USGS
science for a changing world

Water Resources Update
Illinois District Newsletter

U.S. Department of Interior
U.S. Geological Survey

March 2000

Message from the District Chief

For those of you unfamiliar with our agency, the U.S. Geological Survey (USGS), established in 1879 by Congress, provides reliable and impartial information to understand the Nation's natural resources. This information is used to protect life and property from natural disasters, manage the Nation's natural resources, and protect the environment. I am proud to be part of an agency that has a long history of serving the needs of a growing Nation. Traditionally, the Districts within the USGS, Water Resources Division (WRD) have issued an occasional formal report on program activities. This report takes quite a bit of time to produce. Because we are deeply into the information age and people have grown accustomed to instant information, we felt that some sort of less formal and more frequent information outlet was needed. This newsletter is an attempt to meet this need and will evolve over time as we adapt to the information needs of the public and other agencies.

Within the water-resources community in Illinois, the USGS is probably best known for the streamflow-data network. However, we also are involved in numerous other data collection activities and interpretive projects. In this and subsequent newsletters, we will highlight some of these efforts. A sampling of some of these efforts include the measurement of the diversion of water from Lake Michigan, studies on urbanization effects on water quality, hydraulic modeling of river and lake systems, water quality of the Illinois River Basin, sedimentation of rivers and lakes, and contamination of surface water and ground water from natural and human activities.

It is with great pleasure that I present to you the first of what I hope to be many periodic newsletters intended to inform the public and Governmental Agencies of USGS, WRD activities in Illinois.

Robert R. Holmes, Jr.
Illinois District Chief

Table of Contents

Message from the District Chief . . 1
USGS Awarded 1
Are we drinking too much arsenic? 2
Outreach in the Illinois District . . 3
Upper Illinois River Basin, NAWQA 4
Cooperator Spotlight 6
Employee Spotlight 7
Illinois District Publications 8

USGS Awarded

The U.S. Geological Survey was selected for the year 2000 "Making Waves Award" presented by the Rivers Project at their annual Clean Water Celebration in Peoria, Illinois.
Mr. Robert Hirsch, Chief Hydrologist, accepted the award and addressed over 5,000 top high school students on March 19 and 20, 2000.

Are we drinking too much arsenic?
By Kelly L. Warner

The lower Illinois River Basin (LIRB) is 1 of 59 basins being studied by the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) program as part of a study of our Nation's water quality. The 59 basins include parts of most major river basins and aquifer systems throughout the Nation.

The deep glacial drift aquifer (DGDA) in the LIRB is a deep sand-and-gravel deposit filling the Mahomet Bedrock Valley (MBV) and overlain by more than 100 feet of clayey till (fig.1). This hydrogeologic setting is common in the Midwest from Illinois through Ohio, and these aquifers are a major source of drinking water. Contamination of these aquifers is minimal, but natural contaminants such as arsenic are present. Arsenic concentrations in the ground water in parts of the DGDA in central Illinois exceed the U.S. Environmental Protection Agency (USEPA) interim drinking water standard of 50 micrograms per liter (µg/L). The current USEPA standard of 50 µg/L is under revision. If the USEPA standard was lowered to 20 µg/L, many public and private water supplies would have to address arsenic contamination (table 1).

Over 140 ground-water samples were collected in this study. Ground-water samples were analyzed for over 170 different chemical constituents, including trace elements, nutrients, metals, major ions, radon, tritium, stable isotopes, pesticides, and metabolites. The ground-water chemistry of the DGDA was evaluated using data collected from 30 private domestic-supply wells within the MBV. The shallow glacial drift aquifer (SGDA) was evaluated using data collected from 87 wells. The SGDA wells include 57 newly installed monitoring wells, 29 private domestic-supply wells, and 1 public-supply well. Ground water from 10 of the wells in the DGDA was resampled for arsenic speciation (forms of arsenic).

