WISCONSIN

A Summary of Water-Resources Activities

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

1991

A SUMMARY OF WATER RESOURCES ACTIVITIES

U.S. GEOLOGICAL SURVEY
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1991

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UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY, 1991

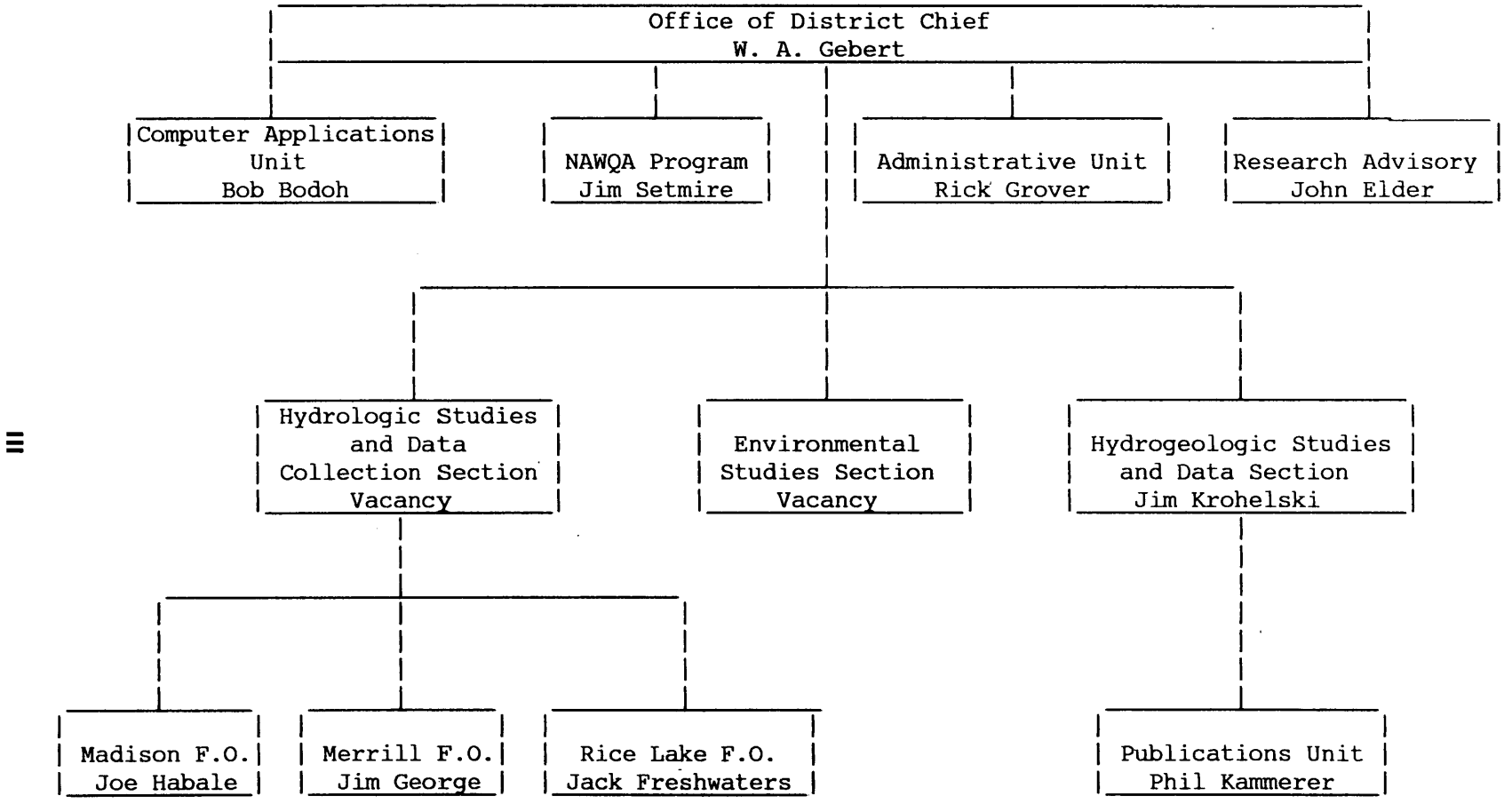
Prepared in cooperation with:

Wisconsin Department of Natural Resources
Wisconsin Department of Transportation
Wisconsin Geological and Natural History Survey
Dane County Department of Public Works
Dane County Lakes and Watershed Commission
Dane County Regional Planning Commission
Southeastern Wisconsin Regional Planning Commission
City of Waukesha Water Utility Commission
Green Bay Metropolitan Sewerage District
Madison Metropolitan Sewerage District
Milwaukee Metropolitan Sewerage District
Chippewa County
Rock County Parks Department
Delavan Lake Sanitary District
Green Lake Sanitary District
Balsam Lake Protection and Rehabilitation District
Big Muskego Lake District
Fowler Lake Management District
Hills Lake Management District
Little Muskego Lake District
Okauchee Lake District
The District of Powers Lake
Whitewater Lake Management District
Wind Lake Management District
Bad River Band of Lake Superior Chippewa Indians
Forest County Potawatomi
Lac Courte Oreilles Governing Board
Menominee Indian Tribe of Wisconsin
Oneida Tribe of Indians of Wisconsin
Red Cliff Band of Lake Superior Chippewa Indians
St. Croix Tribes of Wisconsin
Stockbridge-Munsee Band of Mohican Indians
Winnebago Tribe of Wisconsin
Corps of Engineers, U.S. Army
Environmental Protection Agency
Federal Emergency Management Agency
Illinois Department of Transportation
City of Beaver Dam
City of Fond du Lac
City of Hillsboro
City of Madison
City of Middleton
City of Peshtigo

City of Thorp
City of Waupun
City of Galena, Ill.
Town of Delavan
Town of Delton
Town of Norway
Town of Sand Lake
Village of Oconomowoc lake
Village of Wittenberg

June 1991

Water Resources Division
Wisconsin District



CONTENTS

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
Lac du Flambeau Band of Lake Superior Chippewa Indians
Illinois Department of Transportation
City of Beaver Dam
City of Galena, Ill.
City of Hillsboro
City of Peshtigo
City of Thorp
City of Waupun
Village of Wittenberg
Rock County

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--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--Wisconsin" report.

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

PROGRESS (July 1990 to June 1991): During the current fiscal year, streamflow data were collected at a total of 92 sites: 34 sites for the Wisconsin Department of Natural Resources, 8 sites for the Corps of Engineers, 14 sites for the Southeastern Wisconsin Regional Planning Commission, 6 sites for the Federal program, 3 for the Dane County Regional Planning Commission, 2 sites for Federal Energy Commission Licensees, 2 for the Madison Metropolitan Sewerage District, and 1 site each for the Lac du Flambeau Band of Lake Superior Chippewa Indians, cities of Beaver Dam, Galena, Hillsboro, Peshtigo, Thorp, Waupun, and village of Wittenberg. Streamflow data were also collected at 15 sites for agencies working jointly. Lake-level data were collected at two sites for the Dane County Department of Public Works, at two sites for the Corps of Engineers, and at one site for Rock County.

Computation of streamflow and lake-level records for all the network stations for the 1990 water year was completed, stored in our WATSTORE computer data base, and published in the annual "Water Resources Data--Wisconsin, Water Year 1990" report.

More than 100 requests for streamflow information were answered.

PLANS (July 1991 to June 1992): Data collection will continue at 92 continuous-streamflow stations (see the following list) and lake levels at 5 stations. Present plans are to install an additional gaging station (acoustic velocity meter) on the Fox River at Oshkosh in the summer or fall of 1991. Streamflow records will be computed and data published for the 1991 water year. Requests for streamflow information will be answered.

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 1992 FY

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	Fed., C of E, Detroit
04027500	White River - Ashland	1948-	DNR
04029990	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
04077400	Wolf River - Shawano	1907-09, 1911-	FERC
0407809265	Middle Branch Embarrass River - Wittenberg	1990-	Village of Wittenberg
04079000	Wolf River - New London	1896-	C of E, Detroit
XXXXXXXX	Fox River - Oshkosh	1991	DNR
04084445	Fox River - Appleton	1986-	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
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, 1988	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
05357335	Bear River - Manitowish Waters	1991	Lac du Flambeau Band of Lake Superior Chippewa Indians
05360500	Flambeau River - Bruce	1951-	DNR, FERC
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
05369945	Eau Galle River - low water bridge	1982-83, 1986-	C of E, Vicksburg
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
05381000	Black River - Neillsville	1905-09, 1914-	DNR
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
05400800	Wisconsin River - Wisconsin Rapids	1914-50, 1958-	FERC
05401050	Tenmile Creek - Nekoosa	1963-79, 1987	DNR
05402000	Yellow River - Babcock	1944-	DNR
05404000	Wisconsin River - Wisconsin Dells	1935-	DNR
05404116	S. Br. Baraboo River - Hillsboro	1988-	City of Hillsboro
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
05410490	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
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
05427718	Yahara River - Windsor	1990	DCRPC
05427948	Pheasant Branch - Middleton	1974-	DCRPC
05427965	Spring Harbor Storm Sewer - Madison	1976-	DCRPC
05429500	Yahara River - McFarland	1930-	DNR
05430150	Badfish Creek - Cooksville	1977-	MMSD
05430175	Yahara River - Fulton	1977	MMSD
05430500	Rock River - Afton	1914-	DNR
05431486	Turtle Creek - Clinton	1939-	C of E, R. Island
05432500	Pecatonica River - Darlington	1939-	C of E, R. Island
05433000	E. Br. Pecatonica River - Blanchardville	1939-1986,1988	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

LAKES

04082500	Lake Winnebago - Oshkosh	1882-	C of E, Detroit
04084255	Lake Winnebago - Stockbridge	1983-	C of E, Detroit
05427235	Lake Koshkonong - Newville	1987	Rock County
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

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 213 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 1990): 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.

PROGRESS (July 1990 to June 1991): Nine wells were destroyed or discontinued in 1990. As of March 1990, all of the proposed 63 key wells are being monitored. One hundred 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--Wisconsin, Water Year 1990", is completed.

The current network is as follows:

Observation wells:

Recording -- 26
Nonrecording -- 187

PLANS (July 1991 to June 1992): Continue measurements on observation-well network. Replace or hire new local observers. Make quality assurance checks on local observers when possible. Replace A-35 recorders with digital recorders where feasible.

REPORTS:

Erickson, R. M., and Cotter, R. D., 1983, Trends in ground-water levels in Wisconsin through 1981: Wisconsin Geological and Natural History Survey Information Circular No. 43.

Erickson, R. M., 1972, Trends in ground-water levels in Wisconsin, 1967-71: Wisconsin Geological and Natural History Survey Information Circular No. 21.

Devaul, R. W., 1967, Trends in ground-water levels in Wisconsin through 1966: Wisconsin Geological and Natural History Survey Information Circular No. 9.

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 collected for the HBMN program is similar to that for the NASQAN program.

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

PROGRESS (July 1990 to June 1991): Under the NASQAN program, concentration data for fecal bacteria, dissolved oxygen, nutrients, common ions, trace elements, and suspended sediment and measurements of water temperature, specific conductance, and pH were collected bimonthly at stations on the Bad, Chippewa, Black, Wisconsin, and Grant Rivers and Tenmile Creek. These data were collected quarterly at stations on the Fox, Manitowoc, and Milwaukee Rivers and at the HBMN station on the Popple River. Radiochemical data are collected semiannually at the Chippewa and Popple River stations.

Water samples for laboratory analysis were collected during periods of runoff from precipitation and snowmelt at two 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 and suspended-sediment concentrations from the Spring Harbor storm sewer.

Data collected during the 1990 water year were processed for publication in the annual data release "Water Resources Data--Wisconsin, Water Year 1990".

PLANS (July 1991 to June 1992): Continue data collection and processing.

RECONNAISSANCE FOR HERBICIDES IN GROUND WATER IN THE MIDWESTERN UNITED STATES, WI 00351

COOPERATOR: Federal Program

LOCATION: Statewide

PROJECT CHIEF: William G. Batten

PERIOD OF PROJECT: January 1991 to September 1991

OBJECTIVE: The overall objectives of this study are to (1) determine the spatial and seasonal distribution of selected herbicides and nitrate in near-surface aquifers in the midwest and (2) examine regional relationships between the occurrence of herbicides and selected land-use and hydrologic factors.

APPROACH: Reconnaisance samples will be collected in an 11-state area that includes Wisconsin based on areally consistent site-selection criteria, sampling and analytical protocols, and supporting information. The Wisconsin District is responsible for site selection and sample collection in Wisconsin. The 18 sampling sites in Wisconsin include 12 wells in near-surface bedrock (six in the upper half and six in the lower half of the aquifer) and six wells in unconsolidated deposits (three in the upper half and three in the lower half of the aquifer). Two rounds of samples will be collected--one in March and April prior to herbicide application, and one in June and July following herbicide application. Herbicide analyses will include triazine herbicides, two atrazine metabolites, alachlor, and metolachlor.

PROGRESS (January 1991 to June 1991): Sampling sites were selected and the first round of samples was collected.

PLANS (July 1991 to June 1992): Collect the second round of samples.

COLLECTION OF BASIC RECORDS--SEDIMENT, WI 004

COOPERATORS: Wisconsin Department of Natural Resources
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 (before July 1989): 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--Wisconsin".

