing scientific and engineering information and tools for planning and managing water resources in Illinois. This has been accomplished by collecting necessary data, analyzing and synthesizing these data and data from other agencies, developing and applying mathematical models to analyze routine and complex issues, and communicating research results through publications, presentations, and participation in interagency meetings to identify problems and plan solutions. Watershed Science Section (WSS) efforts are focused on several important issues: water supply (see sidebar); streamflow, including droughts and floods; watershed restoration, including monitoring and modeling; and management of large rivers in and adjacent to Illinois.

### *Streamflow: Droughts and Floods*

Some of the most basic information needed is to understand the quantity and variability of water flow in the State's rivers and streams, especially during infrequent

*Erin Bauer services a gage on the Sangamon River near Mahomet.*

droughts and floods. Streamflow impacts from various natural and human factors require analysis because they have tremendous effects on the quantity, quality, and spatial and temporal distribution of surface waters in a watershed. These factors include climate variability, land-use changes, and hydrologic modifications (reservoirs, water-use withdrawals, and effluent discharges).

Estimates of streamflow frequency and climatic and human impacts on streamflow can be useful for 1) analyzing drought and flood frequency and impacts, 2) assessing water availability and water-supply yields of surface water, 3) evaluating in-stream flow levels, 4) providing streamflow estimates for water-quality analyses and regulations, and 5) classifying the hydrologic character of Illinois streams for use in watershed management.

Streamgaging stations measure water flow over time and monitor the status of Illinois rivers and streams. These measurements provide information on the amount and distribution of surface water passing the stations. Because monitoring all streams in a basin is not feasible, gaging stations are established at selected locations, and hydrological principles are used to apply data collected to other parts of the watershed. Historically, the ISWS has conducted regional studies to better define hydrologic relationships that can be used to estimate streamflow frequency, with particular emphasis on defining stream and reservoir yields for water-supply applications.

One such product, the Illinois Streamflow Assessment Model (ILSAM), uses hydrologic principles and regional equations to estimate streamflow frequencies at gaged and ungaged sites throughout Illinois. A database developed for each major watershed contains statistical summarries of streamflow and water-use information. Recent completion of ILSAM for the Rock River watershed now makes it possible to expand the use of this model to describe streamflow characteristics for large and small streams covering more than half of Illinois.

State agencies and consulting engineers primarily have used ILSAM to evaluate water resources, but a new on-line version being developed for the ISWS Web site will make these streamflow estimates readily available to the public, and for a much broader range of applications. Project support is provided by the Illinois Department of Natural Resources (IDNR), Office of Water Resources.

The 7-day, 10-year low flow in streams ($Q_{7,10}$) is the lowest average flow with an average recurrence interval of once in ten years for a consecutive seven-day period. The IEPA often uses $Q_{7,10}$ estimates as the base-flow condition in Illinois streams at which certain water-quality standards apply. These flows are used to determine permit limits for effluent standards and mixing zones as defined by Illinois Pollution Control Board regulations. Allocation of wasteloads also is dependent on $Q_{7,10}$ streamflow, the sum of natural base flows, water withdrawals, and effluent flows.

Since 1973, the ISWS has estimated low flows for Illinois streams and produced $Q_{7,10}$ maps for use by regulators, managers, engineers, and the public. Estimates in these maps are based on 1) statistical analyses of low flows measured at U.S. Geological

Survey streamgages throughout Illinois; 2) regional regression equations that estimate low flows at ungaged sites based on information transferred from gaged sites; and 3) water-use conditions at the time of evaluation, including changes in low flows caused by water-supply withdrawals from streams, effluent discharges to streams, and operation of existing lakes and reservoirs. Regional revisions of $Q_{7,10}$ estimates are appropriate whenever statistical characteristics of low flows shift due to climatic variability, land-use factors, or water-use conditions. In cooperation with the IEPA, the ISWS is updating maps for roughly half of Illinois, including northeastern Illinois, where the most rapid land- and water-use changes are occurring.

## Watershed Restoration

The WSS has played a key role in the development of watershed restoration methods and techniques for decades by implementing and monitoring stream and watershed restoration projects throughout Illinois. These projects have provided the basis for most watershed restoration in Illinois. Staff conducted detailed stream monitoring in support of state and federal initiatives, most notably the Illinois Conservation Reserve Enhancement Program and the Interagency Pilot Watershed Program. These monitoring efforts are designed to detect changes in streamflow, suspended sediment, and nutrients over time as various best management practices (BMPs) are implemented in the Illinois River, Embarras River, Cache River, and Kaskaskia River watersheds.

