

# WISCONSIN

## A Summary of Water-Resources Activities

UNITED STATES DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY



1987

# ***WISCONSIN***

## **A Summary of Water-Resources Activities of the United States Department of the Interior Geological Survey 1987**

This booklet is intended to acquaint you with the U.S. Geological Survey and its water-resources investigations in Wisconsin during 1987. Most of these studies will continue into 1988 or longer.

Water-resources studies are directed from the Wisconsin District office in Madison. Other work of the Survey in Wisconsin entails programs in geology and mapping; those studies are directed from regional offices in Reston, Virginia and Rolla, Missouri.

Most of the Survey's water-related studies are supported by joint-funding agreements with State and local agencies. Formal joint-funded programs will be considered where information is needed and when the study would be mutually advantageous to the Survey and the agency. Costs are shared equally in most studies. If you wish more information about USGS programs in Wisconsin, I would be most happy to talk with you.

**Vernon W. Norman  
U.S. Geological Survey Representative  
6417 Normandy Lane  
Madison, Wisconsin 53719**

# A SUMMARY OF WATER-RESOURCES ACTIVITIES OF THE UNITED STATES DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY, 1987

## PREPARED IN COOPERATION WITH:

Wisconsin Department of Natural Resources  
Wisconsin Department of Transportation  
Wisconsin Geological and Natural History Survey  
Dane County Regional Planning Commission  
Dane County Department of Public Works  
Southeastern Wisconsin Regional Planning Commission  
Madison Metropolitan Sewerage District  
Green Bay Metropolitan Sewerage District Green Lake Sanitary District  
Delavan Lake Sanitary District  
Waukesha Water Utility Commission  
Park Lake Management District  
City of Middleton  
Village of Slinger  
Lac La Belle Management District  
Fowler Lake Management District  
Fox Valley Water Quality Planning Agency  
Okauchee Lake District  
Morris Lake Management District  
Wind Lake Management District  
Wolf Lake Management District  
The District of Powers Lake  
Menominee Indian Tribe of Wisconsin  
Forest County Potawatomi Community  
St. Croix Tribal Council  
Bad River Tribal Council  
Lac du Flambeau Band of Lake Superior  
Chippewa Indians  
Lac Courte Oreilles Governing Board  
Oneida Tribe of Indians of Wisconsin  
Stockbridge-Munsee Tribal Council  
National Park Service  
National Weather Service  
Federal Energy Regulatory Commission  
Corps of Engineers, U.S. Army  
Federal Emergency Management Agency  
Illinois Department of Transportation  
City of Madison  
City of Beaver Dam  
City of Medford  
City of Peshtigo  
Wood County  
City of Waupun  
Town of Norway  
City of Galena, Ill.  
Town of Delavan  
Town of Sand Lake  
City of Thorp  
Florence County  
Forest County  
Oneida County  
Vilas County Board of Commissioners  
University of Wisconsin Arboretum  
U.S. Geological Survey, WRD, Office of Surface Water  
U.S. Geological Survey, WRD, Information Transfer Program  
Village of Slinger

**UNITED STATES DEPARTMENT OF THE INTERIOR**

**DONALD PAUL HODEL, Secretary**

**GEOLOGICAL SURVEY**

*Dallas L. Peck, Director*

---

Write or phone for additional information on:

**THE U.S. GEOLOGICAL SURVEY GEOLOGY**

John S. Dragonetti  
Assistant Director for Intergovernmental Affairs  
U.S. Geological Survey  
109 National Center  
Reston, Virginia  
Phone: (703) 860-7414

**GEOLOGY**

Bruce R. Doe  
Assistant Chief Geologist  
Eastern Region  
U.S. Geological Survey  
953 National Center  
Reston, Virginia 22092  
Phone: (703) 860-6631

**WATER**

Vernon W. Norman, District Chief  
U.S. Geological Survey, WRD  
6417 Normandy Lane  
Madison, Wisconsin 53719  
Phone: (608) 276-3801

**MAPS**

Lawrence H. Borgerding, Chief  
Mid-Continent Mapping Center  
U.S. Geological Survey  
Building 1400, Stop 300  
Rolla, Missouri 65041  
Phone: (314) 364-3680

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## INTRODUCTION

The U.S. Geological Survey was established by an act of Congress on March 3, 1879, to provide a permanent Federal Agency to conduct the systematic and scientific "classification of the public lands, and examination of the geological structure, mineral resources, and products of national domain." An integral part of that original mission includes publishing and disseminating the earth-science information needed to understand, to plan the use of, and to manage the Nation's energy, land, mineral, and water resources.

### U.S. Geological Survey Programs

Since 1879, the research and fact-finding role of the USGS has grown and been modified to meet the changing needs of the Nation it serves. As part of that evolution, the USGS has become the Federal Government's largest earth-science research agency, the Nation's largest civilian mapmaking agency, the primary source of data on the Nation's surface- and ground-water resources, and the employer of the largest number of professional earth scientists. Today's programs serve a diversity of needs and users. Programs include:

- Conducting detailed assessments of the energy and mineral potential of the Nation's land and offshore areas.
- Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.
- Conducting research on the geologic structure of the Nation.
- Studying the geologic features, structure, processes, and history of the other planets of our solar system.
- Conducting the topographic surveys of the Nation and preparing topographic and thematic maps and related cartographic products.
- Developing and producing digital cartographic data bases and products.
- Collecting data on a routine basis to determine the quantity, quality, and use of surface water and ground water.
- Conducting water-resources appraisals to describe the consequences of alternative plans for developing land and water resources.
- Conducting research in hydraulics and hydrology, and coordinating all Federal water-data acquisition.
- Using remotely sensed data to develop new cartographic, geologic, and hydrologic research techniques for natural resources planning and management.
- Providing earth-science information through an extensive publications program and a network of public access points.

Along with its continuing commitment to meet the growing and changing earth-science needs of the Nation, the USGS remains dedicated to its original mission to collect, analyze, interpret, publish, and disseminate information about the natural resources of the Nation--providing "Earth Science in the Public Service".

## **Water Resources Division's Mission and Program**

The mission of the Water Resources Division is to provide the hydrologic information and understanding needed for the optimum use and management of the Nation's water resources for the overall benefit of the people of the United States.

This is accomplished, in large part, through cooperation with other Federal and non-Federal agencies by:

- Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.
- Conducting analytical and interpretive water-resource appraisals describing the occurrence, availability, and the physical, chemical, and biological characteristics of surface water and ground water.
- Conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict their response to stress, either natural or manmade.
- Disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases.
- Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground water.
- Providing scientific and technical assistance in hydrologic fields to other Federal, State, and local agencies, to licensees of the Federal Power Commission, and to international agencies on behalf of the Department of State.

# WISCONSIN DISTRICT

## Organization

The Wisconsin District of the Water Resources Division consists of two operating sections and three support units. Water-resources projects conducted by the District are assigned to one of the two operating sections with responsibility for a project assigned to a project chief. The Wisconsin District consists of persons based at the District Office and at Field Headquarters in Madison, Merrill, and Rice Lake. The Wisconsin District is assisted and advised by research centers, laboratories, technical consultants, and training centers maintained throughout the United States by the Water Resources Division.

**Office of the District Chief**

Vernon W. Norman  
District Chief

**Hydrologic Systems and  
Data Section**

W. A. Gebert

**Hydrogeologic Studies Section**

R. A. Lidwin  
Acting Section Chief

**Cartography and Publications  
Unit**

G. J. Allord

**Computer Applications  
Services Unit**

R. B. Bodoh

**Administrative Services  
Unit**

R. L. Grover

## **HYDROLOGIC SYSTEMS AND DATA SECTION**

The Hydrologic Systems and Data Section studies, analyzes, and interprets hydrologic systems as they relate primarily to the problems of surface-water management and development. The Section collects, analyzes, and prepares for publication the basic data from a statewide network of stations necessary for a continuous inventory of the water resources of the State. Studies are either areal in nature or basic-data oriented and are related to surface-water problems: floods, low flow, water quality, and changing conditions of the resource. Interpretive reports are prepared for areal studies. The Section responds to requests for surface-water related information.

The Section consists of persons experienced in surface-water data analysis, flood frequency and low-flow analysis, digital modeling, water chemistry, sedimentation, limnology, surface-water hydrology, and surface/ground-water relationships.

## **HYDROGEOLOGIC STUDIES SECTION**

The Hydrogeologic Studies Section studies, analyzes, and interprets hydrologic and geologic systems as they relate primarily to the availability, quantity, quality, and uses of ground water within the State. Areal studies are conducted, resulting in interpretive reports. The Section collects, analyzes, and prepares for publication basic data related to ground-water- level fluctuations. The Section maintains a computerized data base of information on wells and borings throughout the State. The Section responds to requests for ground-water-related information.

The Section consists of persons experienced in hydrogeology, ground-water hydraulics, water quality, digital modeling, geophysical techniques, soils, and ground/surface-water relationships.

## **CARTOGRAPHY AND PUBLICATIONS UNIT**

The Cartography and Publications Unit assists District personnel in the production of interpretive and basic-data reports. This assistance includes: type editing, cartographic design and production, and printing. The Unit also coordinates cartographic design and production for a Division-wide series of reports; assists in the use of a prototype geographic information system for digital hydrologic analysis and display of data; and assists in preparing cartographic technical standards for the Water Resources Division.

The Unit consists of persons experienced in various phases of editing and cartography ranging from traditional map design and production to automated digital cartography.

## **COMPUTER APPLICATIONS SERVICES UNIT**

The Computer Applications Services Unit provides automatic data- processing (ADP) services to the District principally through the use of the District's PRIME minicomputer. The Unit is responsible for automatic data processing of water data collected by the District, for developing and maintaining computer files of water-related data and a library of computer programs, for computer programming services, and for answering requests related to the National Water Data Exchange (NAWDEX).

The Unit consists of persons experienced in the application of computer technology to hydrology.

## **ADMINISTRATIVE SERVICES UNIT**

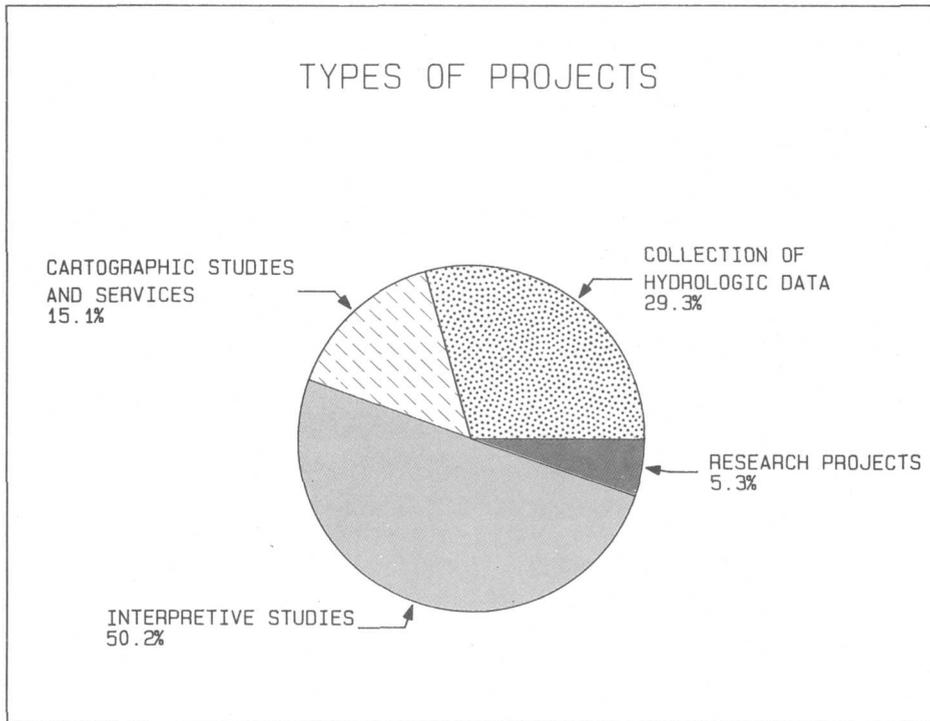
The Administrative Services Unit provides support services in the areas of budgeting, financial management, personnel administration, procurement, and general administrative activities.

## Funding

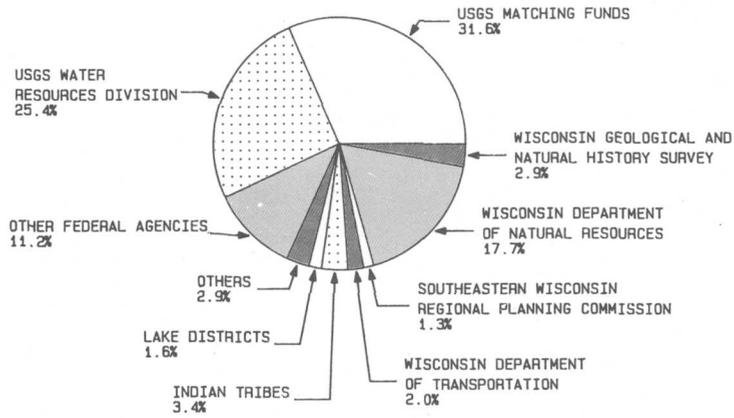
The diagram below shows the percentage of the investigations for fiscal year 1986 in each of the broad categories of collection of hydrologic data, interpretive studies, and research projects:

Funding for the work of the Wisconsin District of the Water Resources Division is obtained from several sources. Most of our work is cooperative: State and local agency offerings are matched by Federal dollars. Some work is funded entirely by other Federal agencies and some Federal dollars are obtained, unmatched, from Water Resources Division.

The breakdown of funding and funding source is shown on the diagram below. This year the total Federal dollars make up about two-thirds of our budget.



# SOURCES OF FUNDING



## **Program**

The program of the Water Resources Division for 1987 has been developed to meet some of the Nation's needs for water-resources information.

In Wisconsin, the program includes the collection of basic hydrologic data as well as interpretive studies. The Northern Midwest Regional Aquifer-System study is also headquartered in the Wisconsin District, but is administered by the Regional office. A description of these projects as of March 31, 1987 follows:

## **COLLECTION OF BASIC RECORDS--SURFACE WATER, WI 001**

**COOPERATORS:** Wisconsin Department of Natural Resources  
U.S. Army Corps of Engineers  
Southeastern Wisconsin Regional Planning Commission  
Federal (Regular)  
Madison Metropolitan Sewerage District  
Dane County Department of Public Works  
Dane County Regional Planning Commission  
Federal Energy Regulatory Commission Licensees  
Lac Courte Oreilles Governing Board  
Menominee Indian Tribe of Wisconsin  
Illinois Department of Transportation  
City of Beaver Dam  
City of Galena  
City of Medford  
City of Peshtigo  
City of Thorp  
City of Waupun  
National Weather Service

**LOCATION:** Statewide

**PROJECT CHIEF:** Barry K. Holmstrom

**PERIOD OF PROJECT:** July 1913-Continuing

**OBJECTIVE:** The objectives of this study are to provide continuous discharge of selected rivers at specific sites to supply the needs for: regulation; analytical studies; definition of statistical properties; trends analysis; determination of the occurrence and distribution of water in streams for planning. The project is also designed to determine lake levels and to provide discharge for flood and low-flow conditions and for water-quality investigations. Requests for streamflow data and information relating to streamflow in Wisconsin are answered. Basic data are published annually in Water Resources Data for Wisconsin.

**APPROACH:** A network of streamflow stations and lake-level stations will be maintained throughout Wisconsin. This includes: operating the equipment at the gaging station to record river or lake stage; making periodic discharge measurements at each streamflow station to establish or verify a stage-discharge rating curve; reducing the periodic stage readings to instantaneous and daily discharges; compilation of monthly and annual discharges, and preparing data for publication in the annual "Water Resources Data for Wisconsin" report.

Requests for streamflow data from other governmental agencies, consultants, and private parties will be processed.

**PROGRESS (July 1913 through March 1987):** The first known streamflow measurements in Wisconsin were made shortly after the Civil War by General Gouverneur Warren on the Wisconsin River and its major tributaries. Several years later, the U.S. Geological Survey began collecting streamflow

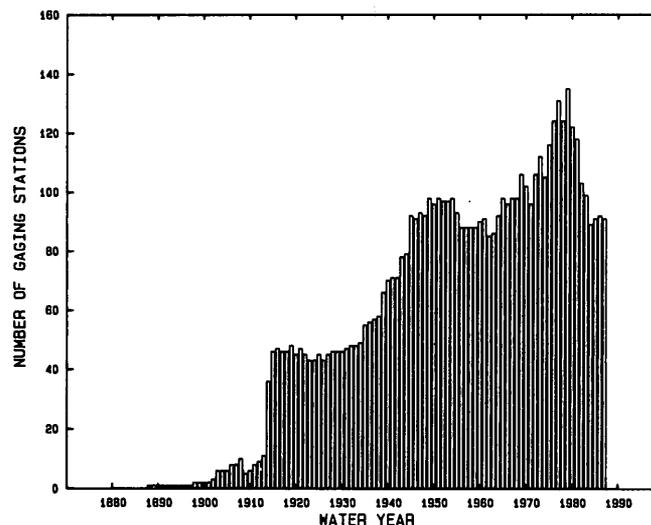
records at four sites: Chippewa River at Chippewa Falls (1888), Fox River at Rapide Croche (1896), Wolf River at New London (1896), and the Fox River at Berlin (1898). In 1913 the cooperative surface-water data program was started with the Wisconsin Rail-road Commission, and included the following stations: Oconto River near Gillett (04071000), Fox River at Berlin (04073500), Wolf River at Keshena Fall near Keshena (04077000), Wolf River at New London (04079000), St. Croix River at St. Croix Falls (05340500), Chippewa River at Bishops Bridge near Winter (05360000), Chippewa River at Chippewa Falls (05365500), Red Cedar River at Menomonie (06369000), Black River at Neillsville (05381000), Wisconsin River at Whirlpool Rapids (05392000), and Wisconsin River at Merrill (05395000). The number of gaging stations increased steadily to 58 in 1938, and reached a maximum of 135 in 1979, before decreasing to the present level of 91 stations. A plot below shows the fluctuation in the number of gaging stations throughout the program.

During the current fiscal year, continuous streamflow data were collected at 36 sites for the Wisconsin Department of Natural Resources, 7 sites for the Corps of Engineers, 15 sites for the Southeastern Wisconsin Regional Planning Commission, 6 sites for the Federal program, 2 sites for Federal Energy Commission Licensees, 2 for the Dane County Regional Planning Commission, 3 for the Madison Metropolitan Sewerage District, and 1 site each for the Menominee Indian Tribe of Wisconsin, and the cities of Beaver Dam, Galena, Medford, Peshtigo, Thorp, and Waupun. Streamflow data were also collected at 13 sites for agencies working jointly. Lake-level data were collected at two sites for the Dane County Department of Public Works and at two sites for the Corps of Engineers.

Computation of streamflow and lake-level records for network stations for the 1985 water year was completed.

More than 120 requests for streamflow information were answered.

**PLANS (April 1 to June 30, 1987):** The U.S. Geological Survey will continue the collection of continuous streamflow data at 91 stations (see the following list) and lake levels at 4 stations, compute and publish streamflow and lake-level records for the 1987 water year, and respond to requests for streamflow information.



