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Water Resources Update
Illinois District Newsletter

U.S. Department of Interior
U.S. Geological Survey
District Web Site: http://il.water.usgs.gov/

November 2003

Compiled by D.M. Ayers

MESSAGE FROM THE ILLINOIS DISTRICT CHIEF, ROBERT R. HOLMES, JR., PHD, P.E.

At the recent Governor's Conference on the Management of the Illinois River System held in Peoria, Illinois, I was asked to speak about the focus and vision of the U.S. Geological Survey (USGS) for the Illinois River system. Prior to that presentation, I discussed this topic with my colleagues in the USGS Biological Resources, Geography (National Mapping), and Geology Disciplines, in order to give a USGS perspective rather than just a Water Resources Discipline perspective. From those discussions, along with discussions with members of my Illinois District Water Resources Discipline staff, we identified six topics of USGS focus in the Illinois River system. These topics not only apply to the Illinois River system but throughout the State, and in some cases, on a national scale. The six topics of focus (in no order of priority) are as follows:

- Data collection and dissemination
- Long-term Resource Monitoring Program (LTRMP)
- National Water-Quality Assessment (NAWQA) program
- *The National Map* program
- 3-D geologic mapping of surficial materials (Earth Surface Dynamics Program)
- Interpretive studies (examples: flood analysis, sedimentation analysis, and stream-restoration research)

Data collection and dissemination long has been a cornerstone activity of the USGS (the streamflow-gaging program being one of the oldest and visible USGS programs). Many of you know or have heard about the NAWQA program (there are two NAWQA projects [study units] in the Illinois River Basin, one for the Upper Illinois River and one for the Lower Illinois River). Also, through reading this and our past Illinois District Newsletters, you likely are familiar with many USGS interpretive studies in Illinois. However, I would like to spend a little time highlighting three USGS programs among the six focus topics that many of you may have little knowledge about: LTRMP, *The National Map*, and 3-D Geologic Mapping.

The LTRMP program is conducted by the Biological Resources Discipline Upper Midwest Environmental Science Center in LaCrosse, Wisconsin (http://www.umesc.usgs.gov/ltrmp.html). The LTRMP collects large amounts of data throughout the Upper Mississippi River system (of which the Illinois River is a part) with the mission to provide decision makers with the information needed to maintain the Upper Mississippi River System as a viable, multiple-use, large river ecosystem. This program is an extensive partnership effort with funding through the U.S. Army Corps of Engineers and field data collection accomplished through agreements with the five Upper Mississippi River Basin States. The long-term goals of LTRMP are to better understand the river system, determine resource trends and impacts on the system, develop management alternatives, manage information, and develop useful products.

The National Map is the USGS Geography Discipline effort to deal with the ever-changing geospatial needs of a changing world (http://mapping.usgs.gov/). The nationwide topographic map (7.5-minute quadrangles) coverage was an immense effort and, if repeated today, would cost roughly between $2 and $3 billion dollars to complete. *The National Map* is a consistent framework for providing geographic knowledge needed by the Nation. It will provide access to high-quality, geospatial data and information from partners to help inform resource managers and the public. This program deviates from dependence on USGS-only data (as in the original USGS topographic mapping program) to incorporating, synthesizing, and disseminating data from multiple sources.

The effort to develop 3-D geologic mapping of surficial materials is part of the Earth Surface Dynamics Program of the USGS Geology Discipline in cooperation with the Illinois State Geologic Survey and the other State Geologic Surveys that are part of the Central Great Lakes Geologic Mapping coalition (http://pubs.usgs.gov/circ/c1190/). These 3-D maps show various geologic details of surficial materials, providing decisions makers with detailed knowedge to make informed choices that will support sustainable development. This knowledge will protect the environment, enable proper and efficient utilization of water and mineral resources, site net facilities, and reduce the cost of the possible effects of geologic hazards.

I encourage you to browse the Web sites of these three excellent programs and read in more detail all available information. In addition, I remind everyone that information of current Water Resources Discipline Illinois District projects and programs, along with real-time streamflow data, are available on the Illinois District Web site (http://il.water.usgs.gov).