*A riffle is constructed in the Spoon River watershed on North Creek.*


Because watershed restoration issues include not only upland changes or disturbances, changes associated with natural, urban, and rural activities are being studied in stream channels, and projects are being designed and constructed to stabilize streams. The Pilot Watershed Program includes helping IDNR select project sites that will reduce erosion and sedimentation and also with project design and construction. Evaluating postconstruction performance of projects in combination with watershed monitoring and data collection in pilot watershed areas provides a robust assessment, implementation, and evaluation opportunity with a scientific basis for formulating management alternatives for Illinois watersheds.

## Managing Large Rivers

Three large rivers encompass Illinois: the Mississippi River (about 500 miles in the west), the Ohio River (133 miles in the south), and the Illinois River (more than 300 miles from Chicago to Grafton). Not only does the Illinois River drain about 44 percent of Illinois, it also provides an inland waterway connection from the Gulf of Mexico via the Mississippi River to the Great Lakes and ultimately to the St. Lawrence Seaway and the Atlantic Ocean.

Although these water resources are not uniformly distributed, they provide water for water supply, commercial and recreational navigation, cooling for power plants, fish and wildlife habitats, and numerous outdoor activities. Construction of locks and dams for navigation has altered the natural form of these major rivers. Increased sediment loads associated with tremendous land-use changes have filled many backwater lakes, sloughs, side channels, and, in some cases, the main channel. Previous ISWS research indicates about eight million tons of sediment are deposited annually in the Illinois River valley, which has resulted in capacity losses that exceed 70 percent in backwater lakes and 90 percent in Peoria Lake.

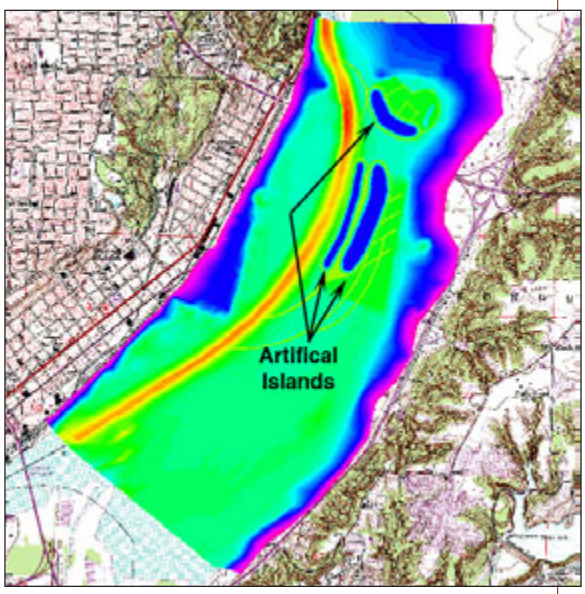
Planning and managing any resource requires scientific evaluation and extensive analyses such as those long conducted by WSS engineers and scientists. Present research is concentrating on revitalizing and partially restoring hydraulic and hydrologic functions of these large rivers by removing deposited sediment to create deepwater habitats, by building islands of dredged sediments to enhance terrestrial habitats, by improving flow of the main river through

floodplains and creating deepwater to improve floodplain function and habitats, and by helping implement BMPs that stabilize streambanks and beds.

These projects use state-of-the-art mathematical models. One such project has shown the potential locations, orientation, and relative size of several artificial islands within the Lower Peoria Lake downstream of the McClugge's Bridge. Three islands are to be built within the next five to ten years (see figure).

Staff also are using models to determine potential levee setbacks or controlled levee breaches that reduce flood heights along the Illinois River and improve floodplain habitats. This research is a direct response to the devastating 1993 flood when many levees along the Illinois, Mississippi, and Missouri Rivers failed. Eventually, it may be possible to install levee gates that reduce floodpeaks during extreme floods.

Only a systemwide approach will succeed because large rivers must be managed within the actual river and within the contributing watershed. However, excessive sediment deposition must be dealt with first before more habitats are lost. Section scientists are working on both fronts and are formulating appropriate management scenarios for large river systems in Illinois.




