WATER-RESOURCES INVESTIGATIONS IN WISCONSIN, 1993

By
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U.S. GEOLOGICAL SURVEY

Open-File Report 93-129

Madison, Wisconsin
1993

U.S. DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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Denver, Colorado 80255

CONTENTS

Illustrations

BASIC MISSION AND PROGRAMS

U.S. Geological Survey

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

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

Conducting detailed assessments of the energy and mineral potential of land and offshore areas.

Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.

Conducting research on the geologic structure of land and offshore areas.

Studying the geologic features, structure, processes, and history of the other planets of our solar system.

Conducting topographic surveys and preparing topographic and thematic maps and related cartographic products.

Developing and producing digital cartographic data bases and products.

Collecting data on a routine basis to determine the quantity, quality, and use of surface water and ground water.

Conducting water-resource appraisals to describe the consequences of alternative plans for developing land and water resources.

Conducting research in hydraulics and hydrology, and coordinating all Federal water-data acquisition.

Using remotely sensed data to develop new cartographic, geologic, and hydrologic research techniques for natural resources planning and management.

Providing earth-science information through an extensive publications program and a network of public access points.

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

Water Resources Division

The mission of the Water Resources Division (WRD) is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States. This mission is accomplished, in large part, through cooperation with other Federal and non-Federal agencies, by:

Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.

Conducting analytical and interpretive water-resource appraisals describing the occurrence, availability, and physical, chemical, and biological characteristics of surface water and ground water.

Conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict their response to stress.

Disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases.

Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground water.

Providing scientific and technical assistance in hydrologic fields to other Federal, State, and local agencies, to licensees of the Federal Energy Regulatory Commission, and to international agencies on behalf of the U.S. Department of State.

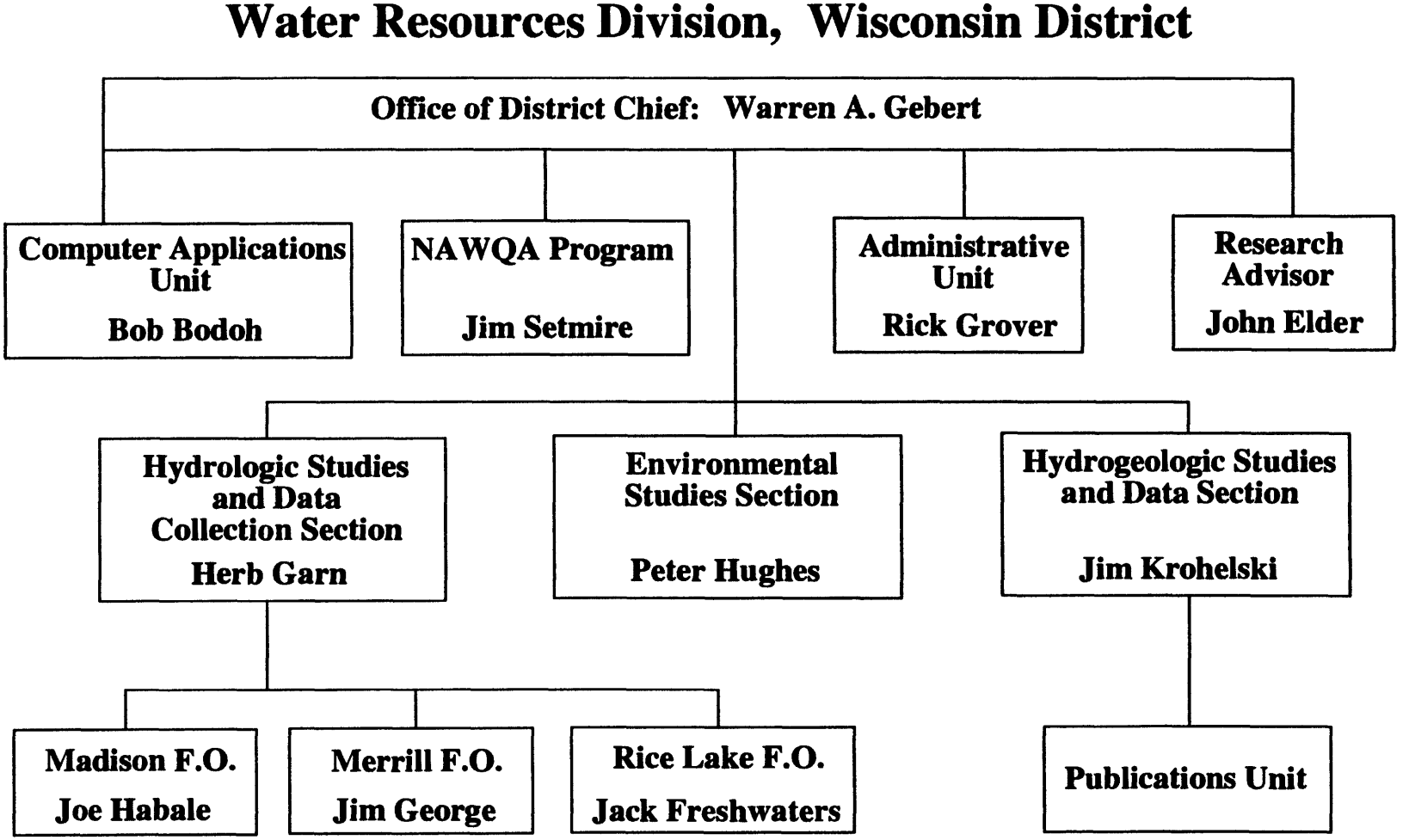


Figure 1 -- Organization chart of the U.S. Geological Survey, Water Resources Division, Wisconsin District.

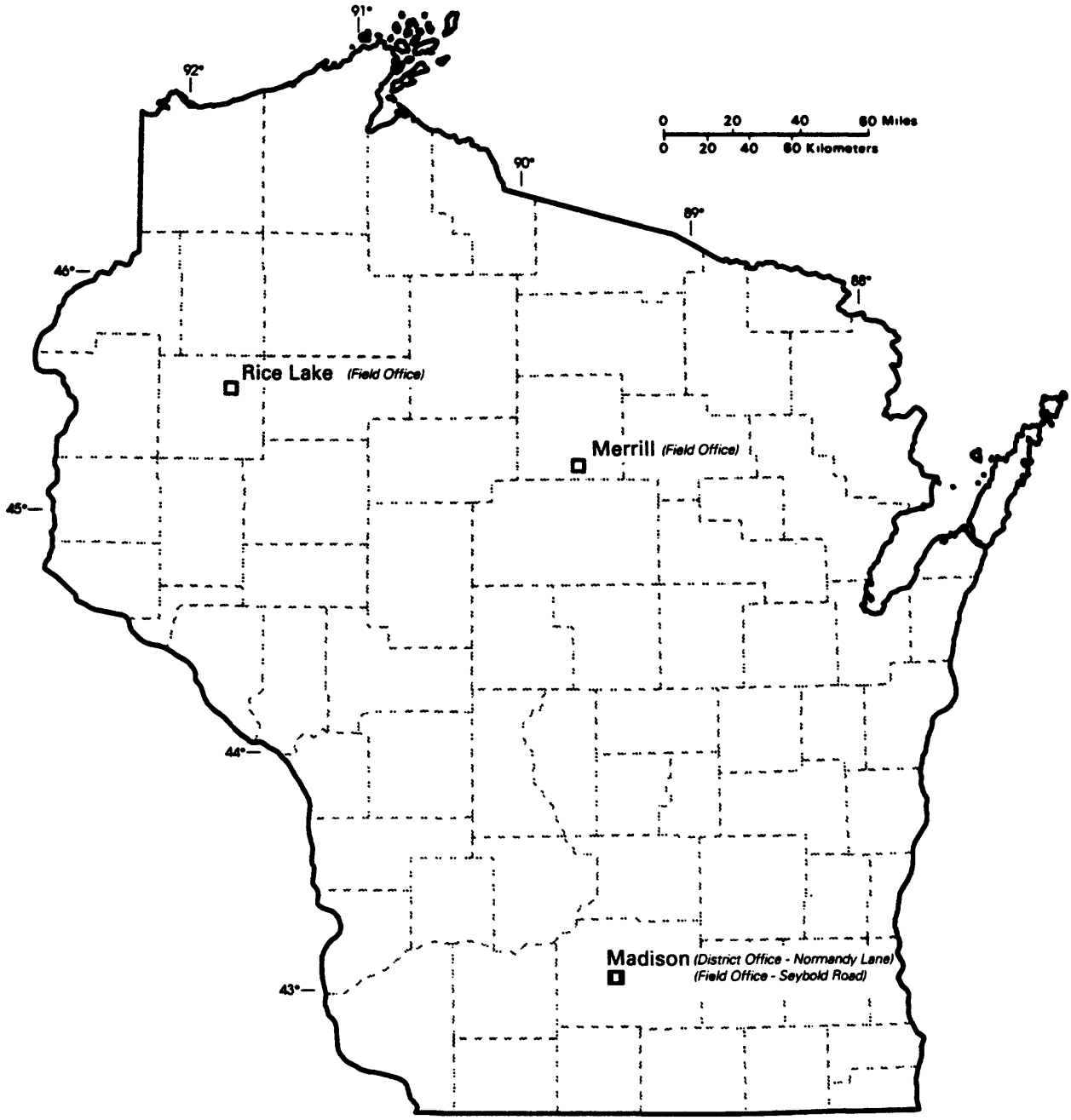


Figure 2. Location of offices in the Wisconsin District.

FUNDING SOURCES

State Agencies

Illinois Department of Transportation
Wisconsin Department of Natural Resources
Wisconsin Department of Transportation
Wisconsin Geological and Natural History Survey

Local Agencies

Brown County Planning Commission
City of Barron
City of Beaver Dam
City Of Brookfield
City of Fond du Lac
City of Galena, Illinois
City of Hillsboro
City of Madison
City of Middleton
City of Peshtigo
City of Sparta
City of Thorp
City of Waupun
Dane County Regional Planning Commission
Dane County Department of Public Works
Darboy Sanitary District #1
East Central Wisconsin Regional Planning Commission
Fontana/Walworth Water Pollution Control Commission
Green Bay Metropolitan Sewerage District
Greenville Sanitary District
Kaukauna Electric and Water Utilities
Kimberly Water Works Department
Madison Metropolitan Sewerage District
Rock County Public Works Department
Southeastern Wisconsin Regional Planning Commission
Town of Menasha Sanitary District #4
Village of Little Chute
Village of Wittenberg

Other Federal Agencies

U.S. Army Corps of Engineers,
  Detroit District
  Rock Island District
  St. Paul District
  Vicksburg, MS
Federal Emergency Management Agency
Federal Energy Regulatory Commission licensees
U.S. Environmental Protection Agency

Indian Tribes

Bad River Band of Lake Superior Chippewa
Lac du Flambeau Band of Lake Superior Chippewa
Menominee Indian Tribe of Wisconsin
Oneida Tribe of Indians of Wisconsin
Red Cliff Band of Lake Superior Chippewa
Sokaogon Chippewa Community
Stockbridge-Munsee Band of Mohican Indians

Lake Districts

Alma/Moon Lake District
Balsam Lake Protection and Rehabilitation District
Big Muskego Lake District
City of Muskego
Dane County Lakes and Watershed Management
Delavan Lake Sanitary District
Druid Lake Protection and Rehabilitation District
Eagle Spring Lake Management District
Fowler Lake Management District
Green Lake Sanitary District
Hooker Lake District
Little Arbor Vitae Lake District
Little Green Lake Protection and Rehabilitation District
Little Muskego Lake District
Little St. Germain Lake District
Loon Lake/Wescot Management District
Marinette County Land Conservation Department
Okauchee Lake District
Park Lake Management District
Potters Lake Rehabilitation and Protection District
Powers Lake Management District
Pretty Lake Management District
Wolf Lake Management District
Town of Baraboo
Town of Bear Lake
Town of Cedar Lake
Town of Delavan
Town of Hubbard
Town of Kansasville
Town of Mead
Town of Merton
Town of Norway
Town of St. Germain
Town of Summit
Town of Troy
Village of Lake Nebagamon
Village of Oconomowoc Lake
Whitewater/Rice Lakes Management District
Wind Lake Management District
Wisconsin Department of Justice

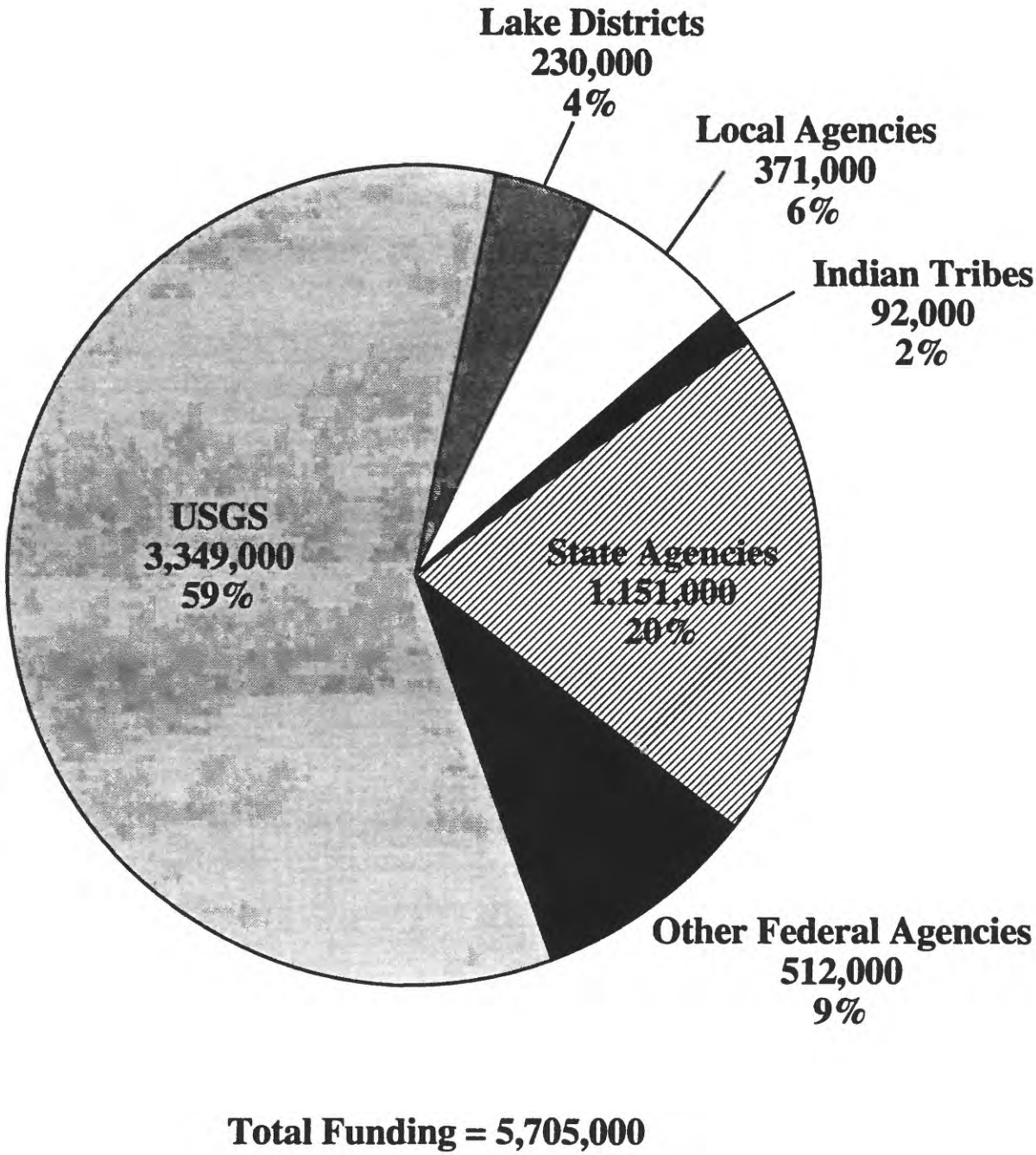


Figure 3. Funding sources for the water-resources program in Wisconsin for the 1993 fiscal year.

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
Federal Energy Regulatory Commission Licensees
Lac du Flambeau Band of Lake Superior Chippewa
Illinois Department of Transportation
City of Barron
City of Beaver Dam
City of Brookfield
City of Galena, Ill.
City of Hillsboro
City of Peshtigo
City of Sparta
City of Thorp
City of Waupun
Village of Wittenberg
Fontana/Walworth Water Pollution Control Commission
Rock County Public Works Department

LOCATION:

Statewide

PROJECT CHIEF:

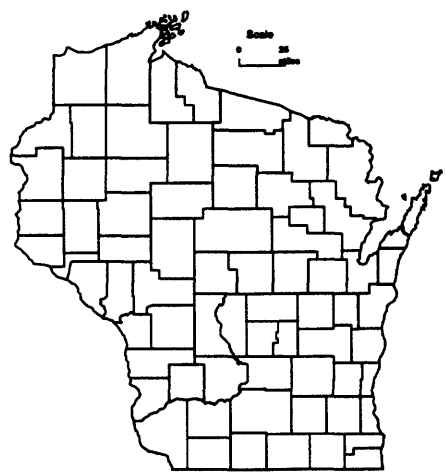
Barry K. Holmstrom

PERIOD OF PROJECT:

July 1913-Continuing

PROBLEM: Surface-water information is needed for surveillance, planning, design, hazard warning, operation, and management in water-related fields such as water supply, hydroelectric power, flood control, irrigation, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water-resources development. An appropriate data base is necessary to provide this information.

OBJECTIVE: The objectives of this study are to provide continuous discharge records for 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 floods, 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 stage records 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 government agencies, consultants, and private parties will be processed.

PROGRESS (July 1992 to June 1993): During the current fiscal year, streamflow data were collected at a total of 95 sites: 37 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 sites for Federal Energy Commission Licensees, 2 sites for the Madison Metropolitan Sewerage District, and 1 site each for the Lac du Flambeau Band of Lake Superior Chippewa, Illinois Department of Transportation, cities of Barron, Beaver Dam, Brookfield, Galena, Hillsboro, Peshtigo, Sparta, Thorp, Waupun, village of Wittenberg, and Fontana/Walworth Water Pollution Control Commission. Streamflow data were also collected at 13 sites for agencies working jointly with the USGS. 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 Public Works Department.

Computation of streamflow and lake-level records for all the network stations for the 1992 water year was completed, stored in our WATSTORE computer data base, and published in the annual "Water Resources Data—Wisconsin, Water Year 1992" report.

More than 100 requests for streamflow information were answered.

PLANS (July 1993 to June 1994): Data collection will continue at 95 continuous-streamflow stations (see the following list) and lake levels at 5 stations. Streamflow records will be computed and data published for the 1993 water year. Requests for streamflow information will be answered.

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 1994 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.
04065106	Menominee River - Niagara	1993-	FERC
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
04082400	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
05356500	Chippewa River - Bruce	1914-	DNR
05357335	Bear River - Manitowish Waters	1991	Lac du Flambeau Band of Lake Superior Chippewa
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
053674464	Yellow River - Barron	1991	City of Barron
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
05382325	La Crosse River - Sparta	1992-	City of Sparta
05391000	Wisconsin River - Lake Tomahawk	1936-	DNR

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 1994 FY

Station no.	Name and location	Period of record (water year)	Cooperator
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
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-	DNR
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
05436500	Sugar River - Brodhead	1914-	DNR
05438283	Piscasaw Creek - Walworth	1992-	Fontana/Walworth WPCC
05543800	Fox River -Watertown - Waukesha	1993-	City of Brookfield
05543830	Fox River - Waukesha	1963-	SEWRPC
05544200	Mukwonago River - Mukwonago	1973-	SEWRPC
05546500	Fox River - Wilmot	1940-	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, 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
Fontana/Walworth WPCC — Fontana/Walworth Water Pollution Control Commission

Figure 4. Location of continuous-record data-collection stations.

DISCONTINUED SURFACE-WATER DISCHARGE STATIONS

The following continuous-record surface-water discharge stations in Wisconsin have been discontinued. Daily streamflow records were collected and published for the period of record, expressed in water years, shown for each station. Those stations with an asterisk (*) after the station number are currently operated as crest-stage partial-record stations. Some of the discontinued project stations with less than 3 years of record have not been included. Information regarding these stations may be obtained from the District Office at the address given on the back side of the title page of this report.

Discontinued surface-water discharge stations

Station name	Station number	Drainage area (sq mi)	Period of record
STREAMS TRIBUTARY TO LAKE SUPERIOR			
Little Balsam Creek at Patzau, WI	04024314	4.89	1976-78
Little Balsam Creek near Patzau, WI	04024315	5.05	1976-78
Little Balsam Creek Tributary near Patzau, WI	04024318	0.60	1976-78
Little Balsam Creek near Foxboro, WI	04024320	3.27	1977-78
Amnicon River near Poplar (Amnicon Falls), WI	04025000	110	1914-16
Bois Brule (Brule) River near Brule, WI	04026000	160	1914-17
Sioux River near Washburn, WI	04026300*	33.9	1965-66
Pine Creek at Moquah, WI	04026347	6.20	1976-78
Pine Creek Tributary at Moquah, WI	04026348	0.48	1976-78
Pine Creek near Moquah, WI	04026349	19.9	1976-78
North Fish Creek near Moquah, WI	040263491	65.4	1990-91
Bad River near Mellen, WI	04026450*	82.0	1971-75
Bad River at Mellen, WI	04026500	98.3	1948-55
Alder Creek near Upson, WI	04026870	22.2	1972-77
Montreal River near Kimball, WI	04028500	100	1924-26
West Fork Montreal River at Gile, WI	04029000	75.0	1918-26, 1943-47
West Fork Montreal River near Kimball, WI	04029500	86.2	1924-26
STREAMS TRIBUTARY TO LAKE MICHIGAN			
North Branch Pine River at Windsor Dam nr Alvin, WI	04063640*	27.8	1967-68
Pine River near Florence, WI	04064000	510	1914-23
Pine River below Pine River Power Plant near Florence, WI	04064500	533	1924-76
Pike River at Amberg, WI	04066500	255	1914-70
Menominee River near McAllister, WI	04067500	3,930	1945-61, 1979-86, 1988-90
Peshtigo River at High Falls near Crivitz, WI	04068000	537	1912-57
Suamico River at Suamico, WI	04072000	60.7	1951-52
Lawrence Creek near Westfield, WI	04072750	13.4	1968-73
Grand River near Kingston, WI	04073050	73.5	1968-75
West Branch White River near Wautoma, WI	04073405	38.9	1964-75
White Creek at Forest Glen Beach near Green Lake, WI	04073462	3.05	1982-88
Swamp Creek above Rice Lake at Mole Lake, WI	04074538	46.3	1977-83, 1985-87
Swamp Creek below Rice Lake at Mole Lake, WI	04074548	56.8	1977-79, 1982-85
Wolf River near White Lake, WI	04075000	485	1935-38
Evergreen Creek near Langlade, WI	04075200*	8.09	1964-73
Wolf River above West Branch Wolf River, WI	04075500	616	1928-62
West Branch Wolf River at Neopit, WI	04076000	93.2	1911-17
West Branch Wolf River near Keshena, WI	04076500	163	1928-32
Embarrass River near Embarrass, WI	04078500	384	1919-85
Little Wolf River near Galloway, WI	04079602	22.6	1974-79
Spaulding Creek near Big Falls, WI	04079700*	5.57	1964-66
Little Wolf River at Royalton, WI	04080000	507	1914-70, 1983-85
Emmons Creek near Rural, WI	04080950	25.1	1977
Storm Sewer to Mirror Lake at Waupaca, WI	04080976	0.04	1971-74
Waupaca River near Waupaca, WI	04081000	265	1916-66, 1983-85
Daggets Creek at Butte Des Morts, WI	04081800	10.6	1977
West Branch Fond du Lac River at Fond du Lac, WI	04083000	83.1	1939-54
East Branch Fond du Lac River near Fond du Lac, WI	04083500	78.4	1939-54
Brothertown Creek at Brothertown, WI	04084200	5.10	1976-77
Onion River at Hingham, WI	04085813	37.2	1979-80
Onion River near Sheboygan Falls, WI	04085845	94.1	1979-82
Milwaukee River at Kewaskum, WI	04086150	138	1968-81
East Branch Milwaukee River near New Fane, WI	04086200	54.1	1968-81