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CHICAGO SURFACE SOILS

BY

ROBERT T. KAY, HYDROLOGIST

The chemical composition of surface soils in Chicago, as in all urban areas, is affected by a variety of natural and anthropogenic (manmade) processes that can result in the concentration of polynuclear aromatic hydrocarbons (PAHs) and inorganic compounds, including metals and radionuclides, in the soils. Many inorganic and PAH compounds are deemed hazardous substances by the U.S. Environmental Protection Agency. Consequently, remediation of residential, commercial, industrial, and waste-disposal sites in the city of Chicago requires remediation of soils containing concentrations of the hazardous PAH and incorganic compounds that are present at concentrations above those prescribed by the Illinois Environmental Protection Agency's Tiered Approach to Cleanup Objectives (TACO) guidance. However, the TACO cleanup objectives for the hazardous PAHs and inorganic compounds are based on assessment of the risk they pose to human health and the environment and often are lower than the ambient (background) concentration of the compound in the surface soil. The need to meet the risk-based TACO remedial objectives results in additional expense associated with the removal and disposal of soils not contaminated by waste-disposal operations with little or no reduction in risk to human health or the environment. It is important to the cost-effective remediation of waste-disposal sites in the city of Chicago to determine the background concentrations of PAH and inorganic compounds in surface soils within the city, which then can be used as the remediation objective.

To characterize the chemistry of ambient surface soils in the city of Chicago, the U.S. Geological Survey (USGS), in cooperation with the City of Chicago, Department of Environment, assessed the concentration of the 16 regulated PAHs and 45 inorganic compounds in 57 samples of ambient surface soils within the city. Sample locations were chosen using a stratified-random sampling approach designed to ensure collection of a representative data set. For the purposes of this discussion, ambient soils are those soils whose chemical composition is affected by ubiquitous natural and anthropogenic processes rather than the site-specific disposal of waste materials.

PAH compounds are a family of fused ring hydrocarbon compounds derived primarily from the imcomplete combustion of organic material including wood, coal, oil, gasoline, and garbage and from leaching from coal-tar products such as asphalt and roofing shingles. PAH compounds are released to the environment largely from automobile and industrial emissions to the atmosphere, where they can be transported long distances from their sources before deposition on the land surface in rain and snow, as well as during the settling of particulate matter. The PAH compounds of interest for environmental investigations are acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene.

The results of soil-quality sampling indicate that at least 11 of the 16 PAH compounds analyzed for were detected in each of the 57 soil samples collected. PAH concentrations, from highest to lowest, typically were in the following order: fluoranthene, pyrene, benzo(b)fluoranthene, phenanthrene, benzo(a)pyrene, chrysene, benzo(a)anthracene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, dibenzo(a,h)anthracene, and anthracene. Naphthalene, acenaphthene, acenaphthylene, and fluorene consistently were at the lowest concentrations in each sample. PAH concentrations showed a log-normal distribution, with the concentrations of the individual PAH compounds being highly correlated (correlation coefficient [r^2] typically greater than 0.85). Correlation of the PAH compounds did show some variation with the molecular weight of the compound.

Statistical analysis indicates that the concentrations of any given PAH compound in ambient surface soils in Chicago may be affected by proximity to an industrial area, but does not appear to be affected by proximity to roadways or non-industrial land uses. The concentra-

tion of any given PAH compound also does not appear to be strongly affected by the organic carbon content of the soil.

The concentration of the different PAH compounds in ambient surface soils is affected by the physical properties of the compound, which are affected by its molecular weight. Lower molecular-weight PAH compounds, which were detected at lower concentrations in the soils, are present primarily in the vapor phase in the atmosphere. Higher molecular-weight PAH compounds, which typically were detected at higher concentrations in the soils, are present in the atmosphere primarily attached to particulate matter (particulate phase). The apparent effect of the phase of the PAH in the atmosphere on the concentration of a PAH in ambient surface soils indicated that atmospheric settling of particulate matter is the primary means of placement of PAH compounds in ambient surface soils in the city of Chicago.

The distribution of benzo(a)pyrene (fig. 1), which approximates the distribution of the remaining PAH compounds within the city, is complex. Elevated concentrations (greater that 5,000 micrograms per kilogram) were detected near Lake Michigan in the northern part of the city, in much of the central and western parts of the city, and in isolated areas in the southern part of the city. Comparatively low concentrations (less than 1,000 micrograms per kilogram) were detected in much of the northwestern, south-central, southwestern, and far southern parts of the city.