NUMBER OF CONTINUOUS-RECORD STREAMFLOW STATIONS OPERATED IN WISCONSIN, 1888 - 1987

**Surface-water gaging stations expected to be operated in 1988 fiscal year**

Station no.	Name and location	Period of record (water year)	Cooperator
04024430	Nemadji River - South Superior	1974-	Fed.
04025500	Bois Brule River - Brule	1943-81, 1984-	Fed.
04027000	Bad River - Odanah	1914-23, 1948	C of E, Detroit
04027500	White River - Ashland	1948-	DNR
XXXXXXXX	Montreal River - Saxon Falls	1987	DNR
04063700	Popple River - Fence	1964-	Fed.
04066003	Menominee River - Pembine	1950-	DNR
04069500	Peshtigo River - Peshtigo	1953-	City of Peshtigo
04071000	Oconto River - Gillett	1906-09, 1914-	Fed.
04071858	Pensaukee River - Pensaukee	1973-	DNR
04073500	Fox River - Berlin	1898-	C of E, Detroit
04074950	Wolf River - Langlade	1966-79, 1981-	Menominee Indian Tribe of Wis.
04077000	Wolf River - Keshena Falls	1907-09, 1911-	FERC
04979000	Wolf River - New London	1896-	C of E, Detroit
04084500	Fox River - Wrightstown	1896-	DNR
04085200	Kewaunee River - Kewaunee	1964-	DNR
04085281	East Twin River - Mishicot	1972-	DNR
04085427	Manitowoc River - Manitowoc	1972-	DNR
04086000	Sheboygan River - Sheboygan	1916-24, 1951-	DNR
04086500	Cedar Creek - Cedarburg	1930-70, 1973-81, 1983-	SEWRPC
04086600	Milwaukee River - Pioneer Road	1982-	SEWRPC
04087000	Milwaukee River - Milwaukee	1914-	SEWRPC
04087030	Menomonee River - Menomonee Falls	1975-77, 1979-	SEWRPC
04087088	Underwood Creek - Wauwatosa	1975-	SEWRPC
04087120	Menomonee River - Wauwatosa	1962-	SEWRPC
04087160	Kinnickinnic River - Milwaukee	1976-	SEWRPC
04087204	Oak Creek - South Milwaukee	1964-	SEWRPC
04087220	Root River - Franklin	1964-	SEWRPC
04087233	Root River Canal - Franklin	1964-	SEWRPC
04087240	Root River - Racine	1963-	SEWRPC
04087257	Pike River - Racine	1972-	SEWRPC
05332500	Namekagon River - Trego	1928-70, 1987	DNR
05333500	St. Croix River - Danbury	1914-81, 1985-	DNR
05340500	St. Croix River - St. Croix Falls	1902-	DNR
05341500	Apple River - Somerset	1901-70, 1987	DNR
05356000	Chippewa River - Winter	1912-	DNR, Lac Courte Oreilles Governing Board
05356500	Chippewa River - Bruce	1914-	DNR
05360500	Flambeau River - Bruce	1951-	DNR
05362000	Jump River - Sheldon	1915-	DNR
05365500	Chippewa River - Chippewa Falls	1888-1983, 1987	DNR
05365707	North Fork Eau Claire River - Thorp	1986	City of Thorp
05368000	Hay River - Wheeler	1951-	Fed.
05369000	Red Cedar River - Menomonie	1907-08, 1913-	DNR
05369500	Chippewa River - Durand	1928-	C of E, St. Paul, DNR
05370000	Eau Galle River - Spring Valley	1944-	C of E, St. Paul
05379500	Trempealeau River - Dodge	1914-19, 1934	C of E, St. Paul, DNR
05380806	Black River - Medford	1985-	City of Medford
05381000	Black River - Neillsville	1905-09, 1914-	DNR

**Surface-water gaging stations expected to be operated in 1988 fiscal year — Continued**

Station no.	Name and location	Period of record (water year)	Cooperator
05382000	Black River - Galesville	1932-	C of E, St. Paul, DNR
05391000	Wisconsin River - Lake Tomahawk	1936-	DNR
05393500	Spirit River - Spirit Falls	1942-	DNR
05394500	Prairie River - Merrill	1914-31, 1939-	DNR
05395000	Wisconsin River - Merrill	1903-	DNR
05397500	Eau Claire River - Kelly	1914-27, 1939-	DNR
05398000	Wisconsin River - Rothschild	1945-	DNR
05399500	Big Eau Pleine River - Stratford	1914-26, 1937-	DNR
05400650	Little Plover River - Plover	1959-	DNR
05400800	Wisconsin River - Wisconsin Rapids	1914-50, 1958-	FERC
05400839	Fourmile Creek - Kellner	1987	DNR
05402000	Yellow River - Babcock	1944-	DNR
05403500	Lemonweir River - New Lisbon	1944-	DNR
05404000	Wisconsin River - Wisconsin Dells	1935-	DNR
05405000	Baraboo River - Baraboo	1914-22, 1943-	Fed.
05406500	Black Earth Creek - Black Earth	1954-	DNR
05407000	Wisconsin River - Muscoda	1903-04, 1914-	C of E, St. Paul, DNR
05408000	Kickapoo River - LaFarge	1939-	DNR, NWS
05410500	Kickapoo River - Steuben	1933-	C of E, St. Paul, DNR
05413500	Grant River - Burton	1935-	C of E, R. Island, DNR
05414000	Platte River - Rockville	1935-	C of E, R. Island, DNR
05415000	Galena River - Buncombe	1939-	City of Galena
05423500	S. Br. Rock River - Waupun	1948-69, 1987	City of Waupun
05424082	Rock River - Hustisford	1978-	C of E, Rock Island, DNR
05425500	Rock River - Watertown	1931-70, 1977-	C of E, R. Island, DNR
05425912	Beaverdam River - Beaver Dam	1984-	City of Beaver Dam
05426000	Crawfish River - Milford	1931-	C of E, R. Island, DNR
05426031	Rock River - Jefferson	1978-	C of E, R. Island, DNR
05426250	Bark River - Rome	1980-	SEWRPC
05427570	Rock River - Indianford	1975-	DNR
05427948	Pheasant Branch - Middleton	1974-	DCRPC
05427965	Spring Harbor Storm Sewer - Madison	1976-	DCRPC
05429500	Yahara River - McFarland	1930-	DNR
05430095	Badfish Creek - Stoughton	1986	MMSD
05430150	Badfish Creek - Cooksville	1977-	MMSD
05430175	Yahara River - Fulton	1977	MMSD
05430500	Rock River - Afton	1914-	DNR
05431500	Turtle Creek - Clinton	1939-	C of E, R. Island
05432500	Pecatonica River - Darlington	1939-	C of E, R. Island
05434500	Pecatonica River - Martintown	1940-	C of E, R. Island
5436500	Sugar River - Brodhead	1914-	DNR
05543830	Fox River - Waukesha	1963-	SEWRPC
05544200	Mukwonago River - Mukwonago	1973-	SEWRPC
05546500	Fox River - Wilmot	1940-	C of E, Chicago, and IL. DOT

**Surface-water gaging stations expected to be operated in 1988 fiscal year — Continued**

Station no.	Name and location	Period of record (water year)	Cooperator
LAKES			
04082500	Lake Winnebago - Oshkosh	1882-	C of E, Detroit
04084255	Lake Winnebago - Stockbridge	1983-	C of E, Detroit
05428000	Lake Mendota - Madison	1903, 1916-	DCDPW
05429000	Lake Monona - Madison	1915-	DCDPW

DNR -- Department of Natural Resources  
 C.of E, Chicago -- Corps of Engineers, Chicago, Illinois  
 C of E, Detroit -- Corps of Engineers, Detroit, Michigan  
 C of E, R. Island -- Corps of Engineers, Rock Island, Illinois  
 C of E, St. Paul -- Corps of Engineers, St. Paul, Minnesota  
 SEWRPC -- Southeastern Wisconsin Regional Planning Commission  
 Fed. -- USGS Federal Program  
 FERC -- Federal Energy Regulatory Commission Licensees  
 MMSD -- Madison Metropolitan Sewerage District  
 DCRPC -- Dane County Regional Planning Commission  
 DCDPW -- Dane County Department of Public Works  
 IL. DOT -- Illinois Department of Transportation



**1987 STREAMFLOW AND LAKE-LEVEL STATIONS**

## **DATA FILES FOR WISCONSIN WELL RECORDS, WI 00201**

**COOPERATOR:** Wisconsin Geological and Natural History Survey

**LOCATION:** Statewide

**PROJECT CHIEF AND DATA BASE ADMINISTRATOR:** William G. Batten

**PERIOD OF PROJECT:** March 1981-continuing

**OBJECTIVE:** The objective of this project is to create and maintain a computerized data base of well records including well location, well construction, geologic, and water-level information. The data base will provide a central repository of valuable records available from State and Federal agencies. These data can then be used to generate hydrologic and geologic maps, tables, and graphs.

**APPROACH:** The National Ground-Water Site Inventory (GWSI) data base management system will be used to store well records. Two prompt programs that automatically set required spacing and length of components, and check syntax, are used to enter data into the data base on the District PRIME computer. The programs that enter data into the PRIME data base also create formatted files that are then used to update the national data base on the U.S. Geological Survey AMDAHL computer in Reston, Va.

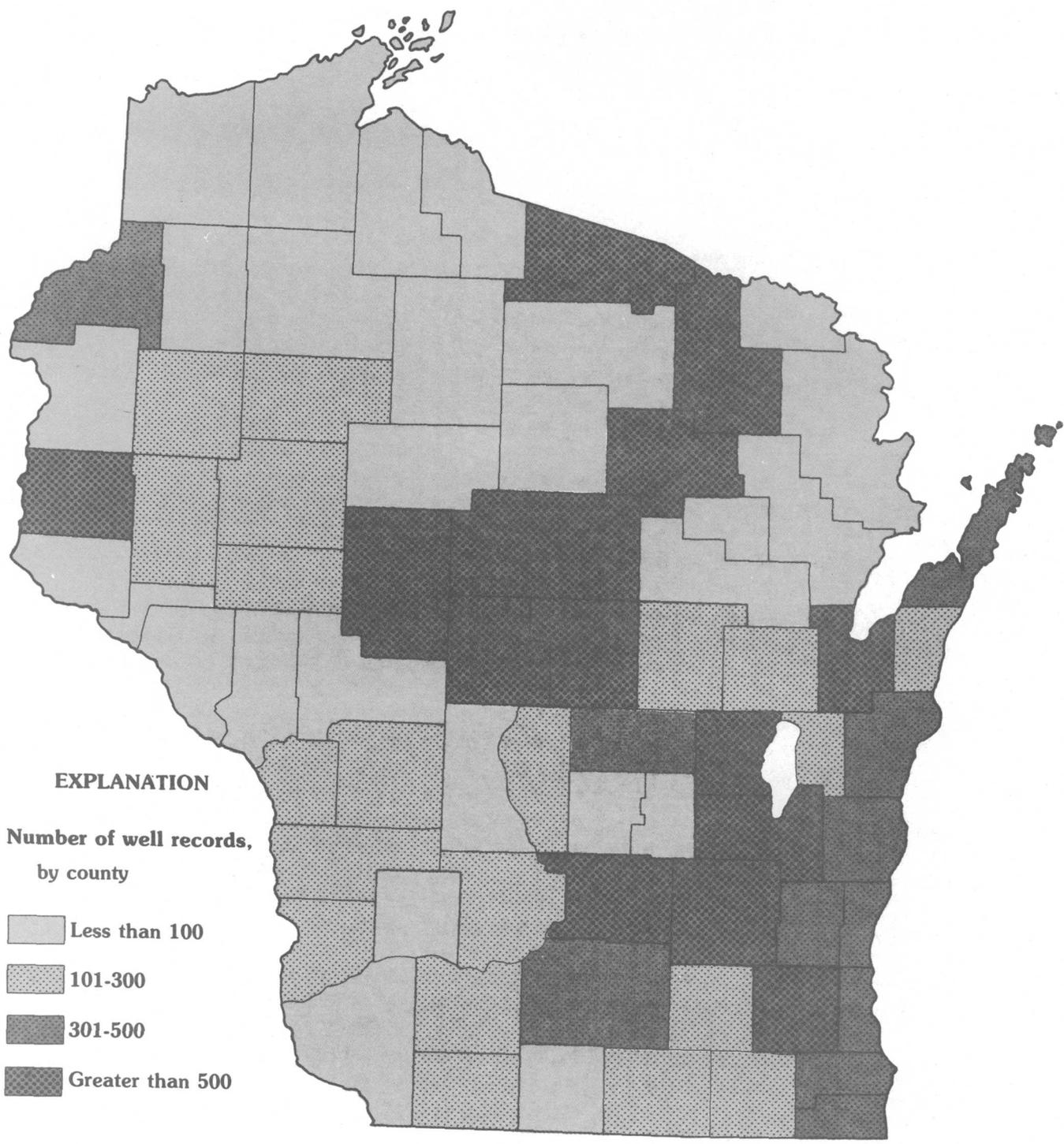
A user-friendly retrieval/tabling program is available to retrieve, interactively or in batch, data files from the PRIME. These files can then be printed in table format or can be used as input to programs for statistical analysis or programs that produce maps at various scales.

**PROGRESS (March 1981 through June 1986):** Problems with data-entry and retrieval programs that resulted from downloading of the GWSI data base to the District PRIME computer were identified and corrected. The system is now available for efficient entry and retrieval of well-construction, geologic, and water-level data.

**(July 1986 through March 1987):** Data from 1,005 new well sites were added to the data base, increasing the total number of sites in the data base to 20,789 ground-water sites. About 5,000 water-level values from the observation- well network were added.

**PLANS (April 1987 to June 1987):** Very limited data entry will occur due to limited remaining funds.

**(July 1986 to June 1987):** Data-base activities for this period are dependent on continued funding levels. Further discussion with cooperating agencies is needed to establish priorities for use of the GWSI ground-water data base.



**EXPLANATION**

**Number of well records,  
by county**

-  Less than 100
-  101-300
-  301-500
-  Greater than 500

**1987 GROUND-WATER SITE INVENTORY (GWSI)**

# COLLECTION OF BASIC RECORDS--GROUND WATER, WI 00202

**COOPERATOR:** Wisconsin Geological and Natural History Survey

**LOCATION:** Statewide

**PROJECT CHIEF:** Robert M. Erickson

**PERIOD OF PROJECT:** July 1946-Continuing

**OBJECTIVE:** The project objective is to maintain records of ground-water-level fluctuations from a network of observation wells representative of Wisconsin's principal aquifers. A subnetwork of key wells is included in this network. Key wells will have long periods of record and will be measured weekly or be equipped with continuous recorders.

The data will be used to determine short-term changes and long-range trends in ground-water levels, and to relate these changes and trends to natural or man-induced changes in storage in the ground-water reservoirs.

**APPROACH:** A basic network of about 227 wells is now being maintained. The network will be constantly modified and improved to provide the best possible coverage of our ground-water resource.

**PROGRESS (July 1946 to June 1986):** Periodic measurements of ground-water levels began on June 15, 1934, on 13 observation wells. The number grew to 23 wells by 1937. In 1946 observation wells began to increase rapidly when the U.S. Geological Survey (USGS), in cooperation with the Wisconsin Geological and Natural History Survey (WG&NHS) initiated a Statewide ground-water observation-well network. In April 1980 a committee of USGS and WG&NHS personnel was formed to evaluate the well network and to recommend how it might be improved. A memorandum report on the history of the network and the progress of the committee was submitted in February 1982. The committee's plan was approved and work began to set up the recommended network.

**(July 1986 to March 1987):** Five new observation wells were established during 1986, four were discontinued. A continuous recorder was installed on one well in Wood County. As of March 1987, 60 of the proposed 63 key wells are being monitored. Ninety-two county resource agents and private individuals have been trained as local observers for measuring ground-water levels. Data for the annual report, "Water Resources Data for Wisconsin, Water Year 1986", is completed.

The current network is as follows: Observation wells: Recording -- 26 Nonrecording -- 201

**PLANS (April 1987 to June 1987):** Continue measurements on observation-well network. Replace or hire new local observers.

**(July 1987 to June 1988):** Complete USGS and WG&NHS recommendations of statewide network. Continue measurements of entire network. Make quality- assurance checks on local observers when possible. Present award certificates to observers who have worked on the project for a long time.



**1987 GROUND-WATER OBSERVATION WELLS**

## COLLECTION OF BASIC RECORDS--WATER QUALITY, WI 003

**COOPERATOR:** Federal Program, Dane County Regional Planning Commission

**LOCATION:** Statewide

**PROJECT CHIEF:** Phil A. Kammerer

**PERIOD OF PROJECT:** July 1964-Continuing

**OBJECTIVE:** The Federal program consists of the National Stream Quality Accounting Network (NASQAN) and the Hydrologic Benchmark Network (HBMN). The objectives of the NASQAN program are to: (1) account for the quantity and quality of water moving within and from the United States, (2) depict areal water-quality variability, and (3) detect changes in stream quality with time. The objective of the HBMN program is to monitor hydrologic characteristics at sites where they are relatively unaffected by man's activities and will remain unaffected for the foreseeable future. The objective of the Dane County Regional Planning Commission (DCRPC)--U.S. Geological Survey cooperative program is to monitor water quality in selected urban streams in Dane County.

**APPROACH:** Chemical, bacteriological, and physical water-quality data will be systematically collected at fixed time intervals and stations for NASQAN.

Data, similar to that for the NASQAN program, will be collected for HBMN.

For the DCRPC--USGS program, data will be collected to evaluate sediment input to Lake Mendota.

**PROGRESS (through September 1986):** Water-quality records collected for this project include monitoring at NASQAN stations (beginning in 1974), the HBMN station (beginning in 1964), and other shorter term ground-water and surface-water quality monitoring, such as the present DCRPC program. Under the NASQAN program concentration data for fecal coliform and streptococci bacteria, dissolved oxygen, nutrients, common ions, trace elements, and suspended sediment, and measurements of water temperature, specific conductance, and pH have been collected bimonthly at stations on the Necedah, Bad, Menominee, Chippewa, Black, and Wisconsin Rivers; and quarterly on the Fox, Manitowoc, Milwaukee, and St. Croix Rivers. Radiochemical data are collected semiannually on the Chippewa River. Under the HBMN program, data are collected quarterly at a station on the Popple River. Water samples for laboratory analysis were collected during periods of runoff from precipitation and snowmelt at the two DCRPC-USGS stations for the DCRPC-USGS program. Automatic, stage-activated samplers are used to collect water-sediment samples for analyses of nutrient and suspended-sediment concentrations from Pheasant Branch Creek and suspended-sediment concentrations from the Spring Harbor storm sewer.

**(October 1, 1986 through March 1987):** Data collection continued at all monitoring stations. Monitoring data of the NASQAN program that began in 1986 was completed. NASQAN stations on the St. Croix, Necedah, and Menominee Rivers were discontinued as a result of the review. No statistically significant water-quality trends were identified at these stations, and land use in the basins is not expected to change. Emphasis of the NASQAN program will shift from the present emphasis on water-quality accounting to detection of water-quality trends and transport of dissolved and suspended materials. Two new stations were chosen to represent areas where land-use and land-management practices could produce measurable water-quality changes. A station in southwestern Wisconsin on the Grant River at Burton began operation in October 1986 and a station in central Wisconsin on Fourmile Creek will begin operation in mid 1987. Other changes in network composition, parameter coverage, and sampling frequency are expected.

**PLANS (April 1987 to September 1987):** The new NASQAN station on Fourmile Creek will be constructed and put into operation. Data collection will continue at all monitoring stations.

**(October 1987 to September 1988):** Data collection will continue at all monitoring stations.



**1987 SURFACE-WATER QUALITY STATIONS**

## COLLECTION OF BASIC RECORDS--SEDIMENT, WI 004

**COOPERATORS:** U.S. Army Corps of Engineers  
Dane County Regional Planning Commission

**LOCATION:** Statewide

**PROJECT CHIEF:** William J. Rose

**PERIOD OF PROJECT:** March 1968-Continuing

**OBJECTIVE:** This project will provide sediment data for use in specific planning and action programs and will develop a data base for determining sediment discharge and yield trends. Streams will be characterized according to range of concentration and particle size of suspended sediment.

**APPROACH:** Sediment-monitoring stations will be operated at selected stream sites areally distributed throughout the State, or located at sites of specific interest to cooperating agencies.

Extent of monitoring at a given site will depend on the characteristics of the basin and the needs of the cooperating agency. Some sites will be sampled manually at infrequent intervals; other sites, where flow responds rapidly to precipitation, will be sampled by automatic samplers.

At sites where bedload or unmeasured sediment discharge may be a significant part of the total sediment discharge, suspended- and bed-sediment particle size will be determined from samples collected concurrently with hydraulic data. These data will be used to estimate total sediment discharge using one of several techniques such as the modified Einstein procedure.

**PROGRESS (March 1968 through March 31, 1987):** Sediment data have been collected at more than 200 stream sites in Wisconsin since 1968. The sampling intensity and length of sampling period varies considerably from site to site. At some sites only a few samples a year were collected at irregular intervals for concentration analysis; at other sites hundreds of samples per year were collected with stage-activated automatic samplers. Suspended and bed material particle-size data are available for many of the sites. Except for data collected as part of the National Stream Quality Accounting Network program, data collection at most sites has been of relatively short (less than 4 years) duration. Most sediment data collection has been in the southern one-third of the State and associated with local special problem studies except for about a 5-year period in the early 1970's when there was a Statewide network of sediment monitoring stations. All data have been published annually in the data report, "Water Resources Data for Wisconsin".