Discontinued surface-water discharge stations

Station name	Station number	Drainage area (sq mi)	Period of record
North Branch Milwaukee River near Fillmore, WI	04086340	148	1968-81
Milwaukee River at Waubeka, WI	04086360	432	1968-81
Mud Lake Outlet near Decker Corner, WI	04086488	7.36	1983-84
Milwaukee River above North Ave Dam at Milwaukee, WI	04087010	702	1982-84
Menomonee River at Germantown, WI	04087018	19.0	1975-77
Jefferson Park Drainageway at Germantown, WI	04087019	1.82	1976-78
Menomonee River at Butler, WI	04087040	60.6	1975-79
Little Menomonee River near Freistadt, WI	04087050*	8.0	1975-79
Noyes Creek at Milwaukee, WI	04087060	1.94	1975-80, 1990
Little Menomonee River at Milwaukee, WI	04087070	19.7	1975-77
Honey Creek at Wauwatosa, WI	04087119	10.3	1975-81
Schoonmaker Creek at Wauwatosa, WI	04087125	1.94	1975-79
Hawley Road Storm Sewer at Milwaukee, WI	04087130	1.83	1975-77
Menomonee River at Milwaukee, WI	04087138	134	1982-84
Kinnickinnic River at Milwaukee, WI	04087160	20.4	1976-83
	ST. CROIX RIVER BASIN		
Namekagon River at Trego, WI	05332000	433	1914-27
Loon Creek near Danbury, WI	05335010	17.6	1970-71
Bashaw Brook near Shell Lake, WI	05335380*	26.6	1964-66
Clam River near Webster, WI	05335500	361	1941-42
St. Croix River near Grantsburg, WI	05336000	2,980	1923-70
Wood River near Grantsburg, WI	05339000	185	1939-40
Rice Creek near Balsam Lake, WI	05341375	12.5	1988-89
Balsam Branch at Balsam Lake, WI	05341402	52.8	1988-90
Kinnickinnic River near River Falls, WI	05342000	165	1917-21
	CHIPPEWA RIVER BASIN		
West Fork Chippewa River at Lessards, nr Winter, WI	05355500	474	1912-16
Couderay River near Couderay, WI	05356121	169	1981-83
Flambeau River at Flambeau Flowage (Flambeau Reservoir), WI	05357500	622	1927-61
Flambeau River near Butternut, WI	05358000	688	1914-39
Pine Creek near Oxbo, WI	05358300	38.9	1971-75
Flambeau River at Babbs Island near Winter, WI	05358500	967	1929-75
South Fork Flambeau River near Phillips, WI	05359500	609	1929-75
Price Creek near Phillips, WI	05359600*	16.9	1964-66
Flambeau River near (at) Ladysmith, WI	05360000	1,790	1903-06, 1914-61
Chippewa River near Holcombe, WI	05361000	3,720	1944-49
South Fork Jump River near Ogema, WI	05361500	327	1944-54
Chippewa River at Holcombe, WI	05362500	4,680	1943-49
Fisher River at (near) Holcombe, WI	05363000	81.5	1944-45
O'Neil Creek near Chippewa Falls, WI	05363500	78.1	1944-45
Yellow River near Hannibal, WI	05363700	86.7	1962-63
Yellow River at Cadott, WI	05364000*	364	1943-61
Duncan Creek at Bloomer, WI	05364500*	50.3	1944-52
Duncan Creek Tributary near Tilden, WI	05364850	4.17	1987-89
Duncan Creek at Chippewa Falls, WI	05365000	117	1943-55
Eau Claire River near Augusta, WI	05366000	509	1914-26
Bridge Creek at Augusta, WI	05366300	35.0	1980
Eau Claire River near Fall Creek, WI	05366500*	760	1943-55
Chippewa River at (near) Eau Claire, WI	05367000	6,620	1903-09, 1944-54
Red Cedar River near Cameron, WI	05367425	442	1966-70
Red Cedar River near Cameron, WI	05367426	443	1971-73
Red Cedar River near Colfax, WI	05367500	1,100	1914-80, 1989-90
Eau Galle River near Woodville, WI	05369900	39.4	1978-83
French Creek near Spring Valley, WI	05369955	6.03	1981-83
Lousy Creek near Spring Valley, WI	05369970	5.97	1981-83
Lohn Creek near Spring Valley, WI	05369985	2.53	1981-83
Eau Galle River at Elmwood, WI	05370500	91.6	1943-54
	BUFFALO RIVER BASIN		
Buffalo River near Tell, WI	05372000	406	1933-51

Discontinued surface-water discharge stations

Station name	Station number	Drainage area (sq mi)	Period of record
TREMPEALEAU RIVER BASIN			
Bruce Valley Creek near Pleasantville, WI	05379288	10.1	1980
Elk Creek near Independence, WI	05379305	108	1980
Trempealeau River at Arcadia, WI	05379400	553	1960-77
Trempealeau River near Trempealeau, WI	05380000	719	1932-34
BLACK RIVER BASIN			
Black River at Medford, WI	05380806	48.1	1984-87
Poplar River near Owen, WI	05380900*	155	1964-66
LA CROSSE RIVER BASIN			
Little LaCrosse River near Leon, WI	05382500	76.9	1934-61, 1979-81
LaCrosse River near West Salem, WI	05383000	396	1914-70
COON CREEK BASIN			
Spring Coulee Creek near Coon Valley, WI	05386490	9.01	1979-81
Coon Creek at Coon Valley, WI	05386500	77.2	1934-40, 1978-81
Coon Creek near Stoddard, WI	05386999	120	1934-40, 1979-81
BAD AXE RIVER BASIN			
North Fork Bad Axe River near Genoa, WI	05387100*	80.8	1964-66
WISCONSIN RIVER BASIN			
Wisconsin River at Conover, WI	05390180	177	1967-71
Pelican River near Rhinelander, WI	05391226	101	1976-79
Wisconsin River at Whirlpool Rapids, near Rhinelander, WI	05392000	1,220	1906-61
Bearskin Creek near Harshaw, WI	05392350*	31.1	1964-66
Tomahawk River near Bradley, WI	05392400	422	1915-27, 1929
Tomahawk River at Bradley, WI	05393000	544	1930-73
New Wood River near Merrill, WI	05394000	82.2	1953-61
Rib River at Rib Falls, WI	05396000	303	1925-57
Little Rib River near Wausau, WI	05396500	79.1	1914-16
East Branch Eau Claire River near Antigo, WI	05397000	81.5	1949-55
Eau Claire River near Antigo, WI	05397110	185	1975-81
Bull Junior Creek (Bull Creek Junior) near Rothschild, WI	05398500	27.4	1944-52
Big Eau Pleine River near Colby, WI	05399000	78.1	1941-54
Hamann Creek near Stratford, WI	05399431	11.3	1977-79
Wisconsin River at Knowlton, WI	05400000	4,530	1921-42
Plover River near Stevens Point, WI	05400500	145	1914-20, 1944-52
Little Plover River near Arnott, WI	05400600	2.24	1959-75
Little Plover River at Plover, WI	05400650	19.0	1959-87
Fourmile Creek near Kellner, WI	05400840	75.0	1964-67
Buena Vista Creek near Kellner, WI	05400853	53.1	1964-67
Tenmile Creek Ditch 5 near Bancroft, WI	05401020	9.73	1964-73
Fourteenmile Creek near New Rome, WI	05401100	91.1	1964-79
Wisconsin River near Necedah, WI	05401500	5,990	1903-14, 1944-50
Big Roche a Cri Creek near Hancock, WI	05401510	9.61	1964-67
Big Roche a Cri Creek near Adams, WI	05401535	52.8	1964-78
Yellow River at Sprague, WI	05402500	392	1927-40
Yellow River at Necedah, WI	05403000	491	1941-57
Lemonweir River at New Lisbon, WI	05403500	507	1944-87
Hulbert Creek near Wisconsin Dells, WI	05403630*	11.2	1971-77
Dell Creek near Lake Delton, WI	05403700*	44.9	1957-1965, 1971-80
Narrows Creek at Loganville, WI	05404200*	40.1	1964-66
Wisconsin River at Prairie du Sac, WI	05406000	9,180	1946-54
Trout Creek at Confluence with Arneson Crk nr Barneveld, WI	05406573	8.37	1976-78
Trout Creek at Twin Parks Dam 8 nr Barneveld, WI	05406574	9.02	1976-79
Trout Creek at County Highway T nr Barneveld, WI	05406575	12.1	1976-78
Trout Creek near Ridgeway, WI	05406577	13.5	1976-79
Knight Hollow Creek near Arena, WI	05406590	7.57	1976-78
Otter Creek near Highland, WI	05406640	16.8	1968-69, 1970-75
Kickapoo River at Ontario, WI	05407500	151	1939, 1973-77
Knapp Creek near Bloomingdale, WI	05408500	8.44	1955-69
West Fork Kickapoo River near Readstown, WI	05409000	106	1939

Discontinued surface-water discharge stations

Station name	Station number	Drainage area (sq mi)	Period of record
WISCONSIN RIVER BASIN CONTINUED			
Kickapoo River at Soldiers Grove, WI	05409500	530	1939
North Fork Nederlo Creek near Gays Mills, WI	05409830	2.21	1968-79
Nederlo Creek near Gays Mills, WI	05409890	9.46	1968-80
Kickapoo River at Gays Mills, WI	05410000	617	1914-34, 1964-77
GRANT RIVER BASIN			
Pigeon Creek near Lancaster, WI	05413400*	6.93	1964-66
Rattlesnake Creek near Beetown, WI	05413451	45.2	1990-91
GALENA RIVER BASIN			
Little Platte River near Platteville, WI	05414213	79.7	1987-90
Sinsinawa River near Hazel Green, WI	05414800	24.9	1987-90
Pats Creek near Belmont, WI	05414894	5.42	1981-82
Madden Branch Tributary near Belmont, WI	05414915*	2.83	1981-82
Madden Branch near Meekers Grove, WI	05414920	15.04	1981-82
APPLE RIVER BASIN			
Apple River near Shullsburg, WI	05418731	9.34	1981-82
ROCK RIVER BASIN			
West Branch Rock River near Waupun, WI	05423000	40.7	1949-70, 1978-81
West Branch Rock River at County Trunk Highway D near Waupun, WI	05423100	43.9	1978-81
East Branch Rock River near Mayville, WI	05424000	179	1949-70
Rock River at Hustisford, WI	05424082	511	1978-85
Johnson Creek near Johnson Creek, WI	05425537	1.13	1978-80
Johnson Creek near Johnson Creek, WI	05425539	13.3	1978-80
Pratt Creek near Juneau, WI	05425928	3.54	1978-80
Whitewater Creek near Whitewater, WI	05426500	11.8	1926-28, 1946-54
Whitewater Creek at Millis Road near Whitewater, WI	05426900	20.6	1978-81
Whitewater Creek at Whitewater, WI	05427000	22.8	1926-28, 1946-54
Koshkonong Creek near Rockdale, WI	05427507	150	1977-82
Token Creek near Madison, WI	05427800*	24.3	1964-66, 1976-81
Sixmile Creek near Waunakee, WI	05427900	41.1	1976-82
Pheasant Branch at Airport Road near Middleton, WI	05427943	9.61	1977-81
South Fork Pheasant Branch at Highway 14 near Middleton, WI	05427945	5.74	1978-81
Pheasant Branch at Century Avenue at Middleton, WI	05427950	20.8	1977-81
Pheasant Branch at mouth at Middleton, WI	05427952	24.5	1978-81
Willow Creek at Madison, WI	05427970	3.15	1974-83
Olbrich Park Storm Ditch at Madison, WI	05428665	2.57	1976-80
Manitou Way Storm Sewer at Madison, WI	05429040	0.23	1971-77
Nakoma Storm Sewer at Madison, WI	05429050	2.30	1972-77
Lake Wingra Outlet at Madison, WI	05429120	6.00	1971-77
Door Creek near Cottage Grove, WI	05429580	15.3	1976-79
Yahara River near Edgerton, WI	05430000	430	1917-18
Oregon Branch at Oregon, WI	05430030	9.93	1979-81
Badfish Creek at County Highway A near Stoughton, WI	05430095	41.9	1956-66, 1986-88
Badfish Creek near Stoughton, WI	05430100	41.3	1956-66
Livingston Branch, Pecatonica River near Livingston, WI	05432055	16.4	1987-91
Yellowstone River near Blanchardville, WI	05433500*	28.5	1954-65, 1978-79
Pecatonica River at Dill, WI	05434000	944	1914-19
Steiner Branch near Waldwick, WI	05433510	5.9	1978-79
Skinner Creek at Skinner Hollow Road near Monroe, WI	05434235	32.6	1978-81
Skinner Creek at Klondyke Road near Monroe, WI	05434240	35.0	1978-81
West Branch Sugar River near Mount Vernon, WI	05435980	32.7	1979-80
Mount Vernon Creek near Mount Vernon, WI	05436000	16.4	1954-65, 1976-80
ILLINOIS RIVER BASIN			
White River near Burlington, WI	05545300	110	1964-66, 1973-82

DISCHARGE RATINGS FOR TAINTER AND ROLLER GATES AT LOCK AND DAM NO. 7 ON THE MISSISSIPPI RIVER AT LA CROSSE, WISCONSIN, WI 00101

COOPERATOR:
U.S. Army Corps of Engineers

LOCATION:
Lock and Dam No. 7 on the Mississippi River at LaCrosse, Wisconsin

PROJECT CHIEF:
Steven R. Corsi

PERIOD OF PROJECT:
June 1992 to September 1993

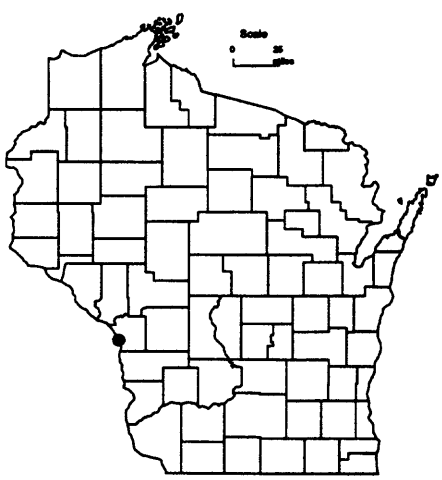
PROBLEM: The operation of the Mississippi River navigation system requires an accurate system to determine discharge on a real-time basis. The current discharge ratings at Lock and Dam No. 7 are based on theoretical equations for roller and tainter gates and have not been verified with field measurements.

OBJECTIVE: The objective of this study is to develop accurate discharge ratings for the roller and tainter gates at Lock and Dam No. 7 on the Mississippi River at LaCrosse, Wisconsin.

APPROACH: Field measurements using a current meter will be made to develop coefficients and equations for calculating discharge at roller and tainter gates. Discharge rating tables will be constructed for numerous different combinations of the decrease in head through the dam and gate openings. The rating tables in this study will be compared to the theoretical ratings currently being used.

PROGRESS (July 1992 to June 1993): All of the needed discharge measurements have been taken.

PLANS (July 1993 to June 1994): Coefficients and equations will be developed for the roller and tainter gates. Discharge rating tables will be constructed. The final report will be written and published in the USGS Water-Resources Investigations Report series.



COLLECTION OF BASIC RECORDS—GROUND WATER, WI 002

PROBLEM: Ground-water data are needed to better determine short-term changes and long-term trends in ground-water levels in the State. It is important to know if these changes are natural or man-induced and how these changes are effecting storage in the ground-water reservoirs.

OBJECTIVE: The objective is to maintain records of ground-water levels from a network of observation wells representative of Wisconsin's principal aquifers.

APPROACH: A basic network of about 203 wells is being maintained. The network will be constantly modified and improved to provide the best possible coverage of our ground-water resource. A subnetwork of key wells is included in this network. Key wells have long periods of record and are measured weekly or are equipped with continuous recorders.

PROGRESS (July 1992 to June 1993): Several computer programs were written and are being used to make data entry of water levels more efficient. Local observers were visited and hired to collect water-level data. Several wells were destroyed or discontinued from the network and were replaced with new ones. Data for the annual report, "Water Resources Data—Wisconsin, Water Year 1992", was completed.

PLANS (July 1993 to June 1994): Continue measurements on observation-well network. Replace and hire new observers and make quality assurance checks when possible. Have water-level information available on computer disk for individuals requesting these types of data. Plan to drill replacement wells in several counties in locations where no other observation wells could be located.

REPORTS:

Patterson, G.L., and Zaporozec, A., 1988, Analysis of water-level fluctuations in Wisconsin wells: Wisconsin Geological and Natural History Survey Information Circular 63.

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.

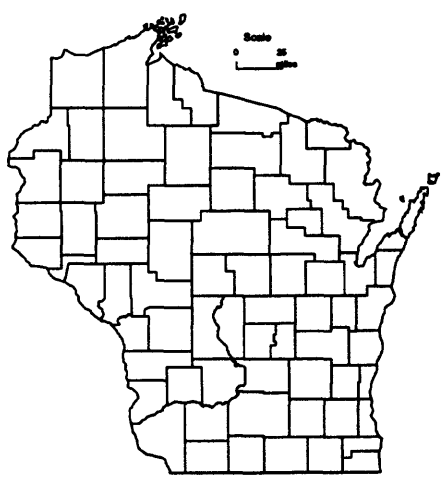
Devaul, R.W., 1967, Trends in ground-water levels in Wisconsin through 1966: Wisconsin Geological and Natural History Survey Information Circular No. 9.

COOPERATOR:
Wisconsin Geological and Natural History Survey

LOCATION: Statewide

PROJECT CHIEF:
Bernie R. Ellefson

PERIOD OF PROJECT:
July 1946-Continuing



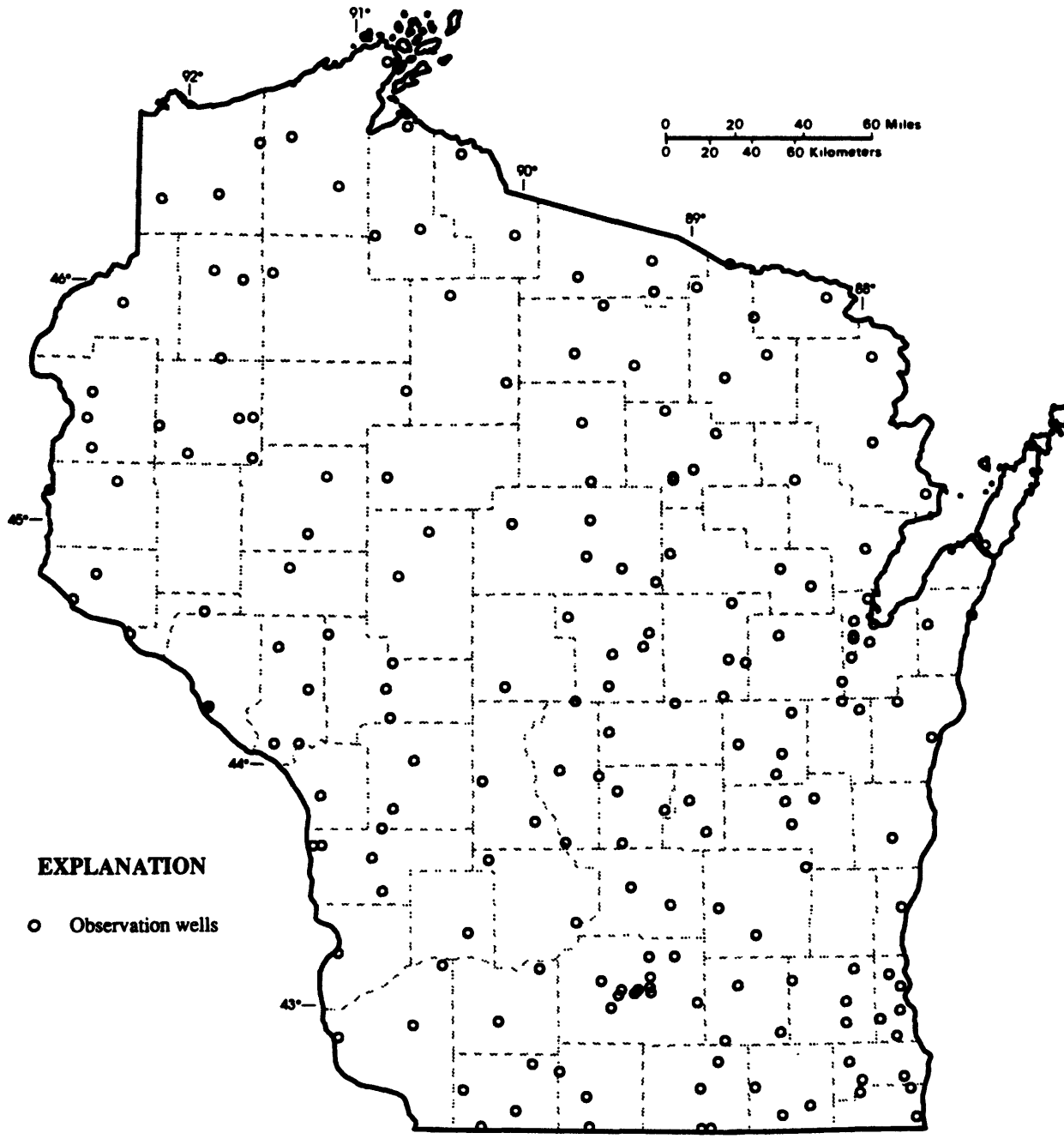


Figure 5. Location of network observation wells.

DETECTION OF FAULTS AND FRACTURED BEDROCK USING ELECTROMAGNETIC AND SEISMIC GEOPHYSICAL TECHNIQUES, COPPER FALLS STATE PARK, MELLEN, WISCONSIN, WI 00201

PROBLEM: The Wisconsin Department of Natural Resources staff -- Copper Falls State Park -- is interested in switching from spring water to ground water for water supply. Well drilling in the past has encountered till and basalt, neither of which yielded adequate amounts of water. Maps dating back to the 1920's suggest the park overlies three areas of faulted bedrock. Fractured bedrock near the faults may yield significant amounts of water if wells intersect fractures. The exact location of the faults and the degree of fracturing is unknown.

OBJECTIVE: The study will attempt to locate faults and areas of fractured bedrock using geophysical methods.

APPROACH: The park is underlain by low permeability igneous rock including gabbro, basalt, and granite. Some sedimentary rocks are present north and east of the Bad River, but are not located close to the areas where water is needed. Faults, where igneous rocks may be fractured and yield adequate amounts of water, have been mapped within the park. The study will attempt to locate these areas using the following methods: (1) fracture trace analysis of air photos, (2) analysis of outcrop data, (3) very low frequency (VLF) electromagnetic geophysics, (4) ground terrain conductivity electromagnetic geophysics, and (5) seismic-refraction geophysics.

The location of faults may be identified by looking for lineations on air photos or for faults in bedrock exposed on the land surface. Assuming the faulted zones have a higher conductivity due to the increase in water content in fractured zones, electromagnetic geophysical surveying should show an anomaly above the fractured area. Where the faults result in a significant change in bedrock topography, the change in bedrock elevation may be identified using the seismic-refraction technique. Fault locations will be identified based on all data collected, and the degree of fracturing will be estimated based on the electromagnetic response.

PROGRESS (July 1992 to June 1993): Electromagnetic data were collected along three transects near a campground in the central area of the park and seismic refraction data were collected along one transect at the park entrance in the southern area of the park. Based on seismic data, the thickness of glacial deposits is over 200 feet thick at the park entrance and is comparable to the thickness of glacial deposits at a nearby domestic well of reportedly high yield. The yield of a new well at the park entrance should be comparable to the yield of the domestic well if sand and gravel material, similar to the material found at the domestic well, is encountered when drilling the new well.

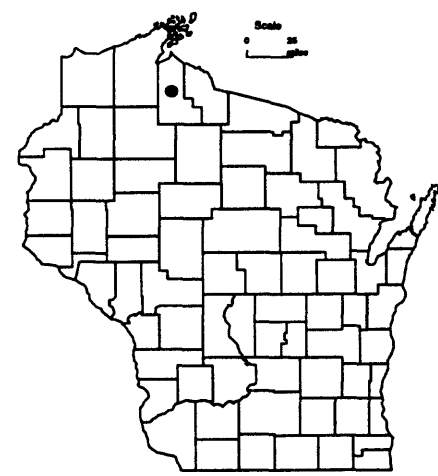
The electromagnetic (EM) surveys, which included ground terrain conductivity method and very low frequency methods, did not show anomalies indicative of water-filled fractures associated with faulted bedrock. Bedrock with water-filled fractures may be present beneath two of the three transects; however, this cannot be determined with EM methods due to the interference from water and electrical utilities. The EM response for the third transect appeared free of interference from man-made conductors. The response indicated an anomaly from a resistive target, instead of anomaly from a conductive target expected from the presence of water-filled fractures. The cause of this resistive anomaly may be from resistive material that fills fractures in

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Copper Falls State Park
Mellen, Wisconsin

PROJECT CHIEF:
Terrence Conlon

PERIOD OF PROJECT:
September 1991 to June 1992



bedrock or the result of a bedrock ridge underlying the glacial deposits. In either case, the likelihood of drilling a water-supply well with an adequate yield is low.

The study showed that the use of geophysics can help in evaluating water-supply plans. Seismic geophysics confirmed that thickness of glacial material was similar to the thickness encountered in a nearby well of reportedly high yield. Electromagnetic geophysical data collected at Copper Falls State Park do not suggest that there is a high density of water-filled fractures in bedrock associated with mapped faults. Based on the EM data and the past drilling experience at the park, obtaining significant amounts of ground water from the bedrock may not be feasible because of low permeability of the bedrock.

REPORTS: The conclusions of the study were sent to the Copper Falls State Park staff in an administrative report. Project is completed.

COLLECTION OF BASIC RECORDS—WATER QUALITY, WI 003

PROBLEM: A long-term base of water-quality data is needed for regional water-quality assessments and water-resource planning.

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.

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.

PROGRESS (July 1992 to June 1993): Under the NASQAN program, concentration data for fecal bacteria, dissolved oxygen, nutrients, common ions, trace elements, suspended sediment, 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 were collected semiannually at the Chippewa and Popple River stations.

Data collected during the 1991 water year were processed for publication in the annual data release "Water Resources Data—Wisconsin, Water Year 1992."

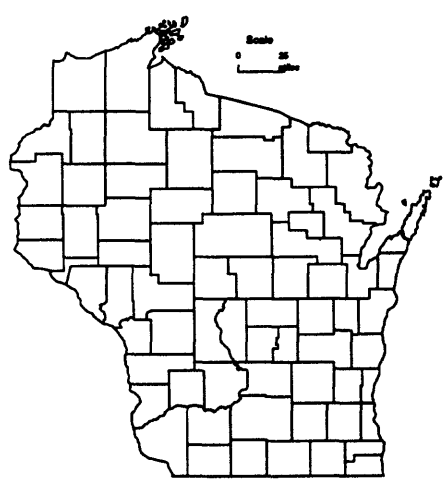
PLANS (July 1993 to June 1994): Data collection and processing will be continued.

