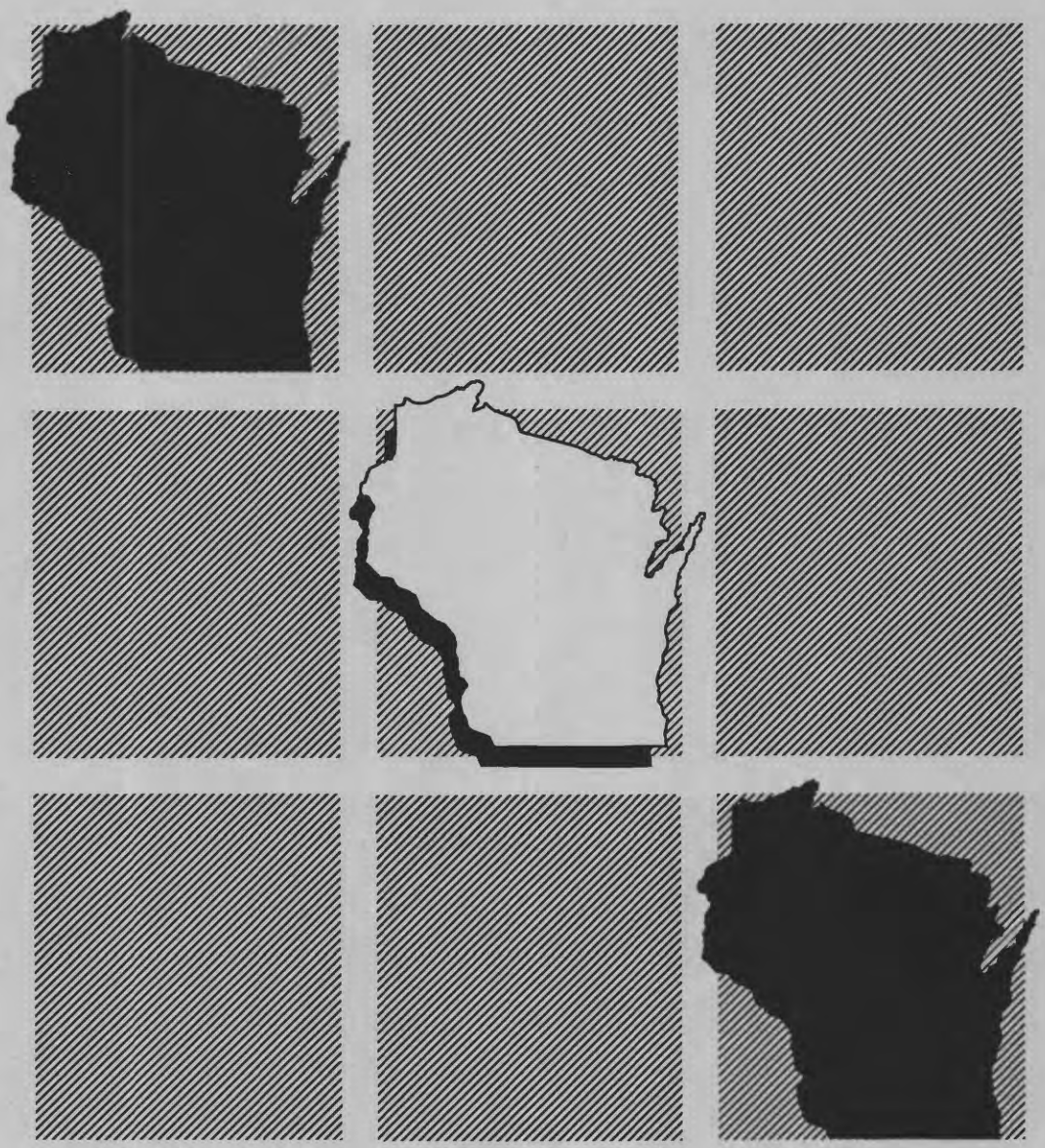
Rec'd 8/10/97

WISCONSIN

Water-Resources Investigations

■

U.S. GEOLOGICAL SURVEY
Open-File Report 97–351



1997

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WATER-RESOURCES INVESTIGATIONS IN WISCONSIN

Compiled by D.E. Maertz

U.S. GEOLOGICAL SURVEY
Open-File Report 97-351

Madison, Wisconsin
1997

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, *Secretary*

U.S. GEOLOGICAL SURVEY
Gordon Eaton, *Director*

For additional information write to:

District Chief
U.S. Geological Survey
8505 Research Way
Middleton, WI 53562

Copies of this report can be purchased from:

U.S. Geological Survey
Branch of Information Services
P.O. Box 25286
Denver, CO 80225-0286

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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.