The 1987 monitoring program is as follows:

**CORPS OF ENGINEERS--**Suspended sediment was sampled at the Grant River at Burton. Monthly and selected storm loads are being determined from these data.

**DANE COUNTY--**Intermittent storm-runoff samples were collected at the Spring Harbor Storm Sewer at Madison and at Pheasant Branch Creek at Middleton.

Progress was made at analyzing and interpreting 1975-83 sediment data that were collected at the Black River near Galesville; Chippewa River near Caryville, at Durand, and near Pepin.

### **PLANS (April 1987 through December 1987):**

**CORPS OF ENGINEERS--**Operation of the Grant River monitoring station will continue. Data collected at the Black River near Galesville; Chippewa River near Caryville, at Durand, and near Pepin; and the Wisconsin River at Muscoda from 1975-83 will be further analyzed, interpreted and summarized in a report.

**DANE COUNTY--**Continue the collection of suspended-sediment concentration data as scheduled. Daily sediment loads will be computed for Pheasant Branch Creek at Middleton.

**(October 1987 through September 1988):** The Corps of Engineers plans to continue funding the Grant River sediment-monitoring stations. Because very little information is available on sediment trends in Wisconsin, cooperating agencies will be encouraged to fund all or part of a network of long-term sediment-monitoring stations.



**1987 STREAM-SEDIMENT STATIONS**

## **FEMA FLOOD-INSURANCE STUDY, WI 006**

**COOPERATOR:** Federal Emergency Management Agency

**LOCATION:** Statewide

**PROJECT CHIEF:** Peter E. Hughes

**PERIOD OF PROJECT:** March 1984 to September 1987

**OBJECTIVE:** Hydrologic and hydraulic analyses will be performed in order to complete flood-insurance studies at communities selected by FEMA.

**APPROACH:** Flood-discharge frequency relationships will be determined from local historical information, gaging station records, or other applicable information. Water-surface profiles will be produced by using step-backwater models or by other acceptable methods and the results will be published in reports prepared according to FEMA specifications.

**PROGRESS (April 1984 through September 1986):** Eighty-eight cities, villages, and counties were evaluated to determine if the existing flood potential warranted a limited-detail flood-insurance study. FEMA selected 51 communities for study by the U.S. Geological Survey from July 1985 through June 1987. Work on 27 of these communities has been completed and the profiles, maps, and reports are undergoing office review.

**(October 1986 through March 1987):** Thirty limited detail studies have been completed and the reports we studies and are presently in office review.

**PLANS (April 1987 to September 1987):** Reports for the remaining 21 studies will be completed.



**1987 FLOOD-INSURANCE STUDIES**

## **WISCONSIN WATER-USE DATA FILE, WI 007**

**COOPERATOR:** Wisconsin Department of Natural Resources

**LOCATION:** Statewide

**PROJECT CHIEF:** James T. Krohelski

**PERIOD OF PROJECT:** March 1978-Continuing

**OBJECTIVE:** The purpose of this project is to collect accurate and complete data on Wisconsin's water use, to store data in the State Water-Use Data System (SWUDS) and the National Water-Use Data System (NWUDS), and to prepare periodic reports on water use in the State.

**APPROACH:** Sources of water-use information will be evaluated. The best available data will be entered into the State Water-Use Data System (SWUDS). Efforts will be made to upgrade the accuracy of water-use data.

**PROGRESS (March 1978 through September 1986):** 1. All sources of water-use information were evaluated. Data being collected by State agencies suitable for entry into a data base were identified.

2. The State water-use data base (SWUDS) was installed on the USGS PRIME computer. Reformatting programs were written to input historic and current water-use information, that was compiled and stored on magnetic tape by DNR, into SWUDS. These data include private, industrial, commercial, and irrigation pumpage for 1978-84. Public-supply water-use data including information on location of wells, depth, aquifer, and amount of water pumped for 1979 and 1984 was input. Municipal return-flow data for 1979 and 1984 has also been entered.

3. A detailed report "Water Use in Wisconsin, 1979", the first of its kind, summarizing all types of water use in Wisconsin, was published.

4. Water-use data were prepared for the Wisconsin contribution to the 5-year report "Estimated Use of Water in the United States in 1980".

5. Aquifers from which municipal wells withdraw water were identified and a report including these data, "Public-Supply Pumpage in Wisconsin, by Aquifer", was published.

6. Irrigation pumpage at selected wells was measured and compared with pumpage reported by State growers. This information was used to establish a more accurate estimate of Wisconsin's irrigation water use.

7. We are cooperating with Wisconsin DNR on a Great Lakes water-use project. Meetings have been held with DNR to describe SWUDS and after assistance in compiling water-use data for the Wisconsin part of the Great Lakes basin.

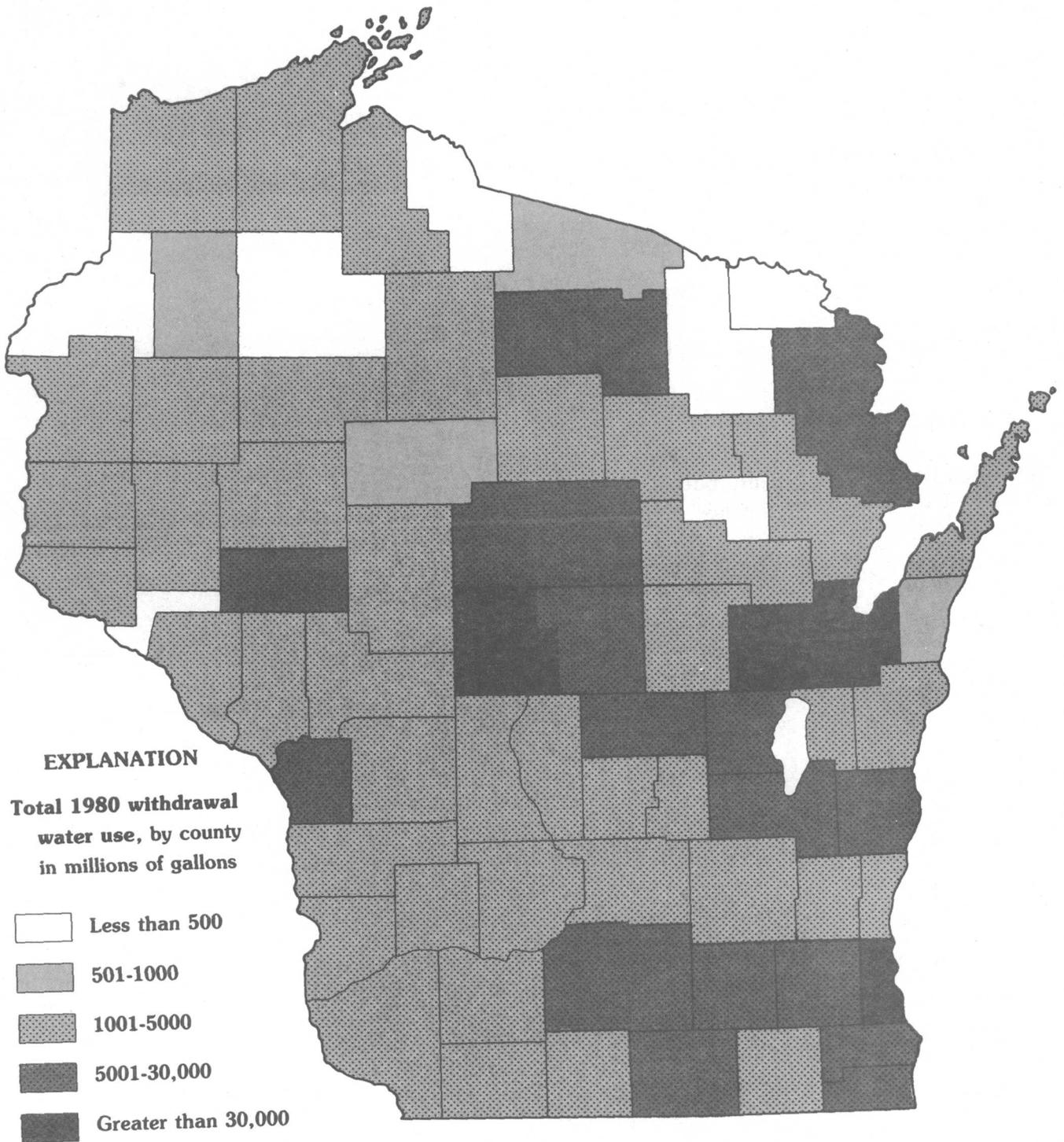
**(October 1986 through March 1987):** 1. The Wisconsin portion of "Estimated Use of Water in the United States in 1985" was completed.

2. A draft of a report titled "Water-Use in Wisconsin, 1985" was completed.
3. A PC/IT was purchased to store SWUDS data. The use of a PC to store water- use data should allow easy access and retrieval of the data for cooperators.
4. Illustrations to be included in the 1987 National Water Summary were partially completed.
5. The report, "Estimated Use of Ground Water for Irrigation in Wisconsin, 1984", was printed.

**PLANS (April 1987 through September 1987):** 1. The report, "Water Use in Wisconsin, 1985", will be completed.

2. The Wisconsin section of the 1987 National Water Summary will be completed.

**(October 1987 through September 1988):** 1. A retrieval and graphics system for the water-use data stored on the PC/IT will be developed.



**1980 WITHDRAWAL WATER USE**

## **LOW FLOW AT OUTFALL SITES, WI 035**

**COOPERATOR:** Wisconsin Department of Natural Resources

**LOCATION:** Selected sites throughout Wisconsin

**PROJECT CHIEF:** Barry K. Holmstrom

**PERIOD OF PROJECT:** April 1972 -- continuing

**OBJECTIVE:** The purpose of this study is to determine the following low-flow characteristics:

1. The annual 7-day mean low flow (Q) for receiving streams at sewage-treatment plants and industrial plants discharging wastes.
2. The annual 7-day mean low flow (Q) for selected streams.
3. The 10-year low mean monthly flows for October, November, April, and May for sites at fill-and-draw wastewater-treatment lagoons or waste- stabilization ponds.

**APPROACH:** Low-flow characteristics of selected streams will be determined by: drainage-area/discharge relationships, graphical regression methods, regression equations, Log-Pearson Type III frequency analysis, and other statistical and graphical methods.

**PROGRESS (April 1972 through March 1987):** Preliminary estimates of Q<sub>7,2</sub> and Q<sub>7,10</sub> were made for approximately 600 streams at sewage-treatment and industrial plants by June 1973. These estimates were based on drainage area-discharge relationships. The second phase confirmed or revised estimates at about 450 of the original sites by July 1974. These estimates were based on graphical-regression analyses relating measured discharge at sites of interest to discharge at nearby gaging stations. The low-flow characteristics at the gaging stations were transferred through the regression lines to determine Q<sub>7,2</sub> and Q<sub>7,10</sub> values at sites of interest. Additional discharge measurements were made at some of the original sites and at about 116 additional sites for the third phase of the study. A report, "Low-Flow Characteristics of Wisconsin Streams at Sewage-Treatment Plants and Industrial Plants", was published in March 1979 updating low-flow characteristics at about 556 sites. Low-flow characteristics have been provided for additional sites requested by DNR since 1979.

To date this year, low-flow estimates were determined at approximately 24 sites in response to requests for information from DNR. A seepage run was made to determine discharges in the South Branch O'Neil Creek basin near Granton. Reconnaissance for potential gaging-station locations were made on the South Branch O'Neil Creek at Granton and South Branch Baraboo River at Hillsboro. A discharge measurement was made on the Chippewa River at Eau Claire to check powerplant record.

**PLANS (April 1 through June 1987):** Low-flow characteristics will be determined in response to DNR requests.

**(July 1987 through June 1988):** Low-flow characteristics at approximately 25 sites will be determine equations.

## ST. CROIX RIVER NATIONAL SCENIC RIVERWAY, WI 067

**COOPERATOR:** National Park Service, U.S.  
Department of the Interior

**LOCATION:** Northwestern Wisconsin

**PROJECT CHIEF:** Peter E. Hughes

**PERIOD OF PROJECT:** April 1975-September  
1986

**OBJECTIVE:** Flood elevations for various frequencies at selected sites within the St. Croix River National Scenic Riverway will be determined. The 100-year flood will be designated on a map. River-water quality will be monitored at selected sites to aid site development and identify possible future changes.



**APPROACH:** The flood plain will be delineated at specific sites using a slope-conveyance analysis. Estimates of floods of differing magnitude will be based on records from nearby gaging stations or on regional flood-frequency characteristics. The water-quality study will include semiannual general reconnaissance at all the selected sites and periodic monitoring for specific purposes at five sites. Various sediment, chemical, and biologic analyses will be made available.

**PROGRESS (April 1975 through April 1987):** Flood elevations and delineations for the 29 requested sites are now complete; progress reports were submitted to the National Park Service. A Water-Resources Investigations report titled "Water Quality in the St. Croix National Scenic Riverway" has been printed.

Special-purpose water-quality investigations were made at two sites on the Namekagon River and five sites on the lower St. Croix River. They were undertaken to monitor the possible effects of sewage effluent at the former site and pesticides at the latter site. Water and bottom-material samples on the Namekagon did not show any pesticide contamination above the detection limit.

Water-quality samples were collected during August 1985 at the Namekagon River near Hayward and near Trego, the St. Croix River near Danbury, the Kettle River near Cloverdale, Minn., and the Snake River near Pine City, Minn. Chemical analyses of the samples showed no significant difference from the data published in the above-mentioned water-quality report.

**PLANS (May 1987):** No further work is planned for this project.

# CHANNEL MORPHOLOGY AND SEDIMENTATION IN PHEASANT BRANCH NEAR MIDDLETON, WI 084

**COOPERATORS:** Wisconsin Geological and Natural History Survey  
City of Middleton  
City of Madison  
Dane County Regional Planning Commission  
U.S. Army Corps of Engineers

**LOCATION:** Near Madison, Wisconsin

**PROJECT CHIEF:** William R. Krug

**PERIOD OF PROJECT:** December 1976 to June 1982, January 1984 to December 1988

**OBJECTIVES:** The objectives of this project are to:

1. Document and evaluate sediment transport, streamflow characteristics, and stream-channel morphology.
2. Relate these hydrologic characteristics to land-use practices.
3. Evaluate the effect that future changes in land use will have on Pheasant Branch.
4. Estimate flood peaks for present and fully urbanized conditions at 18 subbasins in the watershed.
5. Monitor changes in channel morphology in areas affected by urbanization and channel modifications.
6. Measure peak flood discharges in tributary channels affected by urbanization.

**APPROACH:** Streamflow, stream-channel cross-section changes, and sediment load were monitored at five gaging stations through 1982. Channel geometry and sediment transport will be related to discharge to estimate how present and projected land use affect these processes. Since 1984, stream-channel cross-section changes have been monitored in the reach through the urbanized section of Middleton, and in the reach of the South Fork draining the developing area on Madison's west side. Three crest-stage gages will be maintained to monitor flood peaks in the same channels. A rainfall-runoff computer model was used to determine the effects that actual and projected land use have on flood flows. The model was used to estimate flood peaks at 18 subbasins in the watershed for present and fully developed conditions for the 2-, 5-, 10-, and 25-year recurrence interval.

**PROGRESS (December 1976 through December 1986):** From 1977 through 1982 stream-channel cross sections were resurveyed annually. In 1984, additional cross sections were added in an urbanizing reach farther upstream. All of the cross sections have been resurveyed annually. A preliminary analysis of the data collected in 1977 was presented in "Channel Erosion and Sediment Transport in Pheasant Branch Basin near Middleton, Wisconsin--A Preliminary Report" by R. S. Grant and Gerald Goddard.



Streamflow and sediment data were collected from 1977 through 1982 at five sites on Pheasant Branch. These data were used to calibrate and verify a rainfall-runoff model of the basin. This model was used to predict the increases in flood peaks that would result from urbanization of the basin.

In 1984 three crest-stage gages were installed on the South Fork to monitor flood peaks from the area subject to the most urban development. These gages have been monitored through 1986.

**(January 1987 through March 1987):** The cross sections that were not surveyed in the fall of 1986 were surveyed. This phase of the project was suspended due to lack of funds.

**PLANS: (April to December 1987):** The results of previous modeling will be used to estimate the 100-year flood discharge along the South Fork of Pheasant Branch. If necessary, the model will be rerun to complete this simulation. Overbank cross sections will be surveyed at the existing channel cross sections for use in the step-backwater model. The 100-year flood profile will be computed and the limits of the 100-year flood will be plotted on existing maps for that part of the stream in Madison.

**(January to December 1988):** If funding is restored, the cross sections will be resurveyed annually and peak flood discharges will be determined at the crest-stage gage sites. A final report summarizing the observed channel changes and the recorded flood peaks will be published at the end of the study.

# NONPOINT-SOURCE POLLUTION IN THE RIVER, COUNTY, WISCONSIN, WI 090

**COOPERATOR:** Green Lake Sanitary District

**LOCATION:** Green Lake County, south-central Wisconsin

**PROJECT CHIEF:** Stephen J. Field

**PERIOD OF PROJECT:** October 1977 to December 1987

**OBJECTIVE:** The objective of this project is to define the water quality in relation to streamflow in stream basins where nonpoint-source pollution exists.

**APPROACH:** Streamflow will be monitored continuously. Water-sediment samples will be collected by automatic samplers during storm runoff for determination of suspended-sediment and nutrient concentrations. Daily, monthly, and annual mean suspended-sediment and nutrient loads will be computed.

**PROGRESS (October 1977 to March 31, 1987):** During the initial phases of this project, several basins were studied in cooperation with the Wisconsin Department of Natural Resources. Streamflow, specific conductance, and water temperature were monitored continuously and precipitation and dissolved-oxygen data were collected intermittently.

Studies were completed for Steiner Branch, Onion River, Elk Creek, and Galena Rivers. The published reports are:

"Water Quality Assessment of Steiner Branch Basin, Lafayette County, Wisconsin"

"An Assessment of Nonpoint-Source Discharges, Streamflow, and Water Quality in Onion River, Wisconsin"

"Nonpoint-Source Discharges and Water Quality of the Elk Creek Basin, West-Central Wisconsin"

"Relations Between Precipitation, Streamflow, and Water Quality in the Galena River Basin, Wisconsin"

Since the 1982 water year streamflow has ranged from a minimum daily discharge of 0.52 cubic feet per second, October 4, 30, 31, 1983 to 781 cubic feet per second, September 10, 1986. Suspended-sediment yields have ranged from 316 tons per square mile in the 1983 water year to 983 tons per square mile in the 1983 water year. Phosphorus yields have ranged from 356 pounds per square mile in the 1984 water year to 710 pounds per square mile in the 1982 water year.

**PLANS (April 1 to June 30, 1987):** Data for the 1986 water year will be compiled for White Creek and published in 1986 "Water Resources Data for Wisconsin". Continue monitoring at White Creek as scheduled. Silver Creek is also being monitored.

**(July 1, 1986 to June 30, 1987):** Water-sediment samples from storm runoff for determining suspended-sediment and nutrient concentrations will be collected at White and Silver Creeks. Sediment and nutrient loads will be computed and transmitted to the cooperator. Suspended-sediment and phosphorus yields for the 1985 water year were 338 tons per square mile and 473 pounds per square mile, respectively. The 1986 water year loads are being computed.

# **GROUND-WATER-QUALITY APPRAISAL OF WISCONSIN'S AQUIFERS, WI 093**

**COOPERATOR:** Wisconsin Department of Natural Resources

**LOCATION:** Statewide

**PROJECT CHIEF:** Phil A. Kammerer

**PERIOD OF PROJECT:** June 1978 to September 1985

**OBJECTIVE:** The objectives of this project are to delineate and evaluate areas with known ground-water-quality problems and to define the quality of Wisconsin's ground water by aquifer and relate the quality to the hydrogeologic environment.

**APPROACH:** The objectives of the project will be met through two complementary and concurrent studies:

**STUDY 1 (conducted by DNR)--DNR will describe the water resources of the State, summarize water-quality problems, and recommend a ground-water management policy.**

**STUDY 2 (conducted by USGS)--USGS will provide a study of the quality of water from Wisconsin's principal aquifers and present it in three reports.**

**PROGRESS (June 1978 through June 1986):** Work in Study 2 was divided into two phases. During the first phase, profiles showing geology, direction of ground-water movement, and dissolved-solids concentrations in ground water were constructed along 15 cross sections traversing the State to show general hydrogeologic and water-quality relationships between aquifers. The report describing the results of this phase of the project is in review.