COOPERATOR:
Federal Program

LOCATION: Statewide

PROJECT CHIEF:
Phil A. Kammerer

PERIOD OF PROJECT:
July 1964-Continuing



COLLECTION OF BASIC RECORDS—DANE COUNTY PROGRAM, WI 00302

COOPERATOR:
Dane County Regional Planning Commission

LOCATION:
Dane County, Wisconsin

PROJECT CHIEF:
Phil A. Kammerer

PERIOD OF PROJECT:
Continuing

PROBLEM: A long-term base of water-quality data is needed for water-resource planning and assessment of water quality in the lakes and streams of Dane County.

OBJECTIVE: The objectives of this program are to determine suspended-sediment and phosphorus loads on selected tributaries to Lake Mendota and to collect data to identify long-term changes in base-flow water quality in selected streams in Dane County.

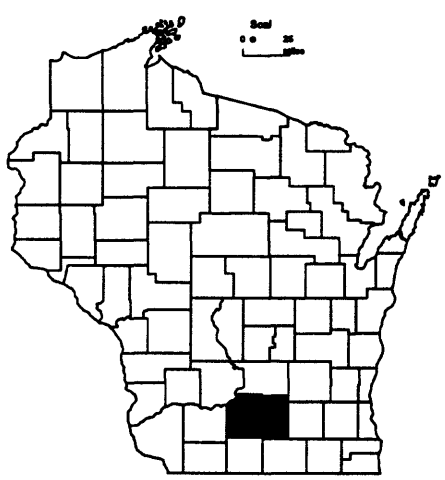
APPROACH: Streamflow-monitoring stations with automatic water-quality samplers are operated on three tributaries to Lake Mendota. Samples for analysis of suspended-sediment and phosphorus concentrations are collected at low flow and during periods when surface runoff is entering the streams. The concentration and streamflow data are used to compute annual suspended-sediment and total-phosphorus loads for each station.

Samples for chemical analysis are collected from selected streams at low flow to provide water-quality data for comparison with historical information to evaluate possible changes in water quality with time.

PROGRESS (July 1992 to June 1993): Suspended-sediment loads for Spring Harbor Storm Sewer at Madison and suspended-sediment and total-phosphorus loads for Pheasant Branch at Middleton and the Yahara River at Windsor were computed for the 1992 calendar year. Base-flow samples were collected for Badger Mill Creek near Verona.

Load and concentration data were published in the annual data report "Water Resources Data—Wisconsin, Water Year 1992."

PLANS (July 1993 to June 1994): Continue data collection and processing for the three stations on tributaries to Lake Mendota.



RESERVOIR SAMPLING, WI 00351

PROBLEM: The use of agricultural chemicals to improve crop yields has increased over the past two decades. Application of these chemical pesticides has created concern for contamination of surface water.

OBJECTIVE: The primary objectives of this study are to (1) determine the occurrence, temporal distribution, and persistence of selected herbicides and herbicide metabolites and nutrients in the outflow from reservoirs in the upper midwest, and (2) determine if the persistence of high concentrations (greater than about 1 µg/L) of herbicides in reservoir outflow can be quantified based on reservoir and drainage basin characteristics, hydrology, land use, herbicide use, and climate. The regional relationships between the occurrence of herbicides and selected land-use and hydrologic factors will be examined.

APPROACH: Reconnaissance 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. Ten sites are being sampled in Wisconsin. Six rounds of samples will be collected - late April or early May, late June or early July, late August, late October, early January and mid-March.

PROGRESS (July 1992 to June 1993): The first round of samples was collected in May 1992.

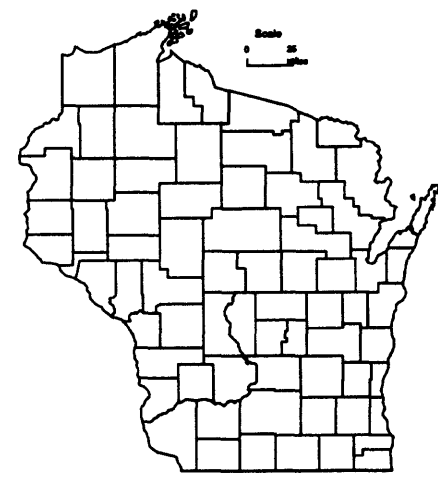
PLANS (July 1993 to June 1994): The remaining rounds of samples will be collected at the same sites where samples were collected in May 1992.

COOPERATOR:
Federal Program

LOCATION:
Statewide

PROJECT CHIEF:
Stephen J. Field

PERIOD OF PROJECT:
April 1992 to March 1993



COLLECTION OF BASIC RECORDS—SEDIMENT, WI 004

PROBLEM: Water-resources planning and water-quality assessment require a knowledge of the quantity and quality of sediment being transported in rivers and streams in Wisconsin.

OBJECTIVE: This project will provide sediment data for use in specific planning and action programs and will develop a data base for determining trends in sediment discharge and yield. 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 throughout the State, including sites of specific interest to cooperating agencies.

The 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 1992): 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 five-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 1992 to June 1993): The 1992 monitoring program is as follows:

CORPS OF ENGINEERS—Suspended sediment was sampled at the Grant River at Burton. Daily loads were determined from these data. The report "Sediment transport, particle sizes, and loads in the lower reaches of the Chippewa, Black, and Wisconsin Rivers in western Wisconsin" was published.

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.

COOPERATORS:

Wisconsin Department of Natural Resources
U.S. Army Corps of Engineers
Dane County Regional Planning Commission

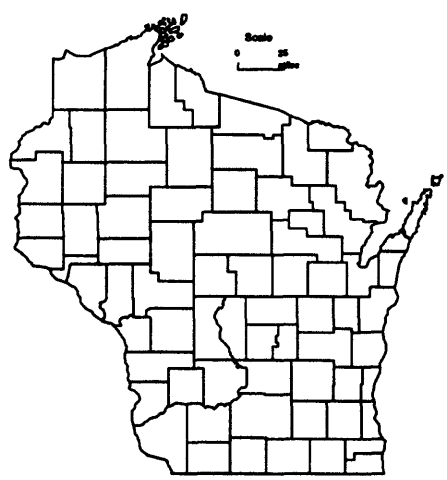
LOCATION: Statewide

PROJECT CHIEF:

William J. Rose

PERIOD OF PROJECT:

March 1968-Continuing



WISCONSIN DEPARTMENT OF NATURAL RESOURCES (WDNR)—A study whose objective was to estimate the coarse-material sediment load at three sites on North Fork Fish Creek near Ashland, Wisconsin, began on July 1, 1989. Monitoring for this study was completed in October 1991. Preliminary load estimates have been provided to the WDNR. The first draft of a brief report summarizing the study is 90% completed.

PLANS (July 1993 to June 1994):

CORPS OF ENGINEERS—Operation of the Grant River monitoring station will continue.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES—The brief report summarizing the results of the North Fork Fish Creek study will be completed.

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., 1992, Sediment transport, particle sizes, and loads in the lower reaches of the Chippewa, Black, and Wisconsin Rivers in western Wisconsin, U.S. Geological Survey Water-Resources Investigations Report 90-4124, 38 p.

FEMA FLOOD-INSURANCE STUDY, WI 006

COOPERATOR:
Federal Emergency Management Agency

LOCATION: Statewide

PROJECT CHIEF:
Steven R. Corsi

PERIOD OF PROJECT:
March 1984-Continuing

PROBLEM: The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 provide for the operation of a flood-insurance program. The Federal Emergency Management Agency (FEMA) needs flood studies in selected areas to determine applicable flood insurance premium rates.

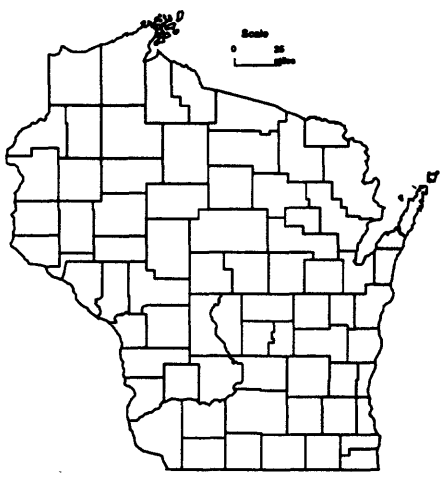
OBJECTIVE: Hydrologic and hydraulic analyses will be performed in order to complete flood-insurance studies at communities selected by FEMA.

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 1992 to June 1993): Time and cost meetings were held to determine the study limits for the city of LaCrosse and Fond du Lac County, Wisconsin. Completed surveying and submitted accompanying data on the lower Wisconsin River to St. Paul Army Corps of Engineers. Completed hydrologic analysis and surveying for the city of Merrill. Completed restudy of Watertown.

PLANS (July 1993 to June 1994): Respond to review comments on completed studies and answer data requests as needed. Complete limited map maintenance (LMM) studies for Verona, LaCrosse, and Fond du Lac County.

REPORTS: Work was completed for the restudy of Watertown and results were sent to FEMA.



WISCONSIN WATER-USE DATA FILE, WI 007

PROBLEM: The need for reliable water-use data by State and Federal planning agencies is increasing as the competition for use of the State's water resources increases. Water-use data in a standardized format needs to be available to assist in making decisions on future water use.

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 to prepare periodic reports on water use in the State.

APPROACH: Sources of water-use information will be evaluated. The best available data will be entered into the SWUDS. Efforts will be made to upgrade the accuracy of the water-use data.

PROGRESS (July 1992 to June 1993): The SWUDS was updated with current water-use information as it became available. These data included high-capacity well data and information on discharge from sewage-treatment plants in the State. Reformatting programs were written or updated as needed for entering data from other agencies into SWUDS. Data was compiled for a 5-year State atlas-type report on water use in Wisconsin.

PLANS (July 1993 to June 1994): Continue to update and maintain the SWUDS data base with current water-use data as it becomes available. Explore the possibility of a cooperative project with Wisconsin Department of Natural Resources to meter selected industrial users to better estimate consumptive water use. Supply water-use data for water-resources studies currently being conducted in the State.

REPORTS:

Ellefson, B.R., Rury, K.S., and Krohelski, J.T., 1988, Water-use in Wisconsin, 1985: U.S. Geological Survey Open-File Report 87-699, 1 sheet, scale 1:500,000,000.

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

Krohelski, J.T., Ellefson, B.R., and Storlie, C.A., 1987, Estimated use of ground water for irrigation in Wisconsin, 1984: U.S. Geological Survey Water-Resources Investigations Report 86-4079, 12 p., 1 pl.

Lawrence, C.L., and Ellefson, B.R., 1984, Public-supply pumpage in Wisconsin, by aquifer: U.S. Geological Survey Open-File Report 83-931, 40 p.

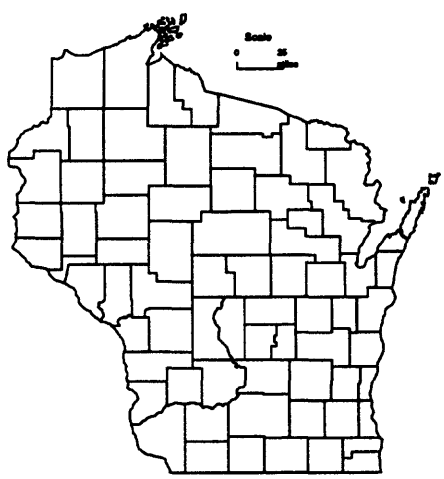
— 1982, Water use in Wisconsin, 1979: U.S. Geological Survey Open-File Report 82-444, 98 p.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION: Statewide

PROJECT CHIEF:
Bernie R. Ellefson

PERIOD OF PROJECT:
March 1978-Continuing



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

PROBLEM: Water-quality standards have been adopted for all surface waters of the State. To implement these standards, the Department of Natural Resources (DNR) has to evaluate the sewage effluent from all waste sources in relation to the low-flow characteristics of the receiving stream. Water-quality standards in Wisconsin are based on a number of streamflow characteristics. These include the annual minimum 7-day consecutive mean flow that occurs on the average of once every 2 years ($Q_{7,2}$) and once every 10 years ($Q_{7,10}$), the annual minimum 30-day consecutive mean flow that occurs on the average of once every 5 years ($Q_{30,5}$), $Q_{7,10}$ values for selected months ($Q_{7,10}$ - month), 10-year low mean monthly flows for October, November, April, and May, and the mean annual discharge.

OBJECTIVE: The purpose of this study is to determine the following streamflow characteristics:

1. $Q_{7,10}$ for receiving streams at sewage-treatment plants and industrial plants discharging wastes.

2. $Q_{7,2}$ for selected streams.

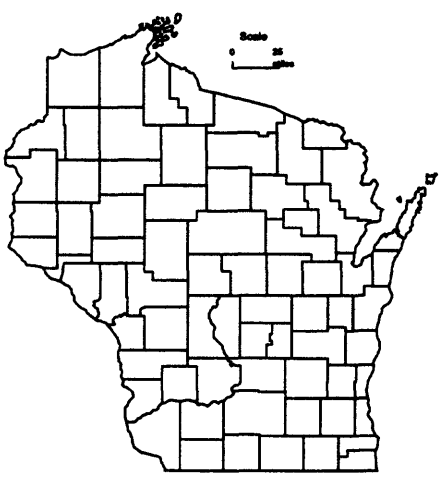
3. The 10-year low mean monthly flows for October (Oct. MMQ_{10}), November (Nov. MMQ_{10}), April (Apr. MMQ_{10}), and May (May MMQ_{10}) for sites at fill-and-draw wastewater-treatment lagoons or waste-stabilization ponds.

4. $Q_{30,5}$ for selected streams.

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

6. $Q_{7,10}$ for selected months 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 1992 to June 1993): Low-flow estimates were determined at approximately 68 sites in response to requests for information from the Surface Waters and Monitoring Section of the DNR.

PLANS (July 1993 to June 1994): 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.

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

PROBLEM: Ground-water-quality problems in Wisconsin have not been summarized and evaluated in a published report. Summary and evaluation of the problems are needed to develop strategies for ground-water protection. Many chemical analyses of Wisconsin's ground water are available, but little attempt has been made to relate water quality to hydrogeology on a regional scale.

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 1992 to June 1993): Preparation of the first report listed below for publication has begun. The second report received Director's approval for publication.

PLANS (July 1993 to June 1994): Publish the Water-Resources Investigations Report listed below. Begin preparation of the Hydrologic Investigations Atlas listed below.

REPORTS:

Kammerer, P.A., Jr., 1993, Ground-water movement and quality in Wisconsin's shallow aquifer system: U.S. Geological Survey Water-Resources Investigations Report 90-4171 (in preparation).

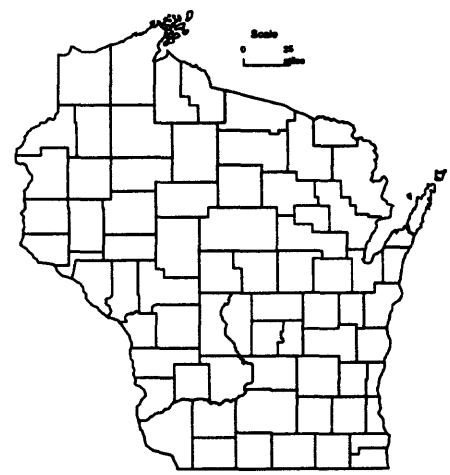
Kammerer, P.A., Jr., Trotta, L.C., Krabbenhoft, D.P., and Lidwin, R.A., Geology, vertical ground-water flow, and dissolved-solids concentrations in groundwater provinces of Wisconsin: U.S. Geological Survey Hydrologic Investigations Atlas (approved for publication).

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION: Statewide

PROJECT CHIEF:
Phil A. Kammerer

PERIOD OF PROJECT:
June 1978 to September 1985



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

PROBLEM: Flood-frequency estimates are required at many sites for bridge and culvert design, as well as for flood-plain management and flood-insurance studies. Most sites at which such estimates are required do not have records of flood peaks.

OBJECTIVES:

1. Develop improved regression equations for the State of Wisconsin.
2. Determine why flood characteristics are different for the Driftless Area.
3. Analyze the network of crest-stage gages to determine which stations can be dropped from the network and what type of sites should be added.

APPROACH: The GLSNET program will be used to analyze the crest-stage gage network. The goal of this analysis will be to determine how to get the most regional flood information from a network of about 100 crest-stage gages. Some stations will be dropped from the network and new stations added as a result of this analysis.

PROGRESS (July 1992 to June 1993): A journal article was published giving the results of the model study on the Coon Creek basin. Annual flood peaks were computed and published in the annual data report at 104 crest-stage stations. The network of crest-stage gages was analyzed to determine which stations provided the least information for regional frequency analysis, and should be replaced by new stations.

PLANS (July 1993 to June 1994): The crest-stage gage network will be monitored with the following changes starting this year: gages which the network analysis showed could be discontinued with little loss to the accuracy of future regression equations will be discontinued, other gages will be added to the network in consultation with the cooperator, and significant effort will be made to improve ratings at all of the gages.

REPORTS:

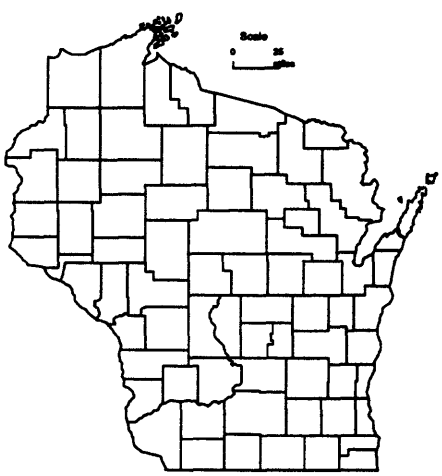
Krug, W.R., 1992, Simulation of temporal changes in rainfall-runoff characteristics, Coon Creek Basin, Wisconsin (in preparation).

Krug, W.R., Conger, D.H., and Gebert, W.A., 1992, Flood-frequency characteristics of Wisconsin streams: U.S. Geological Survey Water-Resources Investigations Report 91-4128, 185 p., 2 pls.

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.

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, 116 p., 2 pls.

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



LIST OF CREST-STAGE GAGES

CHIPPEWA RIVER BASIN
05357360 Bear River near Powell, WI
05357390 Weber Creek near Mercer, WI
05358100 Smith Creek near Park Falls, WI
05359600 Price Creek near Phillips, WI
05361400 Hay Creek near Prentice, WI
05361420 Douglas Creek near Prentice, WI
05361600 North Fork Jump River near Phillips, WI
05364000 Yellow River at Cadott, WI
05364100 Seth Creek near Cadott, WI
05364500 Duncan Creek at Bloomer, WI
05365700 Goggle-Eye Creek near Thorp, WI
05366500 Eau Claire River near Fall Creek, WI
05367030 Willow Creek near Eau Claire, WI
05367480 East Branch Pine Creek Tributary near Dallas, WI
05367700 Lightning Creek at Almena, WI
05370600 Arkansaw Creek Tributary near Arkansaw, WI
05370900 Spring Creek near Durand, WI

CENTRAL WISCONSIN RIVER BASIN
05395020 Lloyd Creek near Doering, WI
05395100 Trappe River Tributary near Merrill, WI
05396100 Pet Brook Tributary near Edgar, WI
05396300 Wisconsin River Tributary at Wausau, WI
05397600 Big Sandy Creek near Wausau, WI
05400025 Johnson Creek near Knowlton, WI
05401800 Yellow River Tributary near Pittsville, WI
05403520 Webster Creek at New Lisbon, WI
05403550 Onemile Creek near Mauston, WI
05403630 Hulbert Creek near Wisconsin Dells, WI
05403700 Dell Creek near Lake Delton, WI

FOX-WOLF RIVER BASIN
04073400 Bird Creek at Wautoma, WI
04074300 Mud Creek near Nashville, WI
04074700 Hunting River near Elcho, WI
04074850 Lily River near Lily, WI
04075200 Evergreen Creek near Langlade, WI
04079700 Spaulding Creek near Big Falls, WI
04081900 Sawyer Creek at Oshkosh, WI
04085030 Apple Creek near Kaukauna, WI

LAKE MICHIGAN BASIN
04085300 Neshota River Tributary near Denmark, WI
04085400 Killsnake River near Chilton, WI
04087050 Little Menomonee River near Freistadt, WI
04087100 Honey Creek at Milwaukee, WI
04087200 Oak Creek near South Milwaukee, WI
04087230 West Branch Root River Canal Tributary near North Cape, WI
04087250 Pike Creek near Kenosha, WI

LAKE SUPERIOR BASIN
04024400 Stony Brook near Superior, WI
04025200 Pearson Creek near Maple, WI
04026200 Sand River Tributary near Red Cliff, WI
04026300 Sioux River near Washburn, WI
04026450 Bad River near Mellen, WI
04027200 Pearl Creek at Grandview, WI

LOWER WISCONSIN RIVER BASIN
05404200 Narrows Creek at Loganville, WI
05405600 Rowan Creek at Poynette, WI
05406800 Rocky Branch near Richland Center, WI
05407100 Richland Creek near Plugtown, WI
05407200 Crooked Creek near Boscobel, WI

MENOMINEE-OCONTO-PESHTIGO RIVER BASIN
04059900 Allen Creek Tributary near Alvin, WI
04063640 North Branch Pine River at Windsor Dam near Alvin, WI
04063688 South Branch Popple River near Newald, WI
04063800 Woods Creek near Fence, WI
04064800 Little Popple River near Aurora, WI
04067760 Peshtigo River near Cavour, WI
04067800 Armstrong Creek near Armstrong Creek, WI
04069700 North Branch Oconto River near Wabeno, WI
04071700 North Branch Little River near Coleman, WI
04071800 Pensaukee River near Pulaski, WI

PECATONICA-SUGAR RIVER BASIN
05413400 Pigeon Creek near Lancaster, WI
05414200 Bear Branch near Platteville, WI
05414213 Little Platte River near Platteville, WI
05414900 Pats Creek near Elk Grove, WI
05414915 Madden Branch Tributary near Belmont, WI
05432300 Rock Branch near Mineral Point, WI
05433500 Yellowstone River near Blanchardville, WI
05435900 Sugar River Tributary near Pine Bluff, WI
05436200 Gill Creek near Brooklyn, WI
05437200 East Fork Raccoon Creek Tributary near Beloit, WI

ROCK-FOX RIVER BASIN
05423800 East Branch Rock River Tributary near Slinger, WI
05425700 Robbins Creek at Columbus, WI
05427200 Allen Creek near Fort Atkinson, WI
05427800 Token Creek near Madison, WI
05430403 Fisher Creek Tributary at Janesville, WI
05431400 Little Turtle Creek at Allens Grove, WI
05545100 Sugar Creek at Elkhorn, WI
05545200 White River Tributary near Burlington, WI
05548150 North Branch Nippersink Creek Tributary near Genoa City, WI

ST. CROIX RIVER BASIN
05333100 Little Frog Creek near Minong, WI
05335380 Bashaw Brook near Shell Lake, WI
05340300 Trade River near Frederic, WI
05341900 Kinnickinnic River Tributary at River Falls, WI

TREMPEALEAU-BLACK RIVER BASIN
05371800 Buffalo River Tributary near Osseo, WI
05371920 Buffalo River near Mondovi, WI
05378200 Eagle Creek near Fountain City, WI
05380800 Black River Tributary near Whittlesey, WI
05380900 Poplar River near Owen, WI
05380970 Cawley Creek near Neillsville, WI
05382200 French Creek near Ettrick, WI
05386300 Mormon Creek near La Crosse, WI
05387100 North Fork Bad Axe River near Genoa, WI

UPPER WISCONSIN RIVER BASIN
05390140 Muskrat Creek at Conover, WI
05390240 Fourmile Creek near Three Lakes, WI
05391260 Gudegast Creek near Starks, WI
05391950 Squaw Creek near Harrison, WI
05392150 Mishonagon Creek near Woodruff, WI
05392350 Bearskin Creek near Harshaw, WI
05393640 Little Pine Creek near Irma, WI
05394200 Devil Creek near Merrill, WI

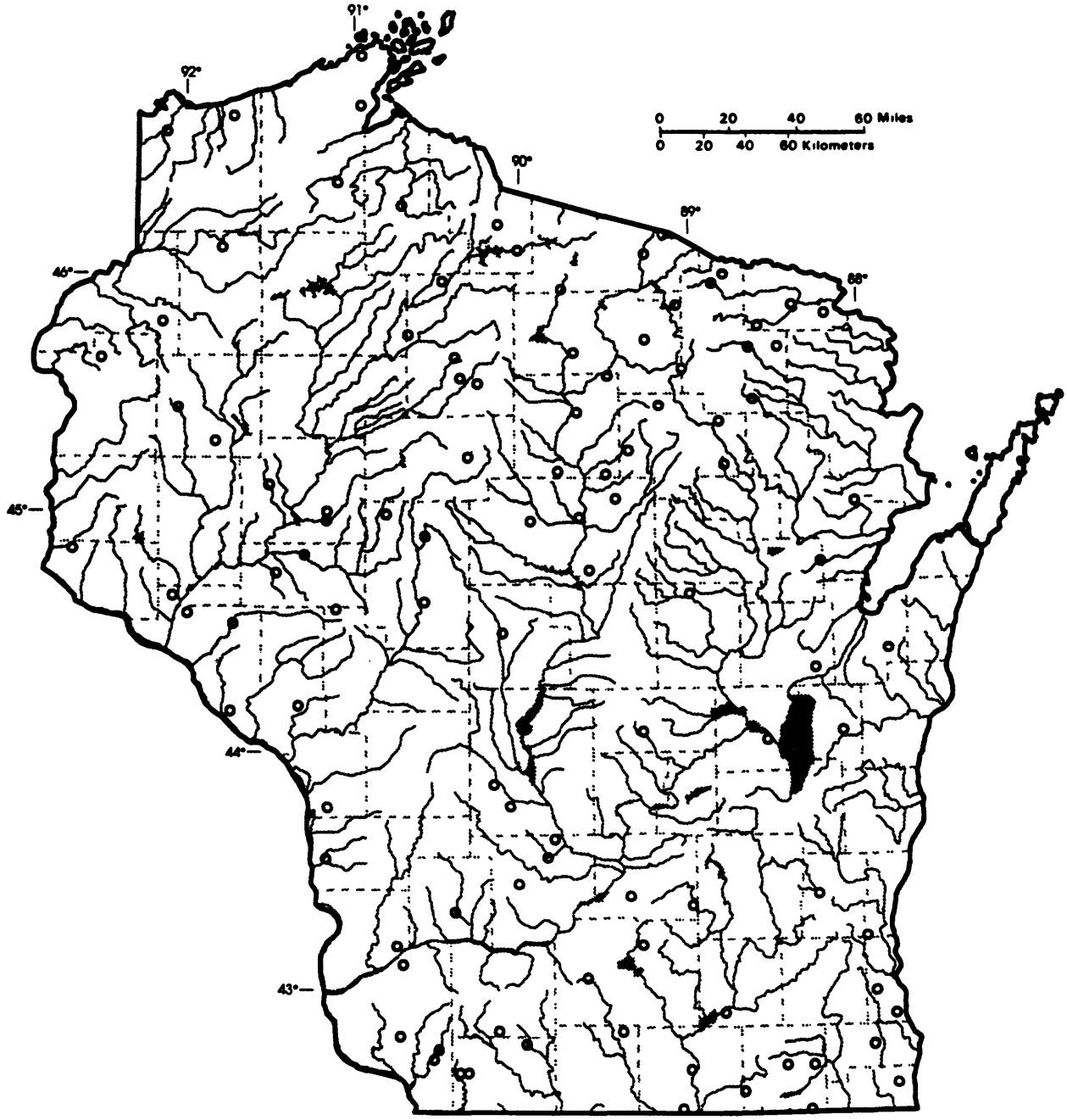


Figure 6. Location of crest-stage-gage data collection stations.