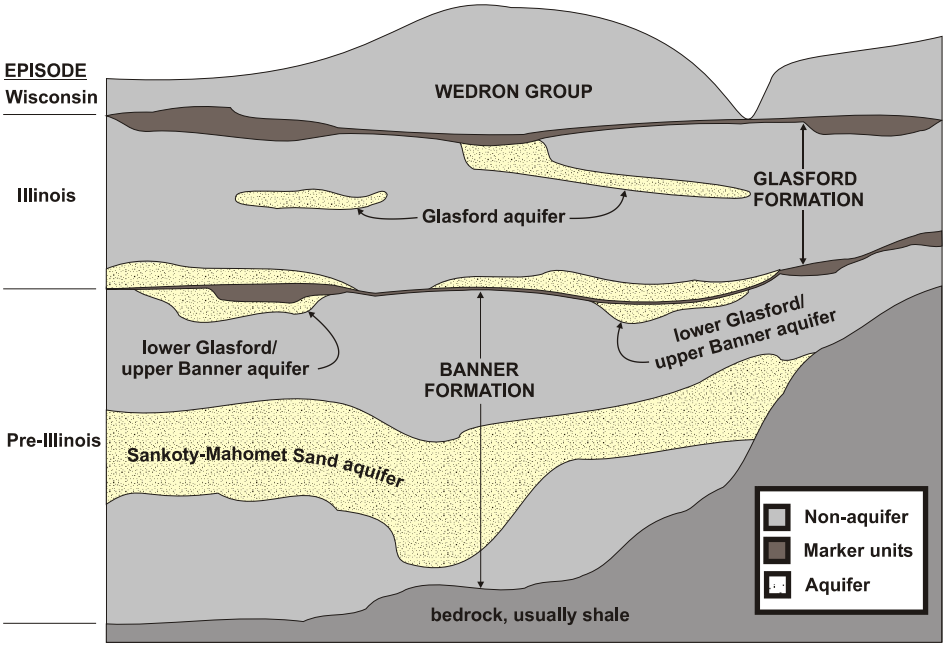

Figure 1. Schematic cross-section of the Mahomet Bedrock Valley in the lower Illinois River Basin.

Data collected in this study from domestic wells was compared with previous analysis from public supplies (Warner, 1999). The percentage of domestic wells (privately owned wells generally serving a household) with ground water concentrations above 50 µg/L is approximately the same as the percentage of public wells (publicly owned wells generally serving a community) with ground water concentrations above 50 µg/L.

The chemistry of arsenic in the DGDA is a complex array of chemical, biochemical, and geochemical reactions that control the dissolved arsenic concentrations. Arsenic speciation was completed for ground-water samples from 10 domestic wells in the DGDA that had the highest concentration of total dissolved arsenic. Arsenate and arsenite are two forms of arsenic that are most common in ground water. Arsenite is the most common form of arsenic in the DGDA (fig. 2). The redox conditions of the aquifer affect speciation of arsenic. The low dissolved oxygen concentrations in the DGDA are associated with arsenite. Arsenite was at least 50 percent of the total dissolved arsenic for all speciation samples from the DGDA. Arsenite is more toxic than arsenate.

Bibliography

Warner, K.L., in press, Analysis of nutrients, selected inorganic constituents, and trace elements in water from Illinois community supply wells, 1984-91: U.S. Geological Survey Water-Resources Investigation Report 99-4152.

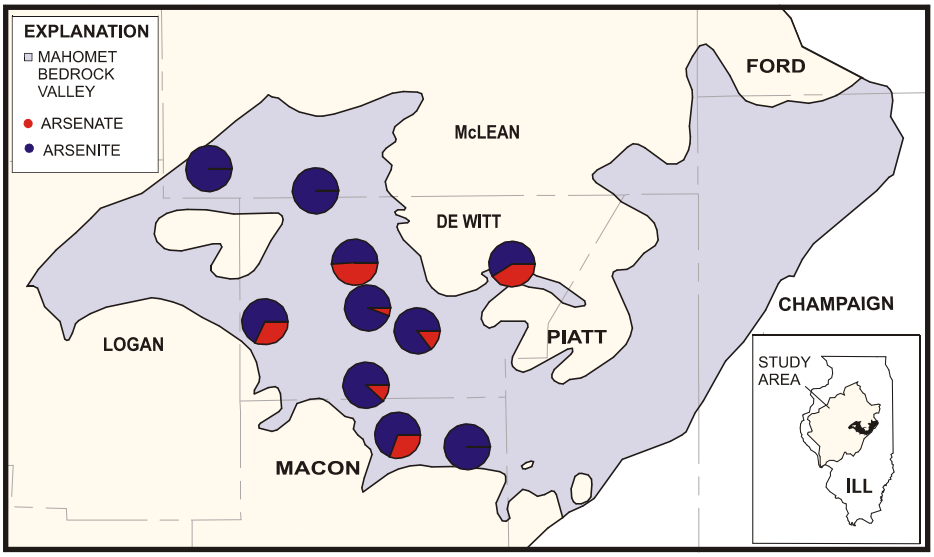

Figure 2. Distribution of arsenite and arsenate in the deep glacial drift aquifer in the Mahomet Bedrock Valley within the lower Illinois River Basin.