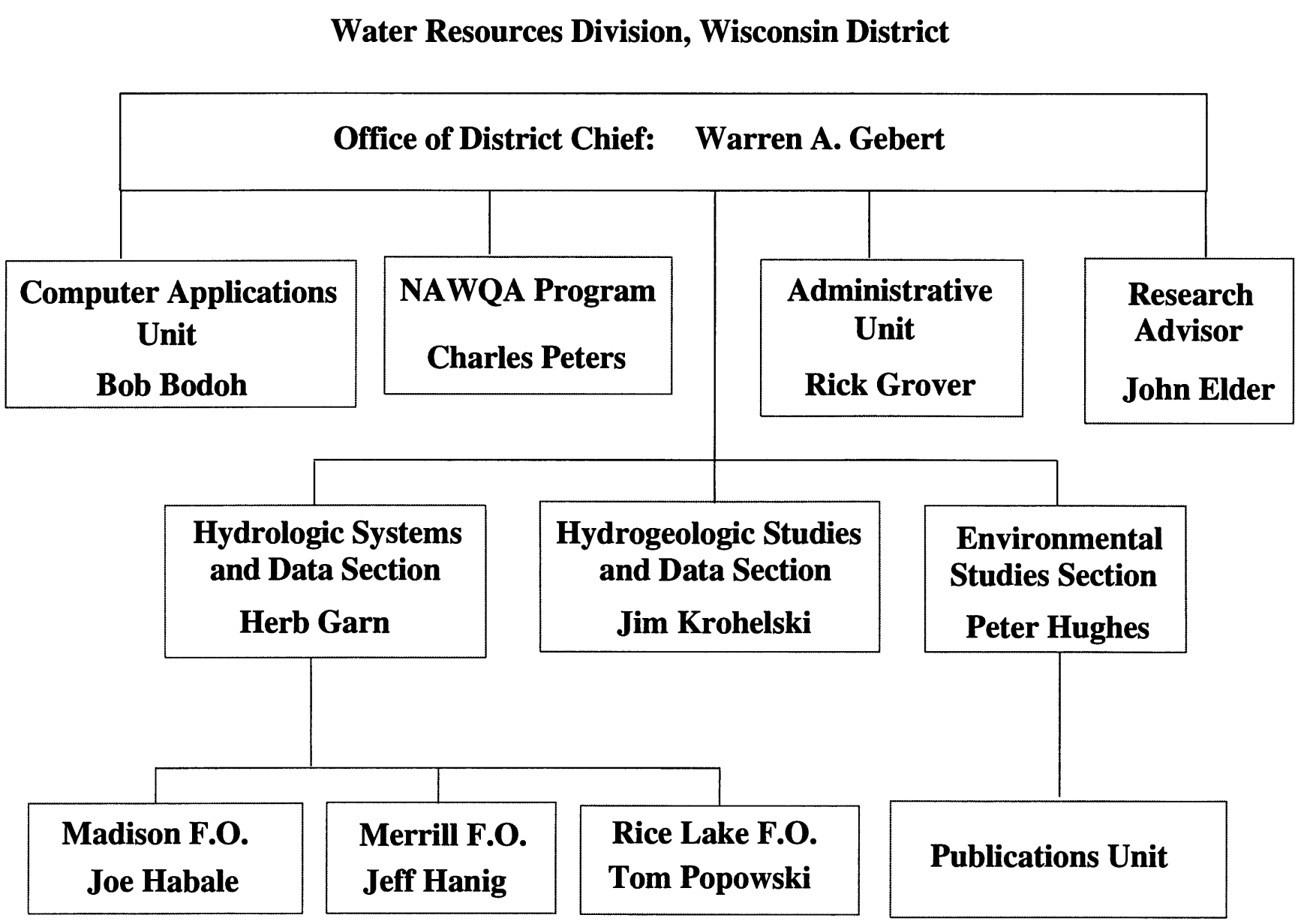


Figure 1. Organization chart of the U.S. Geological Survey, Water Resources Division, Wisconsin District.

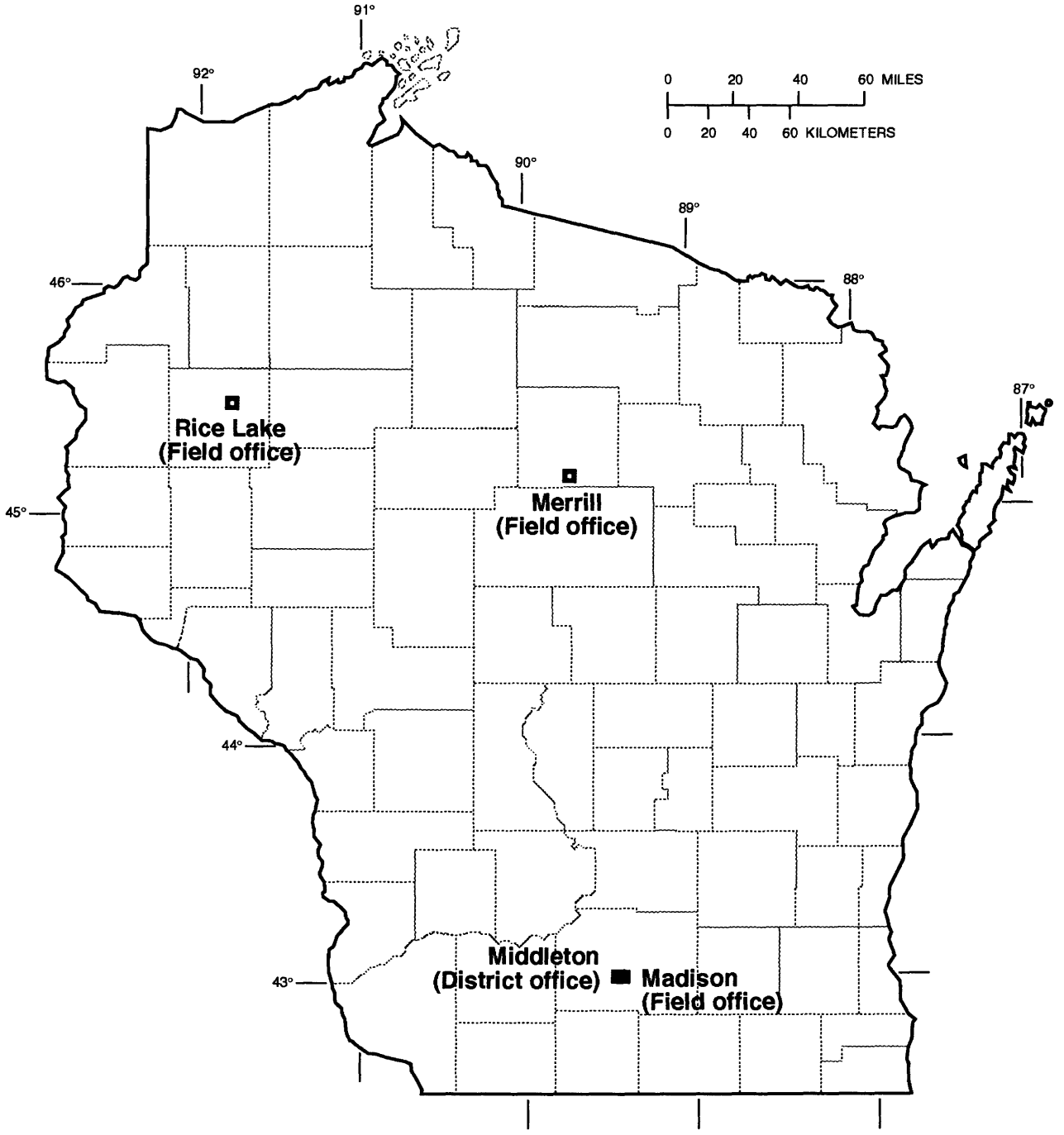


Figure 2. Location of offices in the Wisconsin District.

COOPERATORS

State Agencies
- Illinois Department of Transportation
- Minnesota Pollution Control Agency
- Wisconsin Department of Agriculture, Trade, and Consumer Protection
- Wisconsin Department of Natural Resources
- Wisconsin Department of Transportation
- Wisconsin Geological and Natural History Survey

Local Agencies
- City of Barron
- City of Beaver Dam
- City of Brookfield
- City of Fond du Lac
- City of Hillsboro
- City of Madison
- City of Middleton
- City of Peshtigo
- City of River Falls
- City of Sparta
- City of Thorp
- City of Waupun
- Dane County Regional Planning Commission
- Dane County Department of Public Works
- Fontana/Walworth Water Pollution Control Commission
- Green Bay Metropolitan Sewerage District
- Madison Metropolitan Sewerage District
- Rock County Public Works Department
- Southeastern Wisconsin Regional Planning Commission
- Village of Wittenberg
- Walworth County Metropolitan Sewerage District