Surface soils in the city of Chicago are composed of a mixture of inorganic compounds, and 34 of the 45 inorganic constituents analyzed for were detected in more than 75 percent of the samples collected. The arithmetic mean of the concentration of the 34 inorganic analytes detected in more than 75 percent of the samples of Chicago soils was compared with the arithmetic mean concentration of these analytes in 106 samples of A-horizon soils collected primarily from agricultural areas within 500 kilometers of Chicago. The mean concentration of arsenic, mercury, calcium, magnesium, phosphorus, copper, molybdenum, zinc, selenium was from two to six times higher in Chicago soils, and concentration of lead was about 20 times higher than in soils from the surrounding area.

Inter-element correation coefficients show a high (r^2 greater than 0.98) Pearson product moment correlation coefficients among calcium, magnesium, and carbonate carbon. These correlations indicate that the elevated concentrations of calcium and magnesium in Chicago soils relative to surrounding soils is because of the presence of dolomite bedrock in the soils. High correlations (r^2 greater than 0.70) between aluminum and other clay-borne elements, such as potassium and trace constituents expected in clays including barium, cerium, gallium, lanthanum, lithium, neodymium, scadium, titanium, vanadium, and yttrium, demonstrate that the presence of clay minerals affects the chemical composition of Chicago soils. None of the inorganic compounds displayed a strong correlation with the total concentration of PAHs or the total organic carbon content.

The elevated (in comparison to surrounding agricultural soils) concentrations of arsenic, copper, lead, mercury, molybdenum, nickle, phosphorus, selenium, and zinc and the lack of correlation between the concentration of these elements and the concentration of elements derived from dolomite or clays indicate a potential anthropogenic source of these elements. Lead (concentration factor of 20.4), zinc (7.4), and mercury (4.5) especially are enriched relative to background soils and all seem likely to indicate substantial and widespread anthropogenic modifications to the trace-element character of the soils.

A complete description of the distribution and concentrations of PAHs in Chicago soils is available in USGS Water-Resources Investigations Report 03-4105, “Concentrations of Polynuclear Aromatic Hydrocarbons and norganic Constituents in Ambient Surface Soils, Chicago, Illinois: 2001-02.”

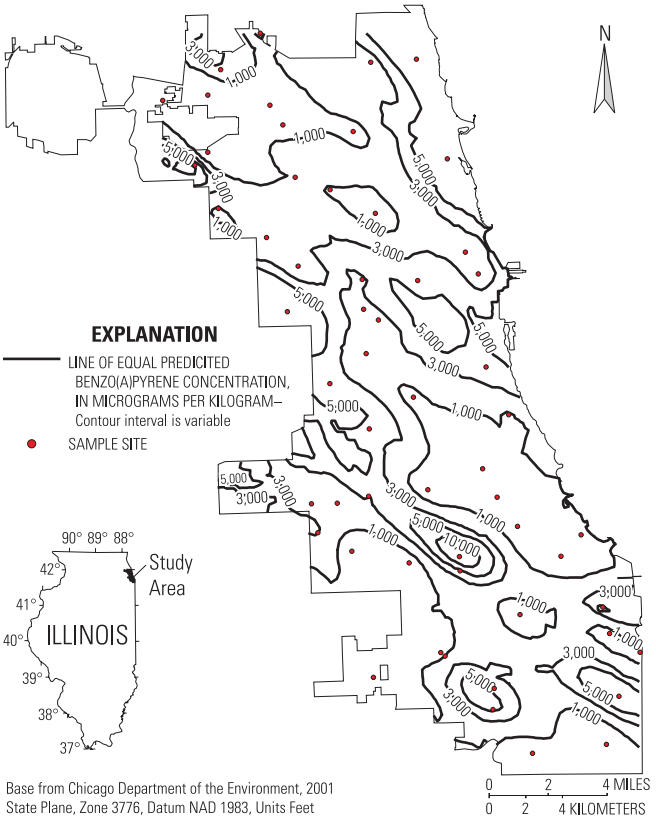

Figure 1. Concentrations of benzo(a)pyrene in ambient surface soils, Chicago, Illinois

Preliminary Results of a Dam-Removal Analysis on Brewster Creek Near St. Charles, Illinois, 2002-03

BY

Timothy D. Straub and Donald Roseboom, Hydrologists

The USGS Water Resources Discipline, in cooperation with the Kane County Department of Environmental Management, the Illinois Environmental Protection Agency (IEPA), and the Northeastern Illinois Planning Commission, is conducting a unique pilot project to evaluate the sediment, dissolved oxygen, and geomorphic response of gradually removing (in five 12- to 18-inch notches over approximately 1 year) a dam on Brewster Creek, a tributary to the Fox River near St. Charles, Illinois. Notching involves cutting a given height across the length (or some portion of the length) of the dam.