During the second phase of the study, ground-water quality and movement in shallow aquifers were investigated. The shallow aquifer, a composite of unconsolidated materials and shallow underlying bedrock, is the aquifer most commonly utilized for water supplies and is the aquifer most susceptible to contamination. A report describing ground-water quality and movement in the shallow aquifer was begun.

**(July 1986 through March 1987):** A draft of the report describing ground-water quality and movement in the shallow aquifer was completed; the report is in review.

**PLANS (April 1987 to June 1987):** Complete review of both remaining reports.

**(July 1987 to June 1988):** Request approval for publication and publish reports.

# WATER-RESOURCES APPRAISAL OF APOSTLE ISLANDS NATIONAL LAKESHORE, WI 100

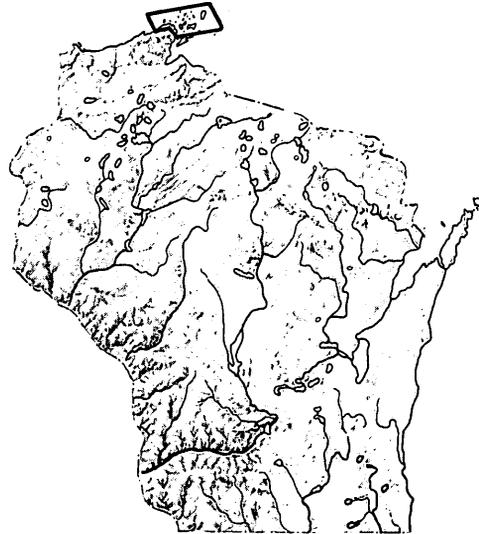
**COOPERATOR:** National Park Service, U.S.  
Department of the Interior

**LOCATION:** Ashland and Bayfield Counties,  
northwest Wisconsin

**PROJECT CHIEF:** William J. Rose

**PERIOD OF PROJECT:** March 1979 to  
September 1985

**OBJECTIVE:** The objectives of the project are to appraise the water resources of the Apostle Islands National Lakeshore and to provide information to assist the National Park Service in managing them.



**APPROACH:** Ground-water availability and quality will be evaluated by analyzing available data and new data will be obtained by testing and sampling new wells. Streamflow and water-quality characteristics will be determined by detailed monitoring at one site, intermittent monitoring at many sites, and correlation and regionalization techniques. Lake Superior circulation patterns will be evaluated by analyzing available data and Landsat imagery. The character of Lake Superior water quality, sediment, and benthos will be determined by evaluating data from a network of deep- and shallow-water sampling stations. A final report will be prepared at the end of the project.

**PROGRESS (March 1979 through September 1986):** Baseline data needed to characterize the flow and water quality of selected mainland and island streams were collected. Four "deep-water" monitoring sites in Lake Superior were established and sampled to characterize the water, sediment chemistry, and the benthic macroinvertebrates. Nine sites were established and sampled in each of two shallow-water, heavy-use areas of Lake Superior. Water, sediment, and benthic organism samples from these sites were sampled and analyzed. Two lagoons, one on Michigan Island and the other on Outer Island, were studied; measurements were made to determine their physical, hydrologic, and chemical characteristics. About a dozen water-supply wells were logged during their construction and subsequently sampled for chemical analysis. Data collected during the study have been summarized and interpreted. A draft copy of a final summary report was prepared and distributed for colleague review.

**(October 1986 through March 1987):** Colleague review comments were reconciled and the report was sent to the Northeastern Region of the U.S. Geological Survey to obtain approval for publication.

**PLANS (April 1987 through September 1987):** Publish the report.

# MAGNITUDE AND FREQUENCY OF GROUND-WATER-LEVEL FLUCTUATIONS, WI 107

**COOPERATOR:** Wisconsin Geological and Natural History Survey

**LOCATION:** Statewide

**PROJECT CHIEF:** Gary L. Patterson

**PERIOD OF PROJECT:** May 1980 to June 1983

**OBJECTIVE:** The objective of the study is to determine the frequency, duration, magnitude, and range of historical ground-water-level fluctuations. These fluctuations will be related to season and precipitation, as well as to other factors that affect levels in each individual well.

**APPROACH:** Water-level data from 104 observation wells with at least 20 years of record will be analyzed by using statistical methods to assign occurrence frequencies to high/low water levels. Precipitation data from approximately 100 stations will be used to prepare hydrographs, cumulative departure-from-normal plots, and 3-year running mean plots. These will be correlated with ground-water-level hydrographs.

Various statistical methods will be tested for applicability in correlating precipitation with water levels.

**PROGRESS (May 1980 through June 1986):** Precipitation and water-level data were analyzed by using cumulative departure from normal, 3-year running mean, precipitation and stage-duration analyses, and Pearson Type III frequency analyses.

Physical characteristics of each well were described and, together with numerical data from the statistical analyses, used in multiple-regression analyses to correlate wells of similar character.

A lay reader report, "Ground-Water Fluctuations in Wisconsin", describes the fluctuations in 11 wells. It was printed in February 1986.

A technical report, "Analysis of Water-Level Fluctuations in Wisconsin Wells", covers all of the 104 wells. It received Director's approval and is in preparation for printing.

**(July 1986 through March 1987):** The lay-reader report "Ground-Water Fluctuations in Wisconsin" has been published. The technical report "Analysis of Water-Level Fluctuations in Wisconsin Wells" received Director's approval.

**PLANS (April 1987 through June 1987):** The technical report will be submitted to the cooperator for printing. Publication of the technical report will complete the project.

# REGIONAL FLOOD-FREQUENCY STUDY FOR URBAN AND RURAL STREAMS IN WISCONSIN, WI 109

**COOPERATOR:** Wisconsin Department of Transportation - Highways

**LOCATION:** Statewide

**PROJECT CHIEF:** Duane H. Conger

**PERIOD OF PROJECT:** July 1985 to September 1990

**OBJECTIVE:** The objectives of this project are to:

1. Develop improved regression equations for the Driftless Area and the entire State.
2. Determine why flood characteristics are different for the Driftless Area.
3. Redefine area boundaries in Marathon County to provide better agreement between observed and estimated flood peaks.

**APPROACH:** Landsat imagery will be used during the first 2 years of the study to improve the regression equations for the Driftless Area. Land-use categories will be classified and stored on a computer tape and merged with digitized basin boundaries. Channel geometries will also be determined and included in the regression equations. Flood characteristics will be studied by the University of Wisconsin, Department of Civil Engineering.

Coon Creek will be studied during the third and fourth years to determine the difference in magnitude of floods with different land use.

The Marathon County area will be studied during the fourth and fifth years to improve boundary areas determined by regression analysis.

**PROGRESS (October 1985 through March 1986):** The report "Estimating Magnitude and Frequency of Floods for Wisconsin Urban Streams" was published.

Ken Potter and Ellen Baldwin, of the University of Wisconsin, studied the effect that generalized least squares has on regressions. They also studied the effect of time-area histograms on peaks in the Driftless Area. Unfortunately, neither study proved to be significant. The Environmental Remote Sensing Center (ERSC) of the University of Wisconsin is using Landsat satellite imagery to provide up-to-date land-cover information for the entire Wisconsin Driftless Area that will assist in refining the flood-frequency models for this region.

**(July 1986 through March 1987):** Drainage areas were digitized for 75 percent of the topographic maps in the Driftless Area. Landsat scenes were classified for 75 percent of the Driftless Area. Step-backwater computations and indirect measurements were used to redefine stage-discharge rating curves at four crest-stage gaging stations. Channel geometries were determined for all gaging stations in the Driftless Area.

Annual flood discharges were determined for the 97 crest-stage gage stations. Numerous flood-frequency requests were processed for the Department of Transportation and other agencies.

**PLANS (April 1987 through June 1987):** The remaining Landsat scenes will be classified according to land-use characteristics.

**(July 1987 through June 1988):** The remaining topographic maps will be digitized and joined together. A computer file will be created where land-use data at the drainage-area sites can be retrieved by latitude and longitude coordinates. Multiple-regression analysis will be performed when the land-use determination is completed.

**(July 1988 through September 1990):** Data will be collected at 97 crest-stage gages. Landsat imagery will be used to determine basin characteristics in the Driftless Area. Improved regression equations will be developed for the Driftless Area and the entire State.

Flood characteristics for streams in the Driftless Area will be studied to determine why they differ from those in streams elsewhere in Wisconsin. Areal factor boundaries will be examined in the Marathon County area to delineate if a better agreement between observed and estimated flood peaks can be obtained.

## EFFECTS OF ACID PRECIPITATION ON LAKES IN NORTHERN WISCONSIN, WI 110

## LONG-TERM EFFECTS OF ACID PRECIPITATION ON LAKES IN NORTHERN WISCONSIN, WI 129

**COOPERATORS:** Wisconsin Department of Natural Resources  
(WI 110)  
Wisconsin Geological and Natural History Survey (WI 110)  
WRD, U.S. Geological Survey (WI 129)

**LOCATION:** Lincoln and Vilas Counties, north-central  
Wisconsin

**PROJECT CHIEF:** Dennis A. Wentz

**PERIOD OF PROJECT:** August 1980-September 1990



**OBJECTIVE:** Determine hydrologic and chemical budgets for Vandercook Lake and Lake Clara in northern Wisconsin to provide information regarding mechanisms and long-term changes of acid loadings to these lakes.

**APPROACH:** Lake inflows from precipitation, overland flow, and ground-water discharge, and lake outflows from evaporation, streamflow, and ground-water recharge will be quantified. Concentrations of major cations and anions, nutrients, and trace elements in selected flow paths will be measured. The lakes will be evaluated for their potential for acidification.

**PROGRESS (August 1980 through March 1987):** Wisconsin DNR personnel made monthly water-level measurements in 35 piezometers and 5 surrounding lakes near Vandercook Lake, and in 37 piezometers and 3 surrounding lakes near Lake Clara. Daily precipitation and pan evaporation were measured by local observers at each site. USGS personnel obtained continuous measurements of lake stage, ground-water levels, and precipitation using recording instrumentation. Air temperature, relative humidity, wind speed, and lake-surface temperature were measured continuously during the open-water period at Lake Clara to allow estimation of evaporation using the mass-transfer technique. Similar data, collected at Vandercook Lake through October 1983 and at Little Rock Lake since April 1984, were used to estimate evaporation at Vandercook Lake. Snowpack on the ice at each site was determined monthly during periods of snow cover. At Lake Clara, intermittent overland flow was monitored using recording instrumentation at one site, and miscellaneous measurements at three additional sites; the intermittent outlet was monitored continuously using a stage recorder. Wisconsin DNR personnel sampled bulk precipitation, lake water, and ground water on a monthly basis at both sites for chemical analysis. At Lake Clara, samples of overland flow and the lake outlet were collected periodically. Approximately 10 percent of the samples were duplicates, collected for quality assurance.

Hydrologic budgets were determined for the 1981 through 1983 water years. Chemical budgets were determined for only the 1982 and 1983 water years, because chemical data were incomplete during the 1981 water year. A draft report describing the results of the study during the 1981 through 1983 water years was written and submitted to the Wisconsin DNR. The results were presented to the American Geophysical Union meeting in Baltimore, Maryland, during May 1986.

Data collection at Lake Clara was discontinued at the end of the 1986 water year.

**PLANS (April 1, 1987 through June 30, 1987):** Continue hydrologic and water-quality data collection at Vandercook Lake.

**(July 1, 1987 through September 30, 1990):** Hydrologic and water-quality data collection will continue at Vandercook Lake. Monthly hydrologic and chemical budgets will be prepared for the period beginning October 1983. A journal article describing results through the 1983 water year, and a report describing hydrologic and chemical budgets for the period 1980-90 will be written.

# GROUND-WATER RESOURCES AND GEOLOGY OF VILAS COUNTY, WISCONSIN, WI 112

**COOPERATORS:** Wisconsin Geological and Natural History Survey (WG&NHS) and Vilas County Board of Commissioners

**LOCATION:** North-central Wisconsin

**PROJECT CHIEF:** Gary L. Patterson

**PERIOD OF PROJECT:** January 1981 to December 1983

**OBJECTIVE:** The objective of the study is to describe the water resources of Vilas County, including ground-water quality, movement, availability, and use; ground-water/surface-water relationships; classification of lakes; and geology.

**APPROACH:** Well records will be reviewed to verify the accuracy of the information. Selected wells will be field located and water levels measured where possible. This information will then be entered into the GWSI (Ground-Water Site Inventory) data base. Sites where data are lacking will be selected, after data review, for the installation of monitoring wells. Water levels will be measured monthly from a network of wells and slug tests will be performed to determine values of hydraulic conductivity. All water-level data will be entered into GWSI and computer-generated contour maps of water levels will be produced.



Seepage runs will be performed on selected streams to determine the relationship between surface and ground water.

Water samples will be collected from about 60 wells and analyzed for common inorganic chemical constituents. Water from about 30 wells will be analyzed for minor constituents.

Lake data collected and tabulated by the Department of Natural Resources (DNR), and supplemented where necessary by USGS, will be used to classify lakes. If possible, lakes will also be classified by their susceptibility to pollution from acid precipitation.

Ground-water temperature will be measured at various times of the year to determine the feasibility of using ground-water heat pumps as an alternative source of energy.

The glacial geology of the county will be mapped by the Wisconsin Geological and Natural History Survey.

**PROGRESS (January 1981 through June 1986):** About 80 test holes were drilled and 70 of them were converted to test wells. Water levels were measured monthly in these 70 wells until December 1982. Water samples were obtained from 51 wells and analyzed for the common ions and nutrients. Thirty-one of the samples were analyzed for trace metals and dissolved organic carbon. Slug tests were done on 50 wells and four sets of temperature measurements were taken on 70 wells. Lake water-quality data were obtained from the DNR and will be used to assign relative susceptibility to harm from acid deposition. Surface-water altitudes and locations were digitized at about 12,000 points and merged with ground-water data from about 500 wells to produce a water-table contour map. Ten short seismic lines were run to supplement existing data on depth to Precambrian bedrock. Glacial geology was mapped by the WG&NHS. A seepage run was made and streamflow was measured at 40 sites on three streams. Records on 613 wells and borings were entered into computer storage (GWSI). About 150 of these were field located by county personnel. The data were analyzed and the final report partially written.

**(July 1986 through March 1987):** The final report was completed and has undergone in-house and review

**PLANS (April 1, 1987 through June 1987):** The report will be revised according to suggestions by the colleague reviewers and it will be submitted to the Regional reports specialist for approval.

**(July 1987 through June 1988):** The final report will be prepared for printing by WG&NHS.

# **A GUIDE TO WISCONSIN'S GROUND-WATER RESOURCES, WI 113**

**COOPERATOR:** Information Transfer Program, WRD, U.S. Geological Survey

**LOCATION:** Statewide

**PROJECT CHIEF:** Greg J. Allord

**PERIOD OF PROJECT:** March 1981 to September 1983

**OBJECTIVE:** The objective of this project is to prepare a report on ground-water in Wisconsin. This report will include data needed for planning purposes.

**APPROACH:** A report will be prepared from existing information and data gathered for numerous State and Federal studies. The report will describe the general aspects of ground-water hydrology as well as Wisconsin's aquifers, water quality, and water use. It will also list additional sources of information and give examples of how the report information can be used to approach ground-water problems. All information will be written in a style that will be understandable by the general public. All material is being prepared in the Sequential Thematic Organization of Publications (STOP) format, which places the text for each topic on a single page and a supporting map or graph on a facing page.

**PROGRESS (April 1, 1986 to March 31, 1987):** An editorial staff of three completed the review of the sections and rewrote many sections of the report.

**PLANS (April 1 to September 30, 1987):** The report will be completed and submitted for final review.

**(October 1, 1987 to June 30, 1988):** The report will be reviewed, approved for publication, and printed as a U.S. Geological Survey Water-Supply Paper.

# EFFECTS OF ACID PRECIPITATION ON LAKES IN NORTHWESTERN WISCONSIN, WI 116

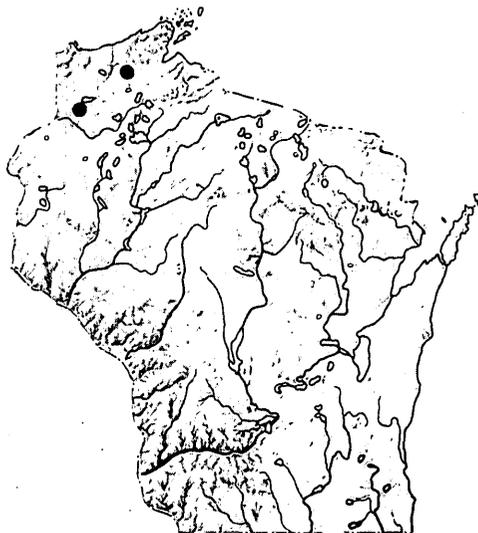
**COOPERATORS:** Wisconsin Department of Natural Resources  
Wisconsin Geological and Natural History Survey

**LOCATION:** Douglas and Bayfield Counties, northwest Wisconsin

**PROJECT CHIEF:** Dennis A. Wentz

**PERIOD OF PROJECT:** July 1981-December 1987

**OBJECTIVE:** Determine hydrologic and chemical budgets for Round and East Eightmile Lakes in northwestern Wisconsin to provide information regarding mechanisms of acid loadings to these lakes and to assist modification and calibration of the Integrated Lake Watershed Acidification Study (ILWAS) ecosystem model to this area.



**APPROACH:** Lake inflows from precipitation and ground-water discharge, and lake outflows from evaporation and ground-water recharge will be quantified. Alkalinity, pH concentrations of major cations and anions, nutrients, and trace elements (including aluminum, lead, and mercury) in selected flowpaths will be measured. The lakes will be evaluated for their potential for acidification.

**PROGRESS (July 1981 through March 1987):** During the first phase of the study (ending August 1983), monthly water-level measurements were made in 39 piezometers and seven surrounding lakes near Round Lake and in 46 piezometers and four surrounding lakes near East Eightmile Lake. Daily precipitation and pan evaporation were measured by local observers at each site. Continuous measurements of lake stage, ground-water levels, and precipitation were obtained using recording instrumentation. Air temperature, relative humidity, wind speed, and lake-surface temperature were measured continuously during the open-water period at each primary study lake to allow estimation of evaporation using the mass-transfer technique. Snowpack at each site was determined monthly during periods of snow cover. Ground water was sampled on a monthly basis at both sites for chemical analysis. Hydrologic budgets for the first 2 years of the study (September 1981 through August 1983) were constructed for both primary study lakes. Draft reports covering (1) hydrologic budgets for the two lakes and (2) chemical input-output budgets for the two lakes have been prepared and submitted to the DNR.

The period from September 1983 through August 1984 was a period of reduced funding between the first and second phases of the study. During this interim period, the data-collection effort was reduced in both frequency and in total number of measurements during a given month.

During the second phase of the study (beginning September 1984), 43 additional piezometers were installed upgradient from Round Lake and 30 additional piezometers were installed upgradient from East Eightmile Lake. Thirteen piezometers were installed downgradient from Round Lake and five piezometers installed downgradient from East Eightmile Lakes. Monthly water-quality samples were collected from many of the upgradient piezometers in an attempt to determine how ground-water quality changes along a flowpath from the recharge area to the lake. Aquifer samples were collected from the augered holes for mineralogic analysis. The USGS three-dimensional ground-water model has been applied to cross sections at both sites to help refine ground-water flow to and from the lakes. Instrumentation for measuring short-wave and long-wave radiation was installed to allow calculation of evaporation by the energy-budget procedure. Data collection was discontinued at the end of the 1986 water year.

**PLANS (April 1 to June 30, 1987):** The USGS chemical-equilibrium models WATEQF and BALANCE will be applied to assist in determining chemical reactions occurring in the ground-water basins upgradient from the lakes. Hydrologic and chemical budgets will be determined for the period September 1983 through August 1986.