EFFECTS OF ACID PRECIPITATION ON LAKES IN NORTHERN WISCONSIN, WI 110
LONG-TERM EFFECTS OF ACID PRECIPITATION ON LAKES IN NORTHERN WISCONSIN, WI 129

PROBLEM: Acid precipitation has damaged lakes in Canada and the northeastern United States. Wisconsin has more susceptible and potentially susceptible lakes than any State east of the Mississippi River. Studies have shown that acid precipitation in northern Wisconsin, where pH's average 4.0 to 4.5, may affect as many as 8,000 lakes. This could seriously affect the tourist-based economy of this area. Long-term hydrologic and chemical budgets of a representative susceptible lake will increase the understanding of the effect of acid precipitation on aquatic systems and will provide information to evaluate and possibly predict these effects so that future damage can be minimized.

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 1992 to June 1993): The report "Hydrology of Lakes Clara and Vandercook" was published. The report "Long-term hydrologic and geochemical responses of a soft-water seepage lake in north-central Wisconsin" was submitted to Water Resources Research.

PLANS (July 1993 to June 1994): The report "Long-term hydrologic and geochemical responses of a soft-water seepage lake in north-central Wisconsin" will be published.

REPORTS:

Wentz, D.A., Rose, W.J., and Webster, K.E., 1992, Long-term hydrologic and geochemical responses of a soft-water seepage lake in north-central Wisconsin (approved, has been submitted to Water Resources Research for publication).

Wentz, D.A., and Rose, W. J., 1991, Hydrology of Lakes Clara and Vandercook in north-central Wisconsin, U.S. Geological Survey Water-Resources Investigations Report 89-4204, 24 p.

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.

COOPERATORS:

Wisconsin Department of Natural Resources (WI 110)
U.S. Geological Survey (WI 129)

LOCATION:

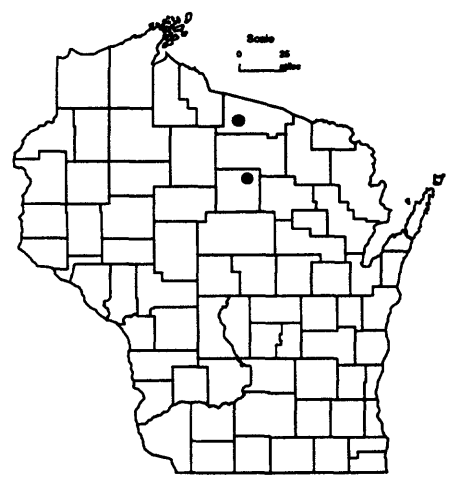
Lincoln and Vilas Counties, north-central Wisconsin

PROJECT CHIEF:

Dennis A. Wentz

PERIOD OF PROJECT:

August 1980 to September 1990



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

PROBLEM: Acid precipitation has damaged lakes in Canada and the northeastern United States. Wisconsin has more potentially susceptible lakes than any State east of the Mississippi River. Studies have shown that acid precipitation in northern Wisconsin, where pH's average 4.0 to 4.5, may affect as many as 8,000 lakes. This could seriously affect the tourist-based economy of this area. Hydrologic and chemical budgets of representative potentially susceptible lakes will increase the understanding of the effect of acid precipitation on aquatic systems and will provide information to evaluate and possibly predict these effects so that future damage can be minimized.

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 1992 to June 1993): Final approved reports on "Hydrology," "Chemistry of Snowpack and Ground Water," and "Chemical Budgets" on the entire 5-year study awaited publication by Electric Power Research Institute (EPRI).

PLANS (July 1993 to June 1994): The final report will be published by EPRI as previously planned or the sections will be published as separate reports in the USGS Water-Resources Investigations Report series.

REPORTS:

Greb, S.R., and Wentz, D.A., 1989, Section 7—Chemical budgets, in Knauer, D.R., and Brouwer, S.A., eds., The Wisconsin Regional Integrated Lake-Watershed Acidification Study (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).

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION:

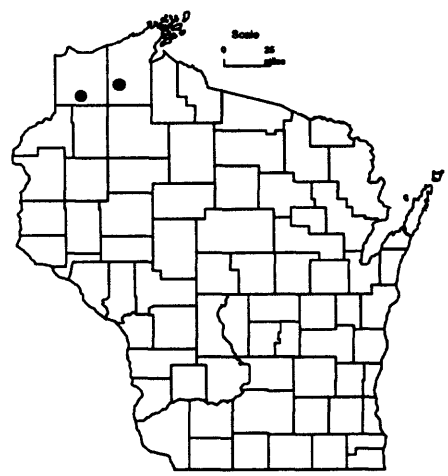
Douglas and Bayfield Counties, northwest Wisconsin

PROJECT CHIEF:

Dennis A. Wentz

PERIOD OF PROJECT:

July 1981 to June 1988



Wentz, D.A., Garrison, P.J., and Bockheim, J.G., 1989, Section 7—Chemical in Knauer, D.R., 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

PROBLEM: For most tribes, there is a need to characterize and define the hydrology and water quality of reservation areas to establish baselines for use by tribal planners and others in future site-specific investigations and studies concerned with long-term water-quality trends. For some tribes, site-specific problems related to ground- and surface-water contamination and water supply need to be defined and assessed.

OBJECTIVE: The objectives are to define water resources and address site-specific problems related to water resources on Wisconsin tribal lands.

APPROACH: Approaches vary because of the variability of types of water resources and problems.

PROGRESS (July 1992 to June 1993):

Oneida Tribe of Indians of Wisconsin

Stage-discharge and water quality for Duck Creek at the gaging station at County Highway FF and water levels in the three shallow observation wells adjacent to the gaging station were monitored. Monthly measurements of water levels of observation well BN-1265 (near Bingo Hall) were made.

Red Cliff Band of Lake Superior Chippewa

Data collected in a 1990 study describing the occurrence, distribution, and sources of mercury and PCB's in the Apostle Islands/Chequamegon Bay area of Lake Superior were analyzed.

Menominee Indian Tribe of Wisconsin

Stage-discharge measurements at the Wolf River at Langlade and water-quality sampling of the Wolf River at County M and at the southern boundary of the Menominee Reservation were continued.

Stockbridge-Munsee Band of Mohican Indians

A gaging station to monitor stage/discharge was installed on the Red River near Morgan. A draft report, using data collected during previous years, describing the water resources of the Stockbridge-Munsee Reservation is being revised.

PLANS (July 1993 to June 1994):

Bad River Band of Lake Superior Chippewa

Wells will be installed and sampled near Odanah to determine water-quality conditions near the water table. The draft report describing the water resources of the Bad River Reservation will be revised.

Oneida Tribe of Indians of Wisconsin

Stage-discharge for Duck Creek at the gaging station at County Highway FF and water levels in the three shallow observation wells adjacent to the gaging station will be monitored. Ground-water capture zones for 5-6 high-capacity wells will be determined.

Red Cliff Band of Lake Superior Chippewa

A journal article describing the occurrence, distribution, and sources of mercury and

COOPERATORS:

Current cooperators include the Bad River and Red Cliff Bands of Lake Superior Chippewa, the Menominee and Oneida Tribes of Wisconsin, the Sokaogon Chippewa Community, and the Stockbridge-Munsee Band of Mohican Indians of Wisconsin.

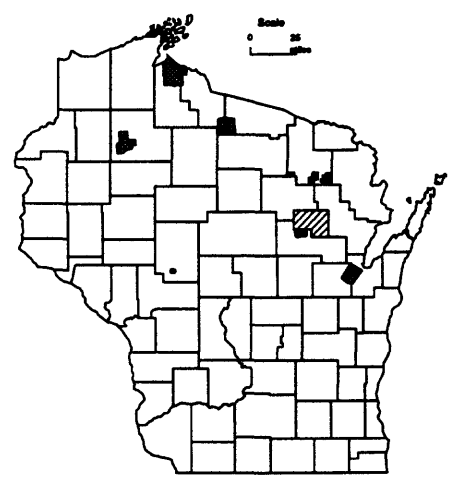
LOCATION: Statewide

PERIOD OF PROJECT:

August 1977-Continuing

PROJECT CHIEFS:

Jim Krohelski, John DeWild



PCB's in the Apostle Islands/Chequamegon Bay area of Lake Superior will be published.

Menominee Indian Tribe of Wisconsin

Stage discharge at the Wolf River at Langlade and water-quality sampling of the Wolf River at County M and at the southern boundary of the Menominee Reservation will continue.

Stockbridge-Munsee Band of Mohican Indians

Stage/discharge measurements at the Red River near Morgan will be continued.

Sokaogon Chippewa Community

Gaging stations to monitor stage/discharge will be installed on Swamp Creek above and below Rice Lake.

REPORTS:

Krabbenhoft, D.P., and Krohelski, J.T., 1992, Data on water quality, lake sediment, and lake-level fluctuation, St. Croix Indian Reservation, Wisconsin, 1981-87: U.S. Geological Survey Open-File Report 92-26, 53 p.

Lidwin, R.A., and Krohelski, J.T., 1992, Hydrology and water quality of the Forest County Potawatomi Indian Reservation, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 91-4136, 30 p. (in press).

Batten, W.G., and Lidwin, R.A., A summary of hydrologic data for the Lac Du Flambeau Indian Reservation, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report (through colleague review).

Krohelski, J.T., and Kammerer, P.A., Water resources of the Menominee Indian Reservation of Wisconsin: U.S. Geological Survey Water-Resources Investigations Report (in Director's office for approval).

Batten, W.G., Water resources of the Bad River Indian Reservation of Wisconsin: U.S. Geological Survey Water-Resources Investigations Report (first draft written).

Krohelski, J.T., Krabbenhoft, D.P., and Hoaglund, J., Hydrology and Water Quality of the Stockbridge-Munsee Indian Reservation, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report (first draft written).

Krabbenhoft, D.P., and Hurley, J., Distribution of PCB and mercury in sediments of the Apostle Islands/Chequamegon Bay area of Lake Superior, Wisconsin, journal article, 5 p. (planned).

LAKE WATER-QUALITY MONITORING, CHEMICAL AND BIOLOGICAL MONITORING OF SELECTED LAKES, WI 133

COOPERATORS:

In the 1992 water year:
Big Muskego, Little Muskego, Fowler, Hills, Wind, Okauchee, Alma/Moon, Hooker, Balsam, Druid, Little Arbor Vitae, Little Green, Little St. Germain, Loon 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); 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); village of Lake Nebagamon (Lake Nebagamon); Summit Township (Silver Lake); town of Bear Lake (Bear Lake); town of Troy (Booth Lake); and town of St. Germain (Big St. Germain Lake)

In the 1993 water year:
Big Muskego, Little Muskego, Fowler, Hills, Wind, Okauchee, Alma/Moon, Hooker, Balsam, Druid, Eagle, Potter, Wolf, Pretty, Little Arbor Vitae, Little Green, Little St. Germain, Loon and Powers Lake Districts; town of Cedar Lake (Balsam, Red Cedar and Hemlock Lakes), village of Oconomowoc Lake (Oconomowoc Lake); Wisconsin Department of Justice (Big Sissabagama Lake); town of Norway (Kee-Nong-Go-Mong and Waubeesee Lakes); 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); village of Lake Nebagamon (Lake Nebagamon); Summit Township (Silver Lake); town of Bear Lake (Bear Lake); town of Troy (Booth Lake); and town of St. Germain (Big St. Germain Lake)

LOCATION:

Selected lakes in Wisconsin

PROJECT CHIEF:

Stephen J. Field

PERIOD OF PROJECT:

June 1983-Continuing

PROBLEM: Lakes are a valuable resource in the State of Wisconsin and their water quality needs documentation.

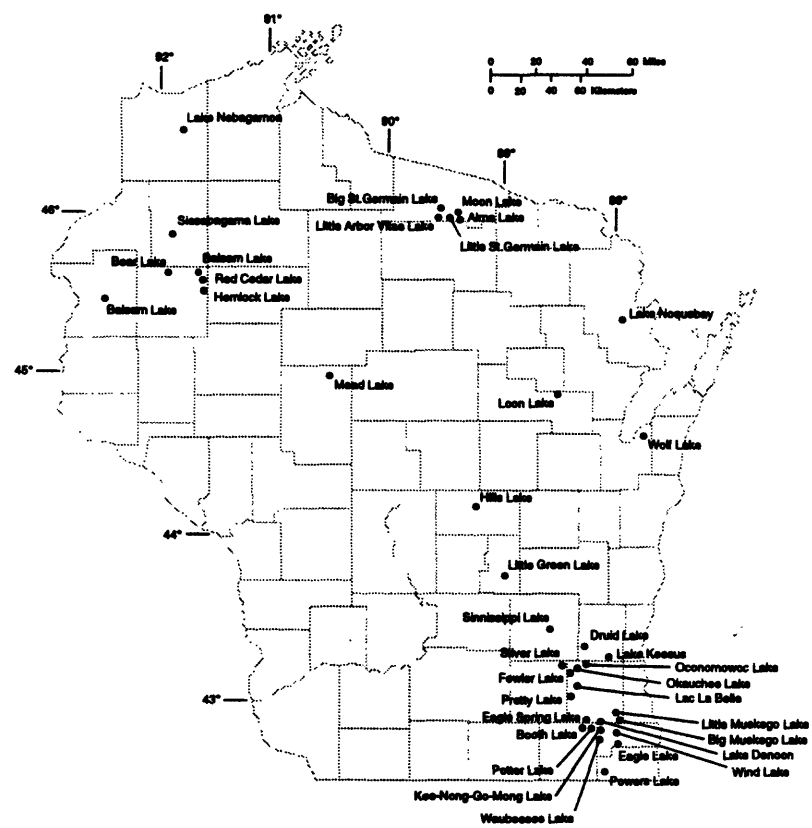
OBJECTIVE: The objective of this project is to determine lake stage and water quality at selected lakes throughout Wisconsin and, through a continuous monitoring program, provide data to detect chemical or biological changes that may take place.

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 1992 to June 1993): In the 1992 water year, total phosphorus, chlorophyll a, dissolved oxygen, temperature, pH, specific conductance, and Secchi-depth data were collected and analyzed at Big Muskego, Little Muskego, Fowler, Wind, Okauchee, Powers, Oconomowoc, Big Sissabagama, Kee-Nong-Go-Mong, Waubeesee, Balsam, Eagle Springs, Denoon, Druid, Keesus, Lac La Belle, Little Arbor Vitae, Little Green, Little St. Germain, Loon, Mead, Noquebay, Nebagamon, Moon, Alma, Silver, Bear, Booth, Big St. Germain, Hooker, and Sinissippi Lakes. A letter evaluating the water quality of each lake was sent to the respective cooperator. In the 1993 water year, Hills, Eagle, Potter, Wolf, Pretty, Red Cedar, Balsam and Hemlock Lakes were added to the program. The locations of lakes included in the monitoring program for water years 1992-93 are shown on the following map.

PLANS (July 1993 to June 1994): In the 1993 water year, 35 lakes will be monitored. We will compile the data and transmit it to the respective cooperator after the August monitoring. The data will be prepared for publication in the annual "Water Resources Data—Wisconsin, Water Year 1993."



LAKE WATER-QUALITY MONITORING, STATEWIDE LAKE-STAGE AND SECCHI-DISC MONITORING, WI 13301

PROBLEM: Lakes are a valuable resource in the State of Wisconsin. Secchi-discs are an inexpensive method for collecting valuable data to determine lake water-quality trends. Lake stage data provides valuable information throughout the State to help explain the high or low lake stages other lakes experience.

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 1992 to June 1993): Lake-stage and/or Secchi-disc data were compiled for three lakes: Anvil, Devils, and Fish. Data have been formatted for publication in "Water Resources Data—Wisconsin, Water Year 1992."

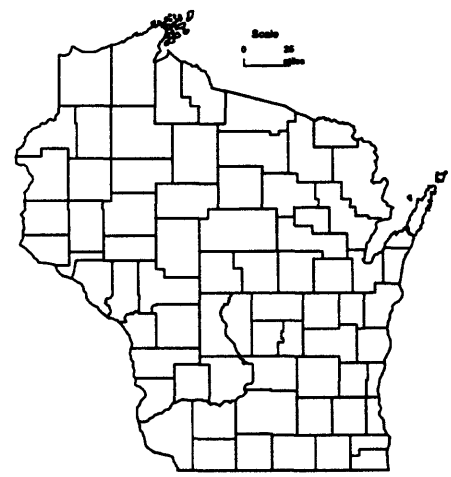
PLANS (July 1993 to June 1994): Project has been discontinued.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION: Statewide

PROJECT CHIEF:
Stephen J. Field

PERIOD OF PROJECT:
October 1984-1993



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

PROBLEM: Fowler Lake is a small drainage lake on the Oconomowoc River. The lake is experiencing nuisance weed and algae growth which have necessitated control programs including mechanical harvesting and chemical application. Identification of the nutrient sources is required to develop management alternatives to control the problem.

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 from the contributing urban area and from the lake; monitor chemical and physical characteristics of the lake water; and estimate internal recycling of nutrients.

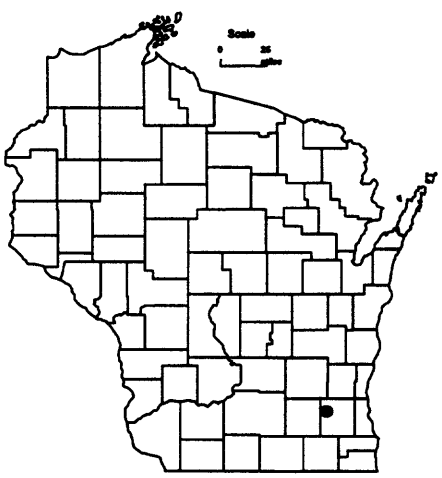
APPROACH: Monitor inflow to Fowler Lake and collect monthly water-quality samples from the lake from January 1984 through November 1984. Calculate a mass balance for nitrogen and phosphorus loads for 1984.

PROGRESS (July 1992 to June 1993): The report is being prepared for publication.

PLANS (July 1993 to June 1994): The report will be printed and distributed.

REPORTS:

Hughes, P.E., Hydrology, water quality, trophic status, and aquatic plants of Fowler Lake, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 91-4076 (in preparation for printing).



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

PROBLEM: Polychlorinated biphenyls (PCB's) in the Lower Fox River have been identified and classified as "in-place pollutants" by the Wisconsin Department of Natural Resources (WDNR) due to the high concentrations found in the bottom sediments (up to 250 milligrams per kilogram). These PCB deposits are believed to be a significant source of continuing PCB loading to Green Bay and Lake Michigan. The WDNR is developing a remedial action plan to reduce the PCB presence in the Fox River and Green Bay. Information is needed regarding the location of PCB deposits and transport rate of PCB's within the Fox River to support this remedial action effort.

OBJECTIVE: The objectives of this study are to estimate the total mass of PCB's present in the study reach bottom sediments, compute the total PCB load carried by the river, and 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's in Green Bay.

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

Acoustical velocity meter (AVM) systems were used to determine discharge in the Fox River at Appleton and DePere. Automated sediment samplers were operated at Appleton, Little Rapid, and DePere, and samples were collected on a daily basis.

Water samples were 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 were determined separately so the PCB partition coefficients could be computed. Water samples were also analyzed to determine total and dissolved organic carbon and other parameters. Samples were collected every two weeks, except in winter. Winter sampling was done about once per month.

The total mass of PCB's present in the study reach was estimated by use of an unconsolidated sediment thickness contour map and sediment-core analysis. The sediment cores were divided into several sections by visual inspection and analyzed for PCB concentration. Sediment cores were also analyzed to determine density of the bottom deposits.

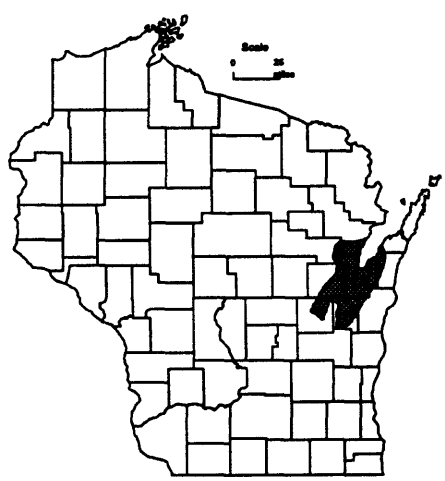
The Water Analysis Simulation Program (WASP) model has been used to simulate PCB kinetics and transport. This modeling effort is done by a USGS employee on loan to the WDNR.

COOPERATOR:
Wisconsin Department of Natural Resources (WDNR)

LOCATION:
Lower Fox River, East Central Wisconsin

PROJECT CHIEF:
Jeffrey J. Steuer

PERIOD OF PROJECT:
July 1985 to June 1994



PROGRESS (July 1992 to June 1993): The report on the Little Lake Butte des Morts phase of the study has been approved for publication. The WASP4 modeling effort by USGS/WDNR has recently been completed. The WASP4 model is being used to simulate advective transport of selected representative PCB congeners. WDNR has used the calibrated WASP model to evaluate various remedial actions.

PLANS (July 1993 to June 1994): The report for the Little Lake Butte des Morts study will be published. Documentation of the WASP modeling effort will continue.

REPORTS:

House, Leo B., 1993, Distribution, concentration, and transport of polychlorinated biphenyls in Little Lake Butte des Morts, Fox River, Wisconsin 1987-88, U.S. Geological Survey Open-File Report 93-31 (pending water-supply paper).

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

PROBLEM: The U.S. Geological Survey initiated the National Water-Quality Assessment (NAWQA) program in 1986 to provide information on the condition of the nation's water resources and identify long-term effects of changes in land- and water-management practices on those resources. Contaminants introduced as a result of land- and water-management practices may have direct and indirect effects on populations and communities of aquatic organisms. The often complex nature of these effects presents challenges for their identification and interpretation.

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: Assistance will be given to the Illinois District and national NAWQA personnel in habitat assessment, biological tissue sampling, site selection, and field logistics for biological sampling in the UIRB. A literature review will be conducted. Data analysis and interpretation will be performed to determine spatial trends in element concentrations of biological tissues collected in the UIRB during 1989 and 1990. Relations between element concentrations in tissues, water, and sediment will also be examined. As a coauthor, portions of a water-supply paper will be written evaluating trace elements in water, sediment, and biota in the UIRB.

PROGRESS (July 1992 to June 1993): Literature compilation and review have been completed. Analysis and interpretation of the data sets have been completed. As a coauthor, the first draft of a water-supply paper entitled "Surface-water-quality assessment of the upper Illinois River basin in Illinois, Indiana, and Wisconsin: major and trace elements in water, sediment, and biota" has been submitted for editorial review.

PLANS (June 1993 to July 1994): The final report will be published after approval is received..

REPORTS:

Fitzpatrick, F.A., Scudder, B.C., Crawford, K.J., and Kupperman, J.B., Surface-water-quality assessment of the upper Illinois River basin in Illinois, Indiana, and Wisconsin: major and trace elements in water, sediment, and biota, 1978 through 1990: U.S. Geological Survey Water-Supply Paper (in review).