The dam was declared a Class I structure by the Illinois Department of Natural Resources (IDNR), having a high probability of causing loss of life and/or substantial economic loss in the event of a failure. The dam was in disrepair and, therefore, needed to be repaired or removed. Costs were prohibitive to repair the dam, so it was decided by the owners to remove the dam. As with repairing dams, the costs and possible environmental effects of removing dams, and managing or removing the sediment impounded behind them also are substantial. Therefore, the concept of gradually removing a dam is to reduce the total project cost and reduce possible environmental effects by allowing the impounded sediment to naturally migrate downstream and a stable, revegetated stream and floodplain to naturally form upstream.

Figure 1. Location of two USGS gages in relation to the dam on Brewster Creek near St. Charles, Illinois.

As part of the project, the USGS is monitoring the sediment concentrations at two gaging stations (one upstream and one downstream of the dam [fig.1]). From June 2002 through June 2003, more than 300 sediment samples have been collected at two gaging stations. Samples were obtained at various stream stages throughout the year, including the first notch of the dam on June 20, 2003. The USGS also monitors dissolved oxygen concentrations before, during, and after each notching event. Additionally, biologists from the IDNR and the Shedd Aquarium in Chicago monitor the stream biota and engineers from the IDNR Office of Water Resources survey stream-channel capacity. Through this effort, notching criteria are being developed based upon watershed flow and sediment release in relation to the amount of stored sediment behind the dam. The notching criteria developed through this pilot project may be expanded to other dam removals in the State. The following discussion summarizes the preliminary data collected by the USGS from June 2002 through June 2003, which includes the first notching on June 20, 2003. Note that all data presented are provisional and subject to revision.

A comparison of discharges and sediment concentrations from storm and notching events are given in table 1. This comparison is useful for understanding the effects of notching on sediment concentrations as compared to concentrations during storms. Data are presented from the two largest storms that occurred

from June 2002 to June 2003 prior to the first notching event. For these storms, the peak discharges were near 100 cubic feet per second (ft^3/s) and the peak sediment concentration rages downstream and upstream of the dam were 222-332 and 475-572 milligrams per liter (mg/L), respectively. During the 2 days before the first notching, the discharge was near 3 ft^3/s and the sediment concentrations varied from 35 mg/L downstream to 29 mg/L upstream. During the first notching, the peak discharge increased from 3 to 24 ft^3/s. During this time, the peak sediment concentrations downstream and upstream of the dam were 108 and 19 mg/L, respectively.

On June 20, 2003, at approximately 5:30 a.m., the pre-notching dissolved oxygen concentration at the gages downstream and upstream of the dam were 7.5 and 7.3 mg/L, respectively. Throughout the notching, the dissolved oxygen at the downstream gage gradually increased to 8.4 mg/L at 10:15 a.m., and then gradually decreased to and stabilized at 7 mg/L from 12:15 p.m. to 1:00 p.m., when the monitoring of dissolved oxygen ended. On July 8, 2003, at approximately 9:00 a.m., the dissolved oxygen concentrations at both the upstream and downstream gages were 7 mg/L. At all times during the monitoring, dissolved oxygen concentration remained above 5 mg/L. These results indicate that the effects of the first notching did not appreciably affect dissolved oxygen concentrations in Brewster Creek.

Table 1. Peak discharge and sediment concentrations at gages upstream and downstream of a dam on Brewster Creek near St. Charles, Illinois

Storm or Notching	Peak Discharge at Downstream Gage (ft^3/s)	Peak Sediment Concentration at Downstream Gage (mg/L)	Peak Sediment Concentration at Upstream Gage (mg/L)
August 22-24, 2002	81	332	475
May 1-2, 2003	101	222	572
Pre-Notching 1 June 18-19, 2003	3	37	29
Notching 1 June 20, 2003	24	108	19