*Artificial islands may be constructed within Lower Peoria Lake.*

## Community Water Supplies

Nearly 90 percent of Illinois' citizens obtain water for residential use from community water supplies. Data from the ISWS Illinois Water Inventory Program show that total withdrawals by all public water-supply systems exceeded 1,700 millions gallons per day (mgd) in 2000. Community systems withdrawing surface water accounted for 84 percent of those withdrawals, with Lake Michigan withdrawals exceeding 1,000 mgd. Other sources of surface water include interstate and intrastate rivers, and 96 reservoirs. The pie chart shows water withdrawals by source for public water supplies in Illinois.

Many communities in central and southern Illinois depend on surface water from relatively small streams and rivers that have periods of extremely low flow. Therefore, most systems depend on some form of raw water storage, either in-channel or side-channel reservoirs. In-channel reservoirs are particularly sensitive to natural features and land use within the tributary watershed as the inflowing stream delivers sediments and other constituents directly to these reservoirs.

The WSS traditionally has conducted surveys of human-made reservoirs to evaluate sedimentation that reduces the storage volume and to determine the remaining storage volume of critical water-supply reservoirs. For example, surveys of public water-supply reservoirs were completed for Lake Mattoon and Lake Paradise, which serve the communities of Mattoon and Neoga and also provide cooling water for power generation.

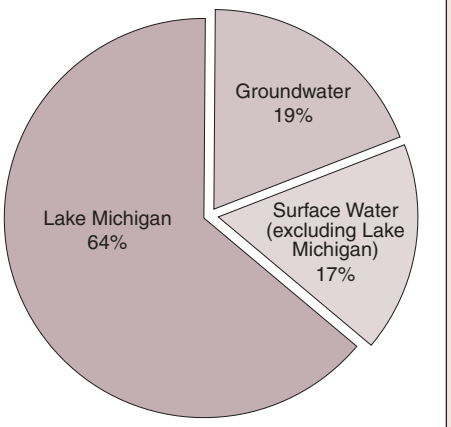
Monitoring reservoir water levels is another aspect of planning and drought preparedness. Section staff contact reservoir operators monthly for water-level observations and track water levels for more than 30 public water-supply reservoirs. New gages also were installed at eight public water-supply reservoirs at various locations to ensure accurate measurement devices.

As Illinois' population continues to grow, so too does water demand. Regions that have relied on groundwater resources

are now looking to surface water to meet new demands. Conjunctive use of groundwater and surface water may be the key to providing a reliable water supply for Illinois' expanding population.

Staff from the ISWS (WSS and Groundwater Section) and the ISGS worked with the Kane County Development Department to plan an in-depth evaluation of water resources in Kane County. Background information on water resources and on the five-year study, which began in spring 2002, were presented at a workshop for Kane County officials.

The ISWS also has developed a comprehensive plan for scientific assessment of water supplies in Illinois (http://www.sws.uiuc.edu/pubdoc/IEM/ISWSIEM2001-03.pdf) that recognizes their importance, as well as impending problems that Illinois officials need to address.




*Sources of public water supply, 2000.*

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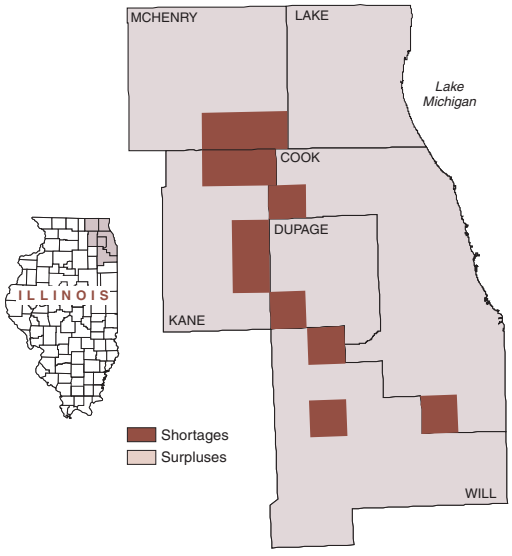


