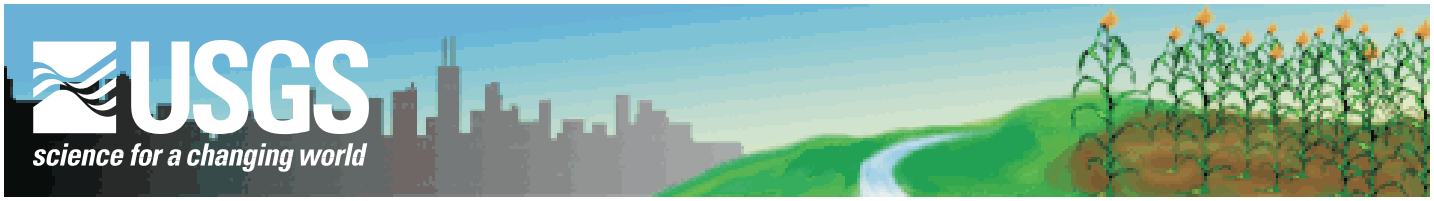
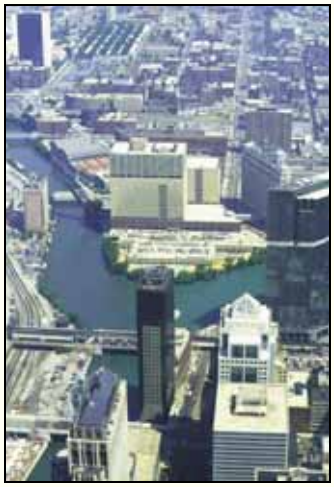


NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

Upper Illinois River Basin

MAJOR WATER-QUALITY ISSUES IN THE UPPER ILLINOIS RIVER BASIN

The Upper Illinois River Basin National Water-Quality Assessment (NAWQA) study will increase the scientific understanding of surface- and ground-water quality and the factors that affect water quality in the basin. The study also will provide information needed by water-resource managers to implement effective water-quality management actions and evaluate long-term changes in water quality.



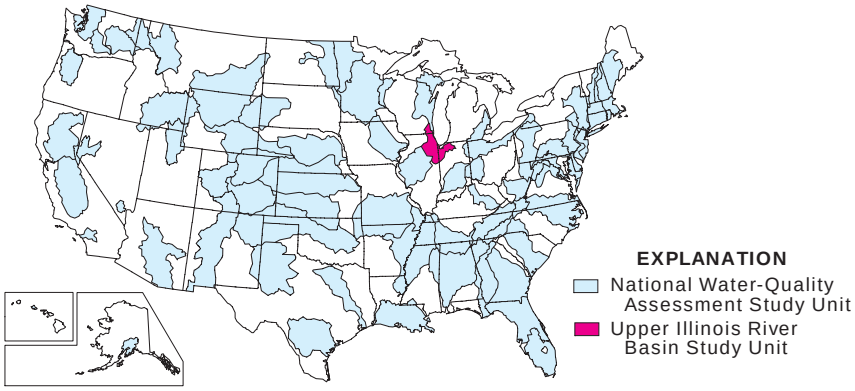
Chicago is the largest city in the upper Illinois River Basin. Construction in developing suburbs may affect biodiversity, habitat, and water quality.

Over the past half century, water-quality improvements in the basin were numerous because of advances in municipal and industrial waste treatment. The effects of industrialization and urbanization on the quality of rivers and ground-water resources, however, remain a primary concern to water-resource managers; planners; Federal, State and local governments; and citizen groups. Many of these issues relate to point and nonpoint pollution sources and are the subject of ongoing research and management programs. Examples of these programs include State and Federally funded projects like the Tunnel And Reservoir Project in the Chicago metropolitan area and program-related initiatives, such as Total Maximum Daily Loads, Best Management Practices, and Wetland Restoration; and State and local programs, such as Ambient Water-Quality Monitoring, Illinois Wellhead Protection, Side Stream Elevated Pool Aeration, Pesticide Management and Monitoring, Wisconsin Watershed Protection Plan, and Conservation 2000. The following is a list of some major water-quality issues that currently face water-resource managers in the upper Illinois River Basin:

- *Atmospheric deposition of pesticides and trace metals and its effect on aquatic biota;*
- *Endocrine disrupting compounds in surface and ground water;*
- *Effectiveness of Federal pollution-control projects on water quality;*
- *Restoration of the Grand Kankakee Marsh and its effect on hydrology and water quality;*
- *Nutrient enrichment of surface and ground waters;*
- *Recovery of water levels in bedrock aquifers and its potential effect on water quality;*
- *Surface-water sampling strategies for computing total maximum daily loads;*
- *Occurrence, transport, and fate of pesticides, trace elements, and volatile organic compounds in surface and ground water;*
- *Effects of urbanization on biodiversity, habitat, and water quality.*

WHAT IS THE 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. Following a 1986 pilot project, the U.S. Geological Survey began implementation of the National Water-Quality Assessment (NAWQA) Program in 1991. This program differs from other national water-quality assessment studies in that the NAWQA integrates monitoring of surface- and ground-water quality with the study of aquatic ecosystems. The goals of the NAWQA Program are to (1) describe current water-quality conditions for a large part of the Nation's freshwater streams and aquifers (water-bearing sediments and rocks), (2) describe how water quality is changing over time, and (3) improve our understanding of the primary natural and human factors affecting water quality.



Assessing the quality of water in every location of the Nation would not be practical; therefore, NAWQA Program studies are conducted within areas called study units. These study units comprise 59 important river and aquifer systems that represent the diverse geography, water resources, and land and water uses of the Nation. The upper Illinois River Basin is one such study unit designed to include (1) many important river systems; (2) unconsolidated and bedrock aquifer systems; and (3) a mixture of agricultural, urban, industrial, and rapidly urbanizing areas. Study activities in the upper Illinois River Basin began in 1997.

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

USGS Fact Sheet FS-072-98
June 1998

STUDY UNIT DESCRIPTION

Physiography and Climate. The upper Illinois River Basin lies within the Central Lowland Province and includes the Great Lakes and the Till Plains sections. Landforms in these physiographic sections are the result of glaciation and typically have less than 300 feet (ft) of relief. The Great Lakes section is further subdivided into the Chicago Lake Plain and Wheaton Morainal subsections, and the Till Plains section is further subdivided into the Kankakee Plain and Bloomington Ridged Plain subsections.

A large part of metropolitan Chicago is within the Chicago Lake Plain subsection. Surface drainage in this area is toward the middle third of the Des Plaines River and the Chicago Sanitary and Ship Canal. Surface drainage in the Wheaton Morainal subsection is toward the Kankakee, Des Plaines, and Fox Rivers. In the Kankakee subsection, surface drainage is toward the Kankakee, Iroquois, and Mazon Rivers, whereas drainage in the Bloomington Ridged Plain subsection is toward the lower Fox River and the upper Iroquois Rivers.

The climate of the upper Illinois River Basin is classified as humid continental. In general, summers are hot and humid, and the winters are cold with an average annual temperature of 9°C. The average annual precipitation for 1951–80 ranged from 32 inches (in.) in the north at the headwaters of the Des Plaines and Fox Rivers to 40 in. in the east at the headwaters of the Kankakee River.

Population and Land Use. About 6 million people, or 86 percent of the 7.6 million people in the upper Illinois River Basin, live in urban areas. The Northeastern Illinois Planning Commission estimates that the Chicago population (about 3 million) grew by 4 percent from 1970 to 1990, whereas the amount of urban land expanded by 51 percent—more than 563 square miles (mi^2). At present, the most rapid Chicago metropolitan expansion is west and northwest toward the Fox River.

Land use in the upper Illinois River Basin is typical of large agricultural and urban areas in the midwestern United States. Collectively, agriculture accounts for 74.7 percent of the land use.

Urban encroachment into agricultural areas, such as along the Kankakee River, may affect water quality of the surficial sand and gravel aquifer.