Table 1. Arsenic in ground water from public-water supplies within the deep and shallow glacial drift aquifer.

[All units are in microgram per liter.]

Public-Water Supplied from Glacial Deposits	No. of Wells	Percentage of Samples Analyzed for Arsenic	
		Above 50	Above 20
State of Illinois	1,070	3	13
Lower Illinois River Basin	515	3	17
Deep Glacial Drift Aquifer in Mahomet Bedrock Valley	42	7	48

Outreach in the Illinois District by Kelly L. Warner

The Illinois District of the USGS provides relevant water-resources information and expertise needed by others to achieve the best use and management of water resources in Illinois, the Midwest, and the United States. One component of this mission is "outreach." Outreach is the general term applied to our interaction with the public, education community, and layperson. An abundance of information about water resources in Illinois is available on the Illinois District homepage on the World Wide Web at http://www.il.water.usgs.gov/. There are numerous other USGS Web sites that provide information on water, geology, biology, and mapping. Information on educational resources and various links are available on the World Wide Web at http://water.usgs.gov/education.html.

The Illinois District is involved in several projects in the State that are funded through the USGS Human Resources Initiative rogram. The Human Resource Initiative supports an internal USGS effort to increase education, training, and utilization of a diverse population of employees, students, teachers, retirees, and others. As part of this effort, the District is involved in recruitment and retention of under-represented groups in the sciences. District personnel have participated in several career fairs in the inner-city Chicago and Peoria areas. Careers in the earth sciences are discussed with many students and teachers. A video, "Earth Science Careers," has been developed that shows earth-science careers and the wide range of applications of education in science for employment in the USGS. The District has initiated an internship with the University of Illinois to bring highly qualified and young scientists to the university and the USGS. The District also is working with the University of Illinois to teach a class through the Civil Engineering Department on "Field Methods in the Hydrologic Sciences."

A new exhibit on "Water" at the Orpheum Children's Science museum in Champaign was funded. The exhibit will encompass two rooms and include water flumes, geomorphic and geologic models, a water-use display, and many hands-on tools for learning about water in our environment. The grand opening of the exhibit is scheduled for Spring 2000.

Upper Illinois River Basin National Water-Quality Assessment Program

During the past 25 years, industry and government made large financial investments that resulted in better water quality across the Nation; however, many water-quality concerns remain. In 1991, the USGS began implementation of the National Water-Quality Assessment (NAWQA) program. This program differs from other national water-quality assessment studies in that the NAWQA program integrates monitoring of surface- and ground-water quality with the study of aquatic ecosystems.

Assessing the quality of water in every location of the Nation would not be practical; therefore, the NAWQA program studies are conducted within study units. The upper Illinois River Basin (UIRB) NAWQA study began in 1997 (the UIRB also was studied as part of the NAWQA pilot program begun in 1986) (fig. 1).

Water-quality issues in the upper Illinois River Basin are numerous and diverse. Some of the water-quality issues being studied in the UIRB are related to the large urban area of Chicago, the rapid spread of some of the Chicago suburbs to land formerly used for agriculture, and the large area of the basin still being used for intensive rowcrop agriculture. Two studies currently being conducted by the UIRB study unit team are highlighted below in brief summaries:

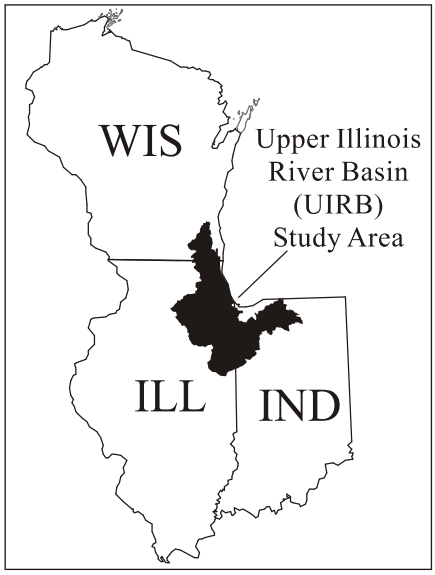

Figure 1. Location of the upper Illinois River Basin.