COOPERATORS:

USGS Headquarters,
Office of Water Quality
USGS Illinois District

LOCATION:

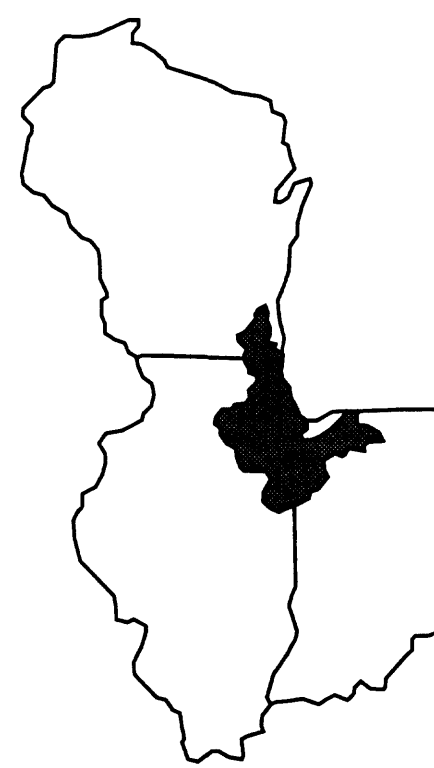
Upper Illinois River Basin (UIRB) in Illinois, Wisconsin, and Indiana

PROJECT CHIEF:

Barbara C. Scudder

PERIOD OF PROJECT:

June 1986 to September 1992



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

PROBLEM: Powers Lake is a mesotrophic lake with good water quality. Phosphorus sources and loads need to be documented to develop a comprehensive management plan to protect the lake's water quality.

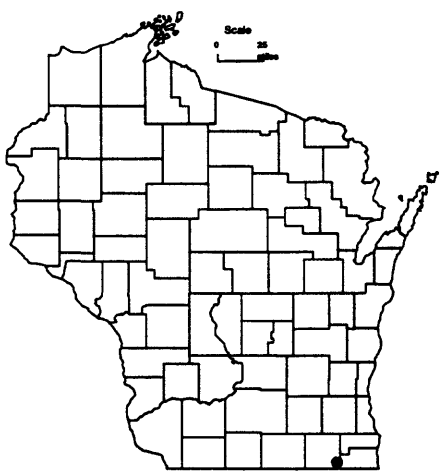
OBJECTIVE: To determine for the 1987 water year (1) a hydrologic budget, (2) a phosphorus budget defining the inputs from surface water, ground water, and precipitation, and the losses, (3) physiochemical depth profiles of the lake water column, and (4) the phytoplankton and zooplankton summer population.

APPROACH:
The following tasks will be completed: monitor streamflow and phosphorus load at inlet and outlet; monitor lake stage; monitor seven minipiezometers to determine ground-water discharge and recharge areas; determine physiochemical characteristics of lake-water column; record precipitation at three sites in the basin; identify and enumerate summer phytoplankton and zooplankton populations; and prepare an annual hydrologic and phosphorus budget.

PROGRESS (July 1992 to June 1993): The report describing the water quality and hydrology of Powers Lake is being prepared for publication.

PLANS (July 1993 to June 1994): The report will be printed and distributed.

REPORTS:
Field, Stephen J., 1993, Hydrology and water quality of Powers Lake in southeastern Wisconsin, U.S. Geological Survey Water-Resources Investigations Report 90-4126.



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

PROBLEM: Many lakes are poorly buffered and are thus potentially sensitive to the effects of acid precipitation. Seepage lakes in the Upper Midwest rely on ground water as their principal source of alkalinity. Seasonal reversals in ground-water flow, or for more extended periods during drought, can result in rapid loss of lake-water alkalinity and consequent acidification. To investigate this problem, an acid-sensitive lake must be studied to determine how lakes respond to periods of no ground-water inflow.

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 1992 to June 1993): Data collection continued at the site until August 1992.

PLANS (July 1993 to June 1994): Report is 90 percent done. Will be sent for colleague/editorial review soon.

REPORTS:

Krabbenhoft, D.P., and Webster, K.E., 1992, Ground-water role in the episodic acidification of Nevins Lake, Michigan (journal article in preparation).

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.

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION:

North-central Upper Peninsula, Michigan

PROJECT CHIEF:

David P. Krabbenhoft

PERIOD OF PROJECT:

March 1989 to September 1992

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

PROBLEM: Smallmouth bass streams in southwestern Wisconsin were a renowned smallmouth bass fishery in the 1950's and 1960's. There has been a considerable concern that the smallmouth bass populations have decreased dramatically. A survey of 10 southwest Wisconsin streams found smallmouth bass populations were low, even though habitat was good. Previous studies have indicated that the population declines may be attributed to declining water quality.

OBJECTIVE: Determine streamflow and water-quality characteristics and examine their relation 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 1992 to June 1993): Report was approved for publication as a U.S. Geological Survey Water-Resources Investigations Report.

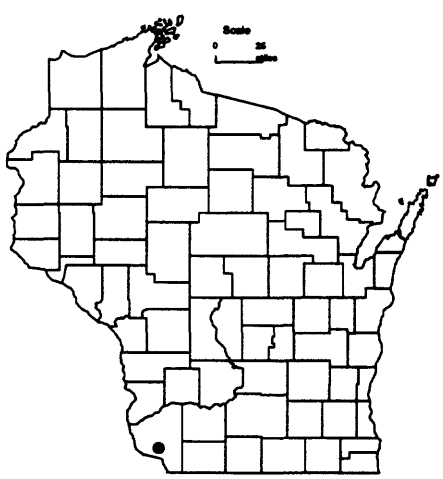
PLANS (July 1993 to June 1994): Report will be published.

REPORTS:

Graczyk, D.J., and others, 1993, Surface-water hydrology and quality, and macro invertebrate of small mouth bass populations in four stream basins in southwestern Wisconsin, 1987-90: U.S. Geological Survey Water-Resources Investigations Report 93-4024.

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, p. 28-38.

Graczyk, D.J., and Sonzogni, W.C., 1991, Reduction of dissolved oxygen concentration in Wisconsin streams during summer runoff: Journal of Environmental Quality, v. 20, no. 2, p. 445-451.



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

PROBLEM: An alternative water source, such as a shallow ground-water aquifer, is needed because increasing municipal pumpage from the deep sandstone aquifer in southern Waukesha County, is accelerating the present rate of water-level decline in this aquifer. Concentrations of naturally occurring radium in water from the sandstone aquifer also have exceeded drinking-water standards.

OBJECTIVE: The objective of this study is to better understand the shallow ground-water system and aquifer characteristics of glacial deposits in a preglacial bedrock valley in southern Waukesha County.

APPROACH: Data from five test holes, geophysical surveys, and existing drillers' well construction reports were compiled to map the bedrock surface. A map of the saturated thickness of glacial deposits was compiled from this map and a previously published water-table map. The texture and thickness of glacial deposits were described at the five test-hole locations. An aquifer test and a slug test were conducted to determine the hydraulic properties of glacial deposits at two test-hole locations.

PROGRESS (July 1992 to June 1993): All data collected during this study were compiled and a U.S. Geological Survey Water-Resources Investigations Report was written to present the results. This report has been approved and publication is anticipated by July 1, 1993.

PLANS: No further plans or funding presently exist for this project.

REPORTS:

Batten, W.G., and Conlon, T.D., 1993, Hydrogeology of glacial deposits in a preglacial bedrock valley, Waukesha County, Wisconsin, U.S. Geological Survey Water-Resources Investigations Report 92-4077, 15 p., 5 illus., 1 tbl.

COOPERATOR:

Waukesha Water Utility

LOCATION:

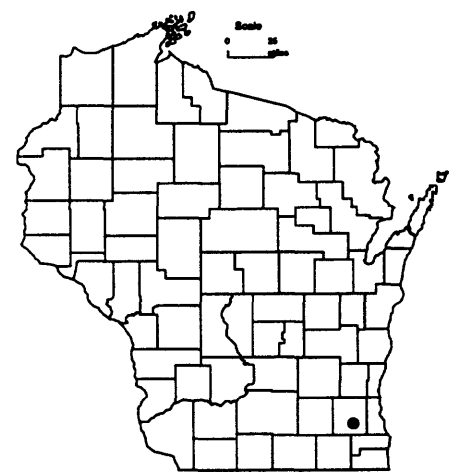
Southern Waukesha County

PROJECT CHIEF:

William G. Batten

PERIOD OF PROJECT:

October 1987 to September 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

PROBLEM: Wind Lake is a eutrophic lake where severe algal blooms occur. Phosphorus sources and loads need to be identified in order to develop a comprehensive management plan to improve the water quality of the lake.

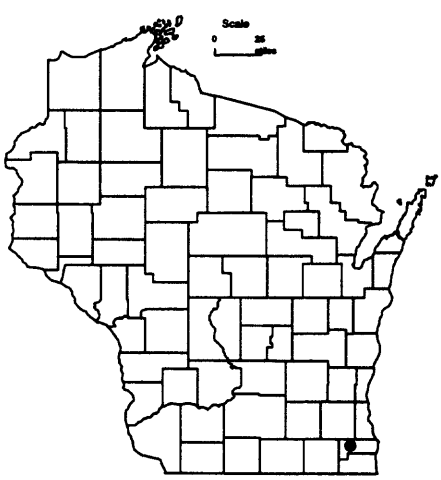
OBJECTIVE: To determine for the 1988 water year (1) phosphorus loads into the lake from surface water, ground water, and precipitation, (2) phosphorus loads from internal recycling, (3) characteristics of the bottom lake sediments, (4) physiochemical characteristics of the water column, (5) phytoplankton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

APPROACH:
The following tasks will be completed: monitor streamflow and phosphorus loads at the inlet and outlet; monitor lake stage; sample bottom lake sediments during winter to determine percent moisture, total phosphorus, iron, and manganese; monitor five minipiezometers to determine the ground-water discharge and recharge areas; determine physiochemical characteristics of lake-water column; during ice-free periods, record precipitation at three sites and evaporation at one site; identify and quantify phytoplankton and zooplankton populations; and prepare an annual hydrologic and phosphorus budget.

PROGRESS (July 1992 to June 1993): A report is being prepared for publication.

PLANS (July 1993 to June 1994): The report will be published.

REPORTS:
Field, Stephen J., 1993, Hydrology and water quality of Wind Lake in southeastern Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 91-4107 (in preparation).



BALSAM LAKE WATER AND PHOSPHORUS BUDGETS, WI 160

PROBLEM: Local residents and property owners along Balsam Lake have perceived a degradation in lake-water quality in recent (last five) years. Rice Creek, the only significant stream discharging to Little Balsam Lake, is considered to be a likely source of phosphorus input to the lake. Rice Lake, a shallow lake through which Rice Creek flows, is also believed by local residents to have experienced deteriorating water quality in recent years. There is speculation that sewage-treatment plant effluent is enriching the waters of Rice Creek and ultimately Balsam Lake. Ground water may be a significant source of phosphorus to the lake. There are limited data that suggest that concentration of phosphorus in ground water in the Polk County area is greater than in the rest of the State. A preliminary assessment indicates that more than half of the water entering Balsam Lake is ground-water discharge.

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 1992 to June 1993): The report is being prepared for publication.

PLANS (July 1993 to June 1994): The report will be printed and distributed.

REPORTS:

Rose, William J., 1993, Water and phosphorus budgets and trophic state, Balsam Lake, northwestern Wisconsin, 1987-89, U.S. Geological Survey Water-Resources Investigations Report 91-4125 (in preparation).

COOPERATOR:

Balsam Lake Protection and Rehabilitation District

LOCATION:

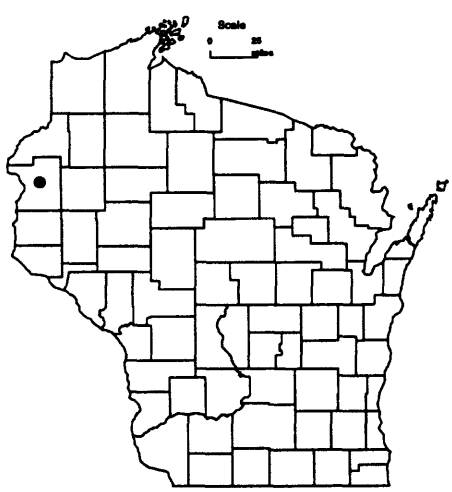
Polk County, northwestern Wisconsin

PROJECT CHIEF:

William J. Rose

PERIOD OF PROJECT:

November 1987 to September 1990



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 Peninsula Michigan.

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

PERIOD OF PROJECT:
July 1987 to September 1992

PROBLEM: Green Bay is an arm of Lake Michigan. There is a significant polychlorinated biphenyls (PCB's) presence in the fish biomass and bottom sediments of the Bay. The Fox, Menominee, Oconto, Peshtigo, and Escanaba Rivers have been identified as sources of PCB's to the Bay. The U.S. Environmental Protection Agency (EPA) is conducting a mass-balance evaluation of the PCB's entering and cycling through the ecosystem of the Bay.

OBJECTIVE: The objective of this study is to determine the load of PCB's and other selected contaminants into Green Bay from its major tributaries. This information will be used as input to the EPA's comprehensive mass-balance study of Green Bay. An additional objective is to evaluate methods used to compute the contaminant loads at the Fox River mouth site.

APPROACH: Water samples will be collected and analyzed for PCB's and suspended-sediment concentrations 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 (or suspended solids) sampling stations will be installed on each river. Constituent loads will be determined by a total integration method, using the contaminant concentration results and corresponding discharge data. The data-collection period is anticipated to run from April 1989 through April 1990.

PROGRESS (July 1992 to June 1993): A summary report has been prepared to describe the field methods used to collect PCB samples and to present the PCB load computed for each tributary. The report is currently in review pending publication as an open-file data report.

PLANS: Project is completed except for the report.

REPORTS:

House, L.B., Concentration and loads of polychlorinated biphenyls to Green Bay from major tributaries, 1989-90 (in review).

SUPERFUND REMEDIAL RESPONSE SUPPORT - EPA REGION V, WI 164

PROBLEM: The U.S. Environmental Protection Agency, Region V, has requested the Wisconsin District to provide technical assistance in the hydrogeological characterization of Superfund sites.

OBJECTIVE: The objective is to broaden the understanding of ground-water hydrology in the vicinity of Superfund sites.

APPROACH: The Wisconsin District will provide hydrogeological and geophysical expertise and support to Region V-Superfund. Services such as drilling and monitor well installation and selective formation packer tests will be conducted upon request by EPA-Superfund throughout Region V.

PROGRESS (July 1992 to June 1993): Work was conducted at the following Superfund sites: Northwest Indiana/southeast Chicago; Industrial Access Landfill, Union Town, Ohio; Allied Signal Aerospace/Bendix Flight Systems, South Montrose, Pennsylvania; Fischer and Porter, Bucks County, Pennsylvania; Parsons Casket, Belvidere, Illinois; Byron Salvage Yard, Byron, Illinois; Medford Scrap Salvage Yard, Medford, Wisconsin.

Boreholes were drilled and monitor wells installed. Selective formation packer tests were conducted to collect water samples and hydraulic data from specific zones.

In addition to the above work, a study to compile geologic and hydrologic data for the Galena/Platteville formation was initiated.

PLANS (July 1993 to June 1994): Convert digital line-graph data from National Mapping Office into ARC/INFO files for Galena/Platteville study. Base map will be created featuring demographic and geographic boundaries. Additional map for the Galena/Platteville study will include dolomite subcrops. Continue to provide assistance throughout Region V upon request.

COOPERATOR:

U.S. Environmental Protection Agency, Office of Superfund

LOCATION:

EPA-Region V (Wisconsin, Illinois, Michigan, Minnesota, Indiana and Ohio)

PROJECT CHIEF:

Bart Manion

PERIOD OF PROJECT:

November 1988-Continuing

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 1992

PROBLEM: To date, the effectiveness of best management practices (BMP's) in Wisconsin has not been determined. The natural variability of water-quality data complicates the detection of changes due to BMP implementation. Research is needed to identify techniques for detecting changes due to BMP implementation and applying the techniques to before and after data.

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 BMP's in two urban basins and seven rural basins 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. 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 BMP's in several basins in Wisconsin.

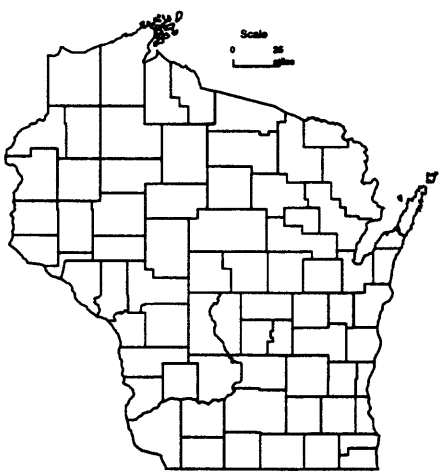
PROGRESS (July 1992 to June 1993): Open-file report and journal article describing statistical techniques were completed; both reports went through review process and received Director's approval. The open-file report is in preparation; the journal article was sent to ASCE Journal of Irrigation and Drainage Engineering for consideration. Annual report describing the progress of all nonpoint evaluation monitoring sites during the 1992 water year was completed.

PLANS (July 1993 to June 1994): Complete and distribute open-file report. Respond to journal peer reviews and continue publication process for journal article. Prepare annual progress report for 1993 water year.

REPORTS:

Walker, J.F., 1993, Statistical techniques for assessing water-quality effects of Best Management Practices, submitted to ASCE Journal of Irrigation and Drainage Engineering.

Walker, J.F., 1993, Techniques for detecting effects of urban and rural land-use practices on stream-water chemistry in selected watersheds in Texas, Minnesota, and Illinois.



HYDROLOGIC INVESTIGATIONS OF WETLAND RESTORATION AND CREATION PROJECTS, WI 170

PROBLEM: Agencies charged with mitigating wetland acreage losses due to construction projects are increasingly turning to wetland restoration and creation as a means of meeting requirements of Section 404 of the Clean Water Act. However, the hydrology and hydrogeology of wetlands is complex and not well understood. This lack of understanding has resulted in a low and unpredictable success rate for wetland mitigation projects.

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 1992 to June 1993): The first data-collection phase is now complete. Information gained from our efforts at the initial two field sites will be used to help guide plans for a new site near Waukesha, Wisconsin. All of the data from the first three years of investigations have been synthesized into the data base. An initial network of 20 piezometers has been installed at the new study site.

PLANS (July 1993 to June 1994): Monitoring will continue at the two sites in Southwestern Wisconsin, although at a decreased level of intensity. The Waukesha site will be intensively monitored. Excavation of the site will begin in November.

COOPERATOR:

Wisconsin Department of Transportation

LOCATIONS:

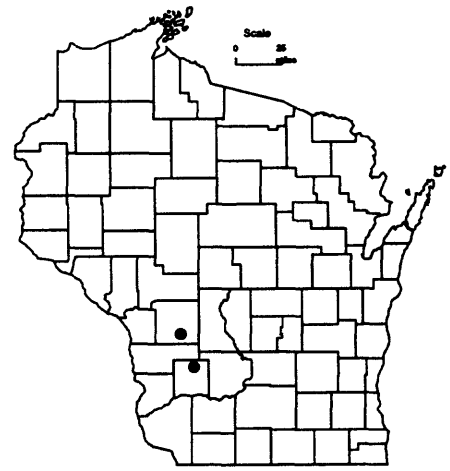
One mile south of Wilton, Wisconsin; one mile north of Hub City, Wisconsin

PROJECT CHIEF:

David P. Krabbenhoft

PERIOD OF PROJECT:

November 1989 to September 1996



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

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Chippewa, Kickapoo, Trempealeau River basins in western Wisconsin

PROJECT CHIEF:
Barbara C. Scudder

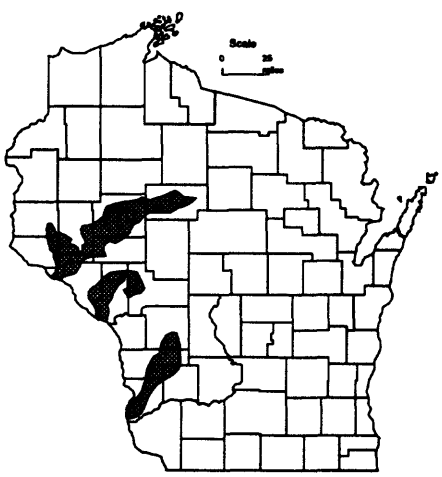
PERIOD OF PROJECT:
July 1990 to July 1992

PROBLEM: The Nonpoint-Source Program of the Wisconsin Department of Natural Resources (WDNR) wants to develop more quantitative methods for estimating pollutant reduction goals and be able to predict the effectiveness of management activities with regard to fisheries. Modeling the physical, chemical, and biological factors affecting the fishery is necessary to determine the sensitivity of the fisheries to different factors, including pollutant loads. Increased sediment and sediment-related factors resulting from agricultural practices are a concern in the three river basins.

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 three river basins in western 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 will be collected by the WDNR in two river basins. WDNR fish crews will be interviewed and selected streams will be visited. The data will be compiled and the models applied. The significance of sediment or sediment-related factors on fish populations in these river basins will be determined using the models. After interpretation of results from the two river basins, methods for collecting habitat data will be revised and habitat data will be collected by the USGS in a third river basin. Models will be applied to this data to determine the importance of sediment or sediment-related factors to fish populations. Literature research on the models and their use will be conducted, and WDNR staff will be consulted regarding previous use of the models. The utility of the models to the DNR's Nonpoint-Source Program will be assessed.

PROGRESS (July 1992 to June 1993): Results of the models indicated that sediment-related factors were of importance to brown and brook trout in several streams in the Kickapoo and Trempealeau river basins. Habitat data-collection methods were then revised to allow for collection of more accurate and suitable data for model input. Using the revised methods, the USGS collected habitat data in two streams in the Chippewa River basin. HSI models, including sensitivity analyses, have been applied for four fish species known to occur in the river basin. Results have been interpreted and the utility of the models for estimating sediment-reduction goals evaluated for the Nonpoint-Source Program.



PLANS (July 1993 to June 1994): A draft of the report has been submitted for editorial review. Publish report after approval is received.

REPORTS:
Scudder, Barbara, Use of habitat suitability index models to assess fine-sediment impacts on brown trout and brook trout habitat (in review).

TRENDS IN WATER QUALITY AND STREAM HABITAT FOR PRIORITY WATERSHEDS, WI 17201-17210

PROBLEM: An evaluation strategy is needed to assess the effectiveness of nonpoint-source pollution control measures in priority watersheds. Several important processes require research including the role of ground water in nonpoint-source contamination, factors leading to dissolved-oxygen reduction in a stream during runoff events, and the impact of management practices on bedload transport. Several techniques need to be developed and/or refined, such as detecting trends in stream-water chemistry, sampling of fish and fish habitat, relationship between fish/fish habitat and changes resulting from watershed management practices, and use of habitat models for determining impact of watershed management on fish populations.

OBJECTIVE: The overall objective of this project is to determine the trends in water quality for 10 sites during and after implementation of improved land-management practices in 4 priority watersheds.

APPROACH: Ten streams were selected in six different priority watersheds. Continuous-record streamflow, water temperature, and dissolved-oxygen gaging stations were installed at each stream site. Water-quality samples will be collected during events and low flows and analyzed for selected constituents.

PROGRESS (July 1992 to June 1993): Continued streamflow and water-quality monitoring at 10 sites in the priority watersheds. Dissolved oxygen was monitored at 9 sites in the priority watersheds. All data was summarized and will be published in the "Water Resources Data—Wisconsin" report for water year 1992. Water-quality loads were calculated for selected parameters and storm periods for the 10 sites.

PLANS (July 1993 to June 1994): Continue streamflow, water-quality (for the 10 sites), and dissolved-oxygen (at 7 sites) monitoring. Water-quality loads for selected parameters and storm periods will be calculated and compared to data collected in 1992. The data will be analyzed to determine if there are any apparent trends in water quality during implementation of the best management plans.

REPORTS:

Graczyk, D.J.; Walker, J.F., Greb, S.R., Corsi, S.R., Owens, D.W., Evaluation of nonpoint source contaminants in Wisconsin: selected data, 1991-92: U.S. Geological Survey Open-File Data Report (in review).

Walker, J.F., and Graczyk, D.J., Preliminary evaluation of effects of best management practices in the Black Earth Creek, Wisconsin, priority watershed, Symposium proceedings in Water Science Technology, September 1993 (in review).