Other Federal Agencies
- U.S. Army Corps of Engineers,
  - Detroit District
  - Rock Island District
  - St. Paul District
  - Vicksburg, MS
- U.S. Army, Department of Defense, Ft. McCoy
- Federal Emergency Management Agency
- Federal Energy Regulatory Commission licensees
  - Dairyland Power Cooperative
  - Niagara of Wisconsin Paper Corporation
  - Northern States Power Company
  - Wisconsin Electric Power Company
  - Wisconsin Power and Light Company
  - Wisconsin Public Service Corporation

Other Federal Agencies (continued)
- Wisconsin Valley Improvement Company
- 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
- Stockbridge-Munsee Band of Mohican Indians

Lake Districts
- City of Muskego
- Druid Lake Protection and Rehabilitation District
- Eagle Spring Lake Management District
- Fowler Lake Management District
- Green Lake Sanitary District
- Kirby Lake Management District
- Little Arbor Vitae Lake District
- Little Cedar Lake
- Little Green Lake Protection and Rehabilitation District
- Little St. Germain Protection and Rehabilitation District
- Middle Genesee Lake District
- Montello Lake Inland Protection and Rehabilitation District
- Okauchee Lake District
- Potter Lake Rehabilitation and Protection District
- Pretty Lake Protection and Rehabilitation District
- Silver Lake Protection and Rehabilitation District
- Twin Lakes Protection and Rehabilitation District
- Wind Lake Management District
- Wolf Lake Management District
- Town of Auburn
- Town of Casey
- Town of Cedar Lake
- Town of Delavan
- Town of Kansasville
- Town of Norway
- Town of St. Germain
- Town of Summit
- Town of Waterford
- Village of Oconomowoc Lake

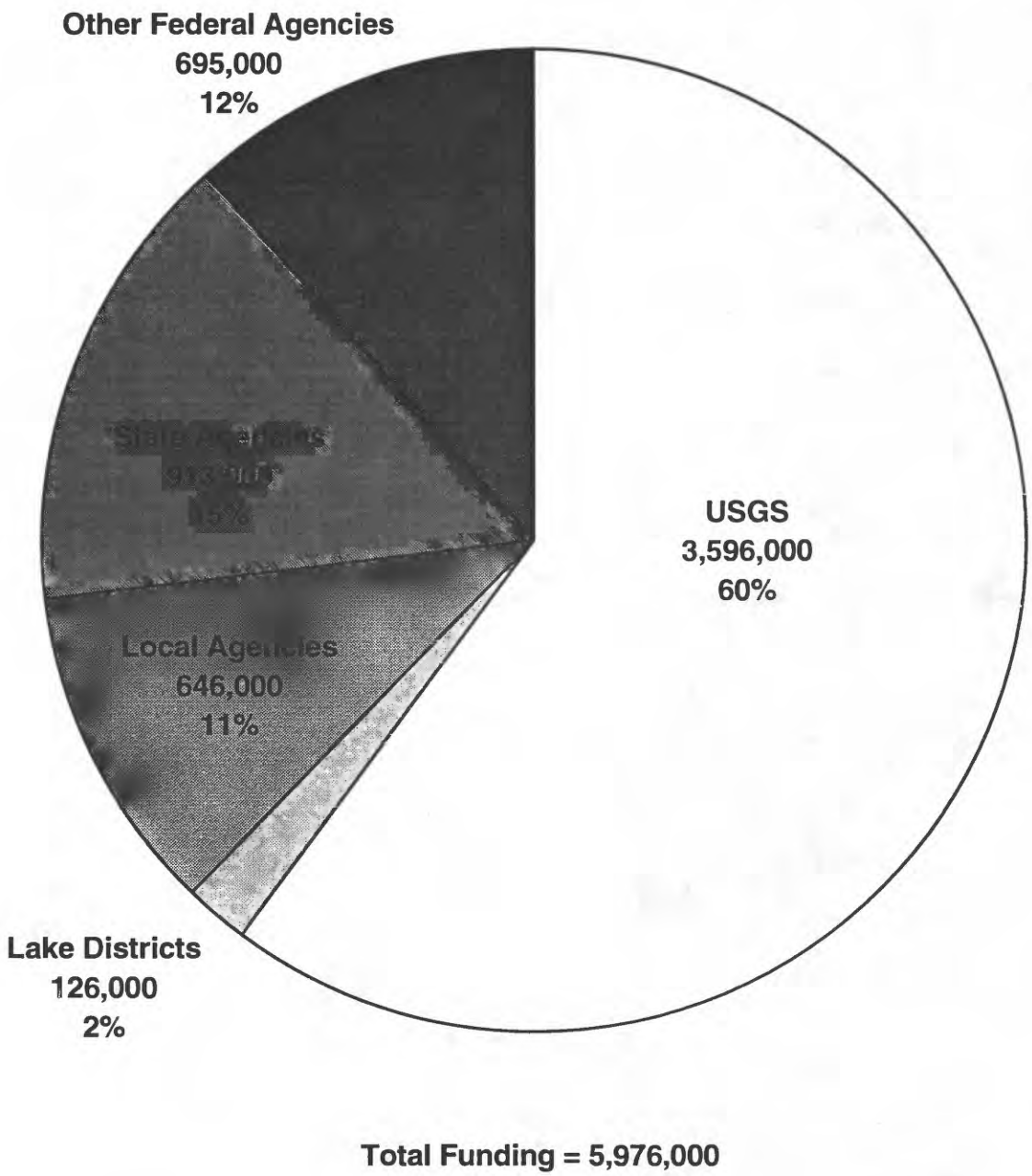


Figure 3. Funding sources for the water-resources program in Wisconsin for the 1997 fiscal year.

SUMMARY OF 1996 HYDROLOGIC CONDITIONS

Streamflow

The statewide average precipitation of 33.37 inches for the 1996 water year was 105 percent of the normal annual precipitation of 31.79 inches for water years 1961-90. Average precipitation values ranged from 77 percent of normal at Trempealeau Dam 6 weather station in west central Wisconsin to 151 percent of normal at Oconto 4 W weather station in northeast Wisconsin (State Climatologist Office, Geological and Natural History Survey, written commun., 1997).

Runoff was variable for rivers throughout the State ranging from 64 percent in southwest Wisconsin to 212 percent in east central Wisconsin. Runoff was lowest (64 percent of the average annual runoff from 1935–96) for the Platte River near Rockville and highest (212 percent of the average annual runoff from 1949–69, 1988–96) for the South Branch Rock River at Waupun. Departures of runoff in the 1996 water year as a percent of long-term average runoff in the State are shown in Figure 4.