Influence of Various Water-Quality Sampling Strategies on Load Estimates for Small Streams

By Dale M. Robertson and Eric D. Roerish

NAWQA, like most intense sampling programs, is limited in the number of samples collected. Therefore, various sampling strategies were examined to determine which enabled the best annual load estimates to be generated for small streams given that only 12 to 30 samples per year can be collected and, therefore, a regression approach is used to estimate loads. The most effective sampling strategy was found to depend on the length of the study. For 1-year studies, fixed-period monthly sampling supplemented with storm chasing (NAWQA approach) was most effective because this strategy resulted in the most precise annual loads, even though they were overestimated by 25 to 50 percent (fig. 2). For studies of about 2 or 3 years in length, fixed-period semi-monthly sampling provided not only the least biased but also the most precise estimates. Regardless of the sampling strategy used, the regression approach using daily average streamflow and only a few samples collected annually is a relatively imprecise means of estimating annual phosphorus and sediment loads for small streams. The most effective strategy resulted in median absolute errors of about 30 percent based on comparison with loads generated with the integration method using extensive data.

The positive biases and imprecise estimates from some strategies were caused by additional high-flow samples collected to define the relation between high flow and high loads. These high-flow samples, however, did not represent the average concentrations for the day. High-flow samples collected using single-stage or peak-flow sampling resulted in the most biased and often the most imprecise estimates. The most effective strategy for collecting representative high-flow samples was manual storm chasing (NAWQA approach) because sampling crews generally cannot respond quickly

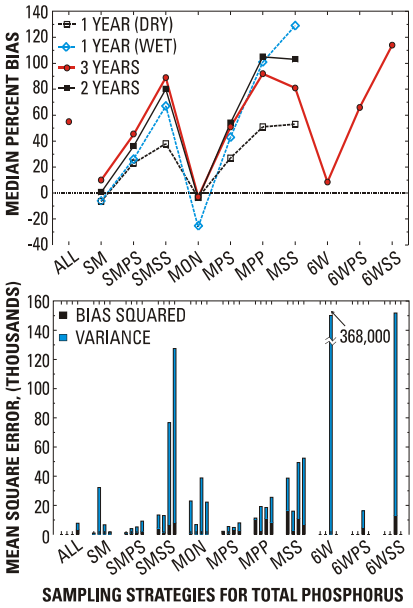

Figure 2. Biases, in percent difference from the "true" yield estimated by the integration method, and mean square errors, in percent squared, for total phosphorus for various sampling strategies. Each group of four bars is given in the following order: 1 year (dry), 1 year (wet), 2 years, and 3 years. All-data and 6-week strategies were used for the 3-year periods only. [All, all data; SM, semi-monthly; SMPS, semimonthly plus storm chasing; SMSS, semimonthly plus single-stage; MON, monthly; MPS, monthly plus storm chasing; MPP, monthly plus peak flow; MSS, monthly plus single-stage; 6W, 6-week; 6WPS, 6-week plus storm chasing; 6WSS, 6-week plus single-stage.]

enough to consistently bias the samples toward the high concentrations during increasing flow.

Nutrients in Surface Waters, 1978-97

By Daniel J. Sullivan

One part of the NAWQA study design is the analyses of existing information. The Illinois Environmental Protection Agency has identified nutrient enrichment and sedimentation as the major causes of water-quality problems in Illinois (Illinois Environmental Protection Agency, 1996). For this reason and because these also are important national issues, nutrients and suspended solids were selected as a topic for retrospective analysis for the upper Illinois River Basin NAWQA study. Only nutrients are discussed here.

Nutrients are essential for algal and macrophyte growth in aquatic environments; but in sufficiently high concentration, these constituents can adversely affect water quality. On a statewide basis, the major source of elevated concentrations of nutrients is agriculture. However, the upper Illinois River Basin is unique in Illinois in that much of the Chicago metropolitan area lies within its hydrologic boundaries. Chicago is the third-largest metropolitan area in the United States, and the largest within the Mississippi River drainage, the largest watershed in the Nation. Urban areas are a source of nutrients and these sources are a major concern in the UIRB. Major characteristics of nutrient concentrations and transport in the upper Illinois River Basin are the following:

* The urban areas of Chicago and its suburbs contribute proportionately higher loads of total phosphorus to study-area streams. For nitrogen, loads of ammonia are higher from urban areas whereas loads of other nitrate are higher from agricultural areas; when total nitrogen is considered, loads are similar from different land uses (Fig. 3).