PROGRESS (July 1990 to June 1991):

The 1990 monitoring program is as follows:

CORPS OF ENGINEERS--Suspended sediment was sampled at the Grant River at Burton. Daily loads are determined from these data.

A report interpreting 1975-83 sediment data that were collected at the Black River near Galesville; Chippewa River near Caryville, at Durand, and near Pepin was approved for publication.

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

WISCONSIN DEPARTMENT OF NATURAL RESOURCES--A study whose objective is to estimate the coarse-material sediment load at three sites on North Fork Fish Creek near Ashland, Wis., began on July 1, 1989. Monitoring has progressed on schedule. Sample sets consisting of suspended- and bed-material sediment and Helley-Smith bedload sediment were collected covering the range from low to high streamflow.

PLANS (July 1991 to June 1992):

CORPS OF ENGINEERS--Operation of the Grant River monitoring station will continue. The report on sediment transport 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 published.

DANE COUNTY--The collection of suspended-sediment concentration data will continue as scheduled at Spring Harbor Storm Sewer at Madison and at Pheasant Branch Creek at Middleton.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES--Data collection at the three North Fork Fish Creek sites will continue through September 30, 1991. A brief report summarizing the study's results will be prepared.

Efforts will continue to establish a long-term sediment monitoring network. About 10 sites areally distributed to sample runoff from the major geographic provinces would provide an adequate network.

REPORTS:

Rose, William J., Sediment transport, particle sizes and loads in the lower reaches of the Chippewa, Black, and Wisconsin Rivers in western Wisconsin, USGS Water Resources Investigations Report 90-4124 (in press).

FEMA FLOOD-INSURANCE STUDY, WI 006

COOPERATOR: Federal Emergency Management Agency

LOCATION: Statewide

PROJECT CHIEF: Peter E. Hughes

PERIOD OF PROJECT: March 1984-Continuing

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 (July 1990 to June 1991): Meetings were held with 10 communities to present published studies. A time and cost meeting was held to determine the study limits for the Pigeon River at Clintonville. A restudy of Sawyer Creek at Oshkosh was completed.

PLANS (July 1991 to June 1992): Respond to review comments on completed studies and answer data requests as needed. Complete a limited map maintenance (LMM) study for Clintonville. Hold time and cost meetings and complete LMM studies for Merrill, Verona and Watertown.

REPORTS: Reports were completed for the restudy of Sawyer Creek at Oshkosh.

WISCONSIN WATER-USE DATA FILE, WI 00700

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Statewide

PROJECT CHIEF: Bernard R. Ellefson

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 SWUDS. Efforts will be made to upgrade the accuracy of the water-use data.

PROGRESS (July 1990 to June 1991):

1. SWUDS was updated with current high-capacity well data and sewage-treatment facility information.

2. Programs were written to format DNR data for entry into SWUDS.

3. Public supply system data for 1990 was compiled. These data include location information and pumpages for all public suppliers.

4. The location of all high-capacity wells and sewage-treatment facilities in SWUDS was verified and a latitude/longitude location was assigned to them.

PLANS (July 1991 to June 1992):

1. The SWUDS data base will be updated as more data becomes available.

2. The reliability of SWUDS data will be checked by comparing location information and data from previous years.

3. Data for the 1990 five-year summary of water use in the United States will be compiled.

4. A water-use atlas-type report based on 1990 data will be prepared.

REPORTS:

Ellefson, B. R., Rury, K. S., and Krohelski, J. T., 1988, Water-use in Wisconsin, 1985: U.S. Geological Survey Hydrologic Investigations Atlas, 1 sheet.

U.S. Geological Survey, 1988, National Water Summary, 1987--Hydrologic events and water supply and demand: U.S. Geological Survey Water-Supply Paper 2350 (in preparation).

Krohelski, J. T., Ellefson, B. R., and Storlie, C. A., 1986, Estimated use of water for irrigation in Wisconsin, 1984: U.S. Geological Survey Water-Resources Investigations 86-4079, 12 p.

Lawrence, C. L., and Ellefson, B. R., 1984, Public-supply pumpage in Wisconsin, by aquifer: U.S. Geological Survey Open-File Report 83-4931, 40 p.

Lawrence, C. L., and Ellefson, B. R., 1982, Water use in Wisconsin, 1979: U.S. Geological Survey Water-Resources Investigations 82-444, 98 p.

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 streamflow characteristics:

1. The annual minimum 7-day mean flow with a recurrence interval of approximately once every 10 years ($Q_{7,10}$) for receiving streams at sewage-treatment plants and industrial plants discharging wastes.

2. The annual minimum 7-day mean flow with a recurrence interval of approximately once every 2 years ($Q_{7,2}$) for selected streams.

3. The 10-year low mean monthly flows for October (Oct. MMQ_{10}), November (Nov. MMQ_{10}), April (Apr. MMQ_{10}), and May (May MMQ_{10}) for sites at fill-and-draw wastewater-treatment lagoons or waste-stabilization ponds.

4. The annual minimum 30-day mean flow with a recurrence interval of approximately once every five years ($Q_{30,5}$) for selected streams.

5. The mean annual discharge (MAQ) for selected streams.

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 (July 1990 to June 1991): Low-flow estimates will be determined at approximately 50 sites in response to requests for information from the Surface Waters and Monitoring Section of the DNR. Low-flow characteristics at additional sites were made for other DNR personnel.

Low-flow characteristics, $Q_{7,2}$ and $Q_{7,10}$ values, for sites published in the Low-flow Characteristics of Wisconsin Streams at Sewage-Treatment Plants and Industrial Plants report and at low-flow partial-record stations were redetermined. This data will be transmitted in tabular format by letter.

PLANS (July 1991 to June 1992): Low-flow characteristics at approximately 50 sites will be determined in response to DNR requests for information. The low-flow characteristics, in most instances, will be determined by drainage-area/discharge relationships or by regression equations. Biological design flows and other flow characteristics may also be determined.

EFFECTS OF LAND USE CHANGES ON AN URBAN LAKE, WI 084

COOPERATORS: City of Middleton
Dane County Regional Planning Commission

LOCATION: Near Madison, Wisconsin

PROJECT CHIEF: William R. Krug

PERIOD OF PROJECT: December 1976 to June 1982, January 1984 to September 1991

OBJECTIVE: The objectives of this project are to:

1. Develop a water budget for Graber's Pond for existing conditions.

2. Evaluate the effects of changing land use on pond water levels.

3. Collect data at selected sites on base-flow water quality six times per year.

APPROACH:

1. Water budget--Existing water levels in Graber's Pond will be monitored and recorded from spring thaw in early 1988 until freeze-up the following winter, and again starting with spring thaw in 1989 until sufficient data is collected to calibrate a simple rainfall-runoff model.

   Rainfall will be recorded at the site. Other meteorological data needed to estimate evaporation will be obtained from the Weather Service Station at the Dane County Regional Airport.

   Ground-water infiltration rates and relationships will be estimated as the residual of changes in pond storage after accounting for rainfall and evaporation.

2. Evaluating the effects of changing land use--A custom designed rainfall-runoff model will be developed for the Graber's Pond watershed using accepted hydrologic methods, similar to the previous study model. This model will be calibrated to existing land use and observed meteorologic conditions. Runoff volumes and pond levels for proposed development conditions will then be estimated for the observed rainfall record, hypothetical seasonal record and for selected high-intensity rainfall events, such as the 100-year, 24-hour storm.

PROGRESS (July 1990 to June 1991): The model used for the other Middleton ponds was adapted for use on Graber's pond and was used to determine the water budget and estimate effects of urbanization.

A report was prepared to describe the model application and to present the changes in long-term water levels of Graber Pond for present and full development in the basin.

Base-flow water-quality data were collected at sites designated by the Dane County Regional Planning Commission during July, August, October, December, April and June.

Sediment-discharge loads were determined for Pheasant Branch at Highway 12 at Middleton.

PLANS (July 1991 to June 1992): Base-flow water-quality data will be collected at sites designated by the Dane County Regional Planning Commission during July, August, October and December.

REPORTS:

House, L. B., 1991, Simulation of the effects of development on water levels in Graber Pond, Middleton, WI: U.S. Geological Survey Water Resources Investigations Report (in preparation).

NONPOINT-SOURCE POLLUTION, WI 090

COOPERATOR: Wisconsin Department of Natural Resources
Green Lake Sanitary District
Chippewa County

LOCATION: Green Lake County, south-central Wisconsin
Chippewa County, west-central Wisconsin

PROJECT CHIEF: Stephen J. Field

PERIOD OF PROJECT: October 1977-Continuing

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 manually on a monthly basis and by automatic samplers during storm runoff. Suspended-sediment and nutrient concentrations will be determined. Daily, monthly, and annual mean suspended-sediment and nutrient loads will be computed.

PROGRESS (July 1990 to June 1991): Streamflow and water quality were monitored at Silver Creek near Ripon, and Green Lake inlet near Green Lake. Streamflow and water quality were monitored at Hay River, Wheeler, and at Red Cedar River at Colfax in the 1990 water year only.

During the 1990 water year, loads were computed for suspended sediment and total phosphorus for the above stations. At Silver Creek near Ripon, annual yields were: total phosphorus, 464 pounds per square mile, and suspended sediment, 18.6 tons per square mile. At Green Lake inlet near Green Lake, annual yields were: total phosphorus, 322 pounds per square mile, and suspended sediment, 28.0 tons per square mile. At Hay River at Wheeler, annual yields were: total phosphorus, 505 pounds per square mile, and suspended solids, 30 tons per square mile. At Red Cedar River at Colfax, annual yields were total phosphorus., 375 pounds per square mile, and suspended solids, 13 tons per square mile.

PLANS (July 1991 to June 1992): Continue monitoring streamflow and water quality at Silver Creek near Ripon and Green Lake inlet near Green Lake. In the 1992 water year, all stations will be discontinued except Silver Creek near Ripon.

REPORTS:

Field, S. J., and Lidwin, R. A., 1982, Water quality assessment of Steiner Branch basin, Lafayette County, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 81-52.

Field, S. J., and Lidwin, R. A., 1984, An assessment of nonpoint-source discharges, streamflow, and water quality in Onion River, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 84-4066.

Field, S. J., 1985, Nonpoint-source discharges and water quality of the Elk Creek basin, west-central Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 84-4094.

Field, S. J., 1986, Relations between precipitation, streamflow, and water quality in the Galena River basin, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 85-4214.

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 complimentary 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 two reports.

PROGRESS (July 1990 to June 1991): Report (2) was approved for publication. Preparation of the report for publication has begun. Report (1) was revised and resubmitted for approval for publication.

PLANS (July 1991 to June 1992): Publish report (2). Publish report (1) after approval is received.

REPORTS:

(1) Kammerer, P. A., Jr., Trotta, L. C., Krabbenhoft, D. P., and Lidwin, R. A., 1991, Generalized geology, water movement, and dissolved solids concentrations along cross sections through Wisconsin's aquifers: U.S. Geological Survey Hydrologic Investigations Atlas (submitted for approval for publication).

(2) Kammerer, P. A., Jr., 1991, Ground-water flow and quality in Wisconsin's shallow aquifer system: U.S. Geological Survey Water-Resources Investigations Report 90-4171 (approved; in preparation for publication).

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

COOPERATOR: Wisconsin Department of Transportation - Highways

LOCATION: Statewide

PROJECT CHIEF: William R. Krug

PERIOD OF PROJECT: July 1985-Continuing

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 two 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 watershed 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 (July 1990 to June 1991): The flood-frequency report was reviewed, revised and approved for publication. Annual flood peaks at 104 crest-stage stations were computed and published in the annual data report.

PLANS (July 1991 to June 1992): The crest-gage network will be monitored with no change for another year. Meanwhile, a network analysis feature of the generalized-least-squares procedure will be proposed to determine if more information could be obtained by making changes in the gage network. This analysis should show which gages could be discontinued with little loss to the accuracy of future regression equations, and what sort of gages should be added to the network to contribute the most to the accuracy of the equations. Additional studies will be proposed to develop a better skew map based on ecoregions and to analyze the declining trend in flood peaks observed in southwestern Wisconsin. A journal article will be prepared giving the results of the model study on the Coon Creek basin.

REPORTS:

Krug, W. R., Conger, D. H., and Gebert, W. A., , 1991, Flood-frequency characteristics of Wisconsin streams: U.S. Geological Survey Water-Resources Investigations Report 91-____, __ p., 8 figs., 2 pl., 6 t (in review).

Conger, D. H., 1986, Estimating magnitude and frequency of floods for Wisconsin urban streams: U.S. Geological Survey Water-Resources Investigations Report 86-4005, 18 p., 3 figs., 8 t.

Conger, D. H., 1981, Techniques for estimating magnitude and frequency of floods for Wisconsin streams: U.S. Geological Survey Water-Resources Investigations Open-File Report 80-1214, 250 p.

Conger, D. H., 1971, Estimating magnitude and frequency of floods in Wisconsin: U.S. Geological Survey Open-File Report, 200 p.

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)
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 to 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. Alkalinity, pH, major cations and anions, nutrients, and trace elements in selected flow paths will be quantified. The lakes will be evaluated for their potential for acidification.

PROGRESS (July 1990 to June 1991): The approved report "Hydrology of Lakes Clara and Vandercook" was prepared for sending to the printer. The report "Long-term hydrologic and geochemical responses of a soft-water seepage lake in northcentral Wisconsin" was revised in response to colleague review comments.