Although land use in the Des Plaines and Fox River Subbasins are best characterized as mixed urban-agricultural, land use in the Kankakee River Subbasin is predominantly agricultural (table 1). About 91 percent of the Kankakee River Subbasin is devoted to growing corn and soybeans. Large areas of crops are irrigated in the Indiana part of the Kankakee River Subbasin, where sandier soils, low relief, and suitable ground-water resources are present. The largest urban area in the Kankakee River Subbasin is Kankakee, Illinois. The population of Kankakee and surrounding suburbs was about 96,255 in 1990.

Table 1. Land use in the upper Illinois River Basin in 1990

Land use	Subbasin (percent)			
	Des Plaines	Fox	Illinois	Kankakee
Urban	58.7	15.7	3.5	3.1
Agricultural	33.2	70.9	88.8	90.9
Forest	5.	7.	4.6	4.4
Wetland	.7	2.1	.4	.8
Water	1.	2.4	1.	.5
Barren	1.5	1.8	1.8	.3

Surface Water. Approximately 91 percent (9,964 mi^2) of the upper Illinois River Basin (10,949 mi^2) is drained by three principal rivers: the Kankakee, the Des Plaines, and the Fox. The Kankakee and Des Plaines Rivers join near Morris, Illinois, to form the Illinois River. The Fox River discharges to the Illinois River at the southwestern basin boundary at Ottawa, Illinois. The largest part of the basin (5,165 mi^2, or 47.2 percent) is drained by the Kankakee River. The Des Plaines River drains 2,111 mi^2 and includes 673 mi^2 that originally drained to Lake Michigan through the Chicago and Calumet Rivers. The Illinois River, lower Des Plaines River, and two canal systems in the Chicago metropolitan area provide a navigable link between Lake Michigan and the Mississippi River.

Ground Water. In the upper Illinois River Basin, aquifers are associated with the Quaternary, Silurian-Devonian, and Cambrian-Ordovician systems. Aquifers in the Quaternary deposits primarily consist of surficial sand and gravel. In contrast, bedrock aquifers consist of the Silurian-Devonian dolomite, limestone, and shale and the Cambrian-Ordovician dolomite, limestone, and sandstone. Ground-water flow through aquifers in the Quaternary, Silurian-Devonian, and Cambrian-Ordovician deposits are at a local (a few to tens of square miles), local-to-intermediate (tens to hundreds of square miles), and intermediate-to-regional (hundreds to thousands of square miles) scale, respectively.

In many places, sand and gravel deposits control the amount and quality of water entering and/or exiting the unconsolidated and bedrock aquifers. The reason is that these deposits facilitate rapid vertical movement of water and dissolved urban and agricultural compounds through the unsaturated zone. In the saturated zone, water and dissolved compounds flow horizontally, vertically upward discharging to streams and irrigation systems (ditches and/or tiles) and/or vertically downward recharging the Silurian-Devonian bedrock. Ultimately, the total volume of stored ground water depends on spatial and temporal variations in the evapotranspiration, pumpage, and streamflow, whereas the types of dissolved compounds present depend on the land use.

In areas where the Cambrian-Ordovician aquifer is confined by the Maquoketa shale, urbanization and/or agricultural production probably does not directly affect water quality; however, the total withdrawals from wells in the Chicago area have raised concern because these withdrawals may be greater than the natural recharge to the aquifer. As many public water suppliers in the Chicago area converted from ground water to Lake Michigan water, water levels in this aquifer recovered as much as 260 ft. More recently, the increased demand for water because of continued suburbanization, coupled with Federal restrictions on providing additional Lake Michigan water, has caused local water-resource managers to develop new supplies in the surficial sand and gravel deposits and/or reactivate available wells open to the bedrock aquifer for supplemental or peak water supply.

Surface-Water/Ground-Water Interaction. In many places, surface water and ground water are hydraulically connected; that is, streams, wetlands, and lakes receive water and dissolved compounds from (discharge), or provide to (recharge), the subsurface. In some urban streams, the apparent ground-water discharge is actually water from Lake Michigan diversions and/or wastewater treatment returns; in this case, water recharges the subsurface. In other flat-lying areas composed of sand and gravel, ground water discharges to the surface over broad areas creating biogeochemically important wetlands. In many cases, the ground-water discharge to these wetlands, such as the former 500,000 acre Grand Kankakee Marsh, is drained and diverted to streams by agricultural ditch and tile systems. In places where ground-water supplies are withdrawn from shallow sand and gravel aquifers, nearby stream water recharges the aquifer flowing toward the withdrawal areas.