**(July 1, 1987 to December 30, 1987):** Data analysis will continue and the final report will be written.

## WATER RESOURCES OF WISCONSIN INDIAN RESERVATIONS, WI 123

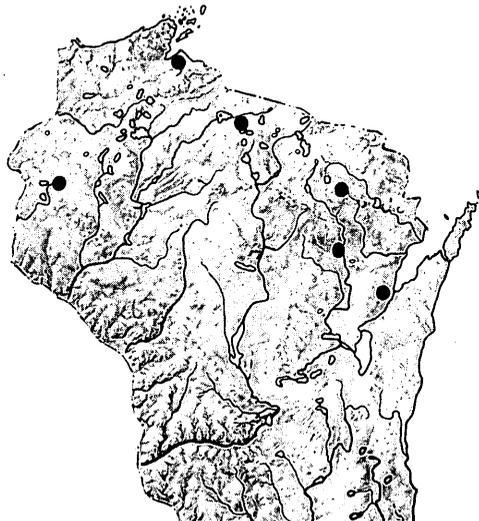
**COOPERATORS:** Bad River Tribal Council, Forest County Potawatomi Community, Lac du Flambeau Band of Lake Superior Chippewa Indians, Menominee Indian Tribe of Wisconsin, Oneida Tribe of Indians of Wisconsin, St. Croix Tribal Council, and Stockbridge-Munsee Tribal Council

**LOCATION:** Northern Wisconsin

**PROJECT CHIEF:** Robert A. Lidwin

**PERIOD OF PROJECT:** August 1977-Continuing

**OBJECTIVE:** The purpose of these studies is to describe the hydrology and ground- and surface-water quality of Wisconsin Indian reservations. The resultant reports will be used by the individual tribes as planning tools and guides to possible resource development. Particular problems or concerns on individual reservations will be considered and the study approaches modified as needed.



**APPROACH:** These studies will evaluate the water resources of Indian lands with special emphasis on specific problem areas. The problem areas will be defined in consultation with individual tribes. In general, the approach will be as follows:

Wells will be inventoried. Ground-water levels will be measured and water-level recorders installed. Additional piezometers will be installed where necessary for good areal coverage. Water samples will be collected from wells and analyzed for selected constituents. Aquifer tests will be conducted to determine the physical characteristics of the major aquifer. Bedrock topography will be defined using seismic surveys in areas lacking adequate drill-hole data.

Discharge measurements will be made on selected streams; in some cases, gaging stations will be established. Low-flow gain-and-loss studies will be performed to help define ground-water/surface-water relationships.

In some areas, wild rice surveys will be made; in other areas stream biota will be examined to document present stream "health".

Stream, lake, and precipitation samples will be collected for analysis of selected chemical constituents.

Maps showing bedrock topography, water table, saturated thickness, and discernible areal patterns of ground-water chemical constituents will be prepared.

Reports describing the water resources and addressing water-resources problems on specific reservations will be prepared for each reservation. These reports will be either in Water-Resources Investigations report format or in map report format, as appropriate.

**PROGRESS (August 1977 through September 1986):** The Mole Lake Indian Reservation was studied initially. An assessment of the existing hydrologic and water-quality conditions was made. Potential impacts of future nearby mining activity were also assessed. A report was written and provided to the tribe. A study of the water resources of the Lac Courte Oreilles Indian Reservation was undertaken for 1 year, but terminated by request of the tribal council. Data collection for similar studies on the Forest County Potawatomi Indian Reservation, the Lac du Flambeau Indian Reservation, and the Menominee Indian Reservation was completed in 1985. The first draft of the final report for the Forest County Potawatomi Indian Reservation was completed and is in review. The final reports for the other two reservations have been begun.

Appraisals of the existing conditions of the water resources of the Bad River Indian Reservation, the St. Croix Indian Reservation, and the Stockbridge-Munsee Indian Reservation are presently being undertaken. Water samples from some of these wells, as well as from piezometers installed earlier, were analyzed for a number of constituents. Lakes have been sampled on the St. Croix and Potawatomi Reservations. Stream sampling has been done on the Menominee, Bad River and Forest County Potawatomi Reservations. Gaging stations were maintained on the Wolf River. Some followup seismic work was performed on the Bad River Reservation.

Monitoring of a paper mill sludge pond complex adjacent to tribal land of the Oneida Indian Reservation is also being performed. Observation wells were installed, developed, and sampled. An electromagnetic survey was completed in the same area to locate a

contaminant plume in the ground water. A continuous recorder was installed on one of the monitoring wells.

**(October 1986 through March 1987):** A seismic survey of the Stockbridge-Munsee Reservation was completed. Domestic wells were sampled and work was begun to study an area where nitrate concentrations in the ground water are extremely high. Water levels in an observation well network continued to be monitored.

Quarterly sampling of monitoring wells on the Oneida Reservation continued as well as weekly monitoring of ground-water levels at the paper mill sludge pond site.

Surface-water and ground-water samples were collected on the Menominee Reservation. Progress was made on the final report for that study.

Progress was made on the final report for the Lac du Flambeau Reservation study.

Additional domestic wells on the Bad River Reservation were sampled.

**PLANS (April 1, 1987 to September 30, 1987):** Additional existing wells will be inventoried and measured on all reservations in the data-collection phases of the studies. Additional lakes and streams will be sampled. Wells will be sampled or resampled and the water analyzed for selected constituents as needed.

Additional observation wells will be installed, developed, and sampled on the Oneida and Bad River Reservations. Geophysical techniques will be used to collect information to aid in preparing water-table and bedrock-surface maps.

A streamflow gaging station on the Wolf River will be maintained. Lake levels will continue to be monitored on selected lakes.

The reports for the Menominee and Lac du Flambeau Reservation will be completed.

A small area on the Stockbridge-Munsee Reservation has a problem with high nitrates in ground water. This area will be studied intensively to determine the extent and source of the problem.

**(October 1987 to September 1988):** Work will begin on a general water-resources appraisal of the Oneida and Red Cliff Reservations. Work on the Bad River, Stockbridge-Munsee, and St. Croix Reservations will continue. Monitoring wells around landfills on the Menominee Reservation will be installed, developed, and sampled.

## REGIONAL REAERATION COEFFICIENTS, WI 126

**COOPERATOR:** Wisconsin Department of Natural Resources

**LOCATION:** Selected streams in Wisconsin

**PROJECT CHIEF:** David J. Graczyk

**PERIOD OF PROJECT:** July 1981-continuing

**OBJECTIVE:** The objective of this project is to determine the reaeration coefficients of small Wisconsin streams to aid in the design and operation of sewage-treatment plants.

**APPROACH:** The reaeration coefficients will be determined for 10 to 20 streams during the project by the steady-state propane-tracer technique. The coefficients will be regionalized for a statewide data base.

**PROGRESS (July 1981 through June 30, 1986):** Reaeration coefficients were determined for nine streams by using the steady-state propane-tracer method. Coefficients were reported to the DNR by letter. Reaeration coefficients have been determined at 12 additional sites by other methods. These coefficients will be utilized in the regionalization process.

**(July 1, 1986 through March 1987):** Reaeration coefficients were determined at 1 stream by using the steady-state propane-tracer method. Coefficient was reported to the DNR by letter.

Regression analysis was done using hydraulic characteristics from the stream studied. These characteristics were depth, width, slope, and velocity.

The best equation was  $K = 2.46 \times \text{slope}^{0.265} \times \text{velocity}^{0.285}$  with a standard error of the estimate of 30 percent. The regression equation will be refined after data collection is complete.

**PLANS (April 1987 to June 1987):** A meeting will be held with DNR personnel to select the sites to be studied during the summer of 1987.

**(July 1987 to June 1988):** Reaeration coefficients will be determined at two to four streams during low-flow conditions in the summer of 1987. The coefficients determined will be reported to DNR by letter.

# GEOGRAPHIC INFORMATION SYSTEMS AND NATIONAL WATER SUMMARY, WI 131

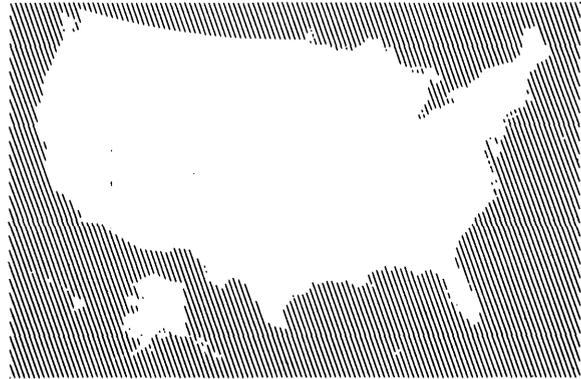
**COOPERATOR:** Office of National Water Summary and Long-Range Planning

**LOCATION:** Nationwide plus Puerto Rico, Virgin Islands, and Pacific Trust Territories

**PROJECT CHIEF:** Greg J. Allord

**PERIOD OF PROJECT:** January 1983-continuing

**OBJECTIVE:** The objective of this project is to assist in the cartographic preparation of the annual publication "National Water Summary". This publication is released as a U.S. Geological Survey Water-Supply Paper and includes a topical discussion for each state in addition to thematic articles in the first half of the paper that relate to significant hydrologic events that occurred within the year.



**APPROACH:** The Wisconsin District, one of the two Water Resources Division Federal Series Reports Units, assists Division in preparing publications for printing. This project is funded with a two-fold purpose: to explore Geographic Information Systems capability and application to WRD mapping activities, and to assist in preparing maps and graphs for final publication. The Wisconsin District cartography section is responsible for using ARC/INFO software to build new and modify existing cartographic data bases for preparing maps that can be printed by conventional printing methods while maintaining quality standards.

**PROGRESS (January 1983 to March 31, 1986):** This project was originally created to assist the National Center to prepare a proof-of-concept test of a Geographic Information System (GIS). The study area chosen was the Fox-Wolf River basin and a report was prepared by the EROS Data Center staff. Since that time, Wisconsin District cartographers have assisted in selecting a GIS and testing cartographic production capability for several special projects.

The ARC/INFO system was installed on the Wisconsin District Prime 750 during November 1985. Since that time, work has concentrated on manipulating the 1:2,000,000 Digital Line Graph data base released by National Mapping Division. This data base covers all 50 states and is representative of maps printed in the "Atlas of the United States". Data files for all states have been checked and stored for all states and are: streams, water bodies, counties, state outlines, and hydrologic unit boundaries. This project has also served as the nucleus of interest in ARC/INFO within the District and is serving as a base on which to build applications of a Geographic Information System to hydrologic studies.

**PLANS (April 1, 1987-continuing):** During the next year, complete data bases will be created and published in two National Water Summary Water-Supply Papers. The 1986 edition concentrates on ground-water quality and the 1987 edition deals with water-use issues. Data bases for both subjects will be created, manipulated, and used to create maps for multicolor publications. In addition, approximately 500 pages of text will be prepared using the District phototypesetting equipment for each report.

Emphasis during the next year will be on continuing to differentiate the needs in data bases for cartographic analysis and cartographic presentation. While preparing maps for publication using digital data bases, Wisconsin District personnel have determined shortcomings in data that are acceptable for analysis but not complete for publication. Additional work will be done to determine types of hardware necessary to produce high-resolution maps.

# HYDROLOGY OF THE CRANDON AREA, WI 132 Ground-Water Flow Model for the Area of a Proposed Mine near Crandon

**COOPERATOR:** Wisconsin Department of Natural Resources

**LOCATION:** An area of 22 square miles south of Crandon, Wis.

**PROJECT CHIEF:** James T. Krohelski

**PERIOD OF PROJECT:** April 1983 to February 1987

**OBJECTIVE:** The objective of the study is to better understand the hydrology of the area and the possible impact of mining on the hydrology of the area.

**APPROACH:** Phases of the study will include:

1. Review of parameters such as hydraulic conductivity and stratigraphy provided to the DNR by Exxon Coal and Minerals Company.
2. Request further data collection from Exxon Coal and Minerals Company if needed.
3. Develop a ground-water flow model and determine if additional data are required.
4. Refine the model and run sensitivity analysis on parameters and boundary conditions.
5. Develop a contaminant-transport model using results of flow modeling as input.
6. Conduct special applications of the models.
7. Complete a report describing general hydrology, results of sensitivity analysis, basis of parameter estimation, contaminant movement, and documentation of the models.

**PROGRESS (April 1983 through June 1986):** The Environmental Impact Statement was reviewed and additional information in hydrologic parameters was requested to better define areal hydrology. Cross-sectional flow and contaminant-transport models were developed. The cross-sectional flow model simulates steady-state premining flow through Rice Lake, Hemlock and Swamp Creeks, and the ore body and mine-waste disposal facility. The contaminant-transport model simulates contaminant movement along a portion of the same cross section used for the flow model. The contaminant-transport model simulates varying seepage rates of a conservative contaminant emanating from the mine-waste disposal facility and moving towards Swamp Creek.

A draft report was written and reviewed by DNR and Exxon Coal and Minerals Company. The report describes the hydrology along the cross section, sensitivity analyses, and the effect of varying seepage from the mine-waste disposal facility, and dispersivity ratios.

**(July 1986 through March 1987):** An areal two-dimensional ground-water flow model was developed to define the range of potential impacts of mine dewatering on local surface-water resources.

Exxon Coal and Minerals Company withdrew their application to mine the Crandon orebody in January.

A report describing work done on the areal model was drafted and submitted for review.

**PLANS:** The reports "Simulation of Ground-Water Flow and Contaminant Transport at a Proposed Copper-Zinc Site, Crandon, Wisconsin" by James T. Krohelski and "Simulation of the Effects of Orebody Dewatering of Ground-Water Flow at a Proposed Mine Site, Crandon, Wisconsin" by James T. Krohelski and Kenneth S. Wade, will be published as open-file reports when they receive the approval from the Regional Reports Specialist.



# LAKE WATER-QUALITY MONITORING, WI 133 Statewide Lake-Stage and Secchi-Disc Monitoring

**COOPERATOR:** Wisconsin Department of Natural Resources

**LOCATION:** Statewide

**PROJECT CHIEF:** Stephen J. Field

**PERIOD OF PROJECT:** October 1984 to June 30, 1988

**OBJECTIVE:** The objectives are to determine lake stage and water transparency at selected lakes throughout Wisconsin and, through a continuous monitoring program, provide the data that will document lake-stage fluctuations and detect water-quality changes that may take place.



**APPROACH:** Staff gages will be installed at each selected lake to monitor stage fluctuations. Reference marks will be established and levels run at each lake. Stage readings will be made weekly during the open-water period, and monthly during the winter by Lake District personnel. Stage data will be entered into the USGS computer data-base storage file. They will be retained as part of the permanent data record of the water resources of Wisconsin.

Secchi-disk readings will be made by Lake District personnel weekly during ice-free periods in the deepest part of the lake. Secchi-disc readings will be entered into the USGS computer data-base storage file.

**PROGRESS (October 1984 to March 31, 1987):** Lake-stage and/or Secchi-disc data were compiled on 24 lakes. Data have been formatted for inclusion into the 1985 water year "Water Resources Data for Wisconsin" publication.

**PLANS (April 1 to June 30, 1987):** Data collection and compilation will be continued.

**(July 1, 1987 to June 30, 1988):** Data will be collected, compiled, and entered into computer storage. Data will be published.

# LAKE-WATER QUALITY MONITORING WI 133 Chemical and Biological Monitoring of Selected Lakes

**COOPERATORS:** Morris, Wolf, Wind, Okauchee, Powers, and Park Lake Districts; Village of Oconomowoc Lake (Oconomowoc Lake); Town of Sand Lake (Big Sissabagama Lake)



**LOCATION:** Selected lakes in Wisconsin

**PROJECT CHIEF:** Stephen J. Field

**PERIOD OF PROJECT:** June 1983-continuing

**OBJECTIVE:** The objective of this project is to determine lake stage and water quality at selected lakes throughout Wisconsin and, through a continuous monitoring program, provide data to detect chemical or biological changes that may take place.

**APPROACH:** Water quality at each lake will be monitored in February, April, June, July, and August. Depth profiles of dissolved-oxygen concentration, temperature, pH, and specific conductance will be determined. In April, the lakes will be sampled at the top and bottom for analysis of the major anions and cations, nitrogen, and dissolved phosphorus. Secchi-disk readings will be made for all months (except February), and total phosphorus and chlorophyll a samples will be collected and analyzed. Weekly stage readings of the lake level will be obtained by a local observer.

**PROGRESS (June 1983 through March 31, 1986):** Total phosphorus, chlorophyll a, dissolved oxygen, and Secchi depth data were collected and analyzed at Morris, Wolf, Wind, Okauchee, Powers, Park, Oconomowoc, and Big Sissabagama Lakes. These data are summarized in the following table: In 1987 water year, a letter evaluating the water quality of each lake was sent to the respective Lake District.

**PLANS (April 1 to June 30, 1987):** Lake-water quality at the 10 lakes in the program will be monitored. Wolf Lake and Powers Lake were discontinued and Big Hills Lake, Fowler Lake, and Lake Noquebay were added.

**(July 1, 1987 to June 30, 1988):** Monitoring will be continued as scheduled for the 10 lakes in the program and for additional lakes as they join the program. We will compile data and submit it to the cooperator after August monitoring. We will prepare data for publication in the annual resources data publication for the 1986 water year.

# HYDROLOGIC CONSIDERATIONS ASSOCIATED WITH THE ARTIFICIAL ACIDIFICATION

## OF LITTLE ROCK LAKE IN VILAS COUNTY, WI 134

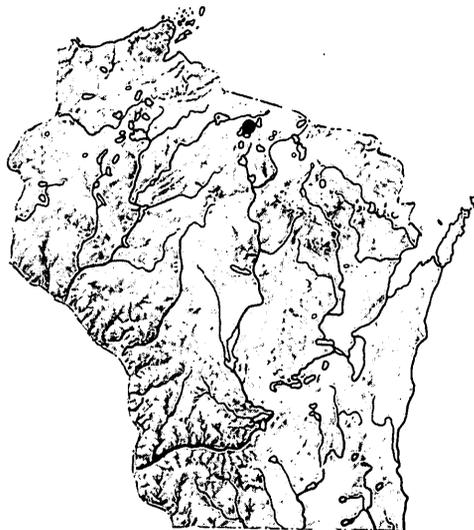
**COOPERATOR:** Wisconsin Department of Natural Resources

**LOCATION:** Vilas County, north-central Wisconsin

**PROJECT CHIEF:** William J. Rose

**PERIOD OF PROJECT:** August 1983 to September 1990

**OBJECTIVE:** The goal of this project is to determine monthly water budgets for each basin (the control and acidified basins) of Little Rock Lake, define ground-water flow paths, and monitor ground-water quality.



**APPROACH:** Inflow to the lake from precipitation, overland flow, and ground-water discharge, and outflow from the lake from evaporation and ground-water recharge will be determined. Ground-water gradients determined from a piezometer network will be evaluated to define flow paths of ground water discharging to and recharging from the lake. Ground water discharging to and recharging from the lake will be sampled from piezometers situated in the appropriate flow paths. Concentrations of major chemical constituents, including hydrogen ion and alkalinity, nutrients, and trace elements, including aluminum and lead, will be determined. Monthly water budgets will be calculated.

**PROGRESS (August 1983 to June 1986):** Instrumentation for hydrologic data monitoring was installed within equipment. Data that are used for calculating lake evaporation (which include class A pan evaporation, wind speed, air and lake-surface temperature, and relative humidity) were measured during nonfreezing periods. Slug tests were done on 50 piezometers to obtain estimates of aquifer hydraulic conductivity. Ground water was sampled monthly at selected piezometers for chemical analysis. Water-table contour maps were plotted and ground-water flow paths defined. Routine monitoring of hydrologic variables needed for water budget determination continued during the period since April 1, 1985, with little change in number of monitoring sites or frequency of measurements.

A marine reflection survey was done in June 1985. The primary purpose of the survey was to determine the presence and thickness of organic sediment. A preliminary sediment thickness map from these data has been constructed. The sediment thickness information is needed for ground-water flow modeling.

Preliminary monthly water budgets for the 1984 and 1985 water years were compiled. In these budgets, net ground-water flow to and from the lake was calculated as the residual of the other budget terms.

**(July 1986 through March 1987):** Routine hydrologic and ground-water quality monitoring continued. An additional recording piezometer was installed near shore up-gradient from the lake. About 20 small diameter (mini) piezometers were installed in the lake.

Monthly water budgets for the lake, the acidified basin, and the control basin were calculated for the 1984-86 water years. Each budget component was determined independently and budget error was determined as the residual.

**PLANS (April 1 through June 1987):** Routine hydrologic and ground-water-quality monitoring will continue. Soil profiles at several sites on hill slopes adjacent to the lake will be evaluated to assess whether interflow is a significant inflow component to the lake.