PLANS (July 1991 to June 1992): The report "Hydrology of Lakes Clara and Vandercook" will be published. The report "Long-term hydrologic and geochemical responses of a soft-water seepage lake in northcentral Wisconsin" will be submitted to Water Resources Research for publication.

REPORTS:

Wentz, D. A., Rose, W. J., and Webster, K. E., 1991, Long-term hydrologic and geochemical responses of a soft-water seepage lake in north-central Wisconsin (in preparation, will be submitted to Water Resources Research for publication.

Wentz, D. A., and Rose, W. J., 1991, Hydrology of Lakes Clara and Vandercook, U.S. Geological Survey WRIR 89-4204, (being prepared for publication).

Wentz, D. A., and Rose, W. J., 1989, Interrelationships among hydrologic-budget components of a northern Wisconsin seepage lake and implications for acid-deposition modeling: Archives of Environmental Contamination and Toxicology, v. 18, p. 147-155.

Chen, C. W., Gomez, L. E., Gherini, Steve, Wentz, D. A., and Whipple, J. J., 1986, Seepage lake acid rain model--Hydrologic processes (abs.): Transactions American Geophysical Union, v. 67, no. 16, p. 282.

Wentz, D. A., Rose, W. J., and Krohelski, J. T., 1986, Hydrology and geochemistry of seepage-lake systems in areas of Wisconsin receiving acid deposition (abs.): Transactions American Geophysical Union, v. 67, no. 16, p. 282.

Wentz, D. A., 1982, Hydrology of Wisconsin lakes potentially affected by acid deposition (abs.): Stevens Point, Wisconsin, American Water Resources Association, Wisconsin Section, Abstracts (March 1982), p. 18-19.

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

COOPERATORS: Wisconsin Department of Natural Resources

LOCATION: Douglas and Bayfield Counties, northwest Wisconsin

PROJECT CHIEF: Dennis A. Wentz

PERIOD OF PROJECT: July 1981 to June 1988

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, major cations and anions, nutrients, and trace elements in selected flowpaths will be measured. The lakes will be evaluated for their potential for acidification.

PROGRESS (July 1990 to June 1991): Final approved reports on "Hydrology", "Chemistry of Snowpack and Ground Water", and "Chemical Budgets" on the entire five-year study awaited publication by EPRI.

PLANS (July 1991 to June 1992): The final report will be published by EPRI.

REPORTS:

Greb, S. R., and Wentz, D. A., 1989, Section 7--Chemical budgets, in Knauer, D. R., and Brouwer, S. A., eds., RILWAS--Wisconsin application, final report: Palo Alto, California, Electric Power Research Institute Publication (in preparation).

Wentz, D. A., 1989, Section 6--Chemistry of snowpack and ground water, in Knauer, D. R., and Brouwer, S. A., eds., RILWAS--Wisconsin application, final report: Palo Alto, California, Electric Power Research Institute Publication (in preparation).

Wentz, D. A., Krohelski, J. T., and Rose, W. J., 1989, Section 5--Hydrology, in Knauer, D. R., and Brouwer, S. A., eds., RILWAS--Wisconsin application, final report: Palo Alto, California, Electric Power Research Institute Publication (in preparation).

Wentz, D. A., Garrison, P. J., and Bockheim, J. G., 1989, Section 7--Chemical budgets, in Knauer, D., and Brouwer, S. A., eds., The Wisconsin Regional Integrated Lake-Watershed Acidification Study (RILWAS): 1981-1983, Palo Alto, California, Electric Power Research Institute Report EA-6214, p. 7-1 to 7-30.

Wentz, D. A., Rose, W. J., and Krohelski, J. T., 1989, Section 5--Hydrologic component, in Knauer, D., and Brouwer, S. A., eds., The Wisconsin Regional Integrated Lake-Watershed Acidification Study (RILWAS): 1981-1983, Palo Alto, California, Electric Power Research Institute Report EA-6214, p. 5-1 to 5-77.

Li, C. S., Bockheim, J. G., Leide, J. E., and Wentz, D. A., 1988, Potential for buffering of acidic precipitation by mineral weathering in a forested entisol: Soil Science of America Journal, v. 52, p. 1148-1154.

Garrison, P. J., Greb, S. R., Knauer, D. R., Wentz, D. A., Krohelski, J. T., Bockheim, J. G., Gherini, S. A., and Chen, C. W., 1987, Application of the ILWAS model to the northern Great Lakes States: Lake and Reservoir Management, v. 3, p. 356-364.

Krohelski, J. T., Wentz, D. A., Rose, W. J., and Elder, J. F., 1987, Ground-water flow in the vicinity of East Eightmile Lake, Wisconsin (abs.): Madison, Wisconsin, American Society of Limnology and Oceanography, Abstracts of Papers for the 1987 Annual Meeting (June 1987), p. 43.

Wentz, D. A., Krohelski, J. T., Rose, W. J., Bockheim, J. G., Garrison, P. J., Knauer, D. R., and Goldstein, R. A., 1987, Hydrologic and chemical budgets of Wisconsin seepage lakes receiving acid deposition, in Perry, R., and others, eds., Acid rain: Scientific and technical advances: London, UK, Selper Ltd., p. 309-316.

Krohelski, J. T., Wentz, D. A., and Rose, W. J., 1986, Ground-water flow in the vicinity of East Eightmile Lake (abs.): Wisconsin Dells, American Water Resources Association, Wisconsin Section, Abstracts (April 1986), p. 7.

WATER RESOURCES OF WISCONSIN INDIAN RESERVATIONS, WI 123

COOPERATORS: Current cooperators include the Bad River, Lac du Flambeau and Red Cliff Bands of Lake Superior Chippewa; the Menominee, Oneida, Winnebago, Forest County Potawatomi, and St. Croix Tribes of Wisconsin; and the Stockbridge-Munsee Band of Mohican Indians of Wisconsin.

LOCATION: Statewide

PERIOD OF PROJECT: August 1977-continuing

PROJECT CHIEFS: Jim Krohelski, Bill Batten, John Dewild

OBJECTIVES: The objectives are to define water resources and address problems related to water resources on Wisconsin tribal lands.

APPROACH: Because of the varibility of types of water resources and problems, approaches vary.

PROGRESS (August 1977 to June 1990): Reports summarizing water-resources and geologic data collected on Menominee and Stockbridge-Munsee tribal lands were written. Reports summarizing water-resources and geologic data collected on St. Croix and Lac du Flambeau tribal lands are through colleague review and were revised to reflect the reviewers' comments. A report summarizing water-resources and geologic data collected on the Potawatomi tribal lands was approved for publication.

PROGRESS (July 1990 to June 1991):

Bad River Band of Lake Superior Chippewa

The direction of ground-water flow near an abandoned recycled-paper sludge dump on the Bad River Reservation was determined. This study was expanded to include an area northwest of the dump where recycled-paper sludge was stockpiled and spread in a gravel pit. Water from a domestic well near the pit was found to be contaminated with organics thought to be related to the sludge.

Oneida Tribe of Indians of Wisconsin

Present ground- and surface-water quality on a large portion of the Oneida Indian Reservation was described by collecting a variety of data within the Duck Creek watershed.

Red Cliff Band of Lake Superior Chippewa

A literature review and proposal to study PCB and metal contamination to Lake Superior and its tributaries in the vicinity of the Red Cliff reservation was submitted to the Tribe, the Bureau of Indian Affairs, and the Great Lakes Protection Fund.

Menominee Indian Tribe of Wisconsin

Stage-discharge measurements at the Wolf River at Langlade and water-quality sampling of the Wolf River at CTY M and at the southern boundary of the Menominee Reservation was continued. Monitoring of five lakes in the southeastern portion of the Menominee Reservation for various physical and chemical parameters to determine water-quality trends was continued.

Winnebago Tribe of Wisconsin

A literature review and summary describing the possible affects of cranberry operations on the water resources of Winnebago tribal lands was completed and submitted to the Tribe.

PLANS (July 1991 to June 1992): Reports summarizing water-resources and geologic data collected on Menominee, Stockbridge-Munsee, St. Croix, and Lac du Flambeau tribal lands will be submitted for Director's approval and a first draft of a report summarizing water-resources and geologic data collected on the Bad River Reservation will be written.

Bad River Band of Lake Superior Chippewa

Water-quality analyses and slug tests will be conducted at several observation well sites at the abandoned recycled-paper sludge dump on the Bad River Reservation and from several domestic wells northwest of the dump where recycled-paper sludge was stockpiled and spread in a gravel pit will be conducted.

Oneida Tribe of Indians of Wisconsin

Possible causes of stream-water depletion within the Duck Creek watershed (Oneida Reservation) will be investigated. These possible causes include drought, capture of ground water from near-by pumping centers, and land-use changes.

Red Cliff Band of Lake Superior Chippewa

A study to determine sources of PCB and mercury in water from inter-island areas and lakes of the Apostle Islands will be initiated. The approach was outlined in a proposal submitted to the Tribe and Bureau of Indian Affairs last year to study PCB and metal contamination to Lake Superior and its tributaries in the vicinity of the Red Cliff reservation.

Menominee Indian Tribe of Wisconsin

Stage-discharge at the Wolf River at Langlade and water-quality sampling of the Wolf River at CTY M and at the southern boundary of the Menominee Reservation will continue. Monitoring of five lakes in the southeastern portion of the Menominee Reservation for various physical and chemical parameters will continue. Water from selected domestic wells serving

residences where high levels of radon were detected will be analyzed for radon. Selected observation wells adjacent to dumps will be replaced with better quality wells.

Stockbridge-Munsee Band of Mohican Indians

A synoptic survey of the Red River and its tributaries to determine the water quality of the Red River watershed within the Reservation will be conducted.

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

COOPERATORS: In the 1990 water year, Big Muskego, Little Muskego, Fowler, Hills, Wind, Okauchee, and Powers Lake Districts; Village of Oconomowoc Lake (Oconomowoc Lake); Wisconsin Department of Justice (Big Sissabagama Lake); Town of Norway (Kee-Nong-Go-Mong and Waubeesee Lakes); Town of Delton (Blass Lake)

In the 1991 water year, Hills and Blass Lakes were discontinued; Balsam, Druid, Lac La Belle, Little Arbor Vitae, Little Green, Little St. Germain, Loon Lake Districts; Eagle Springs Sanitary District, city of Muskego (Denoon Lake); township of Hubbard (Sinissippi Lake), township of Mead (Mead Lake), township of Merton (Keesus Lake), Marinette County Soil and Water Conservation District (Lake Noquebay) were added

LOCATION: Selected lakes in Wisconsin

PROJECT CHIEF: Stephen J. Field

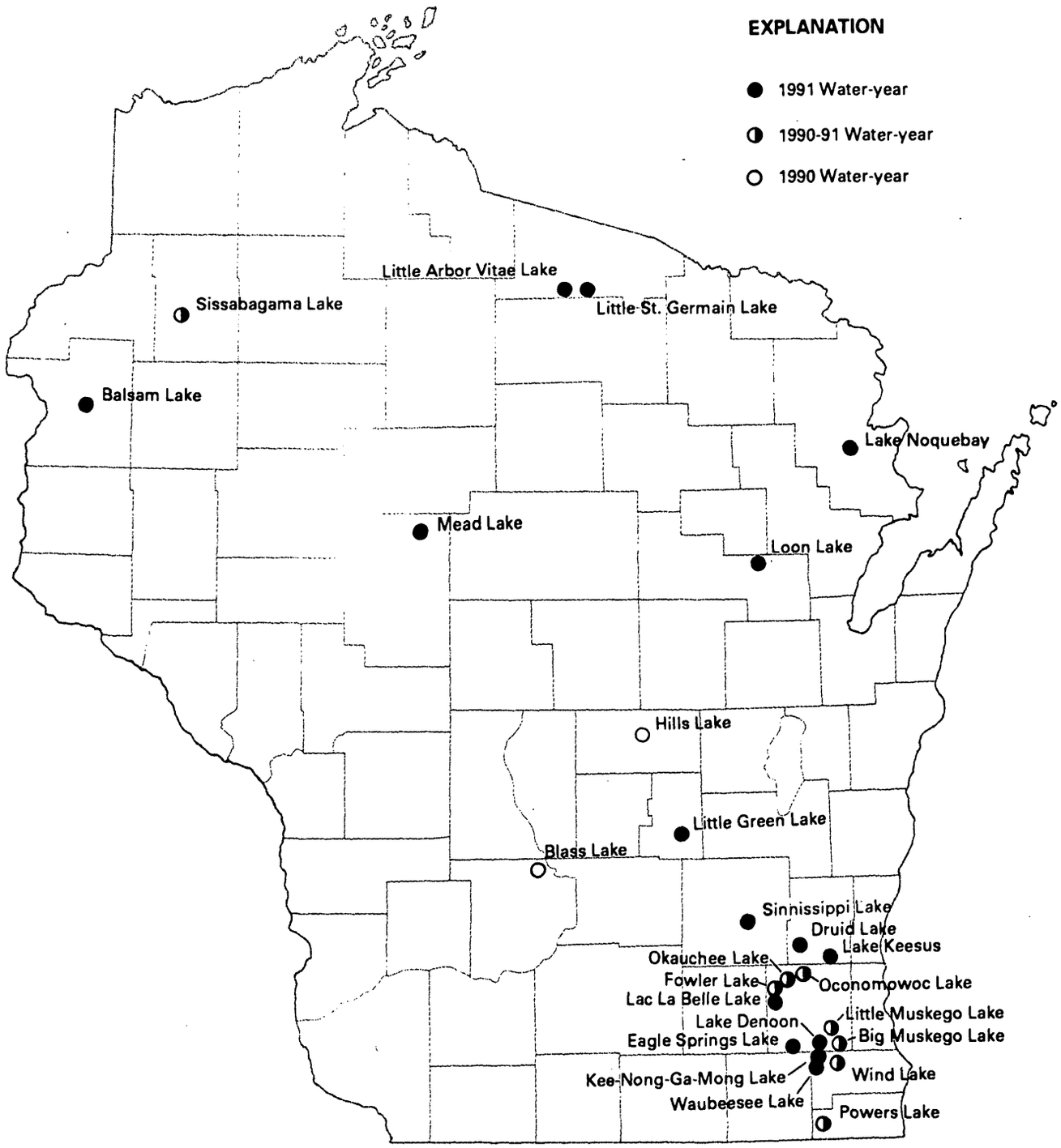
PERIOD OF PROJECT: June 1983-Continuing

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-disc 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 (July 1990 to June 1991): In the 1990 water year, total phosphorus, chlorophyll a, dissolved oxygen, and Secchi-depth data were collected and analyzed at Big Muskego, Little Muskego, Fowler, Hills, Wind, Okauchee, Powers, Oconomowoc, Big Sissabagama, Kee-Nong-Go-Mong, Waubeesee and Blass Lakes. In the 1990 water year, a progress report evaluating the water quality of each lake was sent to the respective cooperator. In the 1991 water year, Hills and Blass Lakes were discontinued, and Balsam, Eagle Springs, Denoon, Druid, Keesus, Lac La Belle, Little Arbor Vitae, Little Green, Little St. Germain, Loon, Mead, Noquebay, and Sinisippi Lakes were added to the program. The locations of lakes included in the monitoring program for water years 1990-91 are shown on the following map.