Water Use. During 1995, an estimated 1,407 million gallons per day (Mgal/d) were used for public and domestic water supply in the upper Illinois River Basin. Of this amount, 203 Mgal/d were withdrawn from ground-water sources, 25 Mgal/d from rivers and lakes, and 1,179 Mgal/d from Lake Michigan. Therefore, most of the water used in the upper Illinois River Basin originates at a source outside of the basin. Excluding Lake Michigan withdrawals, water use from ground-water sources accounts for more

than 93 percent of total public and domestic withdrawals from the upper Illinois River Basin.

The effectiveness of Federal and other pollution-control projects can be evaluated by studying water quality near point-source discharges, such as at this wastewater treatment facility on the Kankakee River.

On the basis of information for 1995, 53.5 percent and 46.5 percent of the ground-water use is from the sand and gravel, and bedrock aquifers (table 2), respectively. This indicates an increase in withdrawals from the surficial sand and gravel aquifers. McHenry County, west of Chicago, relies entirely on the shallow sand and gravel for its public water supplies. Continued urban expansion of Chicago is likely to increase the total urban use of this shallow aquifer.

Table 2. Ground-water withdrawals in the upper Illinois River Basin in 1995
[Mgal/d, million gallons per day]

Aquifer type	Des Plaines (Mgal/d)	Fox (Mgal/d)	Illinois (Mgal/d)	Kankakee (Mgal/d)	Total (Mgal/d)	Percent (Mgal/d)
Bedrock	57.2	26.3	0.06	4.5	88.1	46.5
Sand and gravel	4.6	72.3	4.3	20.0	101.2	53.5

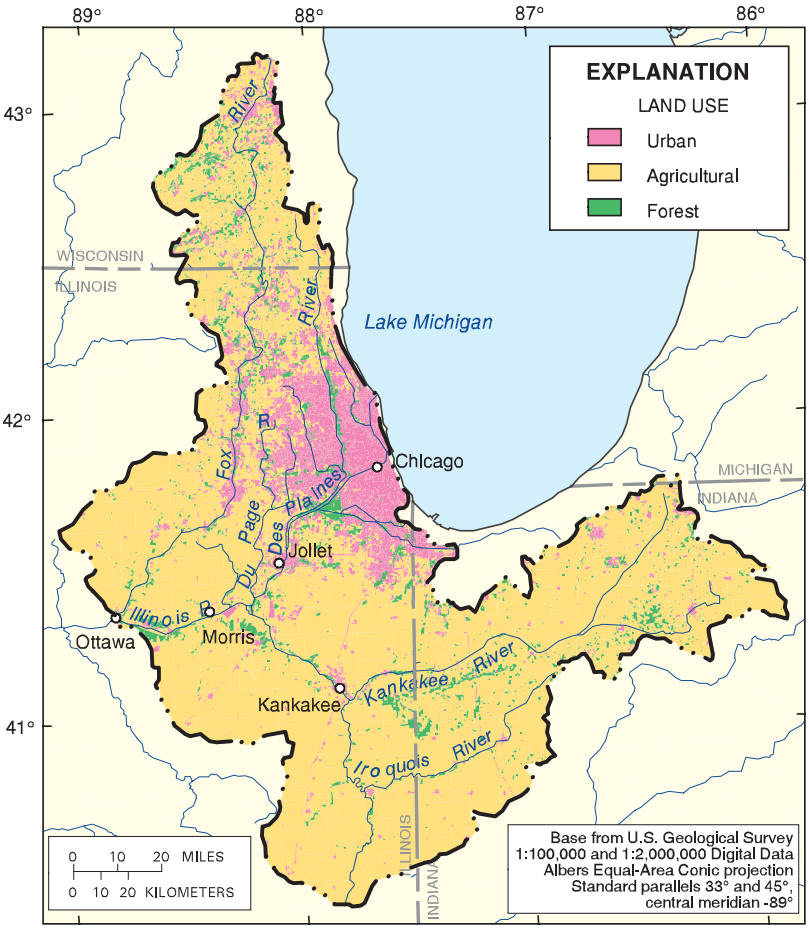
SCHEDULE OF STUDY ACTIVITIES

ACTIVITY \ YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Planning and Study Design														
High-Intensity Monitoring														
Reports														
Low-Intensity Monitoring														