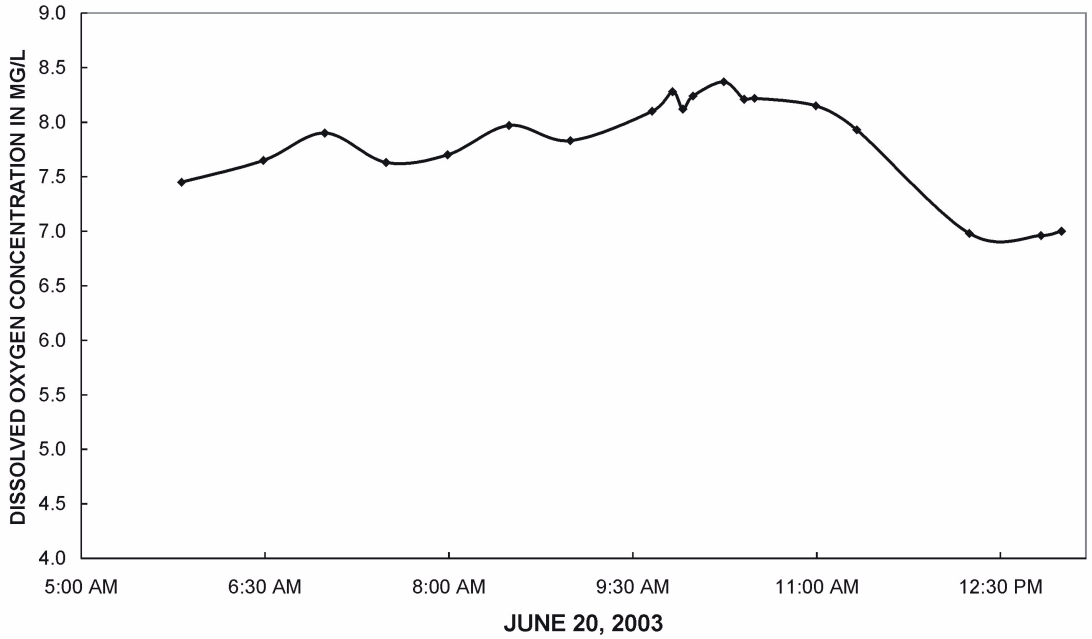

Figure 2. Dissolved oxygen concentration at the gage downstream of the dam on Brewster Creek near St. Charles, Illinois

Measuring Irrigation Discharge in Imperial Valley, Illinois

by

Charles F. Avery, Hydrologist

So you thought that "Imperial Valley" was in California? The moniker "Imperial Valley of the Midwest" or "Imperial Valley" has been used for Mason County, Illinois for many years because of the large number of irrigation systems and the many specialty crops grown there. The region between the Sangamon and Illinois Rivers comprising Mason County and southwestern Tazewell County has the densest grouping of irrigation systems in Illinois and possibly in the Midwest. About 1,840 irrigation systems are present in an area of about 700 square miles, an average density of between 2 to 3 irrigation systems in every square mile. A wide variety of speciality crops are grown there, such as pumpkins, sweet corn and popcorn, cucumbers, melons, and tomatoes, in addition to the ubiquitous field and seed corn and soybeans. Production of some of the specialty crops requires the regular use of irrigation to insure that abundant moisture is available to the crops during their growing season. The sandy soils in much of the area necessitate the use of irrigation for most of the crops when good summer rains do not fall on a frequent enough basis to maintain good soil-moisture levels.

The Imperial Valley Water Authority (IVWA) was created in 1989 when concerns arose over present and future use of the ground-water resource for irrigation in the area. The organization operates under the Water Authorities Act of 1951 passed by the Illinois Legislature. The act gives the trustees various powers, one of which is 'To reasonably regulate the use of water and during any period of actual or threatened shortage, to establish limits upon or priorities as to the use of water.' The Water Authority has been very proactive in their approach to proper management of their water resource by collecting data on ground-water levels, water pumpage by irrigation systems, and rainfall. The data are available on their Web site http://www.outfitters.com/~ivwa/.

Results of a USGS study, recently presented at the Illinois Specialty Growers Association Conference held in Springfield, updated the conversion factor used by the IVWA to determine water withdrawn by all the irrigation wells in the area based on the total electrical consumption by irrigation systems provided them from the local power company. The conversion factor was updated by measuring the instantaneous electrical demand and water discharge at a predetermined sampling of irrigation systems, calculating the conversion factor for each system, and determining the average value of the conversion factor for the sampled systems.