PLANS (July 1991 to June 1992): In the 1991 water year, 23 lakes will be monitored. We will compile the data and transmit it to the respective cooperators after the August monitoring. The data will be prepared for publication in the annual "Water Resources Data--Wisconsin, Water Year 1991".



Lakes monitored for project WI-133, water-years 1990-91

LAKE WATER-QUALITY MONITORING, WI 13301
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-Continuing

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-disc 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 (July 1990 to June 1991): Lake-stage and/or Secchi-disc data were compiled for 21 lakes. Data have been formatted for publication in "Water Resources Data--Wisconsin, Water Year 1990."

PLANS (July 1991 to June 1992): In the 1991 water year, only six lakes will be monitored: Amnicon, Anvil, Devils, Fish, McKensie and Wheeler.

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 1991

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 (July 1990 to June 1991): Routine monitoring of ground-water levels and water quality continued during the year along with the collection of the data to calculate lake evaporation (which includes class A pan evaporation, windspeed, air and lake surface temperatures, and relative humidity). The data base was maintained and evaluated for errors.

PLANS (July 1991 to June 1992): Hydrologic monitoring will continue, but at a much reduced scale from that of the past. Only a few (10-15) wells selected from the well network will be measured regularly. Water budgets will be recalculated for the whole period of record (water years 1983-1991) using the revised ground-water-flow model. A report will be prepared summarizing the general hydrology and water budgets.

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-Continuing

OBJECTIVE: The objectives of the project are to determine:

1. Stream discharge at Jackson Creek near Elkhorn, phosphorus and sediment discharge at Jackson Creek tributary near Elkhorn, phosphorus and suspended-sediment discharge into the lake from Jackson Creek, phosphorus discharge at Delavan Lake tributary, and phosphorus and suspended-sediment discharge from the lake at Delavan Lake outlet. Continuous streamflow will be determined at all sites.

2. Lake stage.

3. Phosphorus characteristics of the lake water and other physiochemical characteristics.

4. The phytoplankton and zooplankton population October through September.

APPROACH: Streamflow into and out of Delavan Lake will be monitored and stream sediment samples will be collected at Jackson Creek tributary, and at Delavan Lake inlet and outlet. Phosphorus samples will be collected at all sites except Jackson Creek. Lake and stream samples will be collected and analyzed for phosphorus content.

PROGRESS (July 1990 to June 1991): Streamflow was monitored continuously at five inflow sites and at one outflow site from Delavan Lake. Water-phosphorus samples were collected monthly at all stream sites except Jackson Creek. During storm runoff, samples were collected by an automatic sampler or by an observer. Water samples were analyzed for total phosphorus and suspended sediment. A continuous lake stage recorder was installed in August 1989. Three sites within the lake were monitored to determine the physiochemical characteristics of the water. The 1990 water year data was compiled for publication in "Water Resources Data--Wisconsin, Water Year 1990". Part of the lake rehabilitation plan was implemented on September 5, 1989, when lake drawdown was started. By November 4, 1989, the lake was drawn down 9.6 feet at which time rotenone was applied to the lake. All fish and zooplankton were killed. Zooplankton first appeared in the May 7, 1990, samples. The lake was restored to its "normal" summer level of 927.08 ft MSL on December 14, 1990.

PLANS (July 1991 to June 1992): Continue monitoring program as scheduled. Compile data for publication.

REPORTS:

Field, S. J., and Duerk, M. D., 1988, Hydrology and water quality of the Delavan Lake drainage basin in southeastern Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 87-4168.

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: Monitor inflow to Fowler Lake and collect monthly water-quality samples from the lake from January 1984 through November 1984. Calculate a mass balance for nitrogen and phosphorus loads for 1984.

PROGRESS (July 1990 to June 1991): The report has been submitted for approval for publication.

PLANS (July 1991 to June 1992): Publish the report.

REPORTS:

Hughes, Peter E., 1991, Hydrology, water quality, trophic status, and aquatic plants of Fowler Lake, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report (submitted for approval).

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 (July 1990 to June 1991): The report is being prepared for publication.

PLANS (July 1991 to June 1992): Publish the report.

REPORTS:

Hughes, P. E., 1989, Hydrologic and water-quality data for the East River basin in northeastern Wisconsin: U.S. Geological Survey Open-File Report 89-245 (being prepared for publication).

OCCURRENCE, TRANSPORT, AND SIMULATION OF PCB IN THE LOWER FOX RIVER, WI 145

COOPERATOR: Wisconsin Department of Natural Resources (WDNR)

LOCATION: Lower Fox River, East Central Wisconsin

PROJECT CHIEF: Leo B. House

PERIOD OF PROJECT: July 1985 to June 1992

OBJECTIVES: The objectives of this study are to estimate the total mass of PCB present in the study reach bottom sediments, to compute the total PCB load carried by the river, and to simulate PCB transport in the river. The study is being coordinated with and will compliment the U.S. Environmental Protection Agency's mass-balance study of PCB in Green Bay.

APPROACH: Streamflow-monitoring and automated suspended-sediment sampling equipment is installed on the Fox River between Neenah/Menasha and DePere. Streamflow and suspended-sediment data will be collected through September 1990.

Acoustical velocity meter (AVM) systems will be used to determine discharge in the Fox River at Appleton and DePere. These systems are required because frequently changing backwater and dam-gate settings make use of a standard stage-discharge rating curve unreliable. Automated sediment samplers will be operated at Appleton, Little Rapid, and DePere, and will collect samples on a daily composite basis.

Water samples will be analyzed to obtain PCB concentrations with resolution of one nano-gram/liter, and a detection limit of three nano-grams/liter. Dissolved and particulate PCB concentrations are determined separately so the PCB partition coefficients can be computed. Water samples will also be analyzed to determine total and dissolved organic carbon, and other parameters. Samples will be collected every two weeks, except for winter. Winter sampling will be about once per month.

The total mass of PCB present in the study reach will be estimated by use of a combination of unconsolidated sediment thickness mapping and sediment-core extraction and analysis. The sediment mapping will use a combination of core extraction, manual probing and measurement, or other geophysical methods to determine sediment depth. The sediment cores will be divided into several sections by visual inspection and analyzed for PCB concentration to determine PCB distribution with depth. Sediment cores will be analyzed to determine density of the bottom deposits.

Statistical correlation and regression analysis will be used to determine what relations exist between PCB water concentrations and river discharge, stage, windspeed, rainfall, suspended sediment, organic carbon, and water temperature. The Water Analysis Simulation Program (WASP) model will be used to simulate PCB kinetics and transport.

PROGRESS (July 1990 to June 1991): AVM stream-gaging stations were operated at Appleton and DePere. Automated sediment samplers were operated at Appleton, Little Rapid, and DePere. A local observer collected daily sediment samples at Kaukauna. Discharge and suspended-sediment data was collected through September. The WDNR collected sediment cores from the entire river for PCB analysis. A preliminary calibration of the WASP4 model has been made by WDNR. The USGS has made miscellaneous discharge measurements of the Neenah and Menasha channels to assist in the calibration of the WASP4 model.

PLANS (July 1991 to June 1992): All data collected for the study was prepared for publication in "Water Resources Data--Wisconsin, Water Year 1990". The WASP4 modelling effort by WDNR will continue. The WASP4 model will be used to simulate congener-specific PCB transport. WDNR will use the calibrated model to evaluate various remedial actions. The report on the Little Lake Butte des Mortes phase of the study will be submitted to headquarters for review and approval and published.

A report of the WASP4 modelling study will be prepared for publication as a USGS Water Resources Research Investigation report or as a peer-reviewed journal article.

REPORTS:

House, Leo B., Distribution, concentration, and transport of polychlorinated biphenyl in Little Lake Butte des Mortes, Fox River, Wisconsin, 1991, USGS Water-Supply Paper (in review).

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 1991

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 1989 to June 1991): Data analyses were completed and results of the study were presented at the AWRA Conference held in Denver in November 1990. Results will be published as AWRA Conference Proceedings.

PLANS (July 1991 to June 1992): No further activity planned for this project.

NAWQA NATIONAL - RELATIONS BETWEEN LAND- AND WATER-MANAGEMENT PRACTICES AND CONTAMINANT EFFECTS ON AQUATIC ORGANISMS, WI 151

COOPERATOR: USGS Headquarters, Office of Water Quality
USGS Illinois District, project IL 075
USGS Oregon District

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.
Yakima River Basin in Washington

PROJECT CHIEF: Barbara C. Scudder

PERIOD OF PROJECT: April 1986 to September 1991

OBJECTIVE: The objectives of the National Water-Quality Assessment (NAWQA) program include (1) describing current surface water-quality conditions; (2) defining long-term trends in water quality; and (3) improving our understanding of factors affecting observed water-quality conditions and trends. The objectives of the Wisconsin project are to investigate the relations between land- and water-management practices and bioavailability of contaminants to aquatic organisms. The effects of these contaminants on aquatic communities in surface-water ecosystems will be evaluated.

APPROACH: Conduct a literature search to determine existing methodology currently used by other investigators in universities, federal and state agencies. Contact investigators outside the USGS to obtain information on unpublished methodologies in use. Evaluate methodology for use in NAWQA projects and develop modifications necessary to meet NAWQA project goals. Develop draft approach and protocol documents for field testing in pilot NAWQA projects where ecological work is presently being conducted. Design forms for recording data in the field and subsequent data entry into computer. Reevaluate methodology after field testing and review of collected data.

PROGRESS (July 1990 to June 1991): Assistance was given to the Illinois District office in site selection for the 1990 NAWQA field work using habitat approach and methodology developed. Data forms were modified after initial field use. A partial draft of the protocol document has been completed.

PLANS (July 1991 to June 1992): The approach and protocol will be reviewed and modified where necessary. Review of methodology outside the USGS will continue. Data collected during 1989-1990 will be reviewed. Portions of interpretive reports will be written for Illinois and Washington basins.

ASSESSMENT OF THE HYDROLOGY AND WATER QUALITY OF POWERS LAKE, WI 153

COOPERATOR: Powers Lake District

LOCATION: Kenosha and Walworth Counties, southeast Wisconsin

PROJECT CHIEF: Stephen J. Field

PERIOD OF PROJECT: October 1986 to September 1988

OBJECTIVE: To determine for the 1987 water year (1) a hydrologic budget; (2) a phosphorus budget defining the inputs from surface water, ground water, and precipitation, and the losses; (3) physiochemical depth profiles of the lake water column; and (4) the phytoplankton and zooplankton summer population.

APPROACH:

1. Monitor streamflow and phosphorus load at inlet and outlet.

2. Monitor lake stage.

3. Monitor seven minipiezometers to determine ground-water discharge and recharge areas.

4. Determine physiochemical characteristics of lake water column.

5. Record precipitation at three sites in the basin.

6. Identify and enumerate summer phytoplankton and zooplankton populations.

7. Prepare an annual hydrologic and phosphorus budget.

PROGRESS (July 1990 to June 1991): Report was completed describing the water quality and hydrology of Powers Lake. For the 1987 water year, phosphorus load at the major inflow stream (drainage area 1.83 square miles) was 200 pounds. Phosphorus load at the lake outlet was 90 pounds. Spring in-lake phosphorus concentrations were 29 micrograms per liter. Summer chlorophyll a maximum concentrations were 6 micrograms per liter and minimum Secchi depths were 2 meters. Blue-green algae dominated the summer populations with 88 percent in June, 98 percent in July, and 96 percent in August. For the zooplankton populations, cladocerans and copepods dominated the June sampling, rotifers dominated in July, while copepods dominated in August. The final report was approved for publication.