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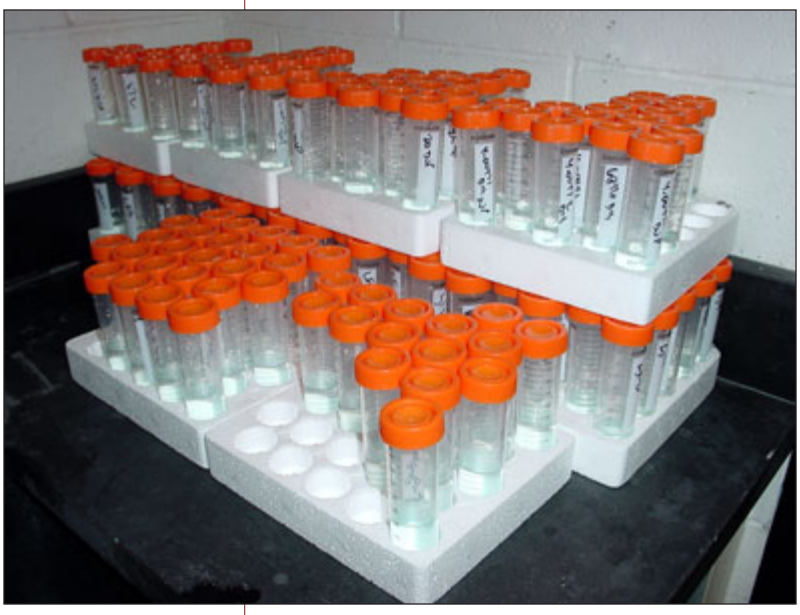

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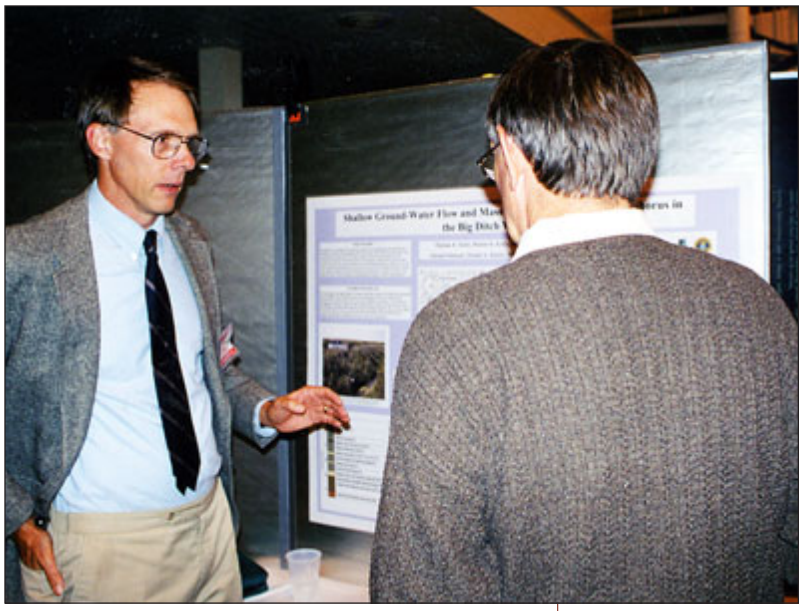

*Tom Holm discuses his poster at the 2001 Midwest Groundwater Conference in Madison, WI.*

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*Noe Velazques obtains a depth to water measurement as Mark Anliker surveys a well location in Kane County.*

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## Watershed Science Section

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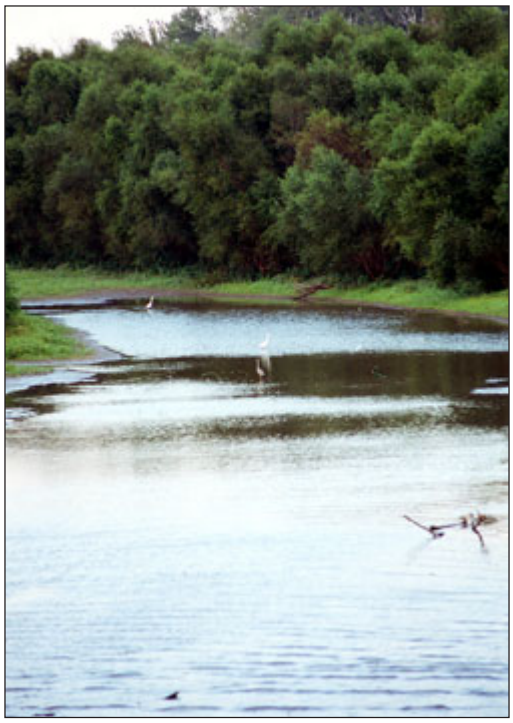
*Jim Slowikowski installs a stream-gaging station at North Creek in western Illinois.*