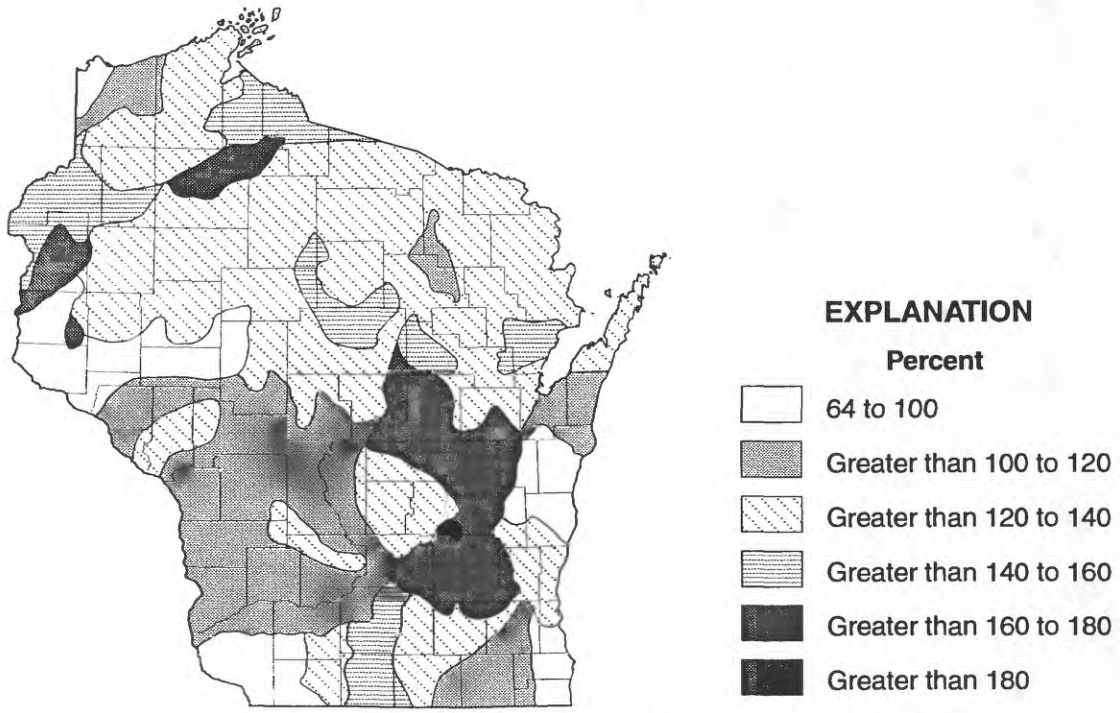


Figure 4. 1996 runoff as percent of long-term average runoff.

Annual discharges for the individual water years (1916-96) at the Oconto River near Gillett, Jump River at Sheldon, and Sugar River near Brodhead are shown in Figure 5. The comparison of monthly and annual discharges for the 1996 water year to discharge for a 81-year base period at the same three gaging stations are shown in Figure 6.

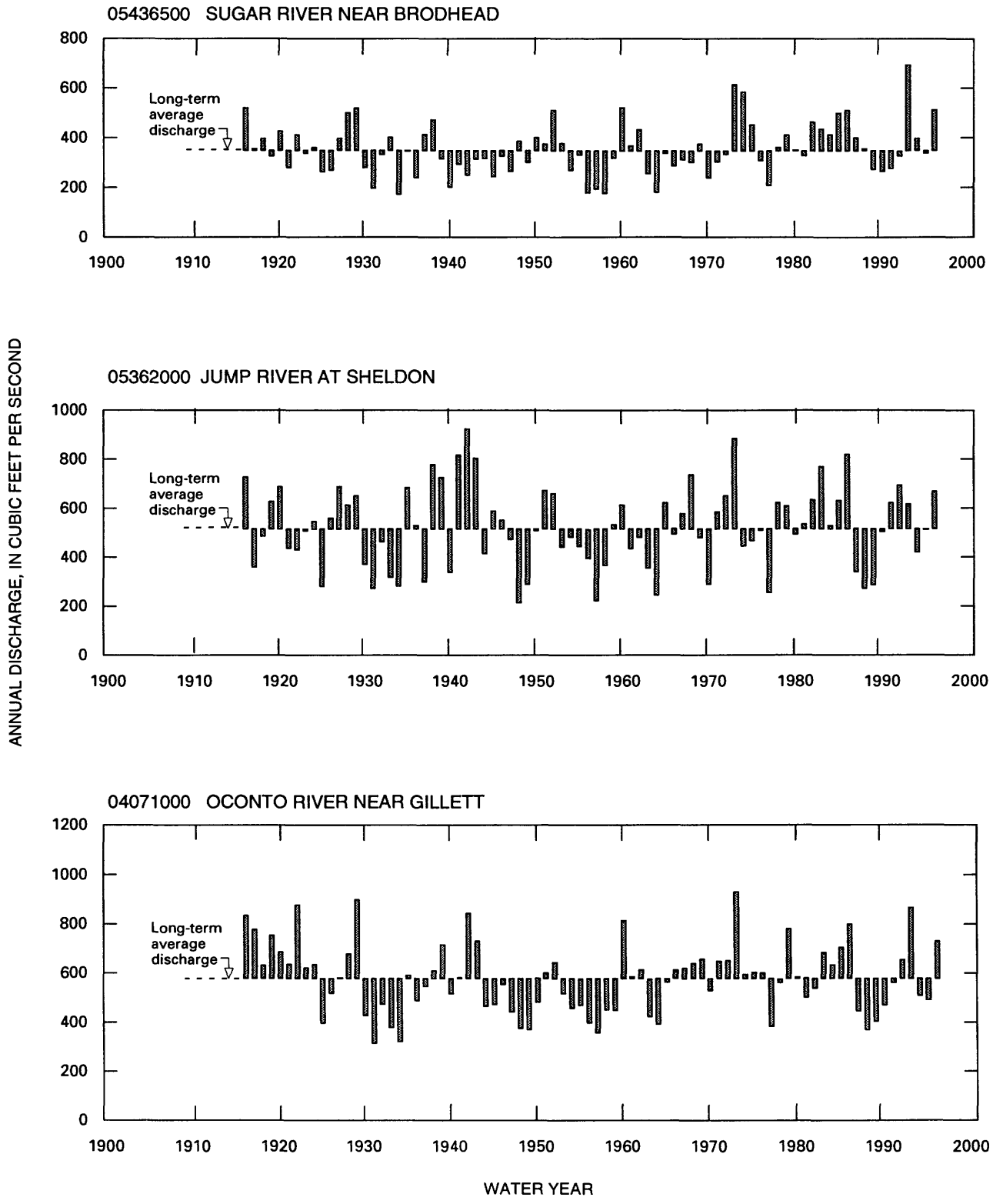


Figure 5. Comparison of annual discharge at representative gaging stations to the long-term average discharge for water years 1916-96.

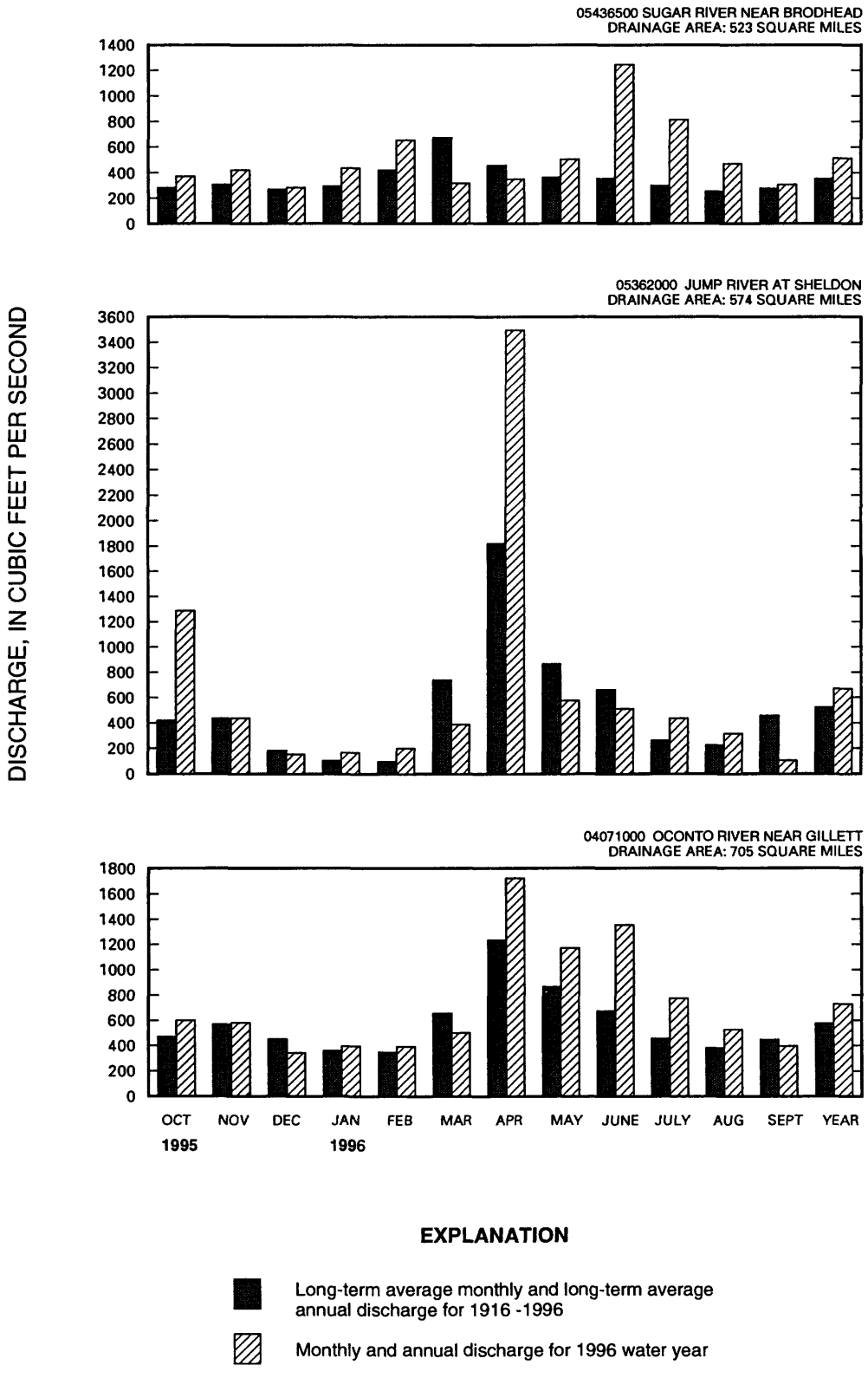


Figure 6. Comparison of discharge at representative gaging stations during water year 1996 with discharge for 1916-96.

Low flows occurred at nine gaging stations where the annual minimum 7-consecutive day average flows (Q7) had recurrence intervals of 2 or more years. The Q7 values typically occurred in late August and September, or in the winter month of January. The low-flow values which occurred in the summer were the result of below normal precipitation in August and September. Most Q7 values occurred at stations draining into Lake Michigan in southeastern Wisconsin. The Q7 values and recurrence intervals for gaging stations that equalled or exceeded 2 years are listed in the following table:

Station number	Station name	Date	Q7 (ft^3/s)	Recurrence interval (years)
04027500	White River near Ashland	Sept. 17–23	134	5
04085281	East Twin River at Mishicot	Sept. 2–9	9.6	2
04087030	Menomonee River at Menomonee Falls	Sept. 13–19	3.5	2
04087120	Menomonee River at Wauwatosa	Sept. 14–20	13	2
04087159	Kinnickinnic River at Milwaukee	Jan. 5–11	4.2	6
04087204	Oak Creek at South Milwaukee	Sept. 14–20	1.0	4
04087220	Root River near Franklin	Sept. 13–19	2.7	4
04087233	Root River Canal near Franklin	Aug. 31–Sept.6	1.7	3
04087240	Root River at Racine	Sept. 19–25	2.1	10

A late snowpack along with a late sudden warm-up and some rain caused flooding in northern Wisconsin in mid to late April (Wisconsin State Journal, April 22, 1996). Isolated storms in October and May and major thunderstorms in June and July also caused floods with discharges that equalled or exceeded those with a recurrence interval of 10 years (Krug and others, 1991). During the three-day period of June 16–18, Port Washington in Ozaukee County received 13.52 inches of rain and had a monthly June total of 18.33 inches which was 60 percent of its average yearly total for the period from 1961–90 (State Climatologist office, UW-Extension, Geological and Natural History Survey, written commun., 1996). The thunderstorms in June caused statewide damages of $67 million to public property, private property, and agricultural crops (Kapela and others, 1996). Governor Thompson asked for federal assistance to help repair flood damage in 15 counties caused by the June storms (Wisconsin State Journal, June 20, 1996). A major storm dumped 8 to 11 inches of precipitation in a 5-hour period on July 17 and 18 in Green County (Wisconsin State Journal, July 19, 1996). Public and private damages in Green County from this storm was about $60 million with as much as $50 million of this amount in crop damages (Wisconsin State Journal, July 20, 1996). Peak discharges at 26 stations which had recurrence intervals that equalled or exceed 10 years are summarized in the following table:

Station number	Station name	Date	Peak discharge (ft^3/s)	Recurrence interval (years)
04027000	Bad River near Odanah	Apr. 20	13,000	10
04027500	White River near Ashland	Apr. 19	4,930	11
04063700	Popple River near Fence	Apr. 26	1,490	48
04066003	Menominee River near Pembine	Apr. 27	22,400	12
04067760	Peshtigo River near Cavour	Apr. 21	1,600	32
04069700	North Branch Oconto River near Wabeno	Apr. 20	621	>100
04071800	Pensaukee River near Pulaski	June 18	1,810	25
04073400	Bird Creek at Wautoma	June 18	141	13
04074850	Lily River near Lily	Apr. 20	167	15

Station number	Station name	Date	Peak discharge (ft^3/s)	Recurrence interval (years)
04074950	Wolf River at Langlade	Apr. 26	2,440	75
04077400	Wolf River near Shawano	Apr. 21	3,860	17
04078500	Embarrass River near Embarrass	June 19	4,830	75
04079700	Spaulding Creek near Big Falls	June 18	93	32
04084500	Fox River at Rapide Croche Dam nr Wrightstown	June 26	14,600	14
04087030	Menomonee River at Menomonee Falls	June 17	1,100	17
04087257	Pike River near Racine	May 20	1,360	10
05332500	Namekagon River near Trego	Apr. 22	2,160	15
05359600	Price Creek near Phillips	Apr. 20	328	48
05360500	Flambeau River near Bruce	Apr. 20	17,900	14
05391950	Squaw Creek near Harrison	Oct. 23	34	25
05393500	Spirit River at Spirit Falls	Apr. 20	3,130	20
05393640	Little Pine Creek near Irma	Apr. 19	210	10
05395000	Wisconsin River at Merrill	Apr. 21	23,400	15
05425500	Rock River at Watertown	June 18	3,790	11
05429500	Yahara River at McFarland	June 19	778	90
05430175	Yahara River near Fulton	June 18	3,230	42

References cited:

Kapela, Rusty, and others, 1996, Wisconsin's Weather Can't Get Any Wilder, in The Wisconsin National Weather Service Badger Weather Report: v. 4, no. 2, p.8–9.

Krug, W.R., Conger, D.H., and Gebert, W.A., 1991, Flood-Frequency Characteristics of Wisconsin Streams: U.S. Geological Survey Water-Resources Investigations Report 91-4128, 185 p.

Wisconsin State Journal, Bad River overflows, closing part of highway: Madison, Wis., April 22, 1996.

_____, Fed asked for flood money: Madison, Wis., June 20, 1996.

_____, 11 inches of rain falls in 5 hours: Madison, Wis., July 19, 1996.

_____, Green County rained out: Madison, Wis., July 20, 1996.

Water Quality

Suspended-sediment and total phosphorus yields for streams in southern Wisconsin for water year 1996 were generally lower than the long-term annual average. The suspended-sediment yield at the Grant River at Burton in southwestern Wisconsin was 80 tons/mi^2 (tons per square mile), or 33 percent of the average annual yield for 1978-96. The suspended-sediment yield for Jackson Creek Tributary near Elkhorn in southeastern Wisconsin for water year 1996 was 101 tons/mi^2, which was 139 percent of the average annual yield for the period 1984-96. The total phosphorus yield for Jackson Creek Tributary was 398 lbs/mi^2 (pounds per square mile), or 85 percent of the 1984-96 annual average. At Silver Creek near Ripon suspended sediment yield was 18.8 tons/mi^2, or 80 percent of the 1988-96 annual average, and total phosphorus yield was 306 lbs/mi^2, or 88 percent of the 1988-96 annual average.

Ground-Water Levels

Maps showing the seasonal ground-water trends for the year (fig. 4) are based on water-level data from 23 shallow-aquifer wells, each having at least 15 years of record. Water-level measurements from each well are grouped so that FALL consists of measurements from October through December 1995; WINTER consists of measurements from January through March 1996; SPRING consists of measurements from April through June 1996; and SUMMER consists of measurements from July through September 1996. Mean seasonal water levels were compared to the long-term mean seasonal water levels. The 1996 water level was considered normal if it was within one-half of the standard deviation on the long-term mean.

In general, shallow ground-water levels during the 1996 water year were normal to above normal for most of the wells in the State. Barron and Milwaukee Counties had below normal ground-water levels at the beginning of the water year, and some of those levels remained below normal for the entire water year. The large extent of normal and above-normal ground-water levels can be attributed to near normal rainfall during the 1996 water year and above normal rainfall during the previous water year.

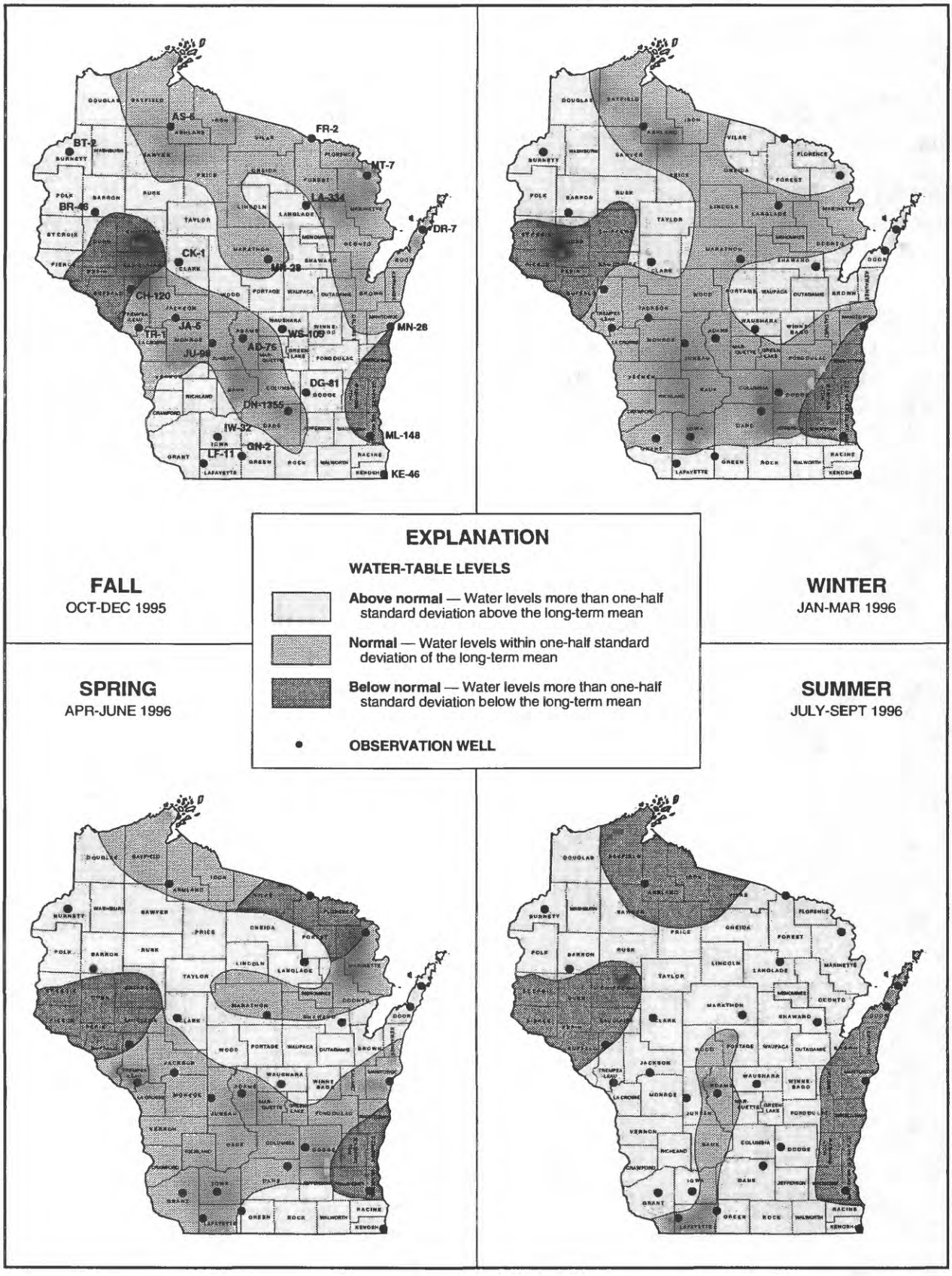


Figure 7. Relation of seasonal water-table levels to long-term means.

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
- Dairyland Power Cooperative
- Niagara of Wisconsin Paper Corporation
- Northern States Power Company
- Wisconsin Electric Power Company
- Wisconsin Power and Light Company
- Wisconsin Public Service Corporation
- Wisconsin Valley Improvement Company

Lac du Flambeau Band of Lake Superior Chippewa
Illinois Department of Transportation
City of Barron
City of Beaver Dam
City of Brookfield
City of Hillsboro
City of Peshtigo
City of River Falls
City of Sparta
City of Thorp
City of Waupun
Village of Wittenberg
Fontana/Walworth Water Pollution Control Commission
Rock County Public Works Department
Menominee Indian Tribe of Wisconsin
Oneida Tribe of Indians of Wisconsin
Stockbridge-Munsee Band of Mohican Indians
Walworth County Metropolitan Sewerage District
Bad River Band of Lake Superior Chippewa Indians

LOCATION:

Statewide

PROJECT CHIEF:

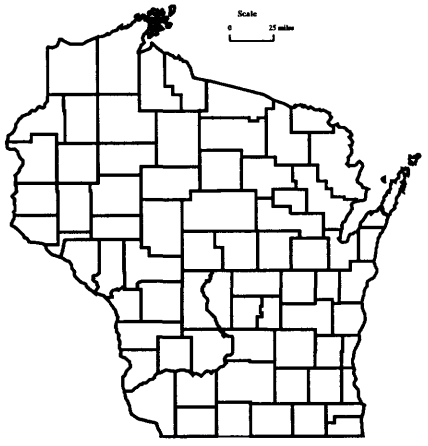
Barry K. Holmstrom

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 the report "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 report "Water Resources Data–Wisconsin".

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

PROGRESS (July 1996 to June 1997): During the current fiscal year, streamflow data were collected at a total of 92 sites: 27 sites for the Wisconsin Department of Natural Resources (WDNR), 17 sites for the Corps of Engineers, 14 sites for the Southeastern Wisconsin Regional Planning Commission, 6 sites for the Federal program, 3 sites for the Madison Metropolitan Sewerage District, and 1 site each for the Bad River Band of Lake Superior Chippewa Indians, Lac du Flambeau Band of Lake Superior Chippewa, Menominee Indian Tribe of Wisconsin, Oneida Tribe of Indians of Wisconsin, Stockbridge-Munsee Band of Mohican Indians, Illinois Department of Transportation, Rock County, Fontana/ Walworth Water Pollution Control Commission, Dane County Department of Public Works, Walworth County Metropolitan Sewerage District, Federal Energy Commission Licensee, and cities of Barron, Beaver Dam, Brookfield, Hillsboro, Peshtigo, Sparta, Thorp, Waupun, and village of Wittenberg. Streamflow data were also collected at four 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, at one site for the Rock County Public Works Department, and one site for the WDNR.

A map showing the locations of all continuous-record streamflow-gaging stations in Wisconsin is shown on page 5.

Computation of streamflow and lake-level records for all the network stations for the 1996 water year was completed, stored in our WATSTORE computer data base, and published in the annual report "Water Resources Data–Wisconsin, water year 1996". More than 100 requests for streamflow information were answered.

PLANS (July 1997 to June 1998): Data will be collected at 92 continuous-streamflow stations (see the following list) and lake levels at 6 stations. Streamflow records will be computed and data published for the 1997 water year. Requests for streamflow information will be answered.

Due to budget constraints by the WDNR, operation of the following stations was discontinued as of July 1, 1996.

04071858 Pensaukee River near Pensaukee
04085200 Kewaunee River near Kewaunee
04085281 East Twin River at Mishicot
04085427 Manitowoc River at Manitowoc

Real-time data can be accessed on World-Wide Web at http://wwwdwimdn.er.usgs.gov

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 1998 FY

Station number	Name and location	Drainage Area	Period of record (water year)	Cooperator
04024430	Nemadji River - South Superior	420	1974-	WDNR
04025500	Bois Brule River - Brule	118	1943-81, 1984-	Fed.
04027000	Bad River - Odanah	597	1914-22, 1948-	Bad River Band of Lake Superior Chippewa Indians
04027500	White River - Ashland	301	1948-	WDNR
04029990	Montreal River - Saxon Falls	262	1987	WDNR
04063700	Popple River - Fence	139	1964-	Fed.
04064500	Pine River - Pine River Powerplant - Florence	533	1924-76, 1996-	WDNR
04065106	Menominee River - Niagara	2470	1993-	FERC
04066003	Menominee River - Pembine	3140	1950-	WDNR
04069500	Peshtigo River - Peshtigo	1080	1953-	City of Peshtigo
04071000	Oconto River - Gillett	705	1906-09, 1914-	Fed.
04072150	Duck Creek - Howard	108	1988-	Oneida Tribe of Indians of WI
04073500	Fox River - Berlin	1340	1898-	C of E, Detroit
04074950	Wolf River - Langlade	463	1966-79, 1981-	Menominee Indian Tribe of WI
04077400	Wolf River - Shawano	816	1907-09, 1911-	WDNR
04077630	Red River - Morgan	114	1993	Stockbridge-Munsee Band of Mohican Indians
0407809265	Middle Branch Embarrass River - Wittenberg	76.3	1990-	Village of Wittenberg
04079000	Wolf River - New London	2260	1896-	C of E, Detroit
04082400	Fox River - Oshkosh	5310	1991	WDNR
04084445	Fox River - Appleton	5950	1986-	C of E, Detroit
04064500	Fox River - Rapide Croche Dam - Wrightstown	6010	1896-	WDNR
04066000	Sheboygan River - Sheboygan	418	1916-24, 1951-	WDNR
04066500	Cedar Creek - Cedarburg	120	1930-70, 73-81, 1983-87, 1991 -	WDNR
04086600	Milwaukee River - Pioneer Road - Cedarburg	607	1982-	SEWRPC
04087000	Milwaukee River - Milwaukee	696	1914-	SEWRPC
04067030	Menomonee River - Menomonee Falls	34.7	1975-77, 1979-	SEWRPC
04087088	Underwood Creek - Wauwatosa	18.2	1975-	SEWRPC
04087120	Menomonee River - Wauwatosa	123	1962-	SEWRPC
04067160	Kinnickinnic River - Milwaukee	20.4	1976-	SEWRPC
04067204	Oak Creek - South Milwaukee	25	1964-	SEWRPC
04067220	Root River - Franklin	49.2	1964-	SEWRPC
04087233	Root River Canal - Franklin	57	1964-	SEWRPC
04087240	Root River - Racine	190	1963-	SEWRPC
04087257	Pike River - Racine	38.5	1972-	SEWRPC
05332500	Namekagon River - Trego	488	1928-70, 1988	WDNR
05340500	St. Croix River - St. Croix Falls	6240	1902-	WDNR
05341500	Apple River - Somerset	579	1901-70, 1987	WDNR
05356000	Chippewa River - Winter	790	1912-	WDNR
05356500	Chippewa River - Bruce	1650	1914-	WDNR
05357335	Bear River - Manitowish Waters	81.3	1991	Lac du Flambeau Band of Lake Superior Chippewa
05360500	Flambeau River - Bruce	1860	1951-	WDNR, FERC
05362000	Jump River - Sheldon	576	1915-	Fed.
05365500	Chippewa River - Chippewa Falls	5650	1888-1983, 1987	WDNR
05365707	North Fork Eau Claire River - Thorp	51	1986	City of Thorp
053674464	Yellow River - Barron	153	1991	City of Barron
05368000	Hay River - Wheeler	418	1951-	Fed.
05369000	Red Cedar River - Menomonie	1770	1907-08, 1913-	WDNR
05369500	Chippewa River - Durand	9010	1928-	C of E, St. Paul
05370000	Eau Galle River - Spring Valley	64.1	1944-	C of E, St. Paul
05379500	Trempealeau River - Dodge	643	1914-19, 1934	C of E, St. Paul
05382000	Black River - Galesville	2080	1932-	C of E, St. Paul, WDNR
05382325	La Crosse River - Sparta	167	1992-	City of Sparta
05391000	Wisconsin River - Lake Tomahawk	757	1936-	WDNR
05393500	Spirit River - Spirit Falls	81.6	1942-	WDNR
05394500	Prairie River - Merrill	184	1914-31, 1939	WDNR

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 1998 FY

Station number	Name and location	Drainage Area	Period of record (water year)	Cooperator
05395000	Wisconsin River - Merrill	2760	1903-	WDNR
05397500	Eau Claire River - Kell	375	1914-27, 1939-	WDNR
05398000	Wisconsin River - Rothschild	4020	1945-	WDNR
05399500	Big Eau Pleine River - Stratford	224	1914-26, 1937-	WDNR
05400760	Wisconsin River - Wisconsin Rapids	5420	1914-50, 1958-	WDNR
05402000	Yellow River - Babcock	215	1944-	WDNR
05404000	Wisconsin River - Wisconsin Dells	8090	1935-	WDNR
05404116	S. Br. Baraboo River - Hillsboro	39.1	1988-	City of Hillsboro
05405000	Baraboo River - Baraboo	609	1914-22, 1943-	Fed.
05406500	Black Earth Creek - Black Earth	45.6	1954-	Dane County
05407000	Wisconsin River - Muscoda	10400	1903-04, 1914-	C of E, St. Paul
05406000	Kickapoo River - LaFarge	266	1939-	WI Dept. Tourism
05410490	Kickapoo River - Steuben	687	1933-	C of E, St. Paul
05413500	Grant River - Burton	269	1935-	C of E, R. Island
05414000	Platte River - Rockville	142	1935-	C of E, R. Island
05423500	S. Br. Rock River - Waupun	63.6	1948-69, 1987	City of Waupun
05425500	Rock River - Watertown	969	1931-70, 1977-	C of E, R. Island
05425912	Beaverdam River - Beaver Dam	157	1984-	City of Beaver Dam
05426000	Crawfish River - Milford	762	1931-	Rock County, Jefferson County
05426250	Bark River - Rome	122	1980-	SEWRPC
05427570	Rock River - Indianford	2630	1975-	Rock County
05429500	Yahara River - McFarland	327	1930-	DCDPW
05430150	Badfish Creek - Cooksville	82.6	1977-	MMSD
05430175	Yahara River - Fulton	517	1977	MMSD
05430500	Rock River - Afton	3340	1914-	C of E, R. Island
05431032	Turtle Creek - Delavan	83.3	1996-	WALCOMET
05431486	Turtle Creek - Clinton	199	1939-	C of E, Rock Island, WALCOMET
05432500	Pecatonica River - Darlington	273	1939-	C of E, R. Island
05433000	E. Br. Pecatonica River - Blanchardville	221	1939-1986, 1988	C of E, R. Island
05434500	Pecatonica River - Martintown	1034	1940-	C of E, R. Island
05435943	Badger Mill Creek - Verona	20.3	1997-	MMSD
05436500	Sugar River - Brodhead	523	1914-	C of E, Rock Island
05438283	Piscasaw Creek - Walworth	9.58	1992-	Fontana/Walworth WPCC
05543800	Fox River - Watertown Road - Waukesha	77.4	1993-	City of Brookfield
05543830	Fox River - Waukesha	126	1963-	SEWRPC
05544200	Mukwonago River - Mukwonago	74.1	1973-	SEWRPC
05545750	Fox River - New Munster	811	1940-	IL. DOT
		LAKES		
04082500	Lake Winnebago - Oshkosh	5880	1882-	C of E, Detroit
04084255	Lake Winnebago - Stockbridge	5880	1983-	C of E, Detroit
05404500	Devil's Lake - Baraboo	4.79	1922-30, 1932, 1934-81, 1985-	WDNR
05427235	Lake Koshkonong - Newville	2560	1987	Rock County
05428000	Lake Mendota - Madison	233	1903, 1916-	DCDPW
05429000	Lake Monona - Madison	279	1915-	DCDPW

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
DCDPW – Dane County Department of Public Works
Fed. – USGS Federal Program
FERC – Federal Energy Regulatory Commission Licensees
Fontana/Walworth WPCC – Fontana/Walworth Water Pollution Control Commission
IL. DOT – Illinois Department of Transportation
MMSD – Madison Metropolitan Sewerage District
SEWRPC – Southeastern Wisconsin Regional Planning Commission
WALCOMET – Walworth County Metropolitan Sewerage District
WDNR – Wisconsin Department of Natural Resources
WI Dept. Tourism – Wisconsin Department of Tourism