PLANS (July 1991 to June 1992): Publish report.

REPORTS:

Field, Stephen J., Hydrology and water quality of Powers Lake in southeastern Wisconsin, USGS Water Resources Investigation Report 90-4126 (in preparation for printing).

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

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Florence and Vilas Counties, northern Wisconsin

PROJECT CHIEF: William J. Rose

PERIOD OF PROJECT: March 1987 to September 1991

OBJECTIVE: Determine hydrologic and chemical budgets for Honeysuckle, Max, and Morgan 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. Evaluate the feasibility of and develop an approach for pumping ground water in an acid lake to raise its pH and alkalinity.

APPROACH: Lake inflows from precipitation and ground-water discharge, and lake outflows from evaporation and ground-water recharge will be quantified. Alkalinity, pH, major cations and anions, nutrients, and trace elements in selected flowpaths will be quantified. The lakes will be evaluated for their potential for acidification.

The ground-water pumping study will be done at Max Lake where a well will be installed to draw water from the lower part of the sand-and-gravel aquifer adjacent to the lake. The chemical quality and quantity of pumped water will be monitored as well as the effects of the pumping on the lake.

PROGRESS (July 1990 to June 1991): Most monitoring emphasis was at Max Lake; lake stage and three wells were monitored at Morgan Lake; and there was no monitoring at Honeysuckle Lake. A summary of data collected at all three lakes was compiled in September.

At Max Lake, 10 peizometers were added to the existing piezometer network. Data from these piezometers will be used to assess the effect of the pumping well on lake/ground-water interaction. Ground water was pumped into the lake from July 26 to August 20, September 12 to 27, and November 1 to 15 at a 16 gallons-per-minute rate to maintain the lake's pH at 5.6.

PLANS (July 1991 to June 1992): Routine data collection will continue at approximately the same level as last year. Max Lake's target pH (5.6) will be maintained by intermittent ground-water pumping. Preliminary water budgets will be computed for all three lakes.

GROUND-WATER CONTROL OF THE CHEMICAL EVOLUTION OF NEVINS LAKE, MICHIGAN, WI 15401

COOPERATORS: Wisconsin Department of Natural Resources

LOCATION: North-central Upper Peninsula, Michigan

PROJECT CHIEF: David P. Krabbenhoft

PERIOD OF PROJECT: March 1989 to September 1992

OBJECTIVE: Determine what role ground water plays in the episodic and rapidly responding chemical character of Nevins Lake, Michigan. It is hypothesized that ground-water inflow to Nevins Lake is periodically discontinued, resulting in a mounded lake system that is particularly sensitive to rapid acidification.

APPROACH: Lake chemistry will be closely monitored and correlated with observed changes in the mounded/flow-through nature of the ground-water flow system. Mass balance calculations on conservative solutes (calcium) in the lake, in combination with precipitation loading rates, will be used to estimate ground-water inflow and outflow rates. A new sampling strategy is being employed whereby water samples are taken from the lakebed rather than wells.

PROGRESS (July 1990 to June 1991): Two years of coordinated lake chemistry and ground-water data have been collected and evaluated. Calculations of ground-water inflow and outflow were made using solute, mass-balance relationships. Samples will be collected this spring and early summer to test the new sampling strategy.

PLANS (July 1991 to June 1992): Data collection will be continued at the site. The results will be written in the form of a journal paper for publication in 1992.

REPORTS:

Krabbenhoft, D.P., and Webster, K.E., 1990, Use of episodic changes in lake water chemistry to estimate ground-water flow rates at Nevins Lake, Michigan. Abstract, American Water Resources Association, Wisconsin Chapter, March 1990.

HYDROLOGY AND WATER QUALITY AT SMALLMOUTH BASS STREAMS IN SOUTHWEST WISCONSIN, WI 155

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Four streams in southwestern Wisconsin: Little Platte River near Platteville, Rattlesnake Creek near North Andover, Sinsinawa River near Hazel Green, and the Livingston Branch of the Pecatonica River near Livingston.

PROJECT CHIEF: David J. Graczyk

PERIOD OF PROJECT: July 1987 to September 1992

OBJECTIVE: Determine streamflow and water-quality characteristics and examine their relationship to bass populations.

APPROACH: Four streams were selected in southwestern Wisconsin; three that have declining smallmouth bass populations and one where populations appear to have remained stable. Continuous streamflow, water temperature, and dissolved-oxygen gaging stations were installed at each site. Water-quality samples were collected and analyzed for selected constituents.

PROGRESS (July 1990 to June 1991): Discontinued data collection at the Sinsinawa River near Hazel Green and the Little Platte River near Platteville. Continued to monitor streamflow and water quality at the Livingston Branch of the Pecatonica River and at Rattlesnake Creek.

Fish populations in the fall of 1990 responded to high streamflows in mid-May to mid-July 1990. Mid-May to mid-July is the normal reproductive period for smallmouth bass. There was above-normal precipitation during this period and higher than normal streamflows. Reproductive success for smallmouth bass measured in the fall of 1990 was poor. No smallmouth bass were found in the Sinsinawa River. Very few young-of-the-year smallmouth bass were found in the other three streams.

A storm in late August 1990 reduced the dissolved-oxygen concentration to less than 0.5 mg/L. A fish kill was reported to have occurred after this storm.

An interpretive report is being prepared jointly by the USGS and WDNR. This report will summarize the streamflow and water-quality conditions during the study period and their effects on macroinvertebrates and smallmouth-bass populations.

PLANS (July 1991 to June 1992): Finish interpretive report and prepare the report for publication.

REPORTS:

Mason, John W., Graczyk, David J., and Kerr, Roger A., 1991, Effects of runoff on smallmouth bass populations in four southwestern Wisconsin streams: in D. Jackson (ed), First International Smallmouth Bass Symposium, Nashville, Tennessee, August 24-26, 1989, Mississippi State University, Mississippi (in press).

Graczyk, David J., and Sonzogni, William C., 1991, Reduction of dissolved oxygen concentration in Wisconsin streams during summer runoff: Journal of Environmental Quality, v. 20 (in press).

EVALUATION OF THE SAND-AND-GRAVEL AQUIFER IN THE PREGLACIAL BEDROCK VALLEY OF SOUTHERN WAUKESHA COUNTY, WISCONSIN, WI 158

COOPERATOR: Waukesha Water Utility

LOCATION: Southern Waukesha County

PROJECT CHIEF: William G. Batten

PERIOD OF PROJECT: October 1987 to September 1991

OBJECTIVE: The objective of this study is to better understand the ground-water system in glacial deposits found in the upper reaches of a preglacial bedrock valley.

APPROACH: A two-dimensional, steady-state, ground-water flow model will be constructed using existing data to determine aquifer properties, boundary conditions, and aquifer geometry for model input. Steady-state model results will be compared with an existing water-table map and with estimated streamflow in the Fox River for calibration. This calibrated model will then be run to simulate various well-field configurations and pumping rates and determine the drawdown in the aquifer and effects of pumpage on flow in the Fox River.

Data from test holes, geophysical surveys, and a pumping test will be used to update input to the model. The updated model will again be used to simulate effects of pumpage on the ground-water system.

PROGRESS (July 1990 to June 1991): A test well was drilled in August 1990 at a site chosen by a private consultant based on geophysical and test-hole data. A multi-layer ground-water flow model was constructed to help interpret the results of a proposed pumping test of the test well. Upon completion of the test well, it was determined that the aquifer material at this site would not provide the needed capacity for a large-scale test lasting several days.

PLANS (July 1991 to June 1992): A small-scale 8-hour pumping test will be conducted using the existing test well to determine aquifer properties. It is currently proposed to conduct geophysical surveys at several sites to determine the thickness of glacial deposits at these sites. It is proposed to then drill a test hole at one or more of these sites to determine the type of glacial deposits and their potential for producing enough water to conduct a large-scale pumping test. A large-scale pumping test will be conducted at one site. An open-file report presenting all data collected thus far in the project is also currently proposed. Any further plans for this project depend on the results of the geophysical survey and test-hole data to be collected from June to August 1991.

ASSESSMENT OF THE HYDROLOGY AND WATER QUALITY OF WIND LAKE, WI 159

COOPERATOR: Wind Lake Management District

LOCATION: Racine County, southeast Wisconsin

PROJECT CHIEF: Stephen J. Field

PERIOD OF PROJECT: October 1987 to September 1989

OBJECTIVE: To determine for the 1988 water year (1) phosphorus loads into the lake from surface water, ground water, and precipitation, (2) phosphorus loads from internal recycling, (3) characteristics of the bottom lake sediments, (4) physiochemical characteristics of the water column, (5) phytoplankton and zooplankton present, and (6) phosphorus discharges from the lake from surface water and ground water. In the 1989 water year, (1) phosphorus loads into the lake from surface water, ground water, and precipitation, (2) physiochemical characteristics of the water column, and (3) phosphorus discharges from the lake from surface water were determined.

APPROACH:

1. Monitor streamflow and phosphorus loads at the inlet and outlet.

2. Monitor lake stage.

3. Sample bottom lake sediments during winter to determine percent moisture, total phosphorus, iron, and manganese.

4. Monitor five minipiezometers to determine ground-water discharge and recharge areas.

5. Determine physiochemical characteristics of lake water column.

6. During ice-free periods, record precipitation at three sites and evaporation at one site.

7. Identify and enumerate phytoplankton and zooplankton populations.

8. Prepare an annual hydrologic and phosphorus budget.

PROGRESS (July 1990 to June 1991): A report describing the results of the study has been prepared and submitted for Director's approval to publish.

PLANS (July 1991 to June 1992): The report will be published.

REPORTS:

Field, S.J., 1991, Hydrology and water quality of Wind Lake in southeastern Wisconsin (submitted for Director's approval).

BALSAM LAKE WATER AND PHOSPHORUS BUDGETS, WI 160

COOPERATOR: Balsam Lake Protection and Rehabilitation District

LOCATION: Polk County, northwestern Wisconsin

PROJECT CHIEF: William J. Rose

PERIOD OF PROJECT: November 1987 to September 1990

OBJECTIVE: Determine monthly and annual water and phosphorus budgets for Balsam Lake and identify the sources of phosphorus in the Rice Creek watershed.

APPROACH: Water and phosphorus budget components to be quantified are (1) change in lake storage, (2) precipitation, (3) surface inflow, (4) ground-water inflow, (5) evaporation, (6) surface outflow, and (7) ground-water outflow. Change in lake storage will be determined by monitoring lake stage. Surface inflows and outflows will be determined by operating two continuous and one intermittent gaging stations. Evaporation will be estimated by applying lake/pan coefficients to class A pan-evaporation values. Ground-water inflows and outflows will be estimated by Darcy equation calculations. Hydraulic-gradient data will be determined from a network of in- and near-lake piezometers. Phosphorus budget components will be quantified for all of the water-budget components except evaporation. Water associated with each of the components will be sampled and analyzed for total phosphorus concentration. Sources of phosphorus in the Rice Creek watershed will be identified by streamflow and phosphorus-concentration monitoring at four stream sites in the Rice Creek watershed.

PROGRESS (July 1990 to June 1991): The final report was written and is in review.

PLANS (July 1991 to June 1992): The final report will be published.

REPORTS:

Rose, W. J., Water and phosphorus budgets and trophic state, Balsam Lake, northwestern Wisconsin, 1987-89 (in preparation).

PCB AND OTHER CONTAMINANT LOADS TO GREEN BAY, LAKE MICHIGAN, WI-161

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Green Bay watershed tributaries, Northeast Wisconsin and Upper Penninsula Michigan.

PROJECT CHIEFS: Peter E. Hughes and Leo B. House

PERIOD OF PROJECT: July 1987 to September 1992

OBJECTIVES: The objectives of this study are to determine the loads of polychlorinated biphenyls (PCBs), dieldrin, lead, and cadmium into Green Bay from its major tributaries. This information will be used in conjunction with EPA's comprehensive mass balance study of Green Bay.

APPROACH: Water samples will be collected and analyzed for PCB, dieldrin, lead, and cadmium concentration from five major tributaries to Green Bay. These are the Fox River at DePere and at the mouth, the Menominee River at Marinette, the Escanaba River at Escanaba, the Oconto River at Oconto, and the Peshtigo River at Peshtigo. Samples will be collected weekly on the Fox and Menominee Rivers during non-winter periods, and approximately once per month during the winter. Samples will be collected once per month at the other sites. Streamflow-monitoring and suspended-sediment sampling stations will be installed on each river. Contaminant loads will be calculated from concentration and stream discharge data using the USGS integration method. The data-collection period is anticipated to run from April 1988 through March 1989.

PROGRESS (July 1990 to June 1991): All field and suspended-sediment data have been entered into the USGS Water-Quality File and calculation of suspended-sediment loads has been completed. Discharge and water-quality data, except for concentrations of PCB and metals, were published in "Water Resources Data--Wisconsin, Water Year 1990".

PLANS (July 1991 to June 1992): Lead, cadmium and PCB loads to Green Bay from the tributaries will be calculated. A report describing the field procedures, summarizing the data collected, and presenting the results of the load calculations will be completed.