This study was made possible largely by the use of a non-invasive flow meter. Accurate measurements of flow in the discharge pipe were accomplished usually in less than 15 minutes at the irrigation system. Installation of the flow meter does not require disruption of the system operation or modification of the discharge pipe. The non-invasive flow meter used for this study operates on the simple concept that sound waves are affected by moving water such that the sound-wave velocity will increase in a downstream flow direction and decrease in an upstream flow direction. A measurement using the flow meter is accomplished by first precisely positioning two transducers on the outside surface of the pipe in certain orientations and spacings governed by the type of pipe material and pipe diameter. The flow meter then is programmed to transmit and receive ultrasonic sound waves back and forth between the transducers. The computer in the flow meter determines the water-velocity profile in the interior of the pipe and, with input provided from the operator about the cross-sectional area of the pipe, displays the water flow inside the pipe in whatever units the operator desires.

The average discharge value determined during the study from the 77 sampled irrigation systems was 1,259 gallons of water per kilowatt-hour of electricity. This value is appreciably lower than the value of 1,505 gallons per kilowatt-hour currently used by the IVWA. This updated value indicates that the water withdrawn for irrigation presently may be overestimated by about 20 percent. The large range in values, from 767 to 1,762 gallons per kilowatt-hour, obtained on the individual systems could be the result of such variables as the depth to water in the well, the efficiency of the well screen and the pump, and the friction losses because of the differing length of and number of bends in the pipe between the well and the pivot.

Cooperator Spotlight

City of Urbana, Department of Public Works

The mission of the City of Urbana (population 37,362), Department of Public Works is to provide Urbana citizens a healthy, desirable, and safe environment through responsible management and maintenance of public works facilities and related services. The department provides a large number of services to the public. Some of these services include the following: providing maintenance and construction of city infrasturture (for example, sidewalks and lightning); providing engineering services for city projects (such as drainage); maintaining city-owned trees and landscape; and overseeing recycling and environmental issues. The department has seven divisions, including the Enironmental Management Division, which is tasked with providing environmental protection services through enforcement of health, safety, and welfare codes.

In order to provide timely information and relevant scientific data concerning drainage and flooding issues, the USGS in cooperation with the Department of Public Works, has installed and is operating two streamflow-gaging stations on Boneyard Creek and one rainfall-gaging station located at Urbana Middle School. The streamflow station at Race Street (measuring continuous stage) and the rainfall station have been operating since 2000. The streamflow station at Lincoln Avenue (measuring continuous stage and discharge) has been operating since 2001. Data collected at these stations are available on a real-time basis. Real-time data from these stations give emergency-management officials the ability to make decisions during floods and allow citizens to make decisions regarding their lives and property. In addition, the data are used to study flood issues along the Boneyard Creek. The USGS is using data from these stations along with available computer models of Boneyard Creek to evaluate the effectiveness of the flood-control and remediation projects that recently have been completed on the Boneyard by the cities of Champaign and Urbana, and the University of Illinois. Data collected at these stations are of vital importance for accurate flow simulation and understanding the hydrology of the Boneyard watershed.

Employee Spotlight

Timothy D. Straub
Hydrologist

Tim Straub began his career at the USGS-Illinois District, as a student trainee in 1994 working on various surface- and ground-water projects. In 1995, he received a B.S. in Civil/Environmental Engineering from the University of Illinois, Urbana-Champaign (UIUC). After receiving his B.S., he started working for the USGS full-time as a Hydrologist and taking classes part-time, pursuing a Masters degree. He received an M.S. in Civil/Hydraulic Engineering from UIUC in 2000.

Tim has been project chief on studies concerning the analysis of dam removal and stream-restoration effects, sediment and geomorphic investigations, hydrologic and hydraulic modeling, and video mapping as part of rapid watershed assessments. Tim enjoys working on a wide variety of projects that span multiple disciplines. He hopes to utilize his experience to advance data-collection and analysis techniques that can be applied to problems in multiple disciplines. For example, much of the data and modeling needed for a floodplain mapping study also are useful for stream-restoration work. Collaborating with other scientists, engineers, and planners and combining resources will be extremely beneficial in future water-resources work.

Tim and his wife, Tammy, live in Urbana with their 3-year old daughter, Jenna, and newly born son, Justin. Tim enjoys running, gardening, volunteering in the community, and spending time with his family.