*There are many backwater lakes such as this along the Illinois River.*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*Electric power generation is the major use of water in Illinois.*

# HONORS

*Kingsley Allan*
Member, Board of Directors, Illinois GIS Association

*James Angel*
Member, Executive Committee, American Association of State Climatologists

*John Beardsley*
Appointed member, Heartland Water Resources Board

*Nani Bhowmik*
Associate Editor, *Journal of Hydraulic Engineering*, American Society of Civil Engineers; Chair, Science Advisory Committee, Illinois River Coordinating Council; and Invited Speaker, Symposium at the University of Kassel, Germany

*Deva Borah*
Secretary, American Society of Civil Engineers, Central Illinois Section - East Branch

*Van Bowersox*
Air Group Coordinator, Technical Council, Air & Waste Management Association; Guest Editor, "NADP 2000 - Ten Years after the Clean Air Act Amendments," Special Issue Section, *Atmospheric Environment* (volume 36, issue 10, 2002); and Reviewer, National Academy of Sciences, National Research Council report

*Mark Brooks*
Vice Chair, National Association of Corrosion Engineers Technical Committee TEG-252X "Preventing the Corrosion of Reinforced Steel in Concrete in Buildings and Parking Garages"

*Stanley Changnon*
Member, Committee on Transportation, American Meteorological Society

*Karen Harlin*
Member, Environmental Advisory Task Force for Laboratory Accreditation, Association of Official Analytical Chemists International; and Member, Standard Methods Review Committee, American Water Works Association

*Steven Hilberg*
Invited presenter, Committee on Partnerships in Weather and Climate, National Research Council of the National Academy of Sciences, Boulder, CO, June 27, 2002

*Steven Hollinger*
Member, Illinois Carbon Sequestration Advisory Committee

*Robert Larson*
Chair, National Atmospheric Deposition Program Data Management and Analysis Subcommittee

*Michael Palecki*
Member, U.S. Drought Monitoring Panel

*Mark Peden*
Administrative Vice-chair, ASTM International Committee D-22, Sampling and Analysis of Atmospheres

*Loretta Skowron*
Vice-Chair, American Society for Testing and Materials (ASTM) Subcommittee D22.01, Quality Assurance; Secretary, ASTM Subcommittee D22.06, Atmospheric Deposition

*Kent Smothers*
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*Allen Williams*
Member, Working Group 3, Agricultural Production Systems, Illinois Council on Food and Agricultural Research

*Douglas Walker*
Associate Editor, *Ground Water*, 2002–2005

*Steven Wilson*
Recipient, Individual Groundwater Award, Central Regional Groundwater Protection Planning Committee

*Derek Winstanley*
Member, External Advisory Board, Institute for Environmental Science and Policy, University of Illinois at Chicago; and Member, Subcommittee on Water Quality Planning and Management, Interagency Coordination Committee on Groundwater

# ADJUNCT & EMERITUS APPOINTMENTS

## *Adjuncts to University of Illinois at Urbana-Champaign*

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Derek Winstanley, Department of Geography

*Atmospheric Environment Section*
James Angel, Department of Geography
Kenneth Beard, faculty, Department of Atmospheric Sciences
Stanley Changnon, Department of Geography and Department of Atmospheric Sciences
Steven Hollinger, Department of Natural Resources and Environmental Sciences
David Kristovich, Department of Atmospheric Sciences and Department of Geography
Kenneth Kunkel, Department of Atmospheric Sciences
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Thomas A. Prickett
Thomas A. Prickett & Associates
Urbana, IL

## *Emeritus Appointments*

Russell Lane, Principal Scientist Emeritus, 1981
Ralph Evans, Principal Scientist Emeritus, 1984
Stanley Changnon, Chief Emeritus, 1985
Robert Sasman, Professional Scientist Emeritus, 1987
Richard Schicht, Principal Scientist Emeritus, 1989
Eugene Mueller, Principal Scientist Emeritus, 1990
Donald Staggs, Professional Scientist Emeritus, 1990
Richard Semonin, Chief Emeritus, 1991
Chester Neff, Principal Scientist Emeritus, 1992
Michael Terstriep, Principal Scientist Emeritus, 1993
Krishan Singh, Principal Scientist Emeritus, 1996
Wayne Wendland, Principal Scientist Emeritus, 1996
Thomas Butts, Senior Professional Scientist Emeritus, 1998
Raman Raman, Principal Scientist Emeritus, 1998
Donald Gatz, Principal Scientist Emeritus, 1999
Nani Bhowmik, Principal Scientist Emeritus, 2001
Shundar Lin, Senior Professional Scientist Emeritus, 2002