ROLES OF GROUND-WATER TRANSPORT AND LAKE SEDIMENT SORPTION PROCESSES IN MERCURY CYCLING IN NORTHERN WISCONSIN LAKES, WI 163

COOPERATOR: Wisconsin Department of Natural Resouces (WDNR)

LOCATION: Vilas County, Wisconsin

PROJECT CHIEF: John F. Elder, David P. Krabbenhoft

PERIOD OF PROJECT: July 1988 to December 1991

OBJECTIVES: The objectives of this project are to:

1. Determine ground-water contributions to the hydrologic budget in each of five study lakes in Vilas County,

2. Determine ground-water contributions to the inputs and losses of mercury in each lake,

3. Describe the speciation of mercury in the bottom sediments of the study lakes, particularly the proportion and distribution of methyl mercury.

APPROACH: This project is part of an interagency, interdisciplinary study of mercury biogeochemistry in northern Wisconsin lakes. It includes investigations of the sources, distribution, transport and speciation of mercury in the lakes to improve understanding of processes leading to bioaccumulation of mercury in fish tissue.

Five lakes in north-central Wisconsin were selected for study. The five lakes span a pH range from 4.6 to 7.2 and a dissolved organic carbon range of 1-5 milligrams per liter. All are seepage lakes; hence the ground-water inflows and outflows are important parts of the hydrologic budgets of the lakes. Piezometers and well nests are installed as necessary to establish a data base to describe the ground-water flow system in the watershed of each lake. Also, special sampling methodologies have been developed for collecting ground-water samples for mercury analysis.

Methyl mercury is of particular concern because of its high toxicity and its tendency to accumulate in fish muscle tissue. Bottom-sediment cores are collected from established sites in the study lakes, and analyzed for total and methyl mercury. The data are compared with ground-water and pore-water mercury data to evaluate mercury mobility and phase transfer processes in the sediments.

PROGRESS (July 1990 to June 1991): Hydrologic monitoring and analysis of thermal profiles continued as planned. Using the data produced by these analyses, ground-water flow regimes and ground-water/lake-water relationships were investigated.

Samples of ground water were collected from wells, seepage meters installed in lake sediments, and trenches dug in sand on lake shores. The samples were used for analysis of mercury to determine the importance of ground-water transport as an input pathway for mercury to the lakes.

Bottom-sediment samples were collected in transects from near shore to mid-lake in both basins of Little Rock Lake. The samples were analyzed for total and methyl mercury, other trace elements, sulfur, phosphorus, and organic carbon. The data was interpreted in conjunction with other data describing mercury chemistry of lake water, sediments, pore water, and ground water to better understand the cycling of mercury in the system.

The findings of this study have been presented orally and written in reports currently in preparation. A meeting of the interagency project team was again held in Palo Alto, California in April 1991. The meeting was attended by John Elder, project chief, and Dave Krabbenhoft, ground-water geochemist. Results of the ground-water/pore-water study were presented by Krabbenhoft at the annual meeting of the American Chemical Society in April.

PLANS (July 1991 to June 1992): Final analysis and interpretation of data will be completed. Reports of the results will be prepared for publication.

REPORTS:

Elder, J. F., Trace elements in bottom sediments of northern Wisconsin seepage lakes: concentrations and effects of sediment grain size.

Elder, J. F., and others, Trace elements in bottom sediments of northern Wisconsin seepage lakes: variability with depth, location, and organic carbon content.

Hurley, J. P., Babiarz, C. L., Krabbenhoft, D. P., and Andren, A. W., Cycling processes of mercury at the sediment/water interface in seepage lakes, published in proceedings, American Chemical Society National Meeting, special symposium on the Environmental Chemistry of Lakes and Reservoirs, April 1991.

Krabbenhoft, D. P., Bowser, C. J., Gat, J. R., and Kendall, Carol, Stable isotopic approaches to the hydrology of ground water-lake systems, published in proceedings, American Chemical Society National Meeting, special symposium on the environmental chemistry of lakes and reservoirs, April 1991.

This summer, both papers by Krabbenhoft will be expanded into chapters in an American Chemical Society Series book.

SUPERFUND REMEDIAL RESPONSE SUPPORT - EPA REGION V, WI 16400

COOPERATOR: United States Environmental Protection Agency, Region V

LOCATION: Byron and Belvidere, Illinois

PROJECT CHIEF: Bart J. Manion

PERIOD OF PROJECT: November 1988-Continuing

OBJECTIVE: The U.S. Environmental Protection Agency, Region V, has requested technical assistance from the Wisconsin District to help in the hydrological characterization of superfund sites. The Wisconsin District will provide the requested assistance, in turn enhancing our knowledge of ground-water hydrology in the vicinity of superfund sites.

APPROACH: The Wisconsin WRD District is responsible for drilling, selective formation tests, and monitoring well installation. A network of monitoring wells consisting of deep bedrock wells and shallow water-table wells averaging 100 feet in depth will be drilled and installed at superfund sites near Byron and in Belvidere, Illinois. Selective formation tests and collection of water samples will be conducted in specific boreholes.

PROGRESS (July 1990 to June 1991):

Byron, Illinois - Six boreholes were drilled--three in bedrock and three to the water table. Twelve wells were constructed and developed--six in bedrock and six in unconsolidated deposits. Selective formation tests were conducted in five zones of seven boreholes. Water samples were collected from each zone.

Belvidere, Illinois - Three bedrock wells were constructed and developed. Selective formation tests were conducted in 5 zones of 5 boreholes at 10-foot intervals. Water samples were collected from each zone.

Argonne, Illinois - A selective formation test was conducted in 7 zones of an existing well at 10-foot intervals. Water samples were collected from each zone.

PLANS (July 1991 to June 1992):

Byron, Illinois - Selective formation tests will be conducted on three boreholes. Sixty soil samples will be collected. Sixteen wells will be constructed and developed--eight will be water-table wells and eight will be bedrock wells.

Belvidere, Illinois - Selective formation test will be conducted on one borehole. A borehole will be augered and cored to approximately 50.0 feet. Four wells will be constructed and developed--one will be a shallow bedrock well and the remaining three will be deep bedrock wells.

BEST MANAGEMENT PRACTICE EVALUATION, WI 166

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: State of Wisconsin

PROJECT CHIEF: John F. Walker

PERIOD OF PROJECT: July 1989 to September 1994

OBJECTIVE: Investigate statistical analysis techniques for assessing trends in water quality due to Best Management Practice (BMP) implementation using data from other states. The effectiveness of BMPs in one urban basin (this study) and two rural basins (project WI 168) in Wisconsin will be determined using the identified statistical techniques.

APPROACH: A comprehensive literature search will be conducted to identify viable statistical analysis techniques and identify needs for method modification or development. Data for several rural and urban basins in other states will be compiled and used to test the selected techniques. A continuous-record gaging station equipped with an automatic refrigerated sampler will be installed in a small urban basin in Madison and operated through June 30, 1993. The sampler will collect flow-composite samples, which will be analyzed for total suspended solids, total phosphorus, trace metals, and several organic priority pollutants. Storm loads of total suspended solids and total phosphorus will be computed and used along with rainfall data and land-use information to assess the effectiveness of the BMPs.

PROGRESS (July 1990 to June 1991): A gaging station in an urban area in Madison was installed, and data collection began in November 1990. Samples were analyzed for total suspended solids, total phosphorus, trace metal and organics concentrations for all storms through June 1991. Several statistical techniques for detecting trends were compared for three rural and three urban sites. A draft report describing the statistical techniques was sent to the cooperator for review in October 1990. Review comments were received from the cooperator in March 1991. A revised version of the report was sent out for colleague review in May 1991.

PLANS (July 1991 to June 1992): Continue to operate the gaging station in Madison. Storm loads and rainfall characteristics will be computed as data is received. Samples collected for this period will be analyzed for total suspended solids and total phosphorus concentrations. Complete the review process for the report and submit to an appropriate journal for publication.

REPORTS:

Walker, J. F., Techniques for detecting trends in stream-water quality caused by changes in land management (in review).

MOBILITY OF POLYCHLORINATED BIPHENYLS (PCBs) FROM BOTTOM SEDIMENTS TO WATER IN AN INDUSTRIALIZED RIVER BASIN, WI 167

COOPERATOR: Wisconsin Department of Natural Resouces (WDNR)

LOCATION: Fox River and Little Lake Butte des Mortes, Northeast Wisconsin

PROJECT CHIEF: John F. Elder

PERIOD OF PROJECT: May 1989 to September 1991

OBJECTIVES: The overall goal of this project is to describe the capacity for flux of PCBs between bottom sediments and the water column of the Lower Fox River. This will be accomplished by conducting experiments to:

1. Determine distribution coefficients for sediment-associated PCB congeners in Fox River sediment-water systems.

2. Determine the importance of factors that may influence PCB distributions, including physical characteristics of the sediments, ground-water inflow, and biological activity.

APPROACH: Sediments and water are collected from the Lower Fox River system for use in laboratory experiments. The experiments consist of small glass enclosures that contain measured depths of sediments and overlying water, along with a known concentration of carbon-14-labelled PCB congener. Movement of the congener within the system is determined by monitoring C-14 activity in subsamples of water flowing through the sediments or of the sediments themselves. Conditions of the systems are controlled so that determinations of the effects of certain physical and biological changes can be assessed.

PROGRESS (July 1990 to June 1991): Laboratory work continued as planned. The third set of experiments was conducted in November and the fourth set in March-April. Sediment cores were sampled from two Fox River deposits in October and taken intact to the laboratory where they were used for study of PCB-congener movement in undisturbed cores.

Data has been analyzed as the study progressed. Results indicate that, although the PCBs in the sediments have very limited mobility to the aqueous phase, they have greater mobility than can be attributed to simple diffusion. The nature of the sediments is important; the two sediment deposits sampled for this study are appreciably different in their capacity to release PCB congeners to overlying water.

PLANS (July 1991 to June 1992): Final analysis and interpretation of data will be completed. Reports of the results will be presented to the cooperator and prepared for publication.

REPORTS:

Elder, J. F., James, R. V., and Steuer, J., Mobility of polychlorinated biphenyls (PCBs) from bottom sediments to water in an industrialized river basin in northeastern Wisconsin.

EVALUATING BEST MANAGEMENT PRACTICES IN THE BLACK EARTH CREEK BASIN, WI 168

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Three streams near Cross Plains, Wisconsin: Garfoot Creek, Brewery Creek and Black Earth Creek

PROJECT CHIEF: David J. Graczyk

PERIOD OF PROJECT: July 1989 to September 1996

OBJECTIVE: To determine if dissolved-oxygen characteristics and concentrations of suspended sediment, nitrogen and phosphorus in the streams change after best management practices (BMPs) are implemented.

APPROACH: Continuous-recording streamflow-gaging stations will be installed at five sites. Two of these sites will be equipped with automatic refrigerated samplers. These two sites were monitored in a previous USGS study. Ten to fifteen storms will be sampled and loads calculated for individual storm events. One analysis technique will use regressions to remove the natural variability; changes are detected by applying the Wilcoxon rank-sum test to the regression residuals.

Dissolved oxygen will be monitored at five sites. This data will be used to investigate trends in dissolved-oxygen concentrations.

PROGRESS (July 1990 to June 1991): Continued streamflow, water-quality and dissolved-oxygen monitoring at five sites in the Black Earth Creek basin. All data was summarized and will be published in the "Water Resources Data--Wisconsin" reports for water years 1990 and 1991. Water-quality loads were calculated for selected parameters and storm periods at Garfoot and Brewery Creek.

PLANS (July 1991 to June 1992): Continue streamflow, water-quality and dissolved-oxygen monitoring at the five sites. Water-quality loads for selected parameters and storm periods will be compared to data collected in water years 1985 and 1986. The loads will be compared to determine how effective the best management practices are in improving water quality.

EVALUATING THE TOXICITY OF URBAN RUNOFF, WI 169

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: City of Milwaukee, Wisconsin

PROJECT CHIEF: Peter E. Hughes

PERIOD OF PROJECT: October 1989 to June 1991

OBJECTIVE: The main objective of this project is to determine if urban storm-water runoff violates Wisconsin's water-quality standards for toxic substances. A second objective is to determine the concentration of priority pollutants in the bottom sediments of three urban streams.

APPROACH: To accomplish the first objective, four gaging stations will be established in the City of Milwaukee. Two sites will be located on storm sewers to monitor a residential and a commercial basin. The other two sites will be on Underwood Creek and Noyes Creek. Flow composite samples will be obtained for 10 runoff events using automatic samplers. Each sample will be analyzed for priority pollutants, bacteria, solids, and acute toxicity. Analytical data will be compared to water-quality standards for toxic substances. An attempt will be made to relate instances when water-quality standards are exceeded to characteristics of storms (recurrence interval, duration).

Samples of bottom sediments from the Milwaukee River, Menomonee River and Lilly Creek will be analyzed for priority pollutants.

PROGRESS (July 1990 to June 1991): The data has been entered in the USGS Water-Quality File. Results of the study were presented at the 1990 AWRA Conference in Denver. There were in excess of 47 priority pollutants which were commonly found in urban runoff. The event mean concentrations of these pollutants have been compared between sites. The probability of these concentrations exceeding water-quality criteria has been determined.

PLANS (July 1991 to June 1992): Results of the study will be published in the AWRA Conference proceedings.

HYDROLOGIC INVESTIGATIONS OF WETLAND RESTORATION AND CREATION PROJECTS, WI 170

COOPERATORS: Wisconsin Department of Transportation

LOCATIONS: One mile south of Wilton, Wisconsin
One mile north of Hub City, Wisconsin

PROJECT CHIEF: David P. Krabbenhoft

PERIOD OF PROJECT: November 1989 to September 1996

OBJECTIVE: The overall objective of this study is to gain a better understanding of the hydrology of natural, restored, and created wetlands in order to promote a higher degree of success in wetland restoration and creation projects.