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION:

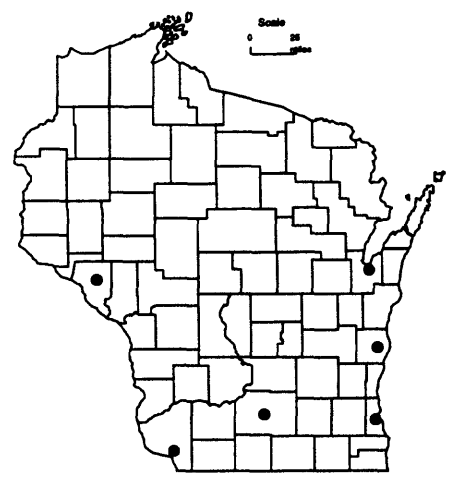
Priority watersheds in Brown, Buffalo, Dane, Grant, Milwaukee and Sheboygan Counties

PROJECT CHIEF:

David J. Graczyk,
Steven R. Corsi, and
David W. Owens

PERIOD OF PROJECT:

October 1990 to September 1997



A METHOD FOR ANALYZING THE EFFECTS OF STORM-WATER DISCHARGE ON POLLUTANT CONCENTRATIONS IN URBAN STREAMS, WI 17211

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Lincoln Creek in Milwaukee, Wisconsin

PROJECT CHIEF:
Steven R. Corsi

PERIOD OF PROJECT:
October 1992 to September 1993

PROBLEM: An effective method is needed for determining a probable distribution of pollutant concentrations in urban streams, pollutant reduction goals, and an optimal way of defining these goals. Given the financial constraint that not all urban streams and storm sewers can be monitored for water quality, a less expensive modeling procedure will need to be developed for this purpose. A statistical technique is desired by the Wisconsin Department of Natural Resources (WDNR) to replace the need for intensive monitoring to assess urban runoff and water quality. This technique will need the capability to predict storm-sewer discharges, concentrations of pollutants from these sewers, their effect on a receiving water, and the reductions needed to achieve water-quality goals.

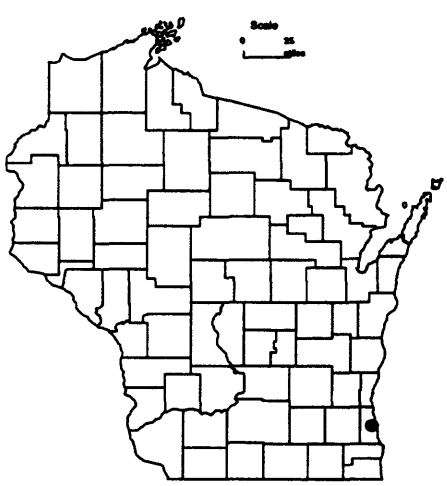
OBJECTIVE: The purpose of this project is to develop a method for determining the effect of storm-water discharges on the levels of pollutants in urban streams.

APPROACH: Existing water-quality models and combinations of models will be explored. The selected modeling method will be applied to Lincoln Creek, a 9.5-square-mile urban stream in Milwaukee County, Wisconsin. Extensive water-quality modeling will be done at two storm sewers discharging into Lincoln Creek and at the outlet of the basin for verification of the models. A probability-dilution method will be used to combine multiple storm-water discharges with a receiving stream resulting in estimated probability distributions of various water-quality constituents at the basin outlet.

PROGRESS (October 1992 to June 1993): Preliminary model selections have been made. The basin has been delineated into logical subbasins for modeling purposes. Monitoring of Lincoln Creek began in March. Calibration data from nearby basins has been obtained.

PLANS (July 1993 to June 1994): Continue to monitor streamflow and water quality in Lincoln Creek. Complete calibration of models and assess their effectiveness for the given problem.

A final report will be prepared that will discuss the modeling techniques, their effectiveness, and their usefulness to WDNR as a water-quality evaluation tool.



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

PROBLEM: Fish and Mud Lakes are seepage lakes separated by about a 200-foot-wide isthmus, but connected by a 5-foot-diameter culvert. Fish Lake is mesotrophic and Mud Lake is eutrophic. Eurasian water milfoil has become a nuisance macrophyte in much of the lake's littoral zone in recent years. A study of Fish Lake in the late 1970's showed significant internal phosphorus loading from the littoral sediment during summer stratification. Extensive row crop farming and large animal feed lots in the western part of the watershed may generate most external loading to both Fish and Mud Lakes. The Wisconsin Department of Natural Resources will be evaluating the lakes' water chemistry and trophic status and testing various means of controlling macrophytes. Identification of the amounts and sources of phosphorus entering the lakes is needed to evaluate phosphorus loading in relation to the lakes' trophic status. This information is needed for developing and assessing lake- and land-management alternatives for maintaining or improving water quality of the lakes.

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 the water budget for Fish and Mud Lakes is as follows:

$$DS = P - E + S + GI + LE - GO$$

where

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

The 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 at a tributary gaging station will 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).

COOPERATOR:

Dane County Lakes and Watershed Commission

LOCATION:

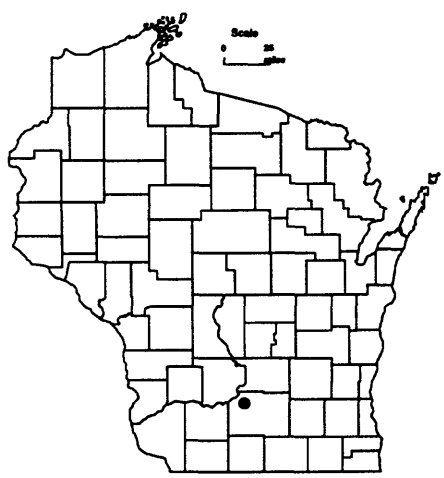
Northwest Dane County near Roxbury, Wisconsin

PROJECT CHIEF:

William J. Rose

PERIOD OF PROJECT:

October 1990 to March 1993



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

PROGRESS (July 1992 to June 1993): Interpretation of data for final report is completed. Preparation of final report is partially completed.

PLANS (July 1993 to June 1994): The final report will be completed.

REPORTS:

Rose, W. J., Hydrology of, and phosphorus loading to, Fish Lake in south-central Wisconsin, 1990-91: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

WISCONSIN LAKES, WHITEWATER LAKE, WISCONSIN, WI 17302

PROBLEM: Whitewater/Rice Lakes are mesotrophic lakes with moderate water-quality problems. Water and phosphorus loadings and in-lake chemistry need to be documented to develop a comprehensive management plan for the lakes.

OBJECTIVE: 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 lakes' 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 four lake-monitoring sites.

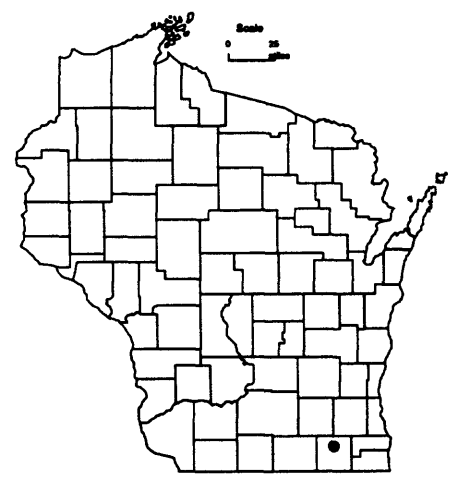
Trophic status: The trophic status of the lake will be evaluated according to Carlson's Trophic-State Index (1977) and by use of other empirical models.

COOPERATOR:
Whitewater Lake Management District

LOCATION:
Whitewater Lake, Walworth County

PROJECT CHIEF:
Stephen J. Field, Jerry Goddard

PERIOD OF PROJECT:
October 1990 to September 1992



PROGRESS (July 1992 to June 1993): All data except ground water has been compiled.

PLANS (July 1993 to June 1994): All data will be published in the annual report "Water Resources Data—Wisconsin." A final report will be published as a U.S. Geological Survey Water Resources Investigations Report.

REPORTS:

Field, Stephen J., Hydrology and Water Quality of Whitewater and Rice Lakes in southeastern Wisconsin (in review).

WISCONSIN LAKES, SILVER CREEK, WI 17303

PROBLEM: Silver Creek has been documented as the primary phosphorus source to Green Lake. Continued documentation of these loads helps to explain the lake's water quality. The station also serves as an indicator of annual phosphorus loading variability to help explain regional lake-water-quality problems.

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 at two sites. 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 1992 to June 1993): Streamflow and water quality were monitored at Silver Creek near Ripon, and Green Lake inlet near Green Lake.

Loads were computed for suspended sediment and total phosphorus for Silver Creek near Ripon. Annual yields were: total phosphorus, 209 pounds per square mile; and suspended sediment, 22.8 tons per square mile. At Green Lake inlet near Green Lake, annual yields were: total phosphorus, 156 pounds per square mile; and suspended sediment, 15.2 tons per square mile.

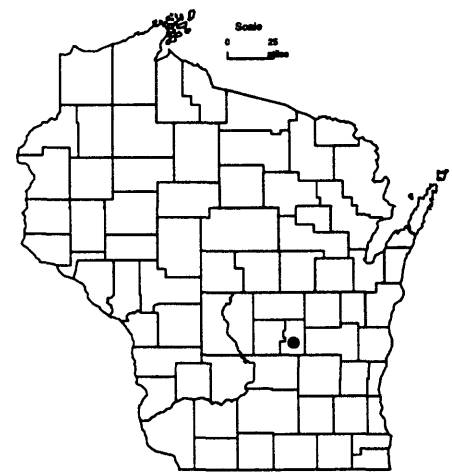
PLANS (July 1993 to June 1994): Continue monitoring streamflow and water quality at Silver Creek near Ripon and Green Lake inlet near Green Lake. All data will be published in the annual "Water Resources Data—Wisconsin" report.

COOPERATOR:
Green Lake Sanitary District

LOCATION:
Green Lake County, south-central Wisconsin

PROJECT CHIEF:
Stephen J. Field

PERIOD OF PROJECT:
October 1977-Continuing



WISCONSIN LAKES, DEVIL'S LAKE WATER-BUDGET MODEL, WI 17304

COOPERATORS:
Town of Baraboo
Wisconsin Department of Natural Resources

LOCATION:
Southeastern Sauk County near Baraboo, Wisconsin

PROJECT CHIEF:
William G. Batten

PERIOD OF PROJECT:
July 1991 to September 1993

PROBLEM: Phosphorus released from bottom sediment in Devil's Lake during anoxic periods has accelerated algae growth, particularly during late summer months, reducing water clarity. The Wisconsin Department of Natural Resources (WDNR) is researching methods to reduce the phosphorus available for algal growth. It is essential to understand the hydrology of Devil's Lake before any remedial action is taken to improve water quality in the lake.

OBJECTIVE: The objectives are to determine the hydraulic parameters and water-budget components of Devil's Lake and to simulate historical lake-stage changes using a FORTRAN computer program.

APPROACH: The hydrologic budget can be described as follows:

$$S = P + RO \pm GW - E$$

where

S = change in lake storage,
P = precipitation falling directly on the lake,
RO = RUNOFF into the lake
GW = ground-water seepage into or out of the lake
E = water evaporated from the lake surface

The following water-budget components will be measured for the period from July 1, 1991 to December 1992:

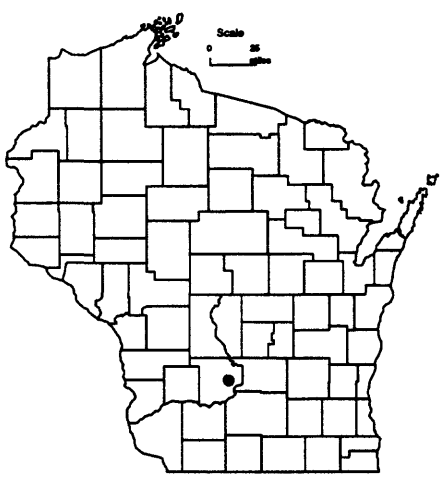
Change in lake storage (S) will be calculated by relating lake stage to lake volume. An in-lake gage will be used to measure lake stage. The relationship between lake stage and lake volume will be described from an existing bathymetric map.

Precipitation (P) will be measured using commercially available measuring devices at two locations near the lake.

Surface-water inflow (SW) will be determined from intermittent discharge measurements of the small spring creek entering the southwest edge of the lake. Estimates of overland flow (RO) along the steep east and west edges of the lake may be necessary to further quantify the surface-water-inflow component with runoff from snowmelt and rainstorms.

Ground-water seepage into and out of the lake (GW) will be determined using Darcy's Law calculations. Data for these calculations will be obtained by determining the relationship between change in lake stage and evaporation rates during periods of no precipitation.

Evaporation (E) data from the Arlington climatological station located about 15 miles east of Devil's Lake will be used to calculate the lake water lost to evaporation.



Historical precipitation and evaporation data and measured hydraulic parameters will be used to calibrate a water-budget model designed to simulate lake stage. Reasonable adjustments of individual parameters will be made as necessary to make simulated stage hydrographs agree with historical stage data for Devil's Lake.

PROGRESS (July 1992 to June 1993): Lake stage, ground-water levels, and precipitation were monitored on a continuous basis through December 1992. Data were compiled and values for each of the water-budget terms were determined. The FORTRAN program was used with this data to simulate lake-stage fluctuations for the 12-year period from 1980-92. These simulated lake stages were calibrated with historical and lake-stage data collected during this study. Simulated lake stage was found to be most sensitive to the runoff coefficient value (the percentage of precipitation reaching the lake for individual storm events) during the calibration process. The final calibrated model simulations show excellent correlation to observed historical lake-stage data.

PLANS (July 1993 to June 1994): Results of the study will be published as a journal article.

WISCONSIN LAKES, ASSESSMENT OF THE WATER QUALITY AND TROPHIC STATUS OF PARK LAKE, COLUMBIA COUNTY, WISCONSIN, WI 17306

COOPERATOR:
Park Lake Management District

LOCATION:
Pardeeville, Columbia County

PROJECT CHIEF:
Phil A. Kammerer

PERIOD OF PROJECT:
October 1992 to November 1994

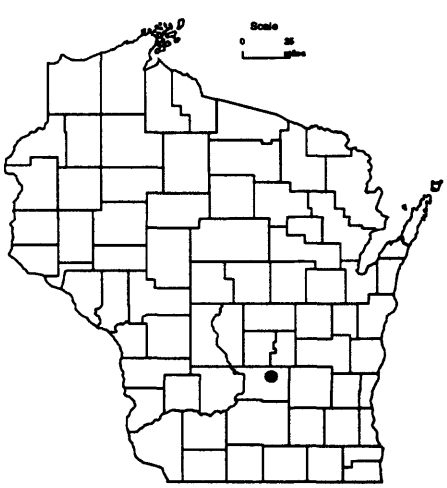
PROBLEM: Local residents on Park Lake perceive deteriorating water quality in the lake due to excessive algae and aquatic plants. No measurements have been made of factors affecting the lake's quality, and measurement of the lake's condition are limited to two years of in-lake data collection in 1986-87.

The Park Lake Management District plans to prepare a lake management plan to limit input of phosphorus, which contributes to excessive algae and plant growth, to the lake. An understanding of the hydrology of the lake and determination of the sources and amounts of phosphorus entering and leaving the lake are needed to develop a management plan. The trophic status of the lake needs to be determined to evaluate the effectiveness of the management plan.

OBJECTIVE: The objectives of this study are to describe the hydrology of the lake, determine a phosphorus budget for the lake, describe present in-lake water quality, and determine the trophic status of the lake.

APPROACH: The study will consist of a year of data collection followed by data analysis and report preparation. Hydrologic and water-quality data will be collected to describe the hydrology of the lake, compute an annual phosphorus budget to determine the sources and amounts of phosphorus that are available for algae and plant growth, and describe the lake's trophic status and seasonal changes in its water quality. Components of the hydrologic budget for the lake that will be measured directly include precipitation, lake stage, and surface inflow. Surface outflow, evaporation from the lake surface, and net ground-water flow will be estimated from other budget components or taken from the literature. The Fox River is assumed to be the major source of phosphorus entering the lake. Phosphorus input and surface-water inflow to the lake will be measured at a monitoring station on the Fox River upstream from the lake.

In-lake water quality will be measured at two locations in the lake to describe seasonal water-quality characteristics of the lake and to provide data needed to evaluate the lake's trophic status. The trophic status of the lake will be evaluated using empirical models.



PROGRESS (July 1992 to June 1993): A streamflow-monitoring station was installed on the Fox River and collection of hydrologic and water-quality data began November 1, 1992. In-lake water-quality measurements began in April 1993.

PLANS (July 1993 to June 1994): Collection of hydrologic data and water-quality measurements on the Fox River and in the lake will continue through October 1993. Data compilation and analysis will begin. Data will be prepared for publication in the annual data report "Water Resources Data—Wisconsin, Water Year 1993", and work on an interpretive report describing the results of the project will begin.

ASSESSMENT OF HYDROLOGY, TROPHIC STATUS, AND LAKE-BED SEDIMENT OF STEWART LAKE NEAR MT. HOREB, WI 17308

PROBLEM: Stewart Lake is a man-made, 8-acre lake just north of the Village of Mt. Horeb. About one third of the lake's 450-acre watershed is in Mt. Horeb. The lake's earthen dam was built in 1940. Local residents believe lake water quality has deteriorated in recent years, and that sediment and nutrient loading to the lake may have increased as a result of the development of two subdivisions in the last 20 years. However, no measurements have been made to quantify or document the lake's condition. Accumulation of sediment in the lake is believed to have significantly reduced the lake's volume. Construction of detention ponds to trap sediment and nutrients and dredging sediment from the lake have been suggested. More information is needed to evaluate the merits of various corrective measures. Sources and quantity of water, sediment, and phosphorus entering the lake need to be determined. Information is needed to evaluate the trophic status of the lake and the chemical character, quantity, and areal distribution of sediment in the lake.

OBJECTIVE: The objectives of the study will be to (1) determine water, sediment, and total-phosphorus budgets for the lake, (2) evaluate the trophic status of the lake, and (3) determine the volume, areal distribution, and chemical character of sediment in the lake.

APPROACH: Data collection will be done between April 1, 1992 through November 30, 1993. Study emphasis will be on only the most significant (with regard to sediment and phosphorus loading) water-budget components owing to funding constraints. These are lake storage, precipitation (P), surface runoff (R), and lake outflow (O). Ground-water inflow and outflow and evaporation will be estimated based on minimal data. P, change in lake storage (DS), and O will be measured continuously. R will be estimated by mass balance ($R = DS - P + O$). Runoff in many small channels and gullies and the lake outlet will be sampled and analyzed for suspended-sediment and total-phosphorus concentrations. The lake's trophic status will be monitored by measuring secchi depth, total-phosphorus concentration, and chlorophyll a concentration. The thickness of sediment accumulated since 1940 will be determined by mapping the present lake bottom and comparing it with the bottom in 1940. Lake sediment will be analyzed for particle size, density, and concentrations of lead and pesticides.

PROGRESS (May 1992 to June 1993): In-lake water-quality monitoring began in May 1992. Most hydrologic instrumentation for the watershed monitoring was installed in October 1992. Owing to instrument problems in October and November 1992, the start of the planned 1-year monitoring period was delayed from October 1 to December 1, 1992. Measurements for mapping the lake bed and lake-sediment sampling were completed in February 1993.

PLANS (July 1993 to June 1994): Hydrologic monitoring will continue through November 1993. Data will be provided to Dane County and published in the annual data report, "Water Resources Data—Wisconsin". The first draft of the final study report will be prepared.

COOPERATOR:

Dane County Lakes and Watershed Commission

LOCATION:

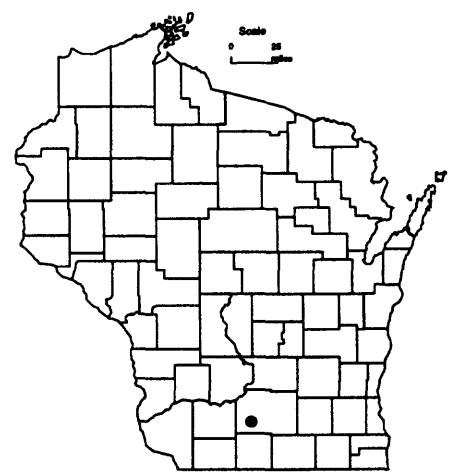
Near Mt. Horeb in
Dane County, Wisconsin

PROJECT CHIEF:

William J. Rose

PERIOD OF PROJECT:

May 1992 to September 1994



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

COOPERATOR:
U.S. Geological Survey
Reston, Virginia

LOCATIONS:
Upper peninsula of Michigan from the Menominee River basin in the west to the Fishdam River basin in the east; and the eastern portion of Wisconsin to include the Menominee, Oconto, Peshtigo, Fox-Wolf River basins discharging to Green Bay, and in Wisconsin that directly drain into Lake Michigan from the west which include the Manitowoc, Sheboygan, Milwaukee, Root, and Pike River basins.

PROJECT CHIEF:
James G. Setmire

PERIOD OF PROJECT:
December 1990-Continuing

PROBLEM: Growing populations throughout the United States have resulted in increased development and use of our water resources. As our water resources become stressed, decisions on how to effectively utilize and manage these resources will need to be made. These decisions must be based on accurate assessments of the quality of the water resource and the factors affecting its use.

OBJECTIVE: The long-term goals of the NAWQA project are to determine the water quality of the streams and aquifers in the Western Lake Michigan Drainages, determine the presence or absence of any trends in the water quality, and provide an understanding of the link between natural and anthropogenic factors and observed water quality. Specific goals are: (1) to determine the occurrence and spatial distribution of a broad array of water-quality constituents in water and stream-bed sediments, (2) determine the occurrence of contaminants in selected target taxa, (3) evaluate the aquatic habitat and community structure of streams in the study unit, (4) assess the surface- to ground-water interaction and the effects of land use on base-flow water quality in selected stream reaches, (5) evaluate the sources and transport of selected hydrophilic compounds in agricultural settings, and (6) assess the influence of land use on shallow ground-water quality in selected land-use settings.

APPROACH: The foundation of the study approach is based upon identifying homogenous subareas of specific land use and environmental characteristics. Identification of these subareas is accomplished by stratifying the study unit into subcategories. Stratification relies on geographical information system technology using digital coverages of environmental variables and land use. The homogenous areas identified with this process (indicator sites) will be incorporated into a complex nested study design of surface-water, streambed sediment, and biological sampling. The sampling strategy consists of a reconnaissance of water quality within the study unit, and a sampling to determine the occurrence and distribution of organic and inorganic constituents in streambed sediments and tissues. Basic fixed-site monitoring of indicator sites, as well as monitoring of drainage basins having heterogeneous land use and environmental variables (integrator sites), will be instituted for two years beginning in FY 1993. Monthly surface-water sampling will be augmented with five to eight event-related samples at both indicator and integrator sites. A subset of these sites (intensive fixed sites) will be sampled seasonally. This component will be accomplished with weekly and/or daily sample collection during a 3- to 9-month period. Other program components include determining the spatial distribution in water and streambed sediments of constituents identified during occurrence survey. This synoptic sampling will focus on sources and transport of selected constituents. Ecological surveys at 50 to 80 sites will evaluate community structure and habitat in relation to land use and other environmental factors. This evaluation likely will occur during FY 1995. Selected ground-water studies also will occur with the evaluation of surface-water/ground-water interaction using shallow wells and lysimeters installed adjacent to selected stream reaches. Effects of land use on ground-water quality will be assessed through sampling of targeted ground water in specific environmental settings.

PROGRESS (July 1992 to June 1993): A drive-by-assessment (drive-by) of 100 sites within the Western Lake Michigan Drainages (WMIC) National Water-

Quality Assessment (NAWQA) study unit was completed in July 1992. Sites for the drive-by were selected from an overlay of land use, texture of surficial deposits, upper bedrock geology, physiographic province, and streams within the study unit. The overlay produced areas of similar factors that have been designated as relatively homogeneous units (RHU's). Sites located completely within these drainages are designated as indicator sites. Sites within RHU's were selected to represent major settings and major water-quality issues within the WMIC study unit. The purpose of the drive-by was to determine whether the site characteristics described by the digital coverage were accurate and to ascertain the suitability of the site for subsequent sampling.

Information from the drive-by was evaluated and 34 of the sites were selected for a field reconnaissance. The purpose of the field reconnaissance was to determine the presence/absence of national target taxa for tissue sampling, and to more thoroughly evaluate the sites for future monitoring plans. Electro-shocking was utilized to identify the relative abundance and type of fish present at each site. The bottom substrate also was sampled to determine the relative abundance and type of benthic macroinvertebrates (specimens were identified in the field). Additionally, a select list of habitat characteristics was measured.

An occurrence survey of bed sediment and tissue was performed during August 24 - September 5, 1992. Sites were chosen by tabulating results from the field reconnaissance for the presence of target taxa. From this list, 12 sites were identified where white suckers (*Catostomus commersoni*) and caddisflies (*Hydropsyche* sp.) were present. Spatial distribution and coverage of the major environmental units (RHU's) also were selection criteria. Bed sediments were collected and wet-sieved through a 63-micrometer mesh for determination of trace elements and through a 2-millimeter mesh for a broad spectrum of organic compounds. White suckers were collected for analysis of organic compounds (whole fish), and *Hydropsyche* were collected and analyzed for trace elements. White sucker livers were collected at one site for trace-element analysis and for comparison with trace-elements concentrations in *Hydropsyche*.

Bed-sediment samples were collected during October 1992 at four large rivers (integrator sites) draining several to many RHU's and more heterogeneous environmental settings. These samples were analyzed for trace-element concentrations and for synthetic organic compounds.

PLANS (July 1993 to June 1994): A retrospective analysis of nutrients and sediment is slated to be completed during FY 1993. This report is an analysis of the major STORET data along with ground-water data from the Wisconsin Department of Natural Resources. The purpose of this report is to provide a conceptual model describing variability of nutrients in water and sediments as well as exploring causal relations. An environmental settings' report also is due to be completed during FY 1993. This report describes the physiography, climate, hydrologic cycle, geology, and biology of the WMIC Drainages study unit and will serve as a reference for these settings for future reports.

The intensive and basic fixed-site monitoring will commence during the spring of 1993. The intensive fixed-site-monitoring component will involve sampling hydrophilic pesticides and nutrients (26 sets of samples) at two agricultural indicator sites (the North Branch of the Milwaukee River and Duck Creek) and one integrator site (the Milwaukee River at Estabrook Park). The basic fixed-site monitoring will involve collection of six monthly and five runoff-event samples at eight sites (three agricultural sites, one urban site, two forested sites, and two integrator sites). The basic fixed-site sampling will continue for two years.