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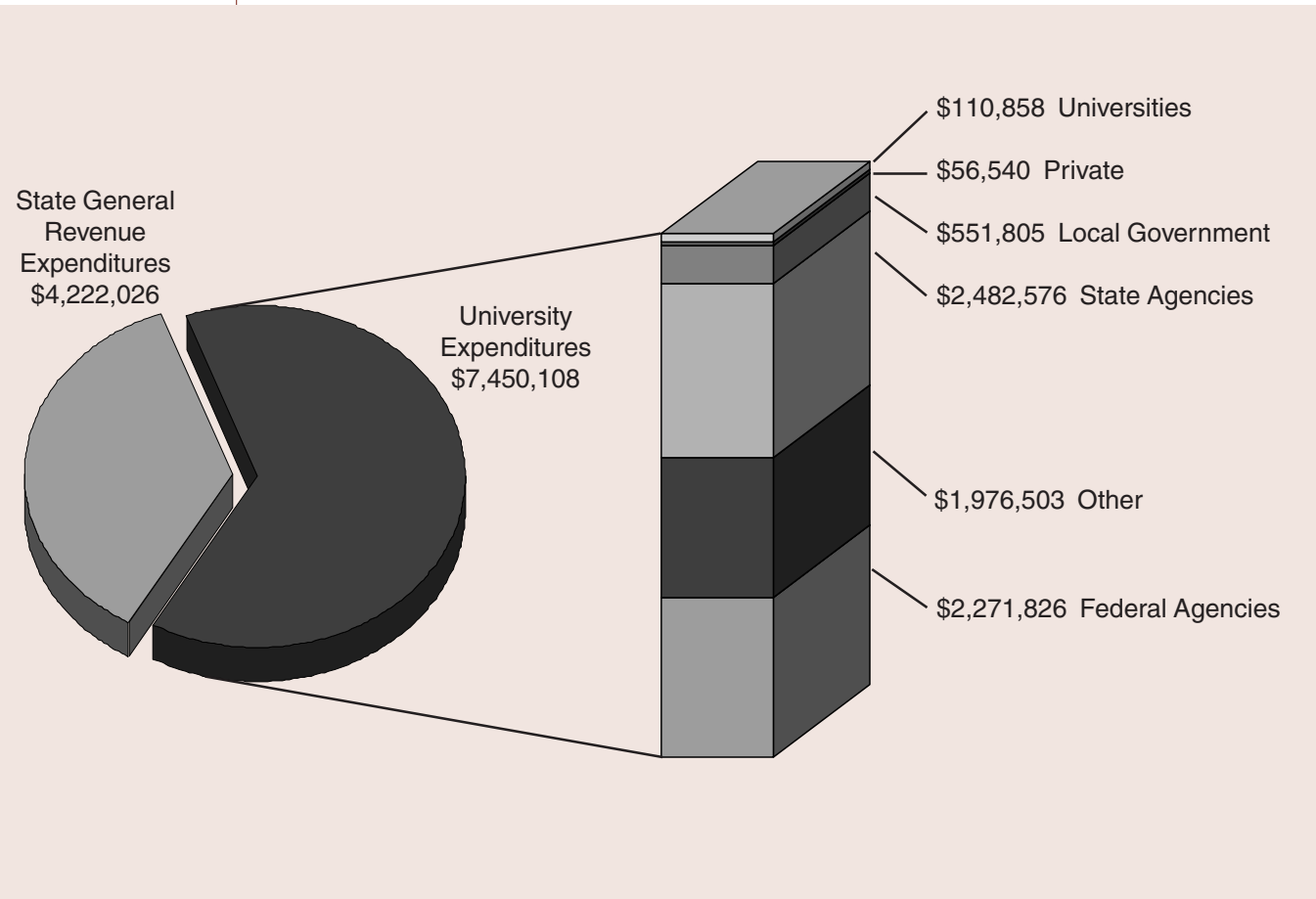

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