APPROACH: Detailed hydrologic investigations of restoration and creation sites will be coupled with contemporaneous study of adjoining natural wetlands. This study plan will allow us to evaluate how experimental wetlands behave relative to their natural counterparts. Test plots employed in the experimental sites will elucidate the importance of several key parameters in restoration and creation sites, and will aid in the development of guidelines for future wetland mitigation design.

PROGRESS (July 1990 to June 1991): The first phase of this project was to conduct an in-depth literature review, and status of the science assessment for wetland hydrology and wetland restoration and creation. Sites were selected in the summer of 1990 and initial instrumentation networks were established at both sites. Construction plans for the creation site (Wilton, Wisconsin) were developed. Construction will commence in spring 1991.

PLANS (July 1991 to June 1992): Background data collection will be continued and monitoring at new sites will begin after construction is completed.

DETERMINATION OF SEDIMENT REDUCTION GOALS IN PRIORITY WATERSHED PROJECTS, WI-171

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Trempealeau and Kickapoo Watersheds in southwestern Wisconsin

PROJECT CHIEF: Barbara C. Scudder

PERIOD OF PROJECT: July 1990 to September 1991

OBJECTIVE: Using Habitat Suitability Index (HSI) models recently developed by the U.S. Fish and Wildlife Service: (1) determine whether sediment or sediment-related factors may be significantly affecting the fish populations in selected streams of two drainage basins in southwestern Wisconsin; (2) estimate the reduction in these factors necessary to effect a significant increase in the fish populations; and (3) assess the suitability of the models for estimating sediment-reduction goals for the Nonpoint Source Program of the Wisconsin Department of Natural Resources.

APPROACH: Fish and fish habitat data needed to use the appropriate models have been collected by the DNR in the two drainage basins. Literature research on the models and their use will be conducted. Field fish-survey crews will be interviewed and selected streams will be visited. The data will be compiled and the models applied by using an IBM-compatible computer. The significance of sediment or sediment-related factors on the fish population will be determined using the models and sediment-reduction goals will be estimated. DNR staff will be consulted regarding previous use of the models and the utility of the models to the DNR's Nonpoint Source Program will be assessed.

PROGRESS (July 1990 to June 1991): Literature research on the models and their use has been completed. Field fish-survey crews were interviewed and selected streams in both watersheds were visited. The data collected by the DNR has been compiled. The model software has been installed. Selected data conversion/interpretation has been performed to obtain information necessary for model input. Appropriate models, including sensitivity analyses are being run on selected streams in the two watersheds.

PLANS (July 1991 to June 1992): Model work including sensitivity analyses will be completed. Sediment-reduction goals will be estimated using the models. The utility of the models for this purpose will be evaluated for the Nonpoint Source Program. A report will be prepared to summarize the results of the project.

EVALUATION OF WATER-QUALITY TRENDS IN PRIORITY WATERSHEDS, WI 172

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: City of Madison, Wisconsin

PROJECT CHIEF: Peter E. Hughes and Steven J. Corsi

PERIOD OF PROJECT: June 1990 to July 1998

OBJECTIVE: The objective of this project is to determine the trends in water quality for five sites during and after implementation of improved land-management practices in four priority watersheds.

APPROACH: Continuous-record streamflow-gaging stations equipped with refrigerated automatic samplers will be installed at the outlets of small basins where it is likely that improved land-management practices will be implemented. Water-quality samples will be collected during each storm event, and periodic samples will be taken during low flow. Continuous dissolved-oxygen concentration and water temperature will be recorded at each gage, and continuous precipitation data will be recorded at three locations in each basin. Periodic bedload samples will also be collected. Statistical techniques will be used to estimate trends in discharge and selected water-quality constituents.

PROGRESS (July 1990 to June 1991): Two gaging stations in Buffalo County, one in Sheboygan County, and one in Brown County have been installed. Samples for 3 to 8 storms have been collected from each site. Data has been entered in USGS databases.

PLANS (July 1991 to June 1992): Continue with the normal data-collection activities. Prepare quarterly summaries of the data for the cooperator.

WISCONSIN LAKES, ASSESSMENT OF THE HYDROLOGY OF AND PHOSPHORUS LOADING TO FISH AND MUD LAKES, DANE COUNTY, WISCONSIN, WI 17300, 17301

COOPERATOR: Dane County Lakes and Watershed Commission

LOCATION: Northwest Dane County near Roxbury, Wisconsin

PROJECT CHIEF: William J. Rose

PERIOD OF PROJECT: October 1990 to March 1993

OBJECTIVE: The objectives of this study are to define the hydrology of Fish and Mud Lakes and to identify and quantify major sources of phosphorus entering the lakes.

APPROACH: The study will be done in two phases. The first phase is data collection and providing the data to the cooperator. The second phase is to interpret the data and publish a summary report. The study will have a one year (November 1, 1990 to October 31, 1991) data-collection period. Hydrology and phosphorus loading will be evaluated using the following techniques:

Water Budget: The equation describing Fish and Mud Lakes' water budget is as follows:

$$DS = P - E + S + GI + LE - GO \quad (1)$$

where

DS is change in lake storage volume,
P is precipitation,
S is surface runoff into the lake,
GI is ground-water discharge to the lake,
E is evaporation,
LE is lake exchange or net flow through the culvert separating the lakes, and
GO is ground-water recharge from the lake.

Study emphasis will be on only the most significant (with regard to phosphorus loading) water budget components owing to funding constraints. These are DS, P, and S. The remaining components (GI, E, LE, and GO) will be evaluated and, if possible, estimated on the basis of minimal data.

Phosphorus loading: An automatic water sampler will be installed and operated at the tributary gaging station to collect storm-runoff samples for total-phosphorus analysis. Forty to sixty samples will be collected--the number of samples will depend on the number of storms. Phosphorus load will be calculated by the streamflow and phosphorus-integration techniques described by Porterfield (1972).

Surface runoff in many small gullies and drainageways will be sampled for phosphorus-concentration analysis. These data will be the basis for estimating the phosphorus concentration of ungaged storm runoff entering the lake.

PROGRESS (October 1990 to June 1991): Installation of most data-collection equipment was completed in October 1990. Data collection began November 1, 1990. Many samples of snowmelt runoff were collected in February and March. Concentrations of total phosphorus generally were high (0.5 to 67 mg/L).

PLANS (July 1991 to June 1992): Data collection will continue as planned through October 31, 1991. Phosphorus loading will be evaluated and preparation of the final report will begin.

REPORTS:

All data will be published in the annual report "Water Resources Data--Wisconsin." A final report will be published as a USGS Open-File Report.

WISCONSIN LAKES, WHITEWATER LAKE, WISCONSIN, WI 17300, 17302

COOPERATOR: Whitewater Lake Management District

LOCATION: Whitewater Lake, Walworth County

PROJECT CHIEF: Stephen J. Field, Leo B. House

PERIOD OF PROJECT: October 1990 to September 1992

OBJECTIVES: The objectives of this study are to (1) determine the hydrologic budget for Whitewater and Rice Lakes, (2) determine the phosphorus budget for the lakes, (3) describe and quantify the lake's water chemistry, and (4) evaluate the trophic status of the lakes.

APPROACH: Data collection will be from November 15, 1990 to November 14, 1991, with emphasis on the open-water period.

Hydrology: Evaporation and precipitation data will be collected at the study site using an evaporation pan and continuous-rainfall recorders. Precipitation data from the nearby Whitewater weather observation station will be used during freezing periods (from about November through March). Lake stage and storage will be monitored by use of a continuous recorder. A bathymetric map will be used to compute changes in lake storage. Seepage from the lake outlets will be measured monthly. The drainage area to Whitewater Lake is small; therefore, tributary and rivulet flow will be estimated using a rainfall-runoff model. Ground-water flow will be estimated using Darcy's Law and minipiezometer data.

Phosphorus loading: Tributary and rivulet phosphorus loadings will be calculated using the rainfall-runoff model and concentration data from samplers and local observers. Septic-system and ground-water inputs of phosphorus will be estimated using literature values and results of previous investigations on the lake. Atmospheric phosphorus inputs will be estimated by use of data from a USGS study in 1984-85 of Lake Delavan, located about 10 miles southeast. Grab samples of precipitation will also be collected for phosphorus analysis during this study.

In-lake water-quality monitoring: Phosphorus outflow in surface water will be sampled when there is flow. Flow is not anticipated from the outlet. The in-lake water quality will be monitored at four sites. Water samples will be collected from the epilimnion and hypolimnion in spring (April) and fall (October or November). Water samples will be collected twice monthly from May through September. The in-lake phosphorus mass will be calculated from this information. Internal phosphorus load from bottom sediments will be estimated as the difference between the changes in observed in-lake mass and external phosphorus inputs. Considerable diurnal fluctuation of dissolved oxygen is expected during the warm summer months because of the dense aquatic macrophytes. A set of 24-hour dissolved-oxygen profiles will be collected in late July at 3-hour intervals at each of the 4 lake-monitoring sites.

Trophic status: The trophic status of the lake will be evaluated according to Carlson's Trophic State Index (1977) and by use of other empirical models.

PROGRESS (October 1990 to June 1991): The continuous lake-stage recorder, minipiezometers, tributary and rivulet samplers, evaporation pan, and continuous-rainfall recorders were installed. Spring chemistry samples were collected at the deep hole. Monitoring was done as scheduled.

PLANS (July 1991 to June 1992): Continue monitoring as scheduled. Begin compiling data for report after November 14, 1991.

REPORTS: All data will be published in the USGS annual report "Water Resources Data--Wisconsin". A final report will be published as a USGS Open-File Report.

NATIONAL WATER-QUALITY ASSESSMENT (NAWQA) OF WESTERN LAKE MICHIGAN, WI 174

COOPERATOR: U.S. Geological Survey, Reston, Virginia

LOCATIONS: Ford and Escanaba River basins in Michigan, Menominee-Oconto-Peshtigo and Fox-Wolf River basins, along with the western Lake Michigan basin in Wisconsin

PROJECT CHIEF: James G. Setmire

PERIOD OF PROJECT: December 1990-Continuing

OBJECTIVES: The long-term goals of the NAWQA project are to describe the status and trends in the quality of water in the western Lake Michigan study area and to provide a sound, scientific understanding of the primary natural and human factors affecting the quality of these resources. For the surface-water component of the study, the objectives are: (1) describe the occurrence and the spatial distribution of a broad array of water-quality constituents, (2) estimate loads of selected water-quality constituents at key locations, (3) provide information on the seasonal variation and the frequency of occurrence of selected water-quality constituents at key locations, (4) define long-term trends in concentrations and/or loads of selected constituents, and (5) identify, describe, and explain, as possible, the major factors that affect observed conditions and trends in surface-water quality. For the ground-water component of the study, the objectives are: (1) describe general ground-water quality conditions for major hydrogeologic settings, (2) describe the geographic distribution within the study area of selected water-quality constituents and problem areas, (3) define long-term trends in ground-water quality, and (4) identify, describe, and explain, as possible, the major factors that affect observed current conditions and trends in ground-water quality.

APPROACH: For both the surface- and ground-water components, available data will be analyzed to provide background information in order to identify water-quality issues in the study area and to serve as a starting point for meeting the study objectives. The surface-water component will have three major types of sampling activities: fixed-station monitoring, synoptic sampling, and selected reach studies. The ground-water component also will have three major activities: regional sampling for a wide array of water-quality constituents, targeted sampling in selected locations of the study area for specific groups of water-quality constituents, and long-term sampling of selected wells.

PROGRESS (December 1990 to June 1991): A fact sheet has been prepared for distribution describing the study area and the major water-quality issues to be addressed by the NAWQA.

PLANS (July 1991 to June 1992): Several iterations of a workplan describing implementation of the western Lake Michigan NAWQA will be prepared during the next year. A retrospective analysis of available data also will be undertaken during FY 1992, while the major sampling activities will not commence until FY 1993.

NORTHERN TEMPERATE LAKES WEBB, WI 175

COOPERATOR: Global Change Hydrology Program, WRD, U.S. Geological Survey

LOCATION: Northcentral Wisconsin

PROJECT CHIEFS: John F. Elder, David P. Krabbenhoft and John F. Walker

PERIOD OF PROJECT: October 1990 to September 1993

OBJECTIVES: The Wisconsin site was one of five chosen by the Global Change Hydrology Program for the investigation of Water, Energy, and Biogeochemical Budgets (WEBB). The overall long-term objective of the Wisconsin WEBB investigation is to understand processes underlying the responses of hydrological, biological, and chemical systems in the study area to climate variations and human activities. The initial funding level supports two research elements, specifically (1) rainfall/streamflow/recharge processes and (2) ground- and surface-water interactions. Each research element will be discussed separately.

RAINFALL/STREAMFLOW/RECHARGE PROCESSES

OBJECTIVE: The objectives of this research element are to investigate the partitioning of precipitation into quick-response streamflow and recharge, and to develop predictive capabilities for the identified streamflow generation and recharge processes.