* Because of the relatively high nutrient concentrations in the study area, annual loads and yields also were relatively large in comparison to four other river basins in the upper Mississippi River Basin (yield is the total amount discharged in tons per year in proportion to the size of the drainage basin). The largest proportion of these loads were from the Des Plaines River Basin; yields of phosphorus from the Fox and Kankakee River Basins were not unusually high. (table 1).

* Significant downward trends in ammonia concentrations were observed at many sites, along with correlative increasing trends in nitrate. This opposite relation is consistent with the reversible capacity for transformation between the reduced form (ammonia) and the oxidized form (nitrate) and may be related to nitrification of wastewater effluents.

* Trends in phosphorus were equally distributed between upward and downward trends. Upward trends were observed at three sites in the Des Plaines River Basin and one tributary to the Fox River. Downward trends were observed at one site in the Des Plaines (Du Page) River Basin and two in the Fox River Basin.

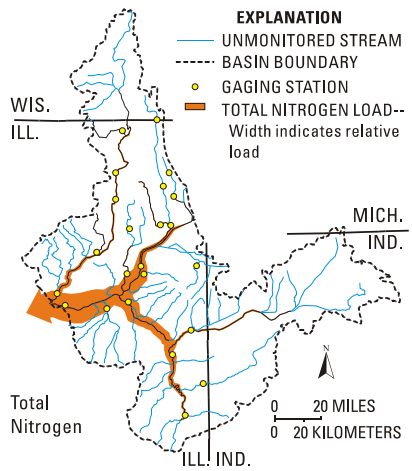

Figure 3. Estimated total nitrogen loads in the upper Illinois River Basin.

References:

Illinois Environmental Protection Agency, 1996, The condition of Illinois water resources, 1972-1996: IEPA Bureau of Water Report 96-067, 8 p.

Martin, J.D., Crawford, C.G., Frey, J.W., and Hodgkins, G.A., 1996, Water-quality assessment of the White River Basin, Indiana: Analysis of selected information on nutrients, 1980-92: U.S. Geological Survey Water-Resources Investigations Report 96-4192, 91 p.

Schnoebelen, D.J., Becher, K.D., Bobier, M.W., and Wilton, T., in press, Selected nutrients and pesticides in streams of the Eastern Iowa Basins: U.S. Geological Survey Water-Resources Investigations Report 99-4028

Table 1. Comparison of loads and yields from selected watersheds in the upper Midwest

Station name	Drainage area (square miles)	Mean annual load (tons per year)			Mean annual yield (tons per square mile per year)		
		Total nitrite plus nitrate	Total nitrogen	Total phosphorus	Total nitrite plus nitrate	Total nitrogen	Total phosphorus
Illinois River at Ottawa, Ill.	10,949	65,000	91,800	5,410	5.9	8.4	0.49
Mississippi River at the mouth of Lake Pepin[a]	47,300	102,000	212,000	3,720	2.2	4.5	.08
White River at Petersburg, Ind.[b]	11,125	40,000	57,000	2,900	3.6	5.1	.26
Iowa River at Wapello, Iowa[c]	12,499	53,800	69,700	2,230	4.3	5.6	.18
Skunk River at Augusta, Iowa[c]	4,303	10,000	13,900	548	2.3	3.2	.13

a. Kroening, S.E., U.S. Geological Survey, written commun., 1999.
b. Martin and others, 1996.
c. Schnoebelen and others, in press.

Cooperator Spotlight

Illinois Department of Natural Resources, Office of Water Resources

The history of the Office of Water Resources can be traced back to 1823 when the Illinois Legislature formed the Illinois Michigan Canal Commission. The Office as it is known today was organized in 1917 when the Civil Administrative Code combined the authorities of the Canal Commissioners, the Rivers and Lakes Commission and the Illinois Waterway Commission. The Foundational powers of the Office are covered by the Rivers, Lakes and Streams Act, which was passed in 1911. The earliest activities of the Office concentrated on the Illinois River and other large river basin issues including flood control, public waters protection and navigation. The design of the navigation system that we have today on the Illinois River, as well as the construction of the locks and dams at Marseilles and Starved Rock, was accomplished by the Office of Water Resources before the State ran out of money for the system and turned it over to the Corps of Engineers. The Office of Water Resources currently operates under the authorities covered by more than 50 State statutes.