The Upper Illinois River Basin study unit is one of 14 NAWQA studies that began in Federal Fiscal Year 1997 (October 1, 1996). Study-unit planning and design, and analysis of available data will be completed during the first 2 years. After the 2-year planning and retrospective analysis period, surface-water, ground-water, and biological data are collected intensively for 3 years (termed the high-intensity phase). A low-intensity phase follows for 6 years, during which water quality is monitored at fewer sites and areas than were assessed during the high-intensity phase. This combination of high- and low-intensity monitoring phases allows the NAWQA Program to examine trends in water quality and biota over time.

During the planning period, available data and results from previous studies in the study unit are reviewed to understand the primary physical, chemical, and biological factors that affect water quality in the study unit and to identify gaps in the available data. Descriptions of how land use and land cover, soils, geology, physiography, climate, and drainage characteristics may affect water quality are to be included in reports. Information obtained from reviews of previous studies, field checks of available monitoring stations and candidate sampling sites, and field reconnaissance data are used to design a sampling program for the study unit.

During the high-intensity phase, chemical, physical, and biological data are collected at local and regional scales to describe the water quality throughout the study unit. Measurements are made to determine water chemistry in streams and aquifers; the quantity of suspended sediment and the quality of bottom sediments in streams; the variety and number of fish, benthic invertebrates, and algae in streams; and the presence of any contaminants in fish tissues. Specific streams and aquifers, chemical compounds, and biological species are selected for sampling to represent the important water resources and water-quality concerns in the study unit and the Nation. A series of reports describing results of retrospective, and high- and low-intensity-phase data collection and analysis are planned.



Generalized land use, major rivers, and selected cities in the upper Illinois River Basin.

ASSESSING WATER QUALITY IN THE UPPER ILLINOIS RIVER BASIN STUDY UNIT

The NAWQA Program is designed to assess the status of and trends in the quality of the Nation's ground- and surface-water resources and link the status and trends with an understanding of the natural and human factors that affect water quality. The design of the Program balances the unique assessment requirements of individual study units with a nationally consistent design and data-collection structure that incorporates a multiscale, interdisciplinary approach. Surface-

and ground-water studies are done at local, intermediate, and regional scales to understand the water-quality conditions and issues within a study unit.

An occurrence and distribution assessment is the largest and most important component of the first intensive study phase in each study unit. The goal of the occurrence and distribution assessment is to characterize, in a nationally consistent manner, the broad-scale geographic and seasonal distributions of water-quality conditions in relation to major contaminant sources and background conditions. The following discussions describe the typical surface- and ground-water monitoring components of the NAWQA occurrence and distribution assessment. The upper Illinois River Basin NAWQA study unit will have a similar design.