A spatial ecological survey will commence during May 1993 and will involve sampling of selected biota along with habitat measurements at about 50 sites. Other work beginning during the summer of 1993 includes a ground-water land-use component involving the installation of 30 shallow wells in one of the major agricultural RHU's. The purpose of this study will be to determine the effects of land use on shallow water quality. These wells will be drilled by personnel from the U.S. Geological Survey District Office in Madison, Wisconsin. Preliminary investigations of the effects of agricultural land use on shallow ground-water quality and the interaction of ground and surface water in a flow path also will occur during the summer of 1993. Shallow ground-water and surface-water samples will be collected in and around the water bodies of the North Branch of the Milwaukee River and Duck Creek for analysis of selected water-quality constituents.

HYDROLOGIC AND BIOGEOCHEMICAL BUDGETS IN TEMPERATE LAKES AND THEIR WATERSHEDS, NORTHERN WISCONSIN, WI 175

PROBLEM: There has been expanding evidence that rates of global changes are increasing. There is a need for research to identify, describe, and quantify the processes that control the Water, Energy, and Biogeochemical Budgets (WEBB) of aquatic ecosystems in order to understand and predict their responses to global changes. Promotion of such research is the function of the Water Resources Division's WEBB program. In the northern highlands lakes district of north-central Wisconsin, five lakes and two bog lakes have been the site of long-term ecological research conducted by University of Wisconsin scientists for the past decade. These studies have provided extensive information about biological and chemical features of the lake systems, but understanding of interactions among the lakes, streams, ground-water system, and wetlands is still limited. Research is urgently needed to describe these interactions and basin-wide processes that influence the character of the lakes.

OBJECTIVE: (1) Describe processes controlling water and solute fluxes in northern Wisconsin lake watersheds, (2) examine interactions among those processes and their relations to climatic variables, and (3) improve the capability to predict changes in water and solute fluxes for a range of spatial and temporal scales. Fulfillment of these objectives in Wisconsin will contribute to meeting the overall objective of the federal global change program: to understand processes underlying the responses of hydrological, biological, and chemical systems to climate variations and human activities.

APPROACH: Selected streamflow/recharge sites on tributaries of Trout Lake are the sites for detailed research of hydrologic processes. Most of the current research effort is concentrated at Allequash Creek, one of four inflowing tributaries of Trout Lake. Analyses of hydrologic connections among precipitation, streamflow, and ground water are conducted at three cross-sections of the Allequash Creek basin. Monitoring and sampling equipment installed at these sites include piezometer nests, lysimeters, tensiometers, precipitation collectors, and thermocouple nests. Analyses of stable isotopes (C-13, O-18, Sr-86, and deuterium) are also used to determine water exchange pathways and sources of stream water. The site-specific hydrologic research is supported by data from several rain gages throughout the study area, and a complete climatological station in the vicinity.

Stream-water and ground-water samples, collected at each of the Trout Lake tributaries and at different points in the Allequash system, undergo analysis for nitrogen species, phosphorus, silica, organic carbon, major ions, and metals. Tributary sampling is done on a monthly basis, supplemented with more intense sampling of particular storms. Coupled with hydrologic data, the water sampling provides a basis for describing chemical budgets.

Investigation of geochemical processes that control transport of important chemical species across stream and lake sediments involves fine-scale sampling at the sediment/water interface. This is done by a variety of techniques, including membrane equilibrators, core squeezing, microprobes, and seepage meters.

COOPERATOR:

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

LOCATION:

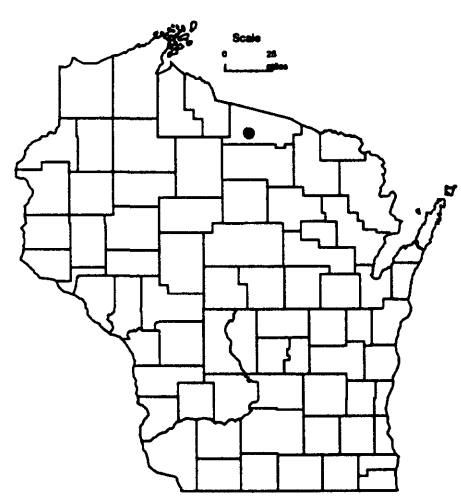
North-central Wisconsin

PROJECT CHIEFS:

John F. Elder,
David P. Krabbenhoft and
John F. Walker

PERIOD OF PROJECT:

October 1990 to September 1993



PROGRESS (July 1992 to June 1993): Three Allequash Creek monitoring sites were established and equipped for intensive hydrologic and geochemical data collection. Precipitation, ground-water and stream samples were analyzed for stable isotope composition; results provided information to characterize the hydrology of the system. Stream-water and ground-water samples were collected approximately monthly at Trout Lake tributaries and in the Allequash system and analyzed for chemical composition. Results to date indicate considerable chemical variation among streams, and among locations within the Allequash system, despite nearly uniform climatic and geologic conditions throughout the basin. It is hypothesized that this variability is controlled by physiographic and hydrologic factors, including watershed size and relief, length of water flow paths, and fraction of peatland in the watershed. It is also affected by the composition and abundance of vegetation in the basin.

PLANS (July 1993 to June 1994): Data collection at hillslope monitoring sites will continue; the data produced will be used to expand and refine descriptions of the hydrologic flow paths in the system. Stream-water and ground-water monitoring will continue for further examination of seasonal and spatial variability. More research will be conducted to examine characteristics of peat deposits and vegetation in the Allequash wetland, leading to estimates of standing carbon pools and changes in these pools with time. Measurements will be conducted to determine gas-phase and aquatic-phase transport of carbon and nutrients through the system.

REPORTS:

Elder, John F., Krabbenhoft, David P., and Walker, John F., 1992, Water, Energy, and Biogeochemical Budgets (WEBB) program: data availability and research at the Northern Temperate Lakes site, Wisconsin: U.S. Geological Survey Open-File Report 92-48.

Krabbenhoft, D.P., Walker, J.F., and Kendall, Carol, and Bullen, T.D., 1992, Definition of water flow paths by stable isotope analysis of ground water, rainfall, and stream water in temperate lake watersheds, northern Wisconsin (journal article, planned).

Walker, J.F., Krabbenhoft, D.P., and Elder, J.F , 1992. Partitioning of precipitation into quick-response streamflow and recharge in temperate lake watersheds, northern Wisconsin (journal article, planned).

SOURCES OF POLLUTANTS IN URBAN RUNOFF, WI 176

PROBLEM: Urban storm-water-runoff quality has adversely impacted local lakes and streams. Identifying the pollutant sources that contribute the majority of pollutant load may offer a cost effective way of controlling the selected pollutant.

OBJECTIVE: Determine the concentration 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 solids, metals, bacteria, and phosphorus concentrations.

PROGRESS (July 1992 to June 1993): Manuscript was completed and sent for editorial and colleague review.

PLANS (July 1993 to June 1994): Revise report and send for approval. Publish report.

REPORTS:

Bannerman, R.T., Owens, D.W., Dodds, R.B., and Hornewer, N.J., Source of pollutants in Wisconsin storm water (in review).

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION:

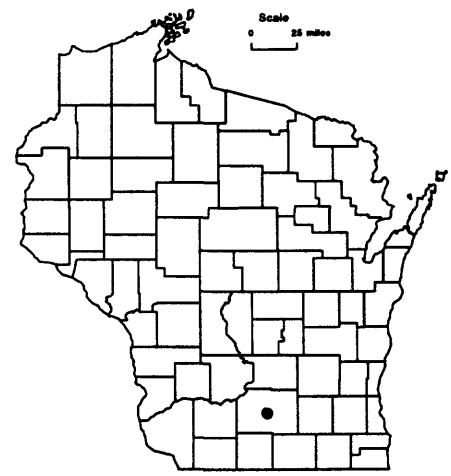
City of Madison, Wisconsin

PROJECT CHIEF:

David Owens

PERIOD OF PROJECT:

March 1991 to June 1992



GROUND-WATER RESOURCES AT THE KETTLE MORAINE SPRINGS FISH HATCHERY, SHEBOYGAN COUNTY, WISCONSIN, WI 178

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Sheboygan County, Wisconsin

PROJECT CHIEF:
Terrence Conlon

PERIOD OF PROJECT:
June 1991 to September 1993

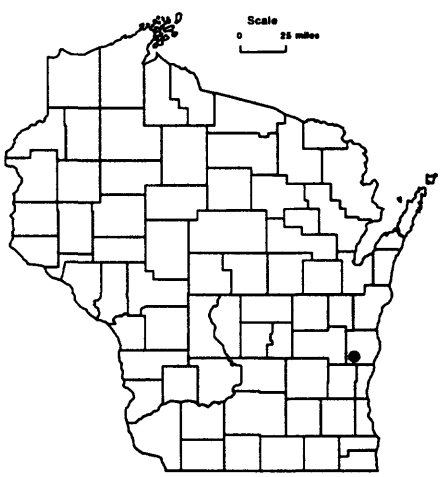
PROBLEM: The Kettle Moraine Springs Fish Hatchery supplies salmon to Lake Michigan. The fish hatchery's present water supply consists of springs and two wells. The hatchery is planning to expand its salmon-rearing operations and add rearing facilities for walleye. Additional water supplies will be obtained by drilling at least one new well. The effect of additional ground-water withdrawals on hatchery springs and wells and on nearby private wells is unknown.

OBJECTIVE: The study will assess the ground-water resources available to the fish hatchery and evaluate the effect on hatchery springs and wells and private wells of developing a ground-water supply.

APPROACH: The fish hatchery may obtain water from the bedrock dolomite aquifer, or sand and gravel deposits if present. Seismic-refraction data will be collected to determine the thickness of glacial deposits and the depth to the bedrock aquifer. Test holes will be drilled to determine if sand and gravel deposits are present and confirm the depth to bedrock obtained from seismic data. Large diameter production wells and observation wells will be installed and monitored during two pumping tests. Results from the aquifer tests will be interpreted using analytical solutions.

PROGRESS (July 1992 to June 1993): Refraction data along six lines were collected and interpreted. Although the thickness of glacial deposits may be as large as 200 feet, data from drilling indicate that the glacial deposits are fine grained and will not support the magnitude of pumping needed at the hatchery. The fine-grained deposits confine the bedrock aquifer. The potentiometric surface of the bedrock aquifer is greater than the land surface. Production and observation wells were installed and instrumented. Two aquifer tests were performed. Preliminary results indicate that (1) the bedrock aquifer is hydraulically connected to the spring system, (2) the hatchery water-supply wells interfere with each other, and (3) the transmissivity of the portion of the aquifer that one water-supply well is open to is approximately 1200 ft^2/day.

PLANS (July 1993 to June 1994): The data from the aquifer tests will be analyzed to estimate the hydraulic properties of the bedrock aquifer at two locations. Distance-drawdown curves will be constructed to evaluate the effect of pumping from each hatchery well on private wells and planned hatchery wells. The effect of pumping on water flows from springs will be evaluated using aquifer test data, flow data and water-level data from wells near the springs. Results of this work will be published in a USGS report.



MERCURY CYCLING IN LAKES, WI 18001

ACIDIC LAKES

PROBLEM: Acid deposition has damaged lakes in Canada and in the northeastern United States. The pH of precipitation in northern Wisconsin averages 4.6 to 4.7, and Wisconsin has more susceptible lakes than any state east of the Mississippi. Many of these lakes are seepage lakes, whose chemistry is closely associated with precipitation chemistry. Previous studies addressing hydrologic and chemical budgets in northern Wisconsin have concentrated on lakes with alkalinities greater than 20 ueq/L; however, to truly address the potential effects of acid deposition on sensitive lake ecosystems, it is necessary to study lakes with alkalinities less than 20 ueq/L.

OBJECTIVE: Determine the 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 bog lakes 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. Continue limited hydrologic monitoring at Vandercook Lake, which has a data base going back to October 1980.

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 mercury plus other 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 1992 to June 1993): Most monitoring emphasis was at Max Lake; lake stage and a single recorder-equipped well were monitored at Morgan Lake; and there was no monitoring at Honeysuckle Lake.

Ground water was pumped into Max Lake from May 7 to June 11 and from September 18 to October 1, 1992, at a 16 gallons-per-minute rate to maintain the lake's pH at 5.6. This was about 8 percent more than was required the previous year to maintain the lake's pH at 5.6.

Regression relations of ground-water inflow and outflow (GW I/O) to head difference between selected near-lake piezometers and Vandercook Lake were developed. These relations were based on data and flow calculations for the 1980-88 period. The relations will be used to estimate GW I/O for the period since 1988 and into the future. This method shows promise as a means of estimating GW I/O for extended periods with minimal piezometer monitoring after an intensive "calibration" period.

PLANS (July 1993 to June 1994): Routine data collection will continue at approximately the same level as last year. Max Lake's pH will be raised from 5.6 to 7.0 and maintained at 7.0 by intermittent ground-water pumping. Preliminary water budgets will be computed for Max Lake.

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION:

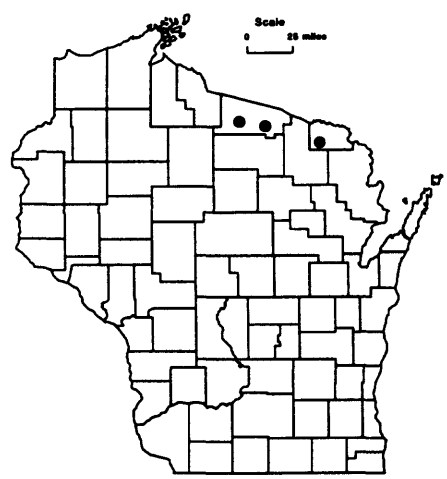
Florence and Vilas Counties, northern Wisconsin

PROJECT CHIEF:

William J. Rose

PERIOD OF PROJECT:

March 1987 to September 1991



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

HYDROLOGIC CONSIDERATIONS ASSOCIATED WITH THE ARTIFICIAL ACIDIFICATION OF LITTLE ROCK LAKE IN VILAS COUNTY, WI

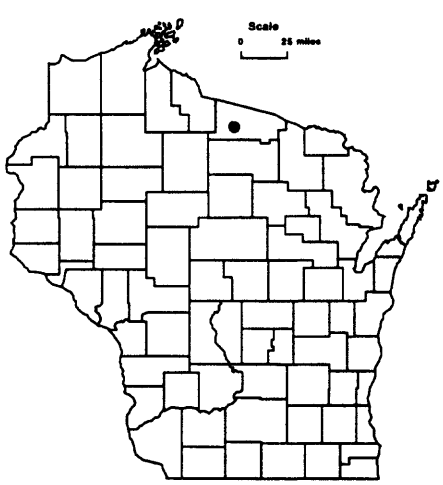
PROBLEM: A multi-agency group will study biological chemical responses to artificial acidification of one basin of two-basin Little Rock Lake by artificially lowering the pH incrementally over an 8-year period. The basins will be separated by a barrier; one basin will be acidified, the other will function as a control. A detailed understanding of the lake hydrology is needed by the group to (1) determine which of the basins to acidify, (2) estimate the amount of acid required to achieve a given pH level, (3) characterize the lake hydrologically to increase the transfer value of the study's results to other lakes, (4) monitor the effects of the acidification on the local ground water, and (5) provide basic hydrologic information on lake hydrology that would be input to any acidification models that may be tested.

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 1992 to June 1993): Routine hydrologic monitoring continued. Analysis of the ground-water-flow components of the lake's water budget for the 1984-1990 water years was completed.

PLANS (July 1993 to June 1994): The report summarizing the lake's general hydrology and water budgets for water years 1984-90 will be published.



REPORTS:
Rose, W.J., Hydrology of Little Rock Lake in north-central Wisconsin (in review).

MERCURY ACCUMULATION, PATHWAYS, AND PROCESSES, WI 18003

PROBLEM: Analytical data from the waters and biota of many Wisconsin lakes has indicated that there is a Statewide problem of mercury contamination in natural water systems. Elevated concentrations of mercury, coupled with the high toxicity of the element, has led to issuance of fish consumption advisories for many Wisconsin lakes. The causes of mercury contamination and processes affecting mercury cycling within the lake systems are not well understood. An intensive study of mercury biogeochemistry in the lakes is needed to provide information that can be applied to develop appropriate management practices.

OBJECTIVE: The project will be one part of a team research program whose overall objective is to understand the processes responsible for aquatic transport and transformation of mercury. Goals of this subproject are to determine net accumulation rates of mercury in lake sediments, qualify advective and diffusive fluxes of mercury from sediments, determine spatial and temporal variations in mercury accumulation and remineralization below the sediment-water interface, and assess the role of complexation and precipitation in controlling the fate of mercury.

APPROACH: The approaches used in this study will be novel, as no previous methods can yield samples without contamination. Methods developed will focus on various near-sediment, sediment, pore-water, and ground-water-sampling techniques.

PROGRESS (July 1992 to June 1993): Many new methods were tested for direct sampling of sediment/water mercury exchange and methylation. The most reliable methods allow for close interval sampling of the profundal water column just above the sediments, as well as littoral pore waters.

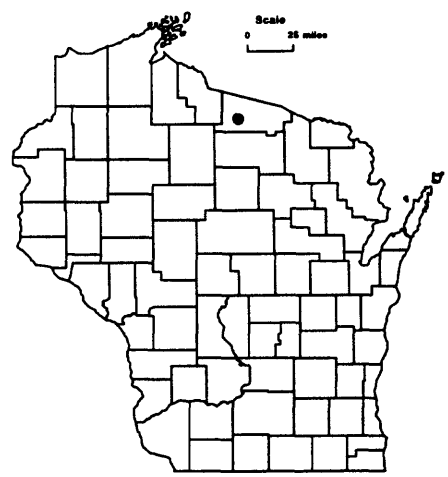
PLANS (July 1993 to June 1994): Sampling will continue at regular intervals to allow for calculation of annual mercury exchange and methylation rates. Final project results will be reported at the International Mercury meeting in June 1994.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
North-central Wisconsin

PROJECT CHIEF:
David P. Krabbenhoft

PERIOD OF PROJECT:
January 1992 to December 1994



ASSESSMENT OF THE HYDROLOGY, WATER QUALITY, AND BIOLOGY OF DELAVAN LAKE, WI 18101

COOPERATOR:
Delavan Lake Town Board

LOCATION:
Walworth County, southeast Wisconsin

PROJECT CHIEF:
Stephen J. Field

PERIOD OF PROJECT:
August 1983-Continuing

PROBLEM: Delavan Lake was a hypereutrophic lake where severe blue-green algae blooms occurred. Nutrient sources and loads were identified and a comprehensive management plan was developed and implemented to improve the water quality of the lake. Monitoring is continuing to determine the effectiveness of the plan.

OBJECTIVE:

1. Determine nutrient and suspended-sediment discharge at Jackson Creek near Elkhorn, Jackson Creek tributary near Elkhorn, Jackson Creek at Mounds Road (wetland outlet), and Delavan Lake inlet. Determine phosphorus discharge from the lake at Delavan Lake outlet. Continuous streamflow will be determined at all sites.

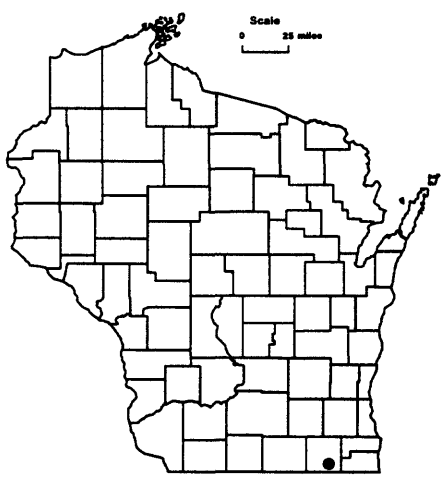
2. Determine lake stage.

3. Determine phosphorus characteristics of the lake water and other physiochemical characteristics.

4. Determine the phytoplankton and zooplankton populations, May through September.

APPROACH: Nutrients and suspended sediments will be monitored at Jackson Creek, Jackson Creek tributary, Jackson Creek wetland outlet, and Delavan Lake inlet. Phosphorus will be monitored at Delavan Lake outlet. Streamflow will be monitored at all sites. Lake stage will be monitored continuously. Phosphorus concentration of the lake water and dissolved oxygen, water temperature, pH, and specific conductance will be monitored. Phytoplankton and zooplankton will be monitored.

PROGRESS (July 1992 to June 1993): Streamflow was monitored continuously at four inflow sites and at one outflow site from Delavan Lake. Water-phosphorus samples were collected monthly at all stream sites. During storm runoff, samples were collected by an automatic sampler or by an observer. Water samples were analyzed for nutrients and suspended sediment. Three sites within the lake were monitored to determine the physiochemical characteristics of the water. The 1992 water-year data was compiled for publication in "Water Resources Data—Wisconsin, Water Year 1992." The final phase of the lake rehabilitation plan continued in the 1992 water year with the construction of the wetland to filter nutrients and sediments to the lake. The wetland was constructed in September - October 1992.



PLANS (July 1993 to June 1994): Continue monitoring program as scheduled. Compile data for publication.

REPORTS:

Field, Stephen J., and Duerk, Marvin D., 1988, Hydrology and water quality of Delavan Lake in southeastern Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 87-4168, 61 p.

WETLAND RETENTION OF SURFACE-WATER NUTRIENT AND SUSPENDED-SEDIMENT LOADS INFLOWING TO A EUTROPHIC LAKE IN SOUTHEASTERN WISCONSIN, WI 18102

PROBLEM: Jackson Creek is the major inflowing tributary to Delavan Lake in southeastern Wisconsin. An artificial wetland has been constructed on the creek as a means of trapping nutrients and sediments that would otherwise flow to the lake and contribute to its eutrophication. Other studies have shown that the trapping function of wetlands is not consistent and depends on little-known processes and particular conditions of the system. More information about the wetland functions is needed to assess and predict the effectiveness of the Jackson Creek wetland construction as a management strategy.

OBJECTIVE: Assess the effectiveness of the Jackson Creek wetland as a nutrient and sediment-retention system, with emphasis on retention of phosphorus. Quantify nutrient and suspended-sediment loads in surface-water inflows and outflows of the wetland. Characterize effects of water flow through the wetland on variability of these loads. Describe phosphorus cycling processes and dominant phosphorus partitioning reservoirs in the wetland.

APPROACH: Phosphorus partitioning and transformation will be investigated in microcosms that simulate the wetland. Phosphorus retention in the microcosms as a function of presence and types of sediments and plants will be determined. Additional samples from selected points within the wetland will be analyzed for phosphorus, nitrogen, and other constituents to allow for comparisons between observations in the natural system and in the microcosms.

PROGRESS (July 1992 to June 1993): A prototype flow-through mesocosm chamber was constructed. It was installed at an indoor location for testing, initially with tap water, then with sediments and water from Jackson Creek wetland. Results of tests were analyzed to determine changes in phosphorus concentrations and chemical speciation. Sediment samples used in the chamber were analyzed for organic-carbon content and particle-size distribution. Continuous-measuring stream gages were installed and water-quality sampling was initiated.

PLANS (July 1993 to June 1994): We will continue to monitor streamflow and water quality. Data will be analyzed to compute loads and variations in concentrations with time and location. The mesocosm will be installed in the Jackson Creek wetland and additional tests will be carried out under natural light and temperature conditions.

REPORTS: (planned; subject to change)

Field, S.J., Goddard, G. L., and Elder, J.F., Nutrient and sediment transport through a constructed wetland in the drainage area of Delavan Lake, Wisconsin.

Elder, J.F., and Manion, B.J., Partitioning processes and principal retention reservoirs of phosphorus in an artificial wetland bordering a eutrophic lake in southeastern Wisconsin.

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION:

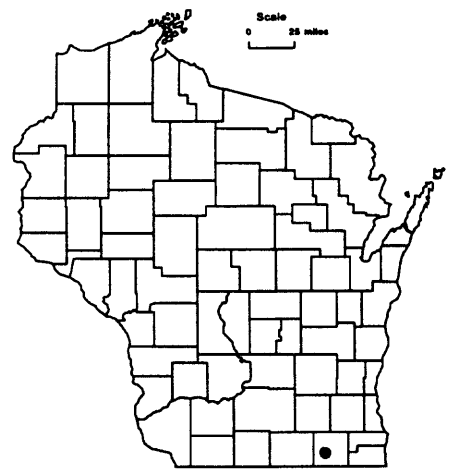
Delavan Lake and Jackson Creek, southeast Wisconsin

PROJECT CHIEF:

John F. Elder

PERIOD OF PROJECT:

October 1991 to September 1996



HYDROGEOLOGY AND GROUND-WATER USE AND QUALITY, FOX CITIES AREA, WISCONSIN, WI 182

COOPERATORS:

East Central Wisconsin Regional Planning Commission; Darboy Sanitary District #4; Greenville Sanitary District; Kaukauna Electrical and Water Utilities; Town of Menasha Sanitary District #4; Kimberly Water Works Department; Wisconsin Geological and Natural History Survey

LOCATION:

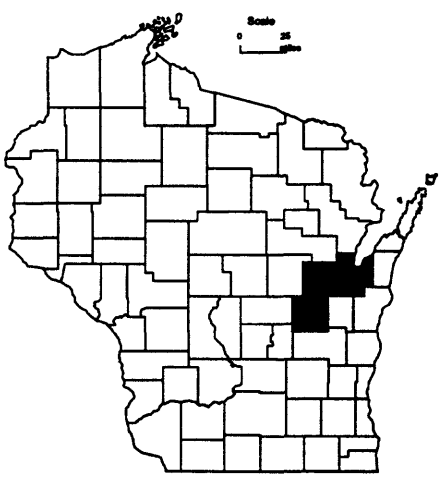
East-central Wisconsin

PROJECT CHIEF:

Terrence Conlon

PERIOD OF PROJECT:

January 1992 to September 1995



PROBLEM: Declining water levels and degraded water quality have been documented in wells open to the sandstone aquifer serving the Fox Cities, a group of cities along the Fox River between Neenah and Green Bay, Wisconsin. Studies indicate that the cone of depression due to pumping in the vicinity of Green Bay has merged with the cone of depression due to pumping in the Fox Cities area. Ground-water development is recognized as a regional problem and requires developing data bases and models to help in managing the ground-water resources in the area.