APPROACH: The approach for this research element involves a combination of isotope sampling and moisture accounting. Initially, three sites have been chosen: one streamflow/recharge site and two upland recharge sites (one exposed, one under the forest canopy). Manual sampling of the stream, piezometers, and lysimeters will be conducted before, during, and after precipitation events. Several rain gages throughout the study area will provide instantaneous intensities as well as composite isotope samples. A complete climatological station will provide support data, and compliments an existing climatological raft run by the University of Wisconsin Long-Term Ecological Research project.

PROGRESS (October 1990 to June 1991): The three initial sites were selected, and the appropriate equipment was installed. For the streamflow generation site, this includes a continuous-record rain gage, a continuous-record streamflow-gaging station, a nest of thermistors for temperature profiling in the stream bed, two continuous-record water-table wells, and an array of lysimeters and soil-moisture sensors along a transect intersecting the stream. For the upland recharge sites, this includes continuous-record rain gages and an array of lysimeters and soil-moisture sensors. In addition, two continuous-record rainfall gages and a complete weather station were installed in the Trout Lake basin to collect support data. A full-time technician was hired and stationed at the University of Wisconsin Trout Lake Station, and data collection was started at all sites. A poster describing the Wisconsin WEBB project was presented at the Spring 1991 USGS Global Change Research Forum in March. A draft of an Open-File report describing the planned project activities was prepared and submitted for colleague review.

PLANS (July 1991 to June 1992): Data-collection activities will continue at all sites. Streams and recharge sites will be sampled before, during, and after rainfall events. Literature searches will be conducted to determine appropriate isotope sampling and analysis techniques, and to consider appropriate rainfall-runoff models. Two seepage runs will be made during summer and fall baseflow periods to examine the spatial variability of ground water/stream interactions. Snowpack surveys and representative samples will be collected during winter and early spring.

GROUND- AND SURFACE-WATER INTERACTIONS

OBJECTIVES: The objectives of this research element are to identify geochemical processes that control the flux of important chemical species at the sediment/lake interface, and to investigate the influence of stream and ground-water flow on the solute budgets for and residence time characteristics of Trout Lake.

APPROACH: The approach for the second research element involves fine-scale sampling at the sediment/lake interface of Trout Lake, and monitoring and sampling all tributary streams to and the outlet from Trout Lake. The fine-scale sampling will consist of a variety of techniques, including membrane equilibrators, core squeezing, microprobes, and seepage-meters. CO_2 and CH_4 production rates for sediment extracts will be used to isolate critical processes. Samples for nutrients and major ions for all of the inlets to and the outlet from Trout Lake will be used to assess the importance of stream sources to solute budgets. Various techniques for estimating the residence time distribution for Trout Lake will be considered.

PROGRESS (October 1990 to June 1991): Sites for lake-bed sampling were selected and preliminary techniques were tested. Continuous-record streamflow-gaging stations were installed on two streams tributary to Trout Lake, and on the Trout River at the outlet from Trout Lake. Daily record collected by observers at the other two tributary streams will be used to estimate discharge for those streams. Samples at all of the streams were collected and analyzed for major ions and nutrients.

PLANS (July 1991 to June 1992): Sampling of the lake-bed sites and research into appropriate sampling techniques will continue. Data collection will continue at the five stream sites. Samples will be collected before, during, and after precipitation events. A literature search will identify appropriate techniques for estimating residence time distributions.

REPORTS (all research elements):

Elder, J.F., Krabbenhoft, D.P., and Walker, J.F., Hydrologic and Chemical Budgets in Temperate Lakes and their Watersheds, Northern Wisconsin: 1991 Work Plan, U.S. Geological Survey Open-File Report, in review

SOURCES OF POLLUTANTS IN URBAN RUNOFF, WI 176

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: City of Madison, Wisconsin

PROJECT CHIEF: Peter E. Hughes

PERIOD OF PROJECT: March 1991 to June 1992

OBJECTIVE: The objective of this project is to determine the concentrations of selected contaminants in sheet flow from urban surfaces and evaluate the relative contributions of the contaminants from different types of surfaces.

APPROACH: Two small urban basins on the southwest side of Madison will be used for evaluation. Fifty-three source areas will be sampled for 10 runoff events between April 15 and June 30, 1991. Samples from streets, rooftops, parking lots, driveways, and lawns will be analyzed for concentrations of metals, phosphorus, and bacteria.

PROGRESS (July 1990 to June 1991): All field equipment was installed and samples from the source areas have been analyzed.

PLANS (July 1991 to June 1992): Enter the data in the USGS database. Summarize the data in a final report.

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, Virginia. Two projects are in progress: discharge determination during ice cover and velocity profiles under an ice cover. The individual objective, approach, progress, and plans for each project follow.

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 U.S. Geological Survey 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 will be collected at three sites in Iowa for the winter of 1988. All of the methods will be compared to the data set with the frequent winter discharge measurements and an error analysis will be performed.

PROGRESS (July 1990 to June 1991): Final report format was changed to water-supply paper. An interim open-file report was prepared, printed and distributed. Water-supply paper was sent to Geologic Division for review. Journal article was accepted by ASCE Journal of Hydraulic Engineering. Galley proofs were reviewed.

PLANS (July 1991 to June 1992): Respond to reviews of water-supply paper.

REPORTS:

Melcher, N. B., and Walker, J. F., 1990, Evaluation of selected methods for determining streamflow during periods of ice effect, U.S. Geological Survey Open-File Report 90-554, 51 p.

Walker, J. F., 1991, Accuracy of selected techniques for estimating ice-affected streamflow, ASCE Journal of Hydraulic Engineering (in press).

VELOCITY PROFILES UNDER AN ICE COVER

OBJECTIVE: The objectives of this project are to determine the variation of coefficients for adjusting point velocity to mean velocity at various locations under an ice cover and to develop recommendations for measuring discharge under an ice cover.

APPROACH: Weekly velocity profiles will be made at 13 sites across the United States. Complete vertical velocity profiles will be made at the usual 20-30 points across the cross section. For each profile, coefficients to adjust point velocity to mean velocity will be computed using an integrated estimate of the mean velocity in the vertical. The coefficients will be analyzed at each site to determine spatial and temporal variations, and for variation across sites. Various computational procedures will be compared to discharge computed using the full profile information.

PROGRESS (July 1990 to June 1991): Analyzed data from a limited comparison of polymer and metal current meter rotors. Began designing experiment to allow assessment of adequacy of database, which was collected largely using polymer rotors. Performed analysis of database subset collected with metal rotors. Began working with Office of Surface Water and Iowa Institute of Hydraulic Research (IIHR) to secure funding for a PhD graduate student to look at theoretical and laboratory aspects of flow characteristics under an ice cover. Presented preliminary results to Northeast Region data section chiefs and surface water specialists meeting in November 1990.

PLANS (July 1991 to June 1992): Complete design of polymer/metal rotor comparison experiment. Collect data during 1991-1992 winter period at original 13 sites. Complete analysis of paired rotor experiment and assess adequacy of database. Begin working with IIHR to direct research of graduate student.

REPORTS:

Walker, J. F., and Wagner, C. R., Analysis of adjustment coefficients for measuring discharge under an ice cover (in preparation).

WISCONSIN DISTRICT PUBLICATIONS

The reports listed below are a partial list of reports prepared by the Wisconsin District in cooperation with other agencies since 1948. The list contains reports that are relevant and contribute significantly to understanding the hydrology of Wisconsin's water resources.

The reports published in a U.S. Geological Survey series are for sale by the U.S. Geological Survey, Box 25425, Federal Center Denver, CO 80225. Prepayment is required. Remittance should be sent by check or money order payable to the U.S. Geological Survey Prices can be obtained by writing to the above address or by calling (303)236-7476. Copies of reports published by the University of Wisconsin, Geological and Natural History Survey, can be obtained from their office at 3817 Mineral Point Road, Madison, WI 53705.

WATER-SUPPLY PAPERS

U.S. Geological Survey, 1990, National water summary 1987--Hydrologic events and water supply and use: U.S. Geologcal Survey Water-Supply Paper 2350, 553 p.

_____,1988, National water summary 1986--Hydrologic events, selected water-quality trends, and ground-water quality: U.S. Geological Survey Water-Supply Paper 2325, 569 p.

_____1986, National water summary 1985--Hydrologic events and surface-water resources: U.S. Geological Survey Water-Supply Paper 2300, 506 p.

_____1985, National water summary 1984--Hydrologic events, selected water-quality trends, and ground-water resources: U.S. Geological Survey Water-Supply Paper 2275, 467 p.

_____1984, National water summary 1983--Hydrologic events and issues: U.S. Geological Survey Waer-Supply Paper 2250, 243 p.

Batten, W.G., and Hindall, S.M., 1980, Sediment deposition in the White River Reservoir, northwestern Wisconsin: U.S. Geological Survey Water-Supply Paper 2069, 30 p.

Sherrill, M.G., 1978, Geology and ground water in Door County, Wisconsin, with emphasis on contamination potential in the Silurian dolomite: U.S. Geological Survey Water-Supply Paper 2047, 38 p.

Hurtgen, D.C., 1975, Summary of floods, June 29-30 in southwestern Wisconsin, in Summary of floods in the United States during 1969: U.S. Geological Survey Water-Supply Paper 2030, p. 116-119.

Bell, E.A., and Sherrill, M.G., 1974, Water availability in central Wisconsin--an area of near-surface crystalline rock: U.S. Geological Survey Water-Supply Paper 2022, 32 p.

Novitzki, R.P., 1973, Improvement of trout streams in Wisconsin by augmenting low flows with ground water: U.S. Geological Survey Water-Supply Paper 2017, 52 p.

Oakes, Edward, Field, S.J., and Seeger, L.P., 1973, The Pine-Popple River basins--hydrology of a wild river area, northeastern Wisconsin: U.S. Geological Survey Water-Supply Paper 2006, 57 p.

Hamilton, L.J., 1971, Water for cranberry culture in the Cranmoor area of central Wisconsin: U.S. Geological Survey Water-Supply Paper 1999-I, 20 p.

Hurtgen, D.C., 1972, Floods of March 27-April 4, 1967, in northwestern and west-central Wisconsin, in Summary of floods in the United States during 1967: U.S. Geological Survey Water-Supply Paper 1880-C, p. 7-10.

Hutchinson, R.D., 1970, Ground-water resources of Racine and Kenosha Counties, Wisconsin: U.S. Geological Survey Water-Supply Paper 1878, 63 p.

Olcott, P.G., 1966, Geology and water resources of Winnebago County, Wisconsin: U.S. Geological Survey Water-Supply Paper 1814, 61 p.

Weeks, E.P., Erickson, D.W., and Holt, C.L.R., Jr., 1965, Hydrology of the Little Plover River basin, Portage County, Wisconsin, and the effects of water-resources development: U.S. Geological Survey Water-Supply Paper 1811, 78 p.

Green, J.H., and Hutchinson, R.D., 1965, Ground-water pumpage and water-level changes in the Milwaukee-Waukesha area, Wisconsin, 1950-61: U.S. Geological Survey Water-Supply Paper 1809-I, 19 p.

Summers, W.K., 1965, Geology and ground-water resources of Waushara County, Wisconsin: U.S. Geological Survey Water-Supply Paper 1809-B, 32 p.

Holt, C.L.R., Jr., and Knowles, D.B., 1963, The water situation in Wisconsin in the role of ground water in the national water situation: U.S. Geological Survey Water-Supply Paper 1800, p. 943-960.

Cline, D.R., 1965, Geology and ground-water resources of Dane County, Wisconsin: U.S. Geological Survey Water-Supply Paper 1779-U, 64 p.

Holt, C.L.R., Jr., 1965, Geology and water resources of Portage County, Wisconsin: U.S. Geological Survey Water-Supply Paper 1796, 77 p.

Berkstresser, C.F., Jr., 1964, Ground-water resources of Waupaca County, Wisconsin: U.S. Geological Survey Water-Supply Paper 1669-U, 38 p.

Knowles, D.B., 1964, Ground-water conditions in the Green Bay area, Wisconsin, 1950-60: U.S. Geological Survey Water-Supply Paper 1669-J, 37 p.

Cline, D.R., 1963, Hydrology of upper Black Earth Creek basin, Wisconsin, with a section on surface water by M.W. Busby: U.S. Geological Survey Water-Supply Paper 1669-C, 27 p.

Collier, C.R., 1963, Sediment characteristics of small streams in southern Wisconsin, 1954-59: U.S. Geological Survey Water-Supply Paper 1669-B, 34 p.

LeRoux, E.F., 1963, Geology and ground-water resources of Rock County, Wisconsin: U.S. Geological Survey Water-Supply Paper 1619-X, 50 p.

Newport, T.G., 1962, Geology and ground-water resources of Fond du Lac County, Wisconsin: U.S. Geological Survey Water-Supply Paper 1604, 52 p.

Knowles, D.B., Dreher, F.C., and Whetstone, G.W., 1964, Water resources of the Green Bay area, Wisconsin: U.S. Geological Survey Water-Supply Paper 1499-G, 66 p.

LeRoux, E.F., 1957, Geology and ground-water resources of Outagamie County, Wisconsin: U.S. Geological Survey Water-Supply Paper 1421, 57 p.

Harger, A.H., and Drescher, W.J., 1954, Ground-water conditions in south-western Langlade County, Wisconsin: U.S. Geological Survey Water-Supply Paper 1294, 39 p.

Foley, F.C., Walton, W.D., and Drescher, W.J., 1953, Ground-water conditions in the Milwaukee-Waukesha area, Wisconsin: U.S. Geological Survey Water-Supply Paper 1229, 96 p.

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