Surface Water. The national study design for surface waters focuses on water-quality conditions in streams using three interrelated components: water-column studies, bed-sediment and fish-tissue studies, and ecological studies. Water-column studies monitor physical and chemical characteristics, which include suspended sediment, major ions, nutrients, organic carbon, and dissolved pesticides, and their relation to hydrologic conditions, sources, and transport. Most surface water is monitored at sites termed either basic-fixed sites or intensive-fixed sites according to the frequency of the sampling. The sampling sites are selected to determine the water quality in relation to important environmental settings in the study unit. Most NAWQA study units have 8–10 basic-fixed and 2–3 intensive-fixed sites. Basic-fixed sites are sampled monthly and at high stream flows for 2 years of the 3-year high-intensity phase. The intensive-fixed sites are monitored more frequently (as often as weekly during key time periods) for at least 1 year to characterize short-term variations of water quality. Basic-fixed or intensive-fixed sites can be either indicator or integrator sites. Indicator sites represent relatively homogeneous, small basins (less than 100 square miles) associated with specific environmental settings, such as a particular land use that substantially affects water quality in the study unit. Integrator sites are established at downstream points in large (thousands of square miles), relatively heterogeneous drainage basins with complex combinations of environmental settings. Indicator sites typically are located in the drainage basins of integrator sites. Water samples also are collected as part of synoptic (short-term) investigations of specific water-quality conditions or issues during a specific hydrologic period (for example, during low streamflow) to provide greater spatial coverage and to allow investigators to assess whether the basic-fixed or intensive-fixed sites are representative of streams throughout the study unit. Bed-sediment and fish-tissue studies assess trace elements and hydrophobic organic contaminants at 15–30 sites to determine their occurrence and distribution in the study unit.

Ecological studies evaluate the relations among physical, chemical, and biological characteristics of streams. Aquatic biological communities at the basic- and intensive-fixed sites are surveyed during the 3 years of the high-intensity-sampling phase. These surveys are done along a delineated stream reach and include a habitat assessment of the site and annual surveys of the fish, algal, and benthic invertebrate communities. Additionally, ecological sampling may be integrated with surface-water synoptic studies to provide greater spatial coverage and to assess whether the biological communities at basic- and intensive-fixed sites are representative of streams throughout the study unit.

Preservation and development of managed wetlands may result in water-quality benefits.

Ground Water. The national study design for ground water focuses on water-quality conditions in major aquifers with emphasis on recently recharged ground water that may be associated with current and recent human activities by using subunit surveys, land-use studies, and flow-path studies. Ground-water samples are analyzed for major ions, nutrients, pesticides, volatile organic compounds, and trace elements. Subunit surveys are used to assess the water quality of major aquifers or systems of aquifers in each study unit. About 30 available wells are randomly selected to be sampled in each of 2–3 aquifer subunits. Land-use studies focus on recently recharged shallow aquifer systems so that the effects of land-use practices and natural conditions can be assessed. Typically, about 20–30 new monitoring wells are randomly located and installed within each land use and aquifer type. Results from the 2–4 land-use studies performed typically can be compared to results from the general subunit surveys to determine the effect of particular land uses on ground-water quality. Flow-path studies use transects and groups of clustered, multidepth monitoring wells to examine specific relations among land-use practices; ground-water flow; and contaminant occurrence, transport, and interactions between surface and ground water.

COMMUNICATION AND COORDINATION

Communication and coordination between the U.S. Geological Survey and other scientific and land- and water-management organizations are critical components of the NAWQA Program. Each study unit maintains a liaison committee consisting of representatives from Federal, State, and local agencies; universities; the private sector; watershed organizations; and others who have water-resource responsibilities and interests. Committee activities include the exchange of information about regional and local water-quality issues, identification of sources of data and information, assistance in the design and scope of study products, and the review of study planning documents and reports.

The overall success of the Upper Illinois River Basin NAWQA study will depend on the advice, cooperation, and information from many Federal, State, regional, and local agencies and the public. The assistance and suggestions of all concerned about the water resources of Illinois, Indiana, and Wisconsin are welcomed.

SUGGESTIONS FOR FURTHER READING

Gilliom, R.J., Alley, W.M., and Gurtz, M.E., 1995, Design of the National Water-Quality Assessment Program: Occurrence and distribution of water-quality conditions: U.S. Geological Survey Circular 1112, 33 p.

Leahy, P.P., Rosenshein, J.S., and Knopman, D.S., 1990, Implementation plan for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 90–174, 10 p.

Schmidt, A.R., and Blanchard, S.F., 1997, Surface-water-quality assessment of the upper Illinois River Basin in Illinois, Indiana, and Wisconsin—Results of investigations through April 1992: U.S. Geological Survey Water-Resources Investigations Report 96–4223, 63 p.

FOR MORE INFORMATION

Information on technical reports and hydrologic data related to the NAWQA Program can be obtained from:

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