THE USGS-ILLINOIS DISTRICT'S NEW SEARCHABLE PUBLICATIONS DATABASE

Jennifer Sharpe and Nils Oberg have developed a new series of Web pages (fig. 1) that allow users to search, sort, and view all Illinois District publications. The main page (fig.1, left panel) gives users the options to search by report series, keyword, author, predefined topics, or regions within Illinois. Once a search is complete, a list is presented (fig. 1, center panel) showing all reports that meet the search criteria along with icons signifying if a report has an associated Abstract and/or PDF or HTML file (fig. 1, right panel). Users then can read the report Abstract and view the full report in PDF format and, in some instances, HTML format as well. The current database contains about 260 publication titles of which about 80 can be viewed in PDF format. To access the Illinois District's Searchable Publications Database, visit:

http://il.water.usgs.gov/pubs/search.html.

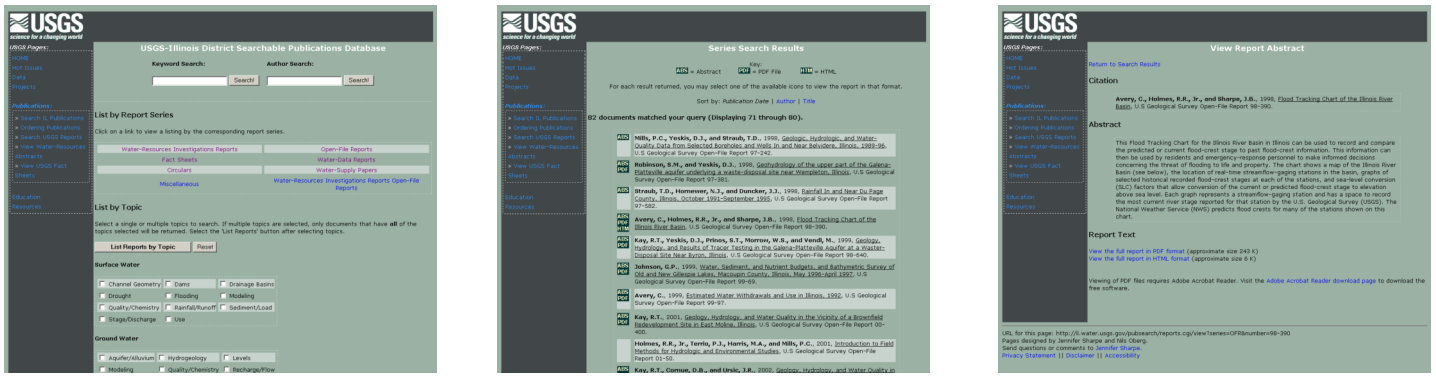

Figure 1. Screen captures of the USGS-Illinois District's Searchable Publications Database Web pages.

ILLINOIS DISTRICT PUBLICATIONS

Listed below are publications that were published recently. Federal Fiscal Year (FY) covers October 1 through September 30. 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 2003

WRIR 01-4121, Monitoring and Analysis of Combined Sewer Overflows, Riverside and Evanston, Illinois, by A.M. Waite, N.J. Hornewer, and G.P. Johnson

WRIR 02-4062, Delineation of the Troy Bedrock Valley and Particle-Tracking Analysis of Ground-Water Flow Underlying Belvidere, Illinois, by P.C. Mills, K.J. Halford, and R.P. Cobb

WRIR 02-4213, Use of Isotopes to Identify Sources of Ground Water, Estimate Ground-Water-Flow Rates, and Assess Aquifer Vulnerability in the Calumet Region of Northwestern Indiana and Northeastern Illinois, by R.T. Kay, E. R. Bayless, and R.A. Solak

OFR 02-487, Flooding in Illinois, April–June 2002, by C.F. Avery and D.F. Smith

WRIR 02-4097, Pesticides in Surface Water in the Lower Illinois River Basin, 1996–98, by R.B. King

WRIR 02-4293, Anthropogenic Constituents in Shallow Ground Water in the Upper Illinois River Basin, by W.S. Morrow

Water-Data Report IL-02, Water Resources Data Illinois, by A.D. Robl, J.W. Angel, and J.R. Norris

WRIR 03-4105, Concentrations of Polynuclear Aromatic Hydrocarbons and Inorganic Constituents in Ambient Surface Soils, Chicago, Illinois: 2001-02, by R.T. Kay, T.L. Arnold, W.F. Cannon, D.Graham, E. Morton, and R. Bienert

WRIR 03-3103, Arsenic in Illinois Ground Water—Community and Private Supplies, by K.L. Warner, A. Martin, Jr., and T.L. Arnold