**PLANS (July 1, 1987 to September 30, 1990):** Routine hydrologic and ground-water-quality monitoring will continue. Monthly water budgets will be computed and previously computed budgets will be refined and revised on the basis of new data as it becomes available. A report will be prepared summarizing the hydrology of Little Rock Lake.

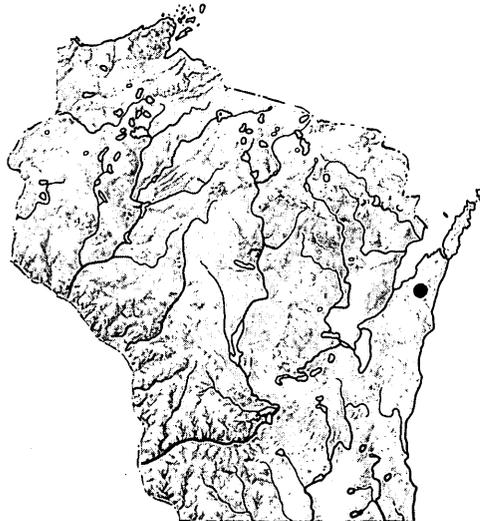
# EVALUATION OF SEDIMENT YIELD HYDROLOGIC MODELING USING GEOGRAPHIC INFORMATION SYSTEMS, WI 135

**COOPERATOR:** Wisconsin Department of Natural Resources

**LOCATION:** Southwestern and northeastern Wisconsin

**PROJECT CHIEF:** Peter E. Hughes

**PERIOD OF PROJECT:** April 1983-continuing



**OBJECTIVE:** The original objective of this project was to coordinate an analysis of the capability of the EPA ANSWERS model by the EROS Data Center and the Wisconsin Department of Natural Resources. The ANSWERS model uses land cover, topographic, and hydrologic data to predict nonpoint source sediment and water quality stream loads for rural basins. These agencies planned to use different techniques of data input to calibrate the model on hydrologic and water-quality data available for two basins in the Galena River watershed. The project objectives were broadened in 1985 to provide discharge and precipitation monitoring and automatic storm-event sampling at one selected site. Monitoring would be continuous for 6 months to 1 year at a given site. (A second phase added to the project is data collection from small basins in Wisconsin to provide calibration data for basins different from the Galena area. A third phase added to the project concerned estimating  $Q_{7,2}$  values at approximately 40 sites in 4 nonpoint-source priority watersheds.)

**APPROACH:** This will be a cooperative study with the Wisconsin Department of Natural Resources (DNR) and the Applications Branch of the EROS Data Center. DNR and EROS will compile and test the ANSWERS model on their respective computers. DNR will calibrate the ANSWERS model on two basins in the Galena River watershed by using manually compiled data. EROS will calibrate the model on the same basins by using the Geographic Information Systems (GIS) approach to input data to the model. The U.S. Geological Survey will provide the hydrologic and water-quality data from monitored runoff events and will evaluate the results of the modeling by both the DNR and EROS. Data from additional sites will be collected to assist in model development.

The  $Q_{7,2}$  estimates will be determined by making a base-flow discharge measurement at the site of interest and determining the  $Q_{7,2}$  by using low-flow regression equations for the basin. The  $Q_{7,2}$  values will be determined by drainage area-discharge relationships, cfsm analyses, and regression equation if base-flow discharge measurements cannot be made in a basin.

**PROGRESS (April 1983 through March 1987):** A monitoring station was established and maintained on a 3.14 square mile basin in the Kewaunee River watershed in northeastern Wisconsin. The station was operated from April through September 1984 and equipped to obtain discharge, rainfall, temperature, dissolved oxygen, and automatic storm-runoff sampler. All data was recorded on a solid-state data logger that was connected to the U.S. Geological Survey host computer in Madison. Data were supplied to the DNR on magnetic tape, paper printouts, and plots. Two remote rain gages were also installed. These data will be used to calibrate the ANSWERS model.

The ANSWERS model has been compiled on the DNR and EROS computers. Compilation of input data is complete and calibration runs were attempted by DNR. Calibration of the model by EROS was never completed. Calibration of the ANSWERS model has been discontinued due to unsatisfactory results and the Wisconsin Department of Natural Resources is attempting to develop a nonpoint-source model that can be used in Wisconsin.

A gaging station was established and maintained for a 125-acre basin in the upper Milwaukee River watershed. The station was started in June 1985 and operation is continuing. Discharge rainfall and storm-sampling data have been provided to the Wisconsin Department of Natural Resources.

$Q_{7,2}$  estimates for about 45 nonpoint sites in 4 basins were transmitted to Wisconsin Department of Natural Resources on December 5, 1986.

**PLANS (April 1987-continuing):** Base-flow discharge measurements will be obtained at approximately 40 sites for 4 nonpoint-source priority watersheds and  $Q_{7,2}$  estimates will be determined for these sites.

# ASSESSMENT OF THE HYDROLOGY, WATER QUALITY, AND BIOLOGY OF DELAVAN LAKE, WI 136

**COOPERATOR:** Delavan Lake Sanitary District

**LOCATION:** Walworth County, southeast Wisconsin

**PROJECT CHIEF:** Stephen J. Field

**PERIOD OF PROJECT:** August 1983 to September 1987

**OBJECTIVE:** The objectives of the project are to determine:

1. Nutrient discharge into the lake from surface water, ground water, and precipitation. Suspended-sediment discharge into the lake will also be determined.
2. Internal recycling of nutrients.
3. Chemical characteristics of the water, bottom sediments of the lake, and other physical characteristics.
4. The phytoplankton, zooplankton, macroinvertebrates, and rooted aquatic macrophytes present.
5. Nutrient discharges from the lake to surface and ground water. Suspended-sediment discharge from the lake will also be determined.



**APPROACH:** Streamflow into and out of Delavan Lake will be monitored, and stream sediment samples will be collected. Lake and stream samples will be collected and analyzed for nutrients and diagnostic biota. Ground-water levels will be monitored and water samples collected and analyzed. Wells will be installed if existing domestic wells are unavailable or inadequate. Precipitation will be monitored; lake bottom sediments will be studied. Water, nutrient, and sediment budgets will be prepared. An interpretive report will be written.

**PROGRESS (August 1983 to March 31, 1986):** Streamflow was monitored continuously at three inflow sites and at one outflow site from Delavan Lake. Water-sediment samples were collected weekly by Delavan Lake Sanitary District personnel. During storm runoff samples were collected by an automatic sampler. Water samples were analyzed for total phosphorus, total nitrite plus nitrate nitrogen, and total organic plus ammonia nitrogen. Miscellaneous discharge measurements were made and water-quality samples were collected at three miscellaneous inflow sites to characterize the loading from the drainage basin. The water levels in 12 piezometers installed for this project at the lake's edge, and in 50 existing wells, were measured quarterly. Six of the piezometers at the lake's edge were sampled quarterly for dissolved nitrite plus nitrate, dissolved phosphorus, and dissolved ammonia plus organic nitrogen. Seasonal ground-water inflow was determined by flow-net analysis.

Recording rain gages, installed in the central part of the drainage basin, that monitor inflow to the lake were operated during ice-free periods. The U.S. Weather Service station 5 miles southeast of Delavan Lake was used to supplement the records and provide the precipitation water-quality data. Three sites within the lake were

monitored to determine the physio-chemical characteristics of the water. The bottom sediments at the deepest part in the lake were analyzed for chemical content. A 2-mile long inlet to the lake was probed to determine the depth of soft sediment, and the sediments were analyzed for chemical content. Phytoplankton, zooplankton, macro- invertebrates, and rooted aquatic macrophytes were identified through a sampling program. A water, nutrient, and sediment budget for the lake was prepared by using streamflow, ground-water, precipitation, and in-lake data. This information was compiled by using a mass-balance approach.

In October 1985 the monitoring was reduced significantly. Streamflow will be monitored continuously at two inflow sites, Jackson Creek tributary and Delavan Lake inlet, and at Delavan Lake outlet. Water samples will be collected during storm runoff with an automatic sampler at Jackson Creek tributary and manual EWI samples obtained by the Delavan Lake Sanitary District personnel at the inlet and outlet. Only total phosphorus will be analyzed. Total phosphorus loads will be computed at these three sites. Three sites within the lake will be monitored to determine depth profiles of dissolved oxygen, water temperature, pH, and specific conductance. Only total phosphorus and dissolved orthophosphate phosphorus will be analyzed in the water column. Phytoplankton and zooplankton will be identified in June, July, and August. A water and phosphorus budget for the lake will be prepared by using streamflow, precipitation, in-lake data, and estimates of the remaining components for these budgets based on the data collected in the 1984 and 1985 water years. This will then be compiled using a mass-balance approach.

**(April 1986 through March 1987):** Report on "Water Quality and Hydrology of Delavan Lake" is in review for publication. The report discusses the results of the data collected in the 1984 and 1985 water years.

**PLANS (April 1 to June 30, 1987):** Continue monitoring as rescheduled.

**(July 1, 1987 to June 30, 1988):** Continue monitoring as rescheduled. Complete report on 1984 and 1985 water year data.

## LAKE ASSESSMENT--FOWLER LAKE, WI 138

**COOPERATOR:** Fowler Lake Management District

**LOCATION:** City of Oconomowoc, Waukesha County, southeast Wisconsin

**PROJECT CHIEF:** Peter E. Hughes

**PERIOD OF PROJECT:** January 1984 to March 1985

**OBJECTIVE:** The objectives of this project are to identify the sources of nutrient enrichment to Fowler Lake; compare the nutrient and suspended-sediment discharge to the Oconomowoc River and contributing urban area, and from the lake; monitor chemical and physical characteristics of the lake water; and estimate internal recycling of nutrients.

**APPROACH:** Stream Monitoring:

Streamflow and water quality will be monitored from February through November 1984 on the Oconomowoc River upstream of Fowler Lake. Discharge and nutrient inflow from the directly connected urban area of the city of Oconomowoc for the same period will be estimated using the Wisconsin Urban Runoff Model (WURM).

Lake Monitoring:

Inlake water quality will be sampled once monthly from January to March and every 2 weeks during the open-water period. Dissolved oxygen, temperature conductivity, and pH will be measured at 3-foot depth intervals at the deepest point of the lake. Nutrient samples from this site will be obtained at three depths: near the surface, the center of the thermocline, and 3 feet above the bottom. Temperature and conductivity profiles will be taken at 11 additional locations to determine the mixing of the river inflow with the lake water. The water level will be recorded weekly during ice cover and daily during open-water conditions. Secchi-disk transparency measurements will be taken at the same time as other water-quality sampling. Rooted aquatic plants will be identified and mapped in June prior to the start of mechanical or chemical control programs.

Ground-Water Monitoring:

Two wells will be installed at an abandoned dump site located on the southeast shore of the lake. Water-levels in these wells will be measured quarterly at which time samples will be collected for analysis of conductivity, pH, chloride, sulfate, and total and dissolved phosphorus. The data will be analyzed to determine the potential for leachate from the abandoned dump site to reach the lake.

Water, Nutrient, Sediment Budget:

Monthly budgets will be prepared using the data collected. Nutrient recycling in the lake will be estimated using a mass balance approach. A final report summarizing the collected data will be published.

**PROGRESS (January 1984 through March 31, 1986):** The stream gage on the Oconomowoc River was installed on February 8, 1984. Water-quality sampling of both the lake and the river began in January. By March 1985, all field data-collection activities had been completed and laboratory analyses received. Data analyses show that the lake water quality generally reflects that of the influent Oconomowoc River, with the river contributing 98 percent of the inflow and 86 percent of the phosphorus load.

Water-quality loadings to the lake from the river and the urban drainage were computed and a summary report written. The report is in the review process.

**(April 1986 through April 1987):** The preliminary report has received office and colleague review. It is now in preparation for final review by the Reston office.

**PLANS (March through December 1987):** Publish the Water-Resources Investigation Report, "The Hydrology and Water Quality of Fowler Lake, Wisconsin".



# WISCONSIN DISTRICT FEDERAL SERIES CARTOGRAPHIC CENTER, WI 139

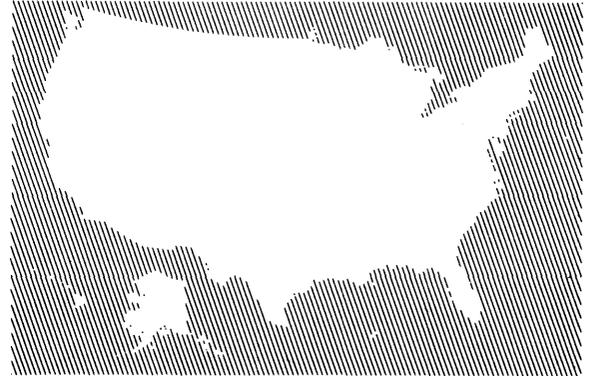
**COOPERATOR:** Office of Scientific Information Management

**LOCATION:** Nationwide

**PROJECT CHIEF:** Greg J. Allord

**PERIOD OF PROJECT:** October 1, 1985-continuing

**OBJECTIVE:** The Geologic Division has primary responsibility for preparing reports that are to be released in the formal series. Due to an increased volume of work and decreasing number of employees, the Water Resources Division has set a goal of producing reports available for printing within 9 months of approval by the Director's Office.



**PROGRESS (October 1, 1983 to March 31, 1986):** Since the beginning of this project, numerous WRD Professional Papers, Water-Supply Papers, and Circulars have been prepared for publication. This has included assisting authors throughout the country in report design and preparation in addition to traditional thematic cartographic efforts.

The Wisconsin District Federal Series Reports Units (FSRU) has been established and supplied with cartographic equipment to accomplish this goal. Previously, this center has obtained large-format contact frames, platemakers, a Compugraphic phototypesetting system, geographic information-system software, color and monochrome graphic-display terminals, a digitizing table, laser printers, and plotters. This equipment allows the staff to use conventional photo-mechanical techniques for preparing thematic maps for printing. In addition, of the two FSRU centers, the Wisconsin District is specializing in determining when digital cartographic methods can best be merged with traditional methods. This has resulted in the creation of a post-processing system on the Prime computer that allows ARC/INFO files to be sent to a SCITEX system for generating high-resolution film negatives. These negatives will be used directly for printing multicolored maps.

This unit during this fiscal year continues to be assigned special priority publications including Regional Aquifer Systems Analysis Professional Papers and a edition publication for the Office of Surface Mining.

**PLANS (April 1, 1981-continuing):** The Wisconsin Federal Series Reports Unit will continue to concentrate on Regional Aquifer reports to be released in the U.S. Geological Survey Professional Paper series. This unit has also been requested to explore new methods of preparing maps for publication and expanding on an integrated publishing system of merging text and graphics.

## **HYDROLOGIC CONCERNS INVOLVED IN LANDFILL SITING, OPERATION, AND MONITORING, WI 140**

**COOPERATOR:** Information Transfer Program, WRD, U.S. Geological Survey

**LOCATION:** Regional

**PROJECT CHIEF:** Gary Patterson

**PERIOD OF PROJECT:** June 1984 to October 1985

**OBJECTIVE:** The project objective is to describe, in simple nontechnical terms, how landfills can affect nearby surface water and ground water.

**APPROACH:** A small pamphlet describing, in general terms, how leachate is produced and how it moves to wells and streams will be written by the project chief and a member of the Wisconsin Department of Natural Resources technical staff. Preventative methods such as proper siting and design, adequate monitoring, and advanced engineering techniques will also be discussed.

**PROGRESS (June 1984 through September 1986):** A detailed pamphlet outline was completed and approved by the Regional Reports Specialist. The Wisconsin DNR project member left the DNR and withdrew from the project. The outline was fully annotated.

**(October 1986 through March 1987):** The report was completed and submitted for in-house review.

**PLANS (April 1987 through September 1987):** In-house group review will be completed and the report will be submitted to the Informational Transfer Program for review. The project will be completed when the report is published in September 1987.

# ASSESSMENT OF THE HYDROLOGY AND WATER QUALITY OF THE BLACK EARTH CREEK WATERSHED, WI 141

**COOPERATOR:** Wisconsin Department of Natural Resources

**LOCATION:** Western Dane County, south-central Wisconsin

**PROJECT CHIEFS:** Stephen J. Field and David J. Graczyk

**PERIOD OF PROJECT:** October 1, 1984 to September 30, 1987

**OBJECTIVE:** The objectives of the study are to: 1. Determine streamflow characteristics of Black Earth Creek and its tributaries.

2. Determine water-quality characteristics and dissolved-oxygen profiles of Black Earth Creek.

3. Identify reaches, tributaries, or sources in the watershed that are contributing nutrient and sediment loads.



**APPROACH:** Continuous-record gaging stations will be operated at two sites on Black Earth Creek and on Brewery Creek and Garfoot Creek and partial-record stations will be established on five tributaries. Periodic discharge measurements and water-quality samples will be collected at these stations during selected low-flow and high-flow events. Automatic water-quality samplers will be operated at the continuous-record gaging stations. Water-quality samples will be collected during low-flow and selected high-flow events. Continuous dissolved-oxygen monitors will be operated on three sites on Black Earth Creek: one at County Trunk P in Cross Plains, another downstream of the sewage-treatment plant in Cross Plains, and a third at the most downstream gaging station.

Low-flow water-quality samples will be collected at 15 miscellaneous sites throughout the basin. Daily and annual loads of sediment, phosphorus, and nitrogen will be calculated. Continuous-record water temperature recorders also will be operated at the four continuous gaging stations.

**PROGRESS (October 1, 1984 through June 1986):** Streamflow data were collected at the four gaging stations. Water-quality samples were collected at the four sites until June 30, 1986; at this time the water-quality sampling program was discontinued.

**(July 1986 to March 1987):** Streamflow data were collected at the four stations and records were prepared for the 1986 water year. Streamflow data were transmitted to the WDNR. Records of water temperature (4 sites) and dissolved oxygen (3 sites) were prepared for the 1986 water year and transmitted to the WDNR.

**PLANS (April 1987 through June 1987):** Report outlines will be prepared and sent to the WDNR and to the Northeastern Regional staff for approval. Data analysis for the report will begin.

**(July 1, 1986 to September 30, 1987):** Data analysis will continue. The report will be written, sent to colleagues for review in August, and then sent to the Northeastern Region reports specialist for approval.

# GROUND-WATER RESOURCES AND GEOLOGY OF WOOD COUNTY, WISCONSIN, WI 142

**COOPERATOR:** Wisconsin Geological and Natural History Survey, and Wood County

**LOCATION:** Central Wisconsin

**PROJECT CHIEF:** William G. Batten

**PERIOD OF RECORD:** October 1984 to September 1987

**OBJECTIVE:** This study will describe ground-water availability, movement, use, and quality in Wood County. Emphasis will be placed on determining the presence of ground-water contamination due to solid-waste disposal and agricultural practices.

The results of this study will be used by local planning and zoning officials to determine land-use practices that best utilize and protect the water resources of the county.



**APPROACH:** Available geologic, water-level, and water-use data from existing wells will be reviewed. About 400 to 500 wells with construction report information will be field located. These well data and additional geologic data from test holes drilled during the study will be used to describe the geology. The glacial geology will be mapped in detail by the Wisconsin Geological and Natural History Survey. The Wisconsin Geological and Natural History Survey will also relate soil type to contamination potential.

Well drillers' specific-capacity data and slug-test data (collected from test holes drilled during this study) will be analyzed to estimate the hydraulic properties of the Precambrian rock aquifer and the glacial sand-and-gravel aquifer.

About 30 wells will be sampled and the water analyzed for major ions and physical properties to define the general ground-water quality in the county. Ground water from wells adjacent to landfills will be sampled and analyzed to determine the possible presence and amount of contamination, if any, by landfill leachate.

Historical and present land use will be discussed regarding their potential impact on water quality. This information can then be used as a basis for future water-quality monitoring.

**PROGRESS (October 1984 through June 1986):** Existing data were reviewed. About 700 wells were inventoried and data entered into the GWSI computer data base. Ten landfills were selected for further study from a field reconnaissance of all known landfills in the county. Electromagnetic surveys were conducted and observation wells were installed at each of these 10 sites.

Approximately 20 domestic wells were sampled to define general ground-water quality throughout the county. About 50 additional domestic wells were sampled for chemical constituents indicative of anthropogenic contamination.