Under the authority of these statutes, the Office of Water Resources regulates construction within the floodways of rivers and streams; regulates construction of appropriate uses in designated flood ways in northeastern Illinois; allocates diversion of water from Lake Michigan; regulates construction in the shorewaters of Lake Michigan; protects public bodies of water from private encroachment and wrongful use; regulates dam safety; operates State locks and waterways; administers lands and waters of the Illinois Waterway and Kaskaskia River navigation project; coordinates the National Flood Insurance Program; plans the conservation of water resources; administers State water-supply storage ar Carlyle, Shelbyville, Rend and Kincaid Reservoirs; plans, and constructs projects to assist units of local government with urban flood damage reduction including acquisition of flood properties; represents Illinois in three river basin commissions and national organizations of water resources, flood-plain management, urban flood control and dam safety; and is the lead State agency for Federal urban flood control and navigation projects, State water planning, and State water laws and policies.

Water-resource data collection and mapping has always been a priority program of the Office of Water Resources. The first annual report of the agency, which was published in 1918, had a section entitled "Importance of Stream Gaging Records." This report stated that "during the fiscal year ending June 30, 1918, the Division of Waterways in cooperation with the U.S. Geological Survey maintained 25 gaging stations on the principal rivers in the State."

Today, the Office of Water Resources is staffed by 106 personnel, including 75 technical staff, in Springfield, Chicago, and Schaumburg. With this staff the Office of Water Resources will continue to maintain its core regulatory and construction programs. In the future, the Office of Water Resources recognizes needs to address issues, laws, and programs to manage resource problems, such as instream-flow protection, drought management, ground-water development, expanding public-water supplies, innovative dredging and dam removals.

The Office of Water Resources works closely with the U.S. Geological Survey, Illinois District on a wide variety of projects, including the collection of water-resources records at over 150 streamflow-gaging stations throughout Illinois.

EMPLOYEE SPOTLIGHT

TERRY ORTEL, HYDROLOGIST, INVESTIGATIONS SECTION

Terry Ortel has been a hydrologist with the U.S. Geological Survey in Urbana, Illinois since June 1997. He has been involved primarily in the development, application, and testing of a flood-simulation system for Salt Creek in Du Page County, Illinois. This work uses the recently released Generation and Analysis of Model Simulation Scenarios (GENSCN) interface, along with Hydrologic Simulation Program Fortran model (HSPF) and Full Equations (FEQ) for unsteady-flow routing models of the Salt Creek watershed. The flood-simulation system, which is being developed in cooperation with the Du Page County Department of Environmental Concerns, will be used by the county to help evaluate the effects of operations of an offline stormwater diversion reservoir based on forecasted rainfall amounts or creek stages. Terry also assists with the processing of real-time, surface-water data collected by the Illinois District for display on the World Wide Web. In this role, Terry works with the hydrologists and hydrologic technicians, who install, operate, and maintain the data-collection network in the field and also with the personnel developing the Web applications to maintain the flow of data from the various field instruments to the Illinois District Web site (il.water.usgs.gov).

Before joining the U.S. Geological Survey, Terry worked for approximately a year in the data-processing department at the Waste Management Research Center in Champaign, Illinois. Prior to that, he worked at the U.S. Army Corps of Engineers, Construction Engineering Research Laboratories in Champaign, Illinois for approximately 4 years. He was a member of a team working to evaluate the status and sustainability of military lands. This work entailed a long-term inventory and monitoring program at over 50 military installations, in the United States and overseas. He worked 2 years at the Illinois State Water Survey on various studies, primarily hydrologic and hydraulic modeling of the Fox River in Illinois and Wisconsin. He also worked at the South Florida Water Management District in West Palm Beach, Florida for 4 years. While there, he was involved with drainage and water supply studies for the Everglades Agricultural Area, an approximately 900 square mile area south of Lake Okeechobee in southern Florida. He also assisted with data collection and analysis for studies related to the Kissimmee River Restoration project in Central Florida. Terry received his M.S. in Agricultural Engineering from Kansas State University in 1986, and his B.S. in Agricultural Engineering from Purdue University in 1984.