OBJECTIVE: The study will (1) characterize the hydraulic properties and boundaries of the aquifer and confining units, (2) map the past and present potentiometric surfaces of the study area, (3) compile a history of aquifer development, (4) estimate recharge rates, (5) define areal distribution of ground-water quality, and (6) calibrate a ground-water-flow model that can be used to evaluate aquifer response to future pumping.

APPROACH: Information to evaluate aquifer properties and past potentiometric surface maps will be compiled from a literature review. Geophysical logging of municipal water supply wells will be performed to better define the hydrostratigraphy. Water levels will be collected to map present potentiometric surfaces. Aquifer recharge rates will be estimated by collecting precipitation and water-level data in selected areas. Water samples will be analyzed to evaluate the quality of ground water. The USGS modular finite-difference ground-water-flow model will simulate the ground-water-flow system and will be calibrated to past and present water levels. Predictive simulations will be used to evaluate aquifer response to future pumping and land-use changes.

PROGRESS (July 1992 to June 1993): Literature review was completed. Well logs and drillers' construction reports were compiled for the area around the Fox Cities and entered into the USGS data base. The conceptual model for the area was tested with a screening model. Model boundaries were selected. Wells in which water levels will be measured were chosen.

PLANS (July 1993 to June 1994): Water-level and water-quality data will be collected. Bedrock cores may be analyzed. Hydraulic properties of surficial deposits will be characterized based on past studies. A ground-water-flow model will be constructed and calibrated.

LAKE MICHIGAN TRIBUTARY LOADING, WI 183

PROBLEM: Concern about the potential negative health and biologic effects of toxic chemicals and heavy metals being transported into Lake Michigan has increased with growing evidence of links between the presence of these contaminants and carcinogens in fish, genetic defects in fish-eating birds, and reproductive disorders in biota. Adequate management of chemical loads requires that the total contribution of contaminants from atmospheric, ground water, and tributary rivers be quantified.

OBJECTIVE: Objectives of this project are to build a streamflow and water-quality data base to act as a baseline for evaluation of future remediation activities; estimate loads of targeted contaminants to Lake Michigan; compare loads between tributaries to target basins of major concern; identify contaminants of greatest concern; and describe the mobility of contaminants.

APPROACH: Acoustic velocity meter monitoring stations will be used at the mouths of the Milwaukee, Sheboygan, Fox, and Menominee Rivers to provide real-time flow and water-quality data. Field sampling will be done on a schedule to collect large volume, composited samples for analyses of toxic organic constituents and heavy metals. Data will be entered into the WATSTORE and ADAPS data bases.

PROGRESS (July 1992 to June 1993): Flow- and water-quality-monitoring stations have been established at the mouths of the four streams. Acoustic velocity meters have been calibrated. Calibration is continuing for the OBS-3 suspended-solids monitors. Shakedown sampling for determining the final field sampling protocols has been planned.

PLANS (July 1993 to June 1994): Complete the shakedown sampling and finalize the field protocols. Begin full-scale sampling of the four tributaries in the spring of 1994 and continue through the spring of 1995. Summarize data collected in a data report.

COOPERATORS:

Environmental Protection Agency
Wisconsin Department of Natural Resources

LOCATION:

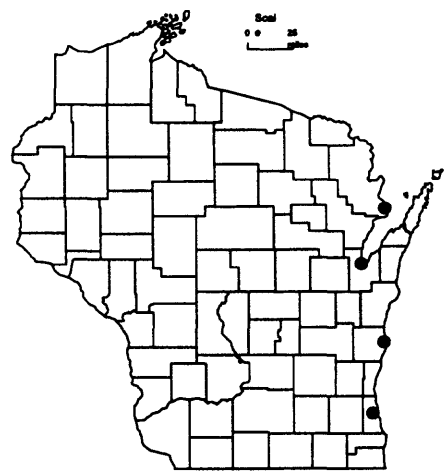
Cities of Marinette, Green Bay, Milwaukee and Sheboygan

PROJECT CHIEF:

Peter E. Hughes

PERIOD OF PROJECT:

July 1992 to December 1995



DELINEATION OF THE POTENTIOMETRIC DIVIDE IN THE SANDSTONE AQUIFER BETWEEN THE WOLF RIVER AND LOWER FOX RIVER BASINS WISCONSIN, WI 184

COOPERATORS:

Brown County Regional Planning Commission
Wisconsin Geological and Natural History Survey

LOCATION:

Brown and Outagamie Counties

PROJECT CHIEF:

William G. Batten

PERIOD OF PROJECT:

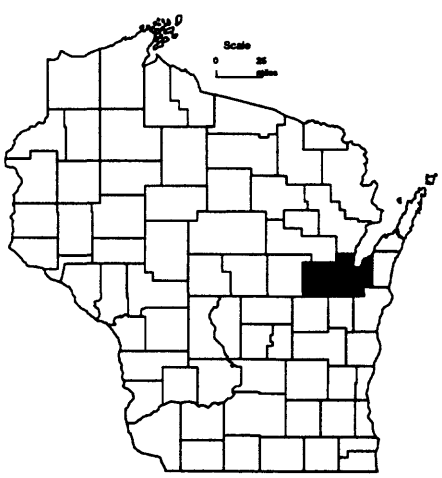
July 1992 to September 1993

PROBLEM: The existence of a regional ground-water divide between the Wolf and Lower Fox Rivers has been postulated but never proven. The location of this divide, if it exists, determines the extent of the ground-water recharge area of the deep Sandstone Aquifer that provides water for much of the Green Bay metropolitan area. Data from this project could be used to refine an existing ground-water-flow model used to estimate drawdowns caused by projected increases in water use in the Green Bay metropolitan area.

APPROACH: Three test wells that fully penetrate the Sandstone Aquifer were drilled in northern Outagamie County. Geologic and hydraulic-head data collected from drilling and packer testing each well were correlated with existing geologic and water-level data to provide evidence of a ground-water divide between the Wolf and Lower Fox Rivers. Water-quality data collected from discrete intervals in each well were used to determine the general water quality and age of water at various depths in the Sandstone Aquifer system.

PROGRESS (July 1992 to June 1993): All test-well data were collected, analyzed, and correlated with existing data. Preliminary results provide some evidence that a ground-water divide exists. However, further analysis is needed. A final report will be written by May 1993 and will be published at a later date.

PLANS (July 1993 to June 1994): A final report will be published as a Wisconsin Geological and Natural History Survey Information Circular.



WATER-QUALITY MONITORING OF INDUSTRIAL STORM-WATER RUNOFF, WI 185

PROBLEM: The United State Environmental Protection Agency (USEPA) is requiring industries to monitor storm-water runoff for given chemical constituents. Sampling techniques need to be developed for industries with and without well-defined drainage networks.

OBJECTIVE: (1) Compare and evaluate different storm-water sampling schemes, (2) estimate storm-event mean concentrations and annual chemical constituent loads from selected industries using appropriate modeling techniques, and (3) design and operate a monitoring program to collect representative storm-water-quality samples.

APPROACH: Paired sampling techniques will be used to determine whether time-composite samples can be substituted for flow-composite samples. Furthermore, source-area sheet-flow sample results will be used to calculate a loading value which will be compared to the flow-composite loading value.

PROGRESS (July 1992 to June 1993): Six sites have been selected for streamflow and water-quality sampling. Flumes and sampling lines have been installed at all six sites. Three sites have been fully operational since spring 1993. Six runoff events at each site will be monitored and sampled before the equipment is moved to another site.

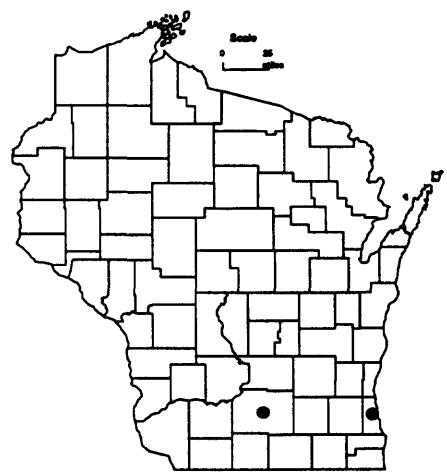
PLANS (July 1993 to June 1994): Continue the streamflow and water-quality monitoring until all six sites have six sampled runoff events. Loads will be computed and summarized using the time-composite, flow-composite and source-area sample concentrations. A final data summary report will be completed.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Madison and Milwaukee, Wisconsin

PROJECT CHIEF:
David W. Owens

PERIOD OF PROJECT:
June 1992 to April 1994



WATER QUALITY OF URBAN STORM-WATER RUNOFF IN MADISON, WISCONSIN, WI 187

COOPERATOR:
City of Madison

LOCATION:
Dane County, south-central Wisconsin

PROJECT CHIEF:
Robert J. Waschbusch

PERIOD OF PROJECT:
August 1992 to December 1993

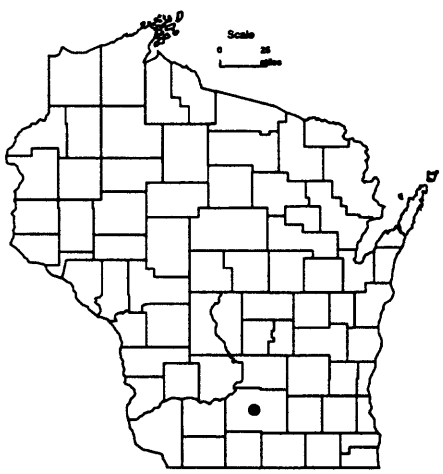
PROBLEM: Section 402 (P) of the Water Quality Act of 1987 requires that municipalities with a population of 100,000 or more obtain permits to control the quality of storm-water runoff. Final results published by the U.S. Environmental Protection Agency require that municipalities prepare permit applications to include, among other information, the following technical data:

1. Characterization of the quantity and quality of discharge from storm conveyance channels/outfalls during periods of dry weather.
2. Characterization of the wet-weather quantity and quality of discharge from representative storm conveyance channels/outfalls during three or more representative storm events.
3. Determination of storm and annual pollutant loadings from each storm conveyance channel/outfall as characterized in item 1 in the permitted municipality.
4. Characterization of rainfall and runoff conditions.
5. Characterization of the quality of water in the receiving stream (waters of the United States) impacted by storm-water runoff outfalls using existing data.

OBJECTIVES: The objectives of the investigation are to:

1. Characterize storm-water quantity and quality for representative urban land uses.
2. Estimate city-wide storm-event mean concentrations and annual pollutant loads of the cumulative discharges.
3. Assist in design of a monitoring program for the life of the permit (5 years) that will provide representative storm-water-quality data for the city.

APPROACH: Seven sites have been selected in Madison for collection of storm-water-quality data. Contributing drainage areas to the sampling sites range from 23 to 105 acres in size and are of a predominantly single land-use type. Land-use types as specified by EPA regulations are residential, commercial, and industrial. Additional land-use types specific to the city of Madison are university and highway. A minimum of 3 event samples per site (total of about 21 samples) will be collected and analyzed for water-quality constituents specified by the Wisconsin Department of Natural Resources (WDNR). Attempts will be made to sample an additional three storms so that more complete characterization is possible.



Discharge will be determined from continuous water-level measurements and theoretical discharge ratings. Event-mean concentrations (EMC) will be determined by flow-composite sampling methods. Constituent loads for pollutants at the seven data-collection sites will be estimated using the WDNR SLAMM model. This model will be used to compute seasonal loads and EMC of certain constituents for a representative storm event.

PROGRESS (July 1992 to June 1993): Samples have been collected from the seven sampling sites for three representative storms. Preliminary estimates of constituent loads and EMC for storm-water runoff at conveyance channels/outfalls have been computed.

PLANS (July 1993 to June 1994): Final computations will be made and a data report will be published.

CONCENTRATION OF RADON-222 IN GROUND WATER AND SOIL GAS IN THE VICINITY OF WISCONSIN INDIAN RESERVATIONS, WI 188

PROBLEM: The Indian Health Service and Great Lakes Intertribal Council have measured indoor air for concentration of radon-222 in homes on Wisconsin Indian Reservations over the last several years. Results from these surveys indicate that the U.S. Environmental Protection Agency's (USEPA) standard of 4 picocuries per liter (pCi/l) of radon-222 in air is frequently exceeded. According to USEPA, radon in ground water generally accounts for 5 percent of the total indoor air concentrations for homes with ground water as the primary source of drinking water. In view of the high concentrations of radon in indoor air for homes on the Wisconsin Indian Reservations and the fact that ground water is the source of all domestic water supply for the reservations, it is possible that the ground water used on these reservations contains radon-222 concentrations in excess of the USEPA proposed standard of 300 pCi/l for municipal supply.

OBJECTIVE: Define the distribution and occurrence of radon-222 in domestic ground-water supplies for Wisconsin Indian Reservations.

APPROACH: Ground water from 30 wells distributed among the 11 Wisconsin Indian Reservations will be sampled and analyzed for radon-222. The number of wells sampled on each reservation will be selected as a percentage of total acreage held by each tribe. After the number of wells to be sampled on each reservation has been determined, specific wells will be chosen by USGS personnel according to following criteria: (1) previous air monitoring of the residence supplied by a well has shown a radon-222 concentration equal to or exceeding 4 pCi/l, (2) a driller's construction report is available and (3) the well is finished in the aquifer most representative of the area. In addition to sampling the ground water, soil gases in the unsaturated zone near the well head will also be sampled and analyzed for radon-222. The concentration of radon in the soil gas samples will be compared to the concentration of radon in corresponding ground-water samples to determine if there is a correlation.

PROGRESS (July 1992 to June 1993): The Quality Assurance Plan required by USEPA was approved. All wells to be sampled were chosen and located. Sampling of ground water and soil gas was initiated.

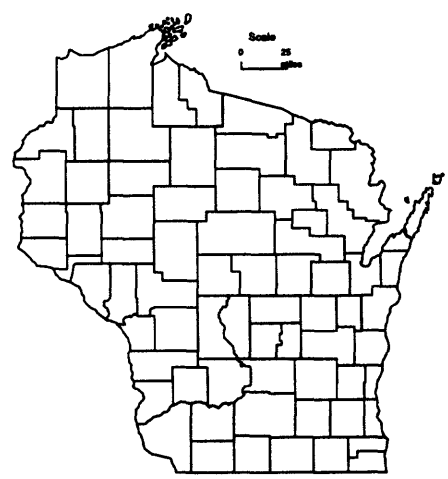
PLANS (July 1993 to June 1994): All ground-water and soil-gas samples will be collected and analyzed for radon. The final report, in the form of either a journal article or a U.S. Geological Survey Open-File Report, will be published.

COOPERATOR:
U.S. Environmental Protection Agency

LOCATION:
Wisconsin Indian Reservations

PROJECT CHIEF:
John F. De Wild

PERIOD OF PROJECT:
October 1992 to September 1993



DANE COUNTY REGIONAL HYDROLOGIC STUDY, WI 189

COOPERATORS:

City of Middleton
Dane County Regional Planning Commission
Madison Metropolitan Sewerage District
Wisconsin Department of Natural Resources
Wisconsin Geological and Natural History Survey

LOCATION:

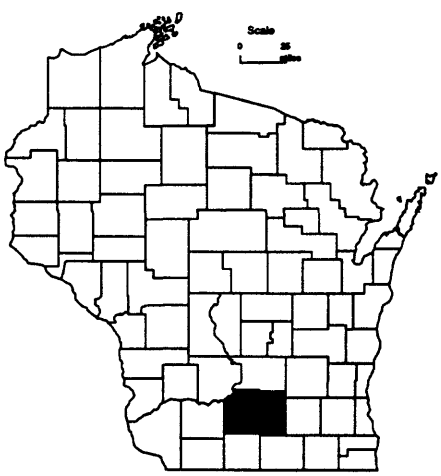
Dane County and parts of surrounding counties

PROJECT CHIEF:

William G. Batten

PERIOD OF PROJECT:

October 1992 to December 1995



PROBLEM: Officials at all levels of government are concerned about the effects of increasing urban growth and development on the surface- and ground-water resources in Dane County. The relationship between surface water and ground water must be understood to allow for increased ground-water withdrawals while protecting the quality and quantity of surface-water resources in the county. A comprehensive study that combines existing water data with new data is neeeded to provide government and planning agencies with a tool to aid in managing the water resources of the Dane County area.

APPROACH: Existing and new data will be compiled to update potentiometric and water-table surfaces, subsurface geology, and aquifer parameters. New data will be collected in areas critical to understanding ground-water flow and direction. A regional ground-water-flow model will be developed to simulate changes in ground-water levels caused by increased pumpage, to identify critical recharge and discharge areas and to show the direction and rate of ground-water flow. The model will then be used as a management tool to simulate and evaluate the effects of management strategies designed to mitigate adverse effects of increased ground-water withdrawals on the surface- and ground-water system in the Dane County area.

PROGRESS (July 1992 to June 1993): Water-level data from deep wells have been used to compile a map of the potentiometric surface in the deep bedrock units. Water levels from shallow wells have been compiled for about half of the county. These data will be used to compile an accurate map of the water table. A survey of ground-water springs was completed for the entire county. Selected springs near municipal-supply wells were monitored to determine if the shallow water-table is affected by ground-water pumpage from deep high-capacity wells in the area.

PLANS (July 1993 to June 1994): A "screening" ground-water-flow model will be completed. This model will be used to identify areas where additional data are needed and to test conceptual models of the ground-water-flow system. All data necessary to describe the ground-water-flow system will be collected and compiled. This includes data from test wells and field work completed as part of this study. A regional ground-water-flow model will be designed, constructed, and calibrated for use in simulating the ground-water-flow system in the county. Input for this model will be derived from the data collected in the early part of this study.

REPORTS: A report that includes water-table and potentiometric-surface maps, hydrogeologic cross sections, values of aquifer parameters, and a conceptual description of the ground-water-flow system will be published. A second report describing the regional ground-water-flow model design, calibration, and results of model simulations of the flow system will also be published.

EFFECTS OF MICROBIAL ACTIVITY ON SEDIMENT/WATER EXCHANGE OF POLYCHLORINATED BIPHENYL CONGENERS IN THE LOWER FOX RIVER, WISCONSIN, WI 190

PROBLEM: The lower Fox River, the principal tributary of Green Bay and Lake Michigan, flows through a heavily industrialized area. More than 100 contaminants have been identified in the system; among the most significant of these are PCB's. To predict possible toxicological effects and downstream transport of these contaminants, it is important to take into account not only their source concentrations, but also the factors that can affect their partitioning, especially their transfer from bottom sediments (the principal repository) to water (the principal medium of transport). There is a scarcity of this kind of information at present.

OBJECTIVE: Describe the role of microbial activity in controlling sediment/water exchange of PCB congeners and determine the extent to which microbially-mediated exchange is dependent on total PCB concentration and congener composition.

APPROACH: Sediment and water samples from the lower Fox River are used in controlled microcosm experiments in elution columns, applying an experimental design similar to that used in previous work. A specific PCB congener, labeled with carbon-14, is mixed uniformly into a measured quantity of sediment which is used to fill a vertical column that is connected to a precision metering pump. Ambient river water is pumped through the system, and carbon-14 activity is monitored over time in the outflow water. The results include data that can be used to calculate observed distribution coefficient—a measure of partitioning of the PCB congener between sediments and water mobility. The elution column experiments will be tested under different conditions to assess effects of microbial activity and presence or absence of oxygen.

PROGRESS (October 1992 to June 1993): Samples were collected from bottom sediment deposits in the lower Fox River to use in column elution experiments. The first phase of experimentation was initiated.

PLANS (July 1993 to June 1994): Experimentation will continue as described in the Approach, and the data produced will be closely examined to test hypotheses about PCB congener flux and microbial effects on this process. Results of each experimental phase will be used to assess needs for further information, and later experiments will be designed to address those needs.

REPORTS (planned; subject to change):

Elder, J.F., James, R.V., Godsy, E.M., and Steuer, J.J., Microbial enhancement of PCB congener mobility at the sediment/water interface in the lower Fox River, Wisconsin.

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION:

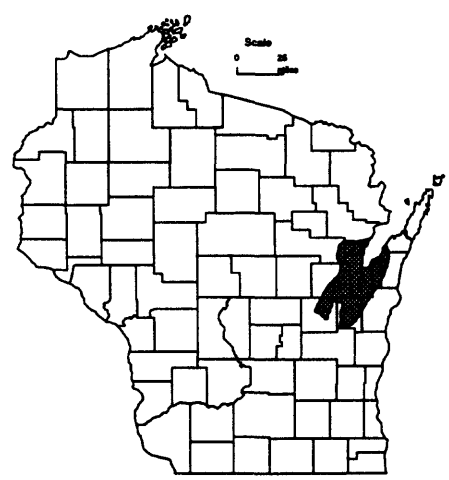
Northeastern Wisconsin

PERIOD OF PROJECT:

October 1992 to September 1995

PROJECT CHIEF:

John F. Elder



TRANSPORT AND BIOGEOCHEMICAL CYCLING OF PCB'S IN THE MILWAUKEE RIVER - THE IMPORTANCE OF ALGAL DYNAMICS, WI 191

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Milwaukee County, eastern Wisconsin

PROJECT CHIEF:
Jeffrey J. Steuer

PERIOD OF PROJECT:
February 1993 to December 1996

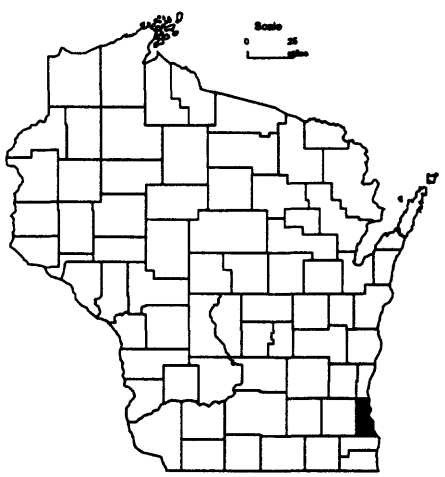
PROBLEM: The Milwaukee Harbor is identified as an area of concern by the International Joint Commission because it is highly contaminated by toxic synthetic organic chemicals and trace metals. A plan is being developed to restore and revive the surface waters of this area, but little is known about the upstream transport of contaminated in-place sediments. Knowledge of the processes that control cycling and transport of polychlorinated biphenyls (PCB's) is essential to the remediation effort. Algal incorporation of PCB's may be a quantitatively important process in this transport.

OBJECTIVE: The objective is to determine the link between algal dynamics and PCB transport by: characterizing total suspended solids (TSS) in the river as biogenic (algal) and detrital components, and determine PCB, organic carbon and lipid concentrations of each fraction; evaluating the link between algal uptake of PCB's and concentration of PCB's in TSS and resuspendable surficial bottom sediments. Milwaukee River PCB loading will be determined at Estabrook Park.

APPROACH: Monitor one site for one year during base-flow and event-flow conditions. An automated water-quality sampler will be used to obtain daily TSS samples. Organic sampling will be done manually on a biweekly basis during the non-winter period. At two sites, algae will be collected seasonally and algal biomass determined. Measured characteristics of water samples will include TSS, PCB's, toxic organic chemicals, particulate organic carbon, dissolved organic carbon, phosphorus, nitrogen, and chlorophyll a.

PROGRESS (February 1993 to June 1993): Project work scope has been finalized with cooperator. Necessary field equipment has been installed and field sampling started.

PLANS (July 1993 to June 1994): Continue algal field and laboratory work. Commence writing PCB loading report.



VELOCITY PROFILES UNDER AN ICE COVER

PROBLEM: The practice of using a single coefficient to adjust measured velocity at a single point in the vertical under an ice cover is suspect in light of recent evidence in the literature. An evaluation of the present technique and development of alternative techniques for measuring discharge under an ice cover is needed.

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 1992 to June 1993): The analysis of the U.S. vertical velocity profile database was completed and a journal article describing the results was written. The review process for the journal article was initiated. Consultation with the University of Iowa Institute of Hydraulic Research (IIHR) regarding research conducted by a graduate student was continued. Exchange of ideas with staff at Water Survey of Canada was continued.

PLANS (July 1993 to June 1994): Complete the review process for the journal article, and submit manuscript with Director's approval to ASCE Journal of Hydraulic Engineering for publication. Respond to journal peer reviews and continue publication process for journal article. Continue interaction with IIHR, and begin joint paper bringing theoretical, lab, and field results together.

REPORTS:

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

COOPERATOR:

Office of Surface Water, WRD, U.S. Geological Survey

LOCATION:

Nationwide

PROJECT CHIEF:

John F. Walker

PERIOD OF PROJECT:

January 1987-Continuing

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.

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