Initial drafts of water table, bedrock structure contour, and thickness of glacial deposits maps were completed. Preliminary analysis of well-construction data to determine aquifer properties was also completed.

**(July 1986 through March 1987):** Water-quality observation wells at landfills and about 60 domestic wells were sampled for chemical indicators of contamination. Preliminary analysis of water-quality data was completed.

**PLANS (April 1987 to June 30, 1987):** Analysis of all hydrologic and water-quality data will be completed. Initial drafts of illustrations and a final interpretive report will be near completion.

**(July 1987 to June 1988):** The interpretive report will be completed, reviewed, and ready for publication by October 1987.

# GROUND-WATER LEVELS ON CREX MEADOWS WILDLIFE AREA, BURNETT COUNTY, WISCONSIN, WI 143

**COOPERATOR:** Wisconsin Department of Natural Resources

**LOCATION:** Burnett County

**PROJECT CHIEF:** Gary Patterson

**PERIOD OF PROJECT:** October 1984-September 1988

**OBJECTIVE:** The project objectives are to describe the shallow ground-water system near Crex Meadows and to determine the relationships between the ground- and surface-water systems. High water levels have been a problem in recent years. This project will include an assessment of the influences of the impounded areas within Crex Meadows and of precipitation on water-level fluctuations within the system.



**APPROACH:** Historical records of wells, test holes, water quality, water levels, streamflow, and precipitation in the vicinity of Crex Meadows will be carefully reviewed. A preimpoundment water-table map will be prepared using late 1930's boring records. Existing domestic wells in the vicinity of the site will be inventoried and water levels will be measured if possible. Some of these wells will be monitored regularly. After inventory of existing data and wells, approximately 10 monitoring wells will be installed within each of four problem areas. The exact number of wells will be based on the number required to define the hydraulic head gradient. Some of these wells will be installed as piezometer nests to determine vertical gradients in the area. Because the DNR plans to lower the level of Phantom Flowage for dike repair, the wells will be installed there first to determine changes in water levels during the lowering and subsequent refilling of the flowage.

**PROGRESS: (October 1984 to June 1986):** Fifty-two shallow monitoring wells were installed; some in November 1984 and some in June 1985. Monthly and biweekly water-level measurements have been made since installation of the wells. Water samples were collected for water-quality analysis from 20 wells in August 1985 and analyzed for common inorganics and metals.

Surface-water gaging stations were established at four sites in August 1985, two on the North Fork of the Wood River, one on Hay Creek, and one on Whiskey Creek. Daily stage observations were made through the summer of 1985, and monthly discharge measurements have been made since August 1985.

Water levels from CCC logs made in the 1930's have been plotted and an estimated 1930 water-table map has been prepared. 1985 and 1986 water-level contour maps have been prepared. Water-level hydrographs of each monitoring well have been constructed.

**(July 1986 through March 1987):** Ground-water level, surface-water stage, and surface-water discharge monitoring was continued.

A report outline has been completed and introductory sections of the report are written.

**PLANS (April 1987 through June 1987):** Water levels and discharge will continue to be monitored. Data analyses and report writing will be continued.

**(July 1987 through June 1988):** Data collection and data analysis and the report draft will be completed.

# EAST RIVER WATER-QUALITY ASSESSMENT STUDY, WI 144

**COOPERATOR:** Fox Valley Water Quality Planning Agency

**LOCATION:** City of Green Bay and Brown County, northeast Wisconsin

**PROJECT CHIEF:** Peter E. Hughes

**PERIOD OF PROJECT:** January 1985 to September 1987



**OBJECTIVE:** The streamflow characteristics of the East River near its mouth and of a small tributary watershed will be determined. The baseline and storm water quality for the same sites will be monitored. The baseline water quality for the East River upstream of the estuary influence will be determined. Dissolved oxygen and temperature at the gaging stations will be monitored. The application of an acoustic velocity meter (AVM) for determining streamflow in an estuary-affected river reach and the utility of telecommunications data retrieval will be demonstrated.

**APPROACH:** An AVM gaging station will be established near the mouth of the East River. A gaging station will be established on a 5-square mile drainage area tributary to the East River to provide data for a model that will be used to extrapolate information to other tributary source areas. Dissolved oxygen and temperature monitoring and storm event water-quality sampling will be supplemented by bimonthly baseline sampling. The transport of phosphorus and sediment both upstream and downstream in the East River estuary reach will be evaluated.

**PROGRESS (January 1985 through March 1986):** Gaging stations have been established near the mouth of the East River and on Bower Creek. The East River site utilizes an acoustic velocity meter because this reach is seiche affected and therefore does not have a stable stage-discharge relationship. Discharge records for the East River site and the Bower Creek site have been completed for the period March 1985 through November 1985. These data were used to calculate the total phosphorus and suspended-sediment loads transported past the gage sites.

**(April 1986 through April 1987):** Data collection was completed in November 1986. Discharge, phosphorus, and sediment records have been computed for the 1986 monitoring period.

**PLANS (May 1, 1987 to July 1987):** A summary report of the discharge, sediment, and phosphorus records will be prepared and provided to the Fox Valley Water Quality Planning Agency.

# SEDIMENT AND ASSOCIATED PCB TRANSPORT OUT OF LITTLE LAKE BUTTE DES MORTES, LOWER FOX RIVER, WISCONSIN, WI 145

**COOPERATOR:** Wisconsin Department of Natural Resources

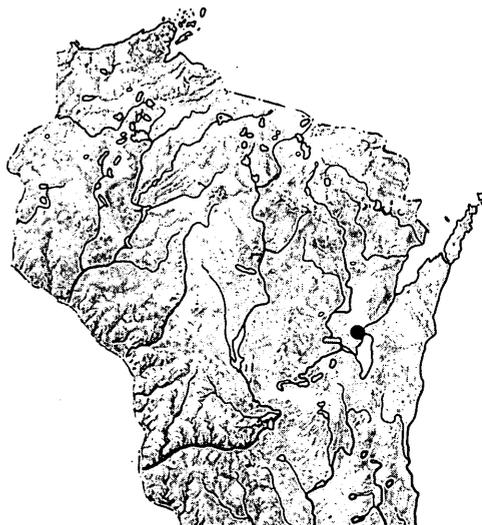
**LOCATION:** Neenah-Menasha, Appleton area in northeast Wisconsin

**PROJECT CHIEF:** Leo B. House

**PROJECT PERIOD:** July 1985 to September 1990

**OBJECTIVE:** The objectives of this study are to estimate the total mass of PCB's present in the Little Lake Butte Des Morts bottom sediments, to determine the average annual sediment and PCB transport out of the lake, to determine what relationships exist between sediment and PCB transport, and to estimate the time required for the lake's PCB-contaminated bottom sediments to be flushed from the lake.

**APPROACH:** A streamflow monitoring and automated suspended-sediment sampling station will be installed at the downstream end of the study area located at Lutz Park in Appleton. River discharge and sediment transport will be monitored for 2 years, ending in June 1988.



An acoustical velocity meter (AVM) system will be installed to determine discharge at the gage site. This system is needed because frequently changing downstream dam gate settings make use of a standard stage-discharge rating curve impractical. Two automated sediment samplers will be operated at the gage site, and will collect samples on a daily basis. A third sediment sampler will be equipped with teflon tubing and used for PCB water-sample collection purposes.

Water samples will be analyzed to obtain PCB concentrations with resolution of one nano-gram per liter. Dissolved and particulate PCB concentrations are determined separately so that PCB partition coefficients can be computed.

This study will estimate the total mass of PCB's present in the study reach using a combination of unconsolidated sediment thickness mapping and sediment core extraction and analysis. The sediment mapping will use a combination of core extraction and ground-penetrating radar or other geophysical methods to determine sediment depth. The sediment cores will be divided into three sections by inspection and analyzed for PCB concentration to determine PCB distribution with depth.

Statistical correlation and regression analysis will be used to determine what relationships exist between river discharge, stage, stream velocity, suspended sediment, total organic carbon, and PCB concentrations in the water column. This information will be used to estimate the current average annual PCB transport out of the study area. This transport rate will then be used to estimate the time required to flush out the PCB contaminated bottom sediments present in the study area.

**PROGRESS (July 1985 to June 1986):** Necessary equipment was purchased and initial installation was completed at the gage site. Workplans and methods were developed for the study.

**July 1986 to March 1987):** The stream-gaging station was fully operational and streamflow monitoring began in July 1986. Collection of automated suspended-sediment samples began in October. Preliminary sampling for PCB concentrations in the water was performed in August, September, and again in February. Preliminary PCB analysis results indicate no significant PCB presence at the upstream end of the study area, but PCB's are definitely present in the water column at the outlet. Therefore, PCB's are either being discharged into the study area, or are being resuspended from bottom-sediment deposits known to contain up to 250 mg/kg PCB concentrations.

**PLANS (April 1987 to June 1987):** Additional preliminary PCB sample collection and analysis will be performed to refine the methodology and investigate the tributary inflows for PCB presence. Unconsolidated sediment depth mapping will be performed using ground-penetrating radar and/or sonic reflection methods.

**(July 1987 to June 1988):** Weekly sampling for water column PCB analysis will begin in July and continue for 1 year. Approximately 50 sediment cores will be extracted from the study area and analyzed for PCB concentration and total organic carbon, along with unit weight information. Continuous collection of discharge information and daily suspended-sediment samples will continue. Contour or color-coded maps will be prepared to present the results of the unconsolidated bottom-sediment depth and PCB mass investigation.

## IRRIGATION AND WATER QUALITY, WI 146

**COOPERATOR:** Wisconsin Department of Natural Resources

**LOCATION:** Portage and Adams Counties, Wisconsin

**PROJECT CHIEF:** Phil A. Kammerer

**PERIOD OF PROJECT:** October 1985 to September 1987

**OBJECTIVE:** This project continues a ground-water-quality monitoring program, begun in 1979, that provides long-term fixed-site ground-water-quality data for the central sand plain. A proposal for extending the scope and length of this project in order to investigate the relationship between ground-water quality, farming practices, and hydrogeology will be prepared.

**APPROACH:** The long-term ground-water quality monitoring program that began in 1979 with the Wisconsin Geological and Natural History Survey as project WI-0035 was resumed. Water samples for chemical analysis are collected from all irrigation wells and piezometers at the beginning and end of the irrigation season; water-level measurements and field measurements of water temperature, pH, and specific conductance are made at the time of sample collection.

**PROGRESS (October 1985 through June 1986):** Ground-water quality monitoring began at four sites in 1979-80 as part of the previous project; each site is a 160-acre field irrigated by a central pivot sprinkler system. Piezometer nests were installed around the perimeter of each site (approximately 10 wells per site) for collection of water samples and measurement of ground-water gradients. Some preliminary conclusions may be drawn from data collected at the beginning and end of each irrigation season through 1984. There are no readily apparent long-term changes with time in water quality occurring at sites that were under irrigation when monitoring began, but there are apparent increases in the concentrations of some constituents in water from the irrigation well on a field that was not brought into cultivation until after the start of the monitoring program. Considerable areal variation in water quality occurs at all sites. Seasonal water-quality changes occur consistently at some wells, especially the irrigation wells.

Water-quality samples are collected and water-level and field water-quality measurements are made at the irrigation and observation wells at the four field sites at the beginning and end of each irrigation season. A summary of previously collected data (ground-water quality, ground-water level, chemical and water application, crop type, and precipitation quantity) and recommendations for continued investigation beyond the end of the current fiscal year was prepared.

**(July 1986 through March 1987):** Water-quality samples were collected and water level and field water-quality measurements were made at irrigation and observation wells at the end of the 1986 irrigation season. A proposal was submitted to DNR for continuation of the project beyond June 30, 1987.

**PLANS (April 1987 to June 1987):** Water-quality samples will be collected and water-level and field water-quality measurements will be made at irrigation and observation wells at the beginning of the 1987 irrigation season.

**(July 1987 to June 1988):** A table of analytical results for samples collected at the end of the 1986 and beginning of the 1987 irrigation seasons, and updated statistical summaries of water-quality data, will be transmitted to the DNR liaison by letter by August 1987. Plans for continuation of the project will be finalized.



# NATIONAL RUNOFF MAPPING, WI 147

**COOPERATOR:** WRD, U.S. Geological Survey

**LOCATION:** Nationwide

**PROJECT CHIEF:** David J. Graczyk

**PERIOD OF PROJECT:** October 1985 to September 1987

**OBJECTIVE:** To prepare mean annual discharges as needed for use in the National Water Summaries. Also to prepare maps of average annual runoff for selected areas in the United States as requested by the U.S. Environmental Protection Agency Corvallis Research Lab.



**APPROACH:** Streamflow data will be used to compute annual runoff for the period 1951-80 for all gaging stations in the country. If streamflow data are not available for the 30-year period, the runoff will be estimated based on correlations with streamflow data from nearby gaging stations. For areas that have no streamflow data available, the average runoff will be estimated based on average runoff values from adjacent units. The average annual runoff values calculated in inches will be plotted in the centroid of the drainage basin. Runoff contours will be drawn based on these values along with topographic variations.

**PROGRESS (October 1985 through September 1986):** Runoff maps at 1:2,000,000 scale were prepared for use in the National Water Summary for 1985 for all states, including Puerto Rico.

A hydrologic atlas report "Average Annual Runoff in the United States, 1951-80" by Warren A. Gebert, David J. Graczyk, and William R. Krug was prepared, approved for publication, and is being printed. Streamflow from the 21 water-resource regions in the United States was determined and the open-file report "A History of Annual Streamflows from the 21 Water-Resource Regions in the United States, 1951-83" by David J. Graczyk, William R. Krug, and Warren A. Gebert was prepared, approved for publication, and is awaiting printing.

Runoff maps for the northeast and parts of the southeast were prepared for the U.S. Environmental Protection Agency. The U.S. Environmental Protection Agency used the maps to determine runoff to 1,000 watersheds for their Direct Delay Response project. An open-file report documenting the methods and the final maps "Maps of Runoff in the Northeastern Region and Southern Blue Ridge Province of the United States during Selected Periods in 1983-85" by David J. Graczyk, W. A. Gebert, W. R. Krug, and G. J. Allord was prepared and approved for publication.

**(October 1986 through March 1987):** Average runoff for 56 sites in the Shenandoah National Park was estimated. These estimates were used by EPA in their Direct Delayed Response project. A report documenting the methods used to determine these estimates is being prepared.

Subregional outflow values for use in a regional water balance for the 1987 National Water Summary was prepared.

**PLANS (April 1987 to September 1987):** A report documenting the methods used to determine

subregional outflows will be prepared.

A runoff map for the eastern United States for the 1951-80 period will be updated. More gaging stations will be used and a large-scale map will be used for compilation. This detailed map will be used by EPA in their Direct Delayed Response project. A report detailing the methods and the final maps will be prepared.

**(October 1987 to September 1987):** Additional work on the 1988 National Water Summary will be done.

# DETENTION POND EVALUATION, WI 149

**COOPERATOR:** Wisconsin Department of Natural Resources

**LOCATION:** City of Madison, University of Wisconsin Arboretum

**PROJECT CHIEF:** Peter Hughes

**PERIOD OF PROJECT:** July 1986 to June 1990

**OBJECTIVE:** Evaluate the design procedures contained in the Wisconsin Manual of Practice by measuring the performance of a few selected detention basins.



**APPROACH:** The Monroe Street detention pond will be instrumented to measure inflow, outflow, and precipitation. Automatic water-quality samplers will be used to sample the storm water inflow and outflow on a flow proportional basis. Nutrients, metals, sediment, and particle size will be sampled. Data will be recorded on site with a Campbell Scientific 21X datalogger and transmitted to the USGS office via telecommunications equipment.

**PROGRESS (July 1986 through March 1987):** Data collection was started in September 1986 and 13 runoff events were sampled. Preliminary data analyses show that sediment concentrations are reduced by a factor of 10 between the inlet and the pond outlets. There was essentially no winter or spring runoff to evaluate the effects of winter accumulation on the performance of the pond.

**PLANS (April 1987 to June 30, 1988):** Continue data collection and prepare monthly summaries of the data for Wisconsin Department of Natural Resources. A final data summary will be provided to Wisconsin Department of Natural Resources after the completion of the data collection.

# ASSESSMENT OF CONTAMINANT EFFECTS ON AQUATIC BIOTA IN SELECTED REACHES OF THE ILLINOIS RIVER SYSTEM: AN APPLICATION OF BIOASSAY METHODOLOGY (WI 150)

**COOPERATORS:** USGS-Headquarters, Office of Water Quality

**LOCATION:** North-American Continent

**PROJECT CHIEF:** John F. Elder

**PERIOD OF PROJECT:** June 1, 1986 to September 30, 1989

**OBJECTIVES:** The objectives of this project are to:

1. Review and evaluate bioassay methodology for study of toxic effects in surface-water ecosystems.
2. Based on the review completed under Objective 1, identify bioassay techniques, if any, that are applicable for general use in the NAWQA Program. Consideration will be given to both the feasibility of conducting the studies in all NAWQA projects and the extent to which the results would meet the general objectives of the program.
3. Identify and describe strengths and weaknesses of the procedures selected for application, and to design experimental and field study for maximizing the utility of those procedures.
4. Apply the experimental designs thus developed to studies of contaminants in the Upper Illinois River system, Illinois and Wisconsin.



**APPROACH:** Initial work on this project involves familiarization and background data collection, including literature reviews on bioassays, site visits to the Illinois River system, and consultation with other researchers involved in bioassay studies. A report that will describe current status of bioassay methodology, discuss advantages and disadvantages of bioassay approaches to water-quality assessment, and evaluate possibilities of applications in the NAWQA Program, will be prepared during the first phase of the project. This will be followed by testing of bioassay procedures that might be useful for the NAWQA river-basin studies. Samples of sediments and water, collected primarily from fixed stations in the Illinois River NAWQA study area, will be used as test media. Sampling will be coordinated with water-quality sampling in order to utilize the chemical data that will be available for the sites. The project will conclude with interpretation of the test results and preparation of a final report that will include recommendations for possible bioassay applications in NAWQA.

**PROGRESS (May 1986 through April 1987):** Literature searches were conducted to acquire reports of bioassay research applied to studies of surface-water contamination. Information was also obtained from correspondence and visits with bioassay researchers in the United States and Canada. Based on this information, combined with the author's own training and experience, several documents and presentations were prepared. An outline of the initial report was completed and the text of the report was partially completed. A discussion of some of this information was presented at a meeting of the NAWQA Surface-Water Pilot Project staff in January. A similar discussion was distributed by memorandum to the WRD Biology Task Group, and to members of the NAWQA Biology Advisory Group formed under the direction of the Water Science and Technology Board of the National Academy of Sciences. Planning for the testing phase of the project was initiated. This included contacts with private laboratories that are candidates for possible contract arrangements for conducting bioassay work, using samples from NAWQA study sites.

**PLANS (April to September 1987):** The initial report will be completed. An approach to the methods-testing phase of the study will be designed and implemented will begin.

**(October 1987 to September 1988):** Testing will continue; most data collection will be completed during the 1988 field season. Analysis of test results will proceed as data are generated.

# UPPER ILLINOIS RIVER BASIN WATER-QUALITY ASSESSMENT--WISCONSIN, WI 151

**COOPERATOR:** Federal Program, funded through the USGS Illinois District (Illinois project II 075)

**LOCATION:** Upper Illinois River basin in Illinois, Wisconsin, and Indiana. The Wisconsin portion of the basin includes the Fox and Des Plaines River basins in southeastern Wisconsin.

**PROJECT CHIEF:** Phil A. Kammerer

**PERIOD OF PROJECT:** April 1986 to September 1989

**OBJECTIVE:** The overall objectives of the main project are (1) to describe present and past surface-water quality conditions and trends in surface-water quality; and (2) to improve our understanding of the relationship between water-quality conditions and trends, and causative factors.

The primary objective of the Wisconsin project is to provide support to achieve the overall objectives of the main project (as explained above).

**APPROACH:** Existing information will be compiled and analyzed to provide a description of past and present water-quality conditions. Regression and trend analysis will be undertaken to identify areal differences and trends in water quality and their probable causes. New information will be collected by generating fixed station monitoring networks, conducting synoptic surveys, and intensive studies of smaller subbasins or river reaches where local problems have been identified. A liaison committee of representatives of State, Federal, and local agencies was formed as a forum for exchange of information, coordination, and planning.