Illinois District Publications

Listed below are publications that were recently published. District policy is to provide copies of our publications to requestors at no cost as long as the publication is in stock in the District office. To obtain copies of the following, or any other Illinois District publication, you may contact Donna Ayers at (217) 344-0037, extension 3053 or by email at dmayers@usgs.gov.

FY 1999

WRIR 98-4268, Environmental Setting of the Upper Illinois River Basin and Implications for Water Quality, by Terri L. Arnold, Daniel J. Sullivan, Mitchell A. Harris, Faith A. Fitzpatrick, Barbara C. Scudder, Peter M. Ruhl, Dorothea W. Hanchar, and Jana S. Stewart

WRIR 98-4220, Potentiometric Levels and Water Quality in the Aquifers Underlying Belvidere, Illinois, 1993-96, by P.C. Mills, C.A. Thomas, T.A. Brown, D.J. Yeskis, and R.T. Kay

WRIR 98-4143, Areal studies aid protection of ground-water quality in Illinois, Indiana, and Wisconsin by Mills, P.C., Kay, R.T., Brown, T.A., and Yeskis, D.J.

WRIR 98-4087, Hydrology, water quality, and nutrient loads to the Bauman Park Lake, Cherry Valley, Winnebago County, Illinois, May 1996-April 1997 by R.T. Kay and Aaron Trugestaad

IL-98, Water Resources Data, Illinois, Water Year 1998 (CDROM), by J.K. Latour, J.C. Maurer, T.L. Wicker, and J.M. Gioja

OFR 99-97, Estimated water withdrawals and use in Illinois, 1992, by C.F. Avery

OFR 98-640, Geology, hydrology, and results of tracer testing in the Galena-Platteville aquifer at a waste-disposal site near Byron, Illinois by Robert T. Kay, Douglas J. Yeskis, Scott T. Prinos, William S. Morrow, and Mark Vendel

OFR 98-390, Flood Tracking Chart for the Illinois River Basin by C.F. Avery, R.R. Holmes, Jr., and J.B. Sharpe

OFR 97-242, Geologic, hydrologic, and water-quality data from selected boreholes and wells in and near Belvidere, Illinois, 1989-96, by P.C. Mills, D.J. Yeskis, and T.D. Straub

OFR 97-381, Geohydrology of the upper part of the Galena-Platteville aquifer underlying a waste-disposal site near Wempletown, Illinois by S.M. Robinson and D.J. Yeskis

FS-137-99, Radium in ground water from public-water supplies in northern Illinois, by Kay, R.T.

FS-063-98, Water Withdrawls in Illinois, 1995 by C.F. Avery

Water quality assessment of glacial drift aquifers--Lower Illinois River Basin by Kelly L. Warner, Abstract published by the Iowa Groundwater Association, 1st, Joint Fall Conference held at the Airport Holiday Inn, Moline, Illinois on November 3, 1998

Uranium and radon in glacial drift aquifers of the lower Illinois River Basin by William S. Morrow, Abstract published by the Iowa Groundwater Association, 1st, Joint Fall Conference held at the Airport Holiday Inn, Moline, Illinois on November 3, 1998

Do samples collected using borehole packers represent aquifer water quality? by P.C. Mills, D.J. Yeskis, and J.M. Rauman, Abstract published by the University of Illinois Water Resources Center, Conference held at the Holiday Inn Conference Center, Urbana, Illinois on November 16-17, 1998

FY 2000

WRIR 99-4229, Volatile Organic Compounds in Ground Water of the Lower Illinois River Basin, by William S. Morrow, Jr.

OFR 99-69, Water, Sediment, and Nutrient Budgets, and Bathymetric Survey of Old and New Gillespie Lakes, Macoupin County, Illinois, May 1996-April 1997, by Gary P. Johnson

——Compiled by D.M. Ayers

COMMENTS

We would like your feedback on our first newsletter. What would you like to see included in future issues? Tell us what you liked or did not like in this issue. To return: fold in half, and return to address on reverse; postage required. Thank you.

☐ Please remove my name from the newsletter mailing list.

Name and Mailing Address