**PROGRESS (April 1986 through September 1986):** Work on the Wisconsin project included compiling a list of published reports on water resources in the Fox and Des Plaines River basins and an inventory of unpublished information in the files of State and local agencies.

**(October 1986 through March 1987):** The inventory of published reports and unpublished data was completed. Representatives of the Wisconsin District participate in planning sessions to develop workplans for the main project.

**PLANS (April 1987 to September 1987):** Provide support for the main project by assisting in review and preparation of reports and in a synoptic survey of trace elements in streambed material in the study area.

**(October 1987 to September 1988):** Continue support activities.



# EFFECTS OF ACID PRECIPITATION ON ACIDIC LAKES IN NORTHERN WISCONSIN, WI 154

**COOPERATORS:** Wisconsin Department of Natural Resources  
Wisconsin Geological and Natural History Survey

**LOCATION:** Florence, Forest, Oneida, and Vilas Counties, northern Wisconsin

**PROJECT CHIEF:** Dennis A. Wentz

**PERIOD OF PROJECT:** March 1987-September 1990

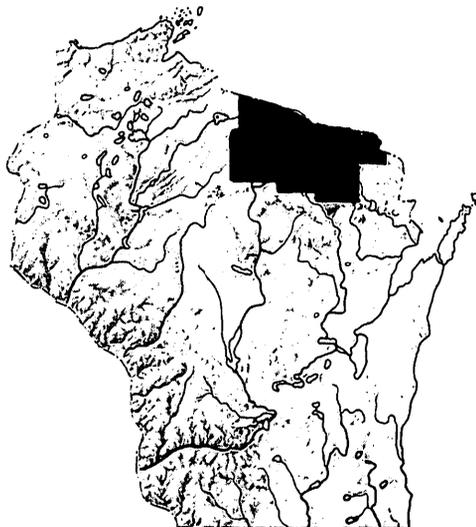
**OBJECTIVE:** Determine hydrologic and chemical budgets for two lakes in northern Wisconsin to provide information about mechanisms of acid loadings to these lakes. Investigate differences between lakes influenced by bogs and clear-water lakes.

**APPROACH:** Lake inflows from precipitation and ground-water discharge, and lake outflows from evaporation and ground-water recharge will be quantified. Alkalinity, pH concentrations of major cations and anions, nutrients, and trace elements (including aluminum, lead, and mercury) in selected flowpaths will be measured. The lakes will be evaluated for their potential for acidification.

**PROGRESS (through March 1987):** Nine candidate lakes were selected based on historical information. A field reconnaissance of these lakes was conducted.

**PLANS (April 1 to June 30, 1987):** Select the two study lakes based on the results of the March and May field measurements.

**(July 1, 1987 to June 30, 1988):** Install instrumentation and begin data collection at the two study lakes.



## OSW RESEARCH, WI 986

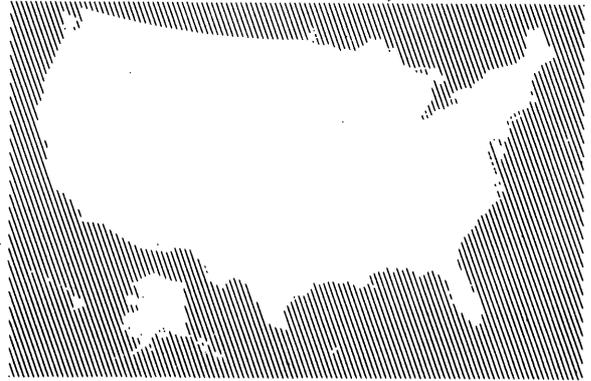
**COOPERATOR:** Office of Surface Water, WRD,  
U.S. Geological Survey

**LOCATION:** Nationwide

**PROJECT CHIEF:** John F. Walker

**PERIOD OF PROJECT:** January 1987-continuing

**OBJECTIVE:** Perform basic research for the Office of Surface Water in Reston, Va. Two projects are in progress: real-time discharge and discharge determination during ice cover. The individual objective, approach, progress, and plans for each project follow.



### REAL-TIME DISCHARGE

**OBJECTIVE:** The objective of this project is to investigate the feasibility of various models to be used for the computation of real-time discharge. During normal operation, a "hindcasting" procedure is used to compute the discharge record. For locations where real-time discharge is needed, the usual approach is unfeasible. Data requirements, parameter estimation, and accuracy are being evaluated for each model under consideration.

**APPROACH:** Data requirements and performance of three models will be compared for an extensive data set, the Missouri River at Nebraska City, Nebr. Daily discharge measurements are available for a 4-year period. Alternative parameter estimation schemes will also be examined.

**PROGRESS (January 1987 through March 1987):** Working versions of the three models have been developed. The model comparisons for the Missouri River data set are well underway. A paper detailing the findings of this research has been started.

**PLANS (April 1987 through September 1987):** The evaluation of the models will be completed and alternative parameter estimation techniques will be identified and evaluated. A first draft of the paper will be completed.

**(October 1987 through September 1988):** Results of this research project will be presented at an appropriate scientific meeting. The paper will be completed and submitted to an appropriate journal for publication.

### DISCHARGE DETERMINATION DURING ICE COVER

**OBJECTIVE:** The objective of this project is to evaluate current and proposed methods for the determination of discharge during periods of ice cover. This work is being performed with the Iowa District.

**APPROACH:** Methods currently used by the USGS and agencies in other countries will be identified

through questionnaires. An extensive literature search will be conducted to determine appropriate methods proposed in the scientific literature. Data requirements will be compiled to assess potential data sets available for evaluation of all the methods. If appropriate data sets cannot be identified, the appropriate data will be collected in Iowa for the winter of 1988. All of the methods will be compared for data set(s) with the frequent winter discharge measurements.

**PROGRESS (January 1987 through March 1987):** I met with Nick Melcher of the Iowa District in March to determine the division of tasks for the project. A questionnaire designed to reveal techniques currently used by the USGS was written. We attended a training course to become familiar with C-SIN, software designed to aid in searches of bibliographic data bases.

**PLANS (April 1987 through September 1987):** The literature search will be performed and potential data sets will be identified. Letters of inquiry will be sent to the appropriate agencies in other countries that collect discharge measurements during ice-covered periods.

**(October 1987 through September 1988):** A system for evaluating the different methods will be developed and the methods will be compared for one or more data sets. The first draft of a report detailing the findings of the project will be completed. Reviews of the report will be solicited.

## NORTHERN MIDWEST REGIONAL AQUIFER-SYSTEM STUDY

This is one of a series of studies of major aquifers in the United States. They are federally funded, and administered by WRD Region of the U.S. Geological Survey. This project is headquartered in the Wisconsin District of the WRD.

**STUDY AREA:** Parts of Illinois, Indiana, Iowa, Minnesota, Missouri, and Wisconsin

**PROJECT CHIEF:** Harley L. Young

**PERIOD OF PROJECT:** October 1978 to September 1987

**OBJECTIVE:** The subject of this project is a regional aquifer system composed primarily of sandstone and dolomite rocks of Cambrian and Ordovician ages. They are the lowermost sedimentary rocks throughout much of the Northern Midwest and supply large quantities of ground water for municipal, industrial, and rural uses. The potentiometric head in the aquifer system has declined hundreds of feet in the heavily pumped Chicago-Milwaukee area and, to a somewhat lesser extent, in other heavily pumped areas.



The objectives of this project are to: 1) describe the geologic, hydrologic, and chemical-quality characteristics of the Cambrian-Ordovician aquifer system, 2) develop a regional data base and computerized data-management system, 3) define the predevelopment hydrologic system and detail the changes induced by man, 4) determine past and present withdrawals from the aquifer and estimate future needs, 5) develop digital computer models of the aquifer system, and 6) estimate the effects of continued and future stress on the aquifer system.

**APPROACH:** The study is conducted by a central project staff in Madison, with the close cooperation and participation of WRD District personnel in each of the six States of the study.

The objectives are being met by: 1) compilation and analysis of existing data and collection and analysis of new data where needed, 2) development of computer models of the aquifer system, and 3) evaluation of past and future impacts from development of the aquifer system.

**PROGRESS (through April 1987):** Hydrologic characteristics and interrelationships of individual rock units within the aquifer system have been studied in some detail, and the overlying aquifers and confining units have been studied in the detail necessary to understand their relationship with the Cambrian-Ordovician aquifer system. The following products or data were compiled with the assistance of the WRD Districts and certain State agencies:

Regional structure and isopach maps of four aquifer and four confining unit layers and a structure map of the Precambrian surface were compiled from State maps sent from each District office, some being products of the particular State Geological Survey.

Historical pumpage from the aquifer system was compiled, as multiyear averages for 12 periods from 1864 to 1980, for input to the regional ground-water flow model.

Work by the WRD District personnel and by some State agencies through contracts has resulted in several publications pertaining to the aquifer system in each State:

Illinois -- Fassnacht (1982), Nicholas, Sherrill, and Young (1987), and Visocky, Sherrill, and Cartwright (1985).

Iowa -- Burkart and Buchmiller (in review).

Minnesota -- Delin and Woodward (1984), Horn (1983), Mossler (1983a and 1983b), and Woodward (1984, 1985, and in press).

Missouri -- Imes (1985)

Wisconsin -- Emmons (1987)

Field activities included contract drilling of five deep test wells that reached the Precambrian basement: three in Wisconsin and one each in Iowa and Illinois. One deep well and two shallow observation wells were drilled at two sites in southeastern Minnesota. Aquifer characteristics were determined from pumping tests and potentiometric head obtained for individual units isolated with inflatable hydraulic packers in these wells and nine other existing wells. Borehole geophysical logs were run on these and an additional 21 wells. The five deep test wells were converted into nests of three or four piezometers individually finished in the Mount Simon, Ironton-Galesville, or St. Peter- Prairie du Chien-Jordan aquifers. These piezometers are now part of the ground-water level monitoring network in each State.

A regional digital-computer model has been developed, as well as more localized models of areas with heavy pumping and large water-level declines. These are: 1) regional model (Mandle and Kontis, in press), 2) northeastern Missouri (Imes, 1985), 3) northeastern Wisconsin (Emmons, 1987), and 4) the Jordan aquifer in Iowa (Burkart and Buchmiller, in review). A model of the Cambrian-Ordovician aquifer system in the Chicago-Milwaukee area is near completion and will be described by H. L. Young and A. J. Mackenzie in USGS PP1405-E.

About 185 ground-water samples were collected and analyzed for all common ions and many trace constituents, of which about 105 were analyzed for stable isotopic composition, including carbon-14 age determination on 35 samples. Various aspects of the water chemistry of the Cambrian-Ordovician aquifer system are described by Siegel and Mandle (1984), Siegel (in press), and Franz (1985), in addition to several abstracts of papers given by D. I. Siegel at technical meetings. Interpretation of stable isotope and other water-quality data suggests that the present day water chemistry in confined parts of the Cambrian-Ordovician aquifer system is partly a result of recharge and discharge patterns that were altered by glaciation during the Pleistocene. A study of saline water in the Mount Simon aquifer in northeastern Illinois has concluded and will be described in a report from the Illinois District.

A report on the regional geohydrologic framework and general water quality of the Cambrian-Ordovician aquifer system in the Northern Midwest will be published as USGS PP1405-B (H. L. Young, in review).

Two additional interpretive reports by D. I. Siegel address the relation of the geochemistry of ground water in the aquifer system to paleoflow conditions in Iowa (in review) and southeastern Wisconsin (in preparation).

**PLANS:** The project is scheduled for completion in September 1987. The Chicago-Milwaukee model is being calibrated for the period 1864-1985. It will be used to simulate future potentiometric heads that would result from the pumping rates that can be predicted from planning agency data and the plans for allocation of Lake Michigan water by the Illinois Department of Transportation.

**REPORTS:** The following reports are a direct result of the Northern Midwest RASA:

1. Barnes, M. J., 1985, The extent and behavior of the mineralized water in the Mt. Simon Formation, northeastern Illinois: De Kalb, Northern Illinois University, M.S. thesis, 127 p.
2. Bennett, G. D., Kontis, A. L., and Larson, S. P., 1982, Representation of multiaquifer well effects in three-dimensional ground-water flow simulation: *Ground Water*, v. 20, no. 3, p. 334-341.
3. Burkart, M. R., and Buchmiller, R. C., Regional evaluation of hydrologic factors and effects of pumping, St. Peter-Jordan aquifer, Iowa: U.S. Geological Survey Water-Supply Paper [in review].
4. Delin, G. N., and Woodward, D. G., 1984, Hydrogeologic setting and potentiometric surfaces of regional aquifers in the Hollandale Embayment, southeastern Minnesota: U.S. Geological Survey Water-Supply Paper 2219, 56 p.
5. Emmons, P. J., 1987, An evaluation of the bedrock aquifer system in northeastern Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 85-4199, 48 p.
6. Fassnacht, T. L., 1982, A seismic reflection study of the Precambrian basement along the Illinois-Wisconsin State line: De Kalb, Northern Illinois University, M.S. thesis, 103 p.
7. Franz, K. E., 1985, Geochemistry of the sandstone and Silurian aquifers in eastern Wisconsin: Syracuse, New York, Syracuse University M.S. thesis, 103 p.

8. Horn, M. A., 1983, Ground-water-use trends in the Twin Cities metropolitan area, Minnesota, 1880-1980: U.S. Geological Survey Water-Resources Investigations Report 83-4033, 37 p.
9. Imes, J. L., 1985, The ground-water flow system in northern Missouri, with emphasis on the Cambrian-Ordovician aquifer: U.S. Geological Survey Professional Paper 1305, 61 p.
10. Kontis, A. L., and Mandle, R. J., 1980, Data-base system for Northern Midwest regional aquifer-system analysis: U.S. Geological Survey Water Resources Investigations Report 80-104, 23 p.
11. ———, Variable-density and multiaquifer-well modifications to Trescott three-dimensional ground-water flow model and support programs used in the Northern Midwest Regional Aquifer-System Analysis: U.S. Geological Survey Water-Resources Investigations Report [in review].
12. Mandle, R. J., and Kontis, A. L., Simulation of regional ground-water flow in the Cambrian-Ordovician aquifer system in the Northern Midwest, United States: U.S. Geological Survey Professional Paper 1405-C [in press].
13. Mossler, J. H., 1983a, Bedrock topography and isopachs of Cretaceous and Quaternary strata, east-central and southeastern Minnesota: Minnesota Geological Survey Miscellaneous Map Series M-52, scale 1:500,000, 2 pls.
14. ——— 1983b, Paleozoic lithostratigraphy of southeastern Minnesota: Minnesota Geological Survey Miscellaneous Map Series M-51, scale 1:500,000, 8 pls.
15. Nicholas, J. R., Sherrill, M. G., and Young, H. L., 1987, Hydrogeology of the Cambrian-Ordovician aquifer system at a test well in northeastern Illinois: U.S. Geological Survey Water-Resources Investigations Report 84-4165, 30 p.
16. Siegel, D. I., Geochemistry of the Cambrian-Ordovician aquifer system in the Northern Midwest: U.S. Geological Survey Professional Paper 1405-D [in press].
17. ———, Reconstruction of the surface profiles of Pleistocene ice sheets from the isotopic content and geochemistry of ground water in the Cambrian-Ordovician aquifer system in Iowa: [Journal article, in review].
18. Siegel, D. I., and Mandle R. J., 1984, Isotopic evidence for glacial meltwater recharge to the Cambrian-Ordovician aquifer, north-central United States: *Quaternary Research*, v. 22, p. 328-335.
19. Steinhilber, W. L., and Young, H. L., 1979, Plan of study for the Northern Midwest Regional Aquifer-System Analysis: U.S. Geological Survey Water-Resources Investigations Report 79-44, 20 p.
20. Visocky, A. P., Sherrill, M. G., and Cartwright, Keros, 1985, Geology, hydrology, and water quality of the Cambrian and Ordovician systems in northern Illinois: Illinois State Geological Survey, Illinois State Water Survey, and U.S. Geological Survey Cooperative Groundwater Report 10, 136 p.
21. Woodward, D. G., 1984, Areal lithologic changes in aquifers in southeastern Minnesota as determined from natural-gamma borehole logs: National Water Well Association Conference on Surface and Borehole Geophysical Methods in Ground Water Investigations, San Antonio, Tex., February 7-9, 1984, Proceedings, p. 788-800.
22. ——— 1985, Trends in municipal wells and aquifer utilization in southeastern Minnesota, 1880-1980: U.S. Geological Survey Water Resources Investigations Report 83-4222, 99 p.
23. ———, Hydrogeologic framework and properties of regional aquifers in the Hollandale embayment, southeastern Minnesota: U.S. Geological Survey Hydrologic Investigations Atlas 677, scale 1:1,000,000, 2 sheets.
24. Young, H. L., Hydrogeology of the Cambrian-Ordovician aquifer system in the Northern Midwest, United States: U.S. Geological Survey Professional Paper 1405-B [in review].

## REPORTS UPDATE

### Reports published during 1987:

- Batten, W. G., Water resources of Langlade County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular.
- Conger, D. H., Estimating magnitude and frequency of floods for Wisconsin urban streams: U.S. Geological Survey Water-Resources Investigations Report 86-4005.
- Emmons, P. J., An evaluation of the bedrock aquifer system in northeastern Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 85-4199.
- Field, S. J., Evaluation of phosphorus loading for Delavan Lake in southeastern Wisconsin, in Proceedings of the 4th Annual Conference: North American Lake Management Society, 1985.
- Field, S. J., Relationship of nonpoint-source discharges, streamflow, and water quality in the Galena River basin, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 85-4214.
- Gebert, W. A., Graczyk, D. J., and Krug, W. R., Average annual runoff in the United States, 1951-80: U.S. Geological Survey Open-File Report 85-627.
- Graczyk, D. J., Water quality in the St. Croix National Scenic Riverway, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 85-4319.
- House, L. B., Simulation of unsteady flow in the Milwaukee Harbor estuary at Milwaukee, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 86-4050.
- Krohelski, J. T., Hydrogeology and ground-water use and quality, Brown County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular.
- Krohelski, J. T., Ellefson, B. R., and Storlie, C. A., Estimated use of ground water for irrigation in Wisconsin, 1984: U.S. Geological Survey Water-Resources Investigations Report 86-4079.
- Krug, W. R., and Goddard, G. L., Effects of urbanization on streamflow, sediment loads, and channel morphology in Pheasant Branch basin near Middleton, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 85-4068.
- Patterson, G. L., and Zaporozec, Alexander, Analysis of water-level fluctuations in Wisconsin wells: Wisconsin Geological and Natural History Survey Circular.
- Walker, J. F., Osen, L. L., and Hughes, P. E., Cost effectiveness of the U.S. Geological Survey's stream-gaging program in Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 86-4125.

### Reports Written and in Review:

- Allord, G. J., Determining land-use values for hydrologic studies: U.S. Geological Survey Open-File Report.
- Allord, G. J., Cotter, R. D., and Zaporozec, Alexander, A guide to Wisconsin's ground-water resources: U.S. Geological Survey Water-Supply Paper.

- Field, S. J., Water quality and hydrology of the Delavan Lake drainage basin in southeastern Wisconsin: U.S. Geological Survey Water-Resources Investigation Report.
- Graczyk, D. J., Gebert, W. A., and Krug, W. R., Maps of runoff in the Northeastern Region and southern Blue Ridge Province of the United States during selected time periods in 1983-85: U.S. Geological Survey Open-File Report 87-106.
- Graczyk, D. J., Krug, W. R., and Gebert, W. A., A history of annual streamflows from the 21 water-resource regions in the United States and Puerto Rico, 1951-83: U.S. Geological Survey Open-File Report 86-128.
- Holmstrom, B. K., Kammerer, P. A., Jr., and Erickson, R. M., Water resources data--Wisconsin, water year 1985: U.S. Geological Survey Water-Data Report.
- Hughes, P. E., Hydrology and water quality of Fowler Lake, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report.
- Kammerer, P. A., Jr., Ground-water quality and movement in Wisconsin's shallow aquifers: U.S. Geological Survey, Water-Resources Investigation Report.
- Krohelski, J. T., and Wade, K. S., Simulation of effects of orebody dewatering on ground-water flow at a proposed mine site, Crandon, Wisconsin: U.S. Geological Survey Open-File Report.
- Krohelski, J. T., and Wade, K. S., Simulation of ground-water flow and contaminant transport at a proposed copper-zinc mine site, Crandon, Wisconsin: U.S. Geological Survey Open-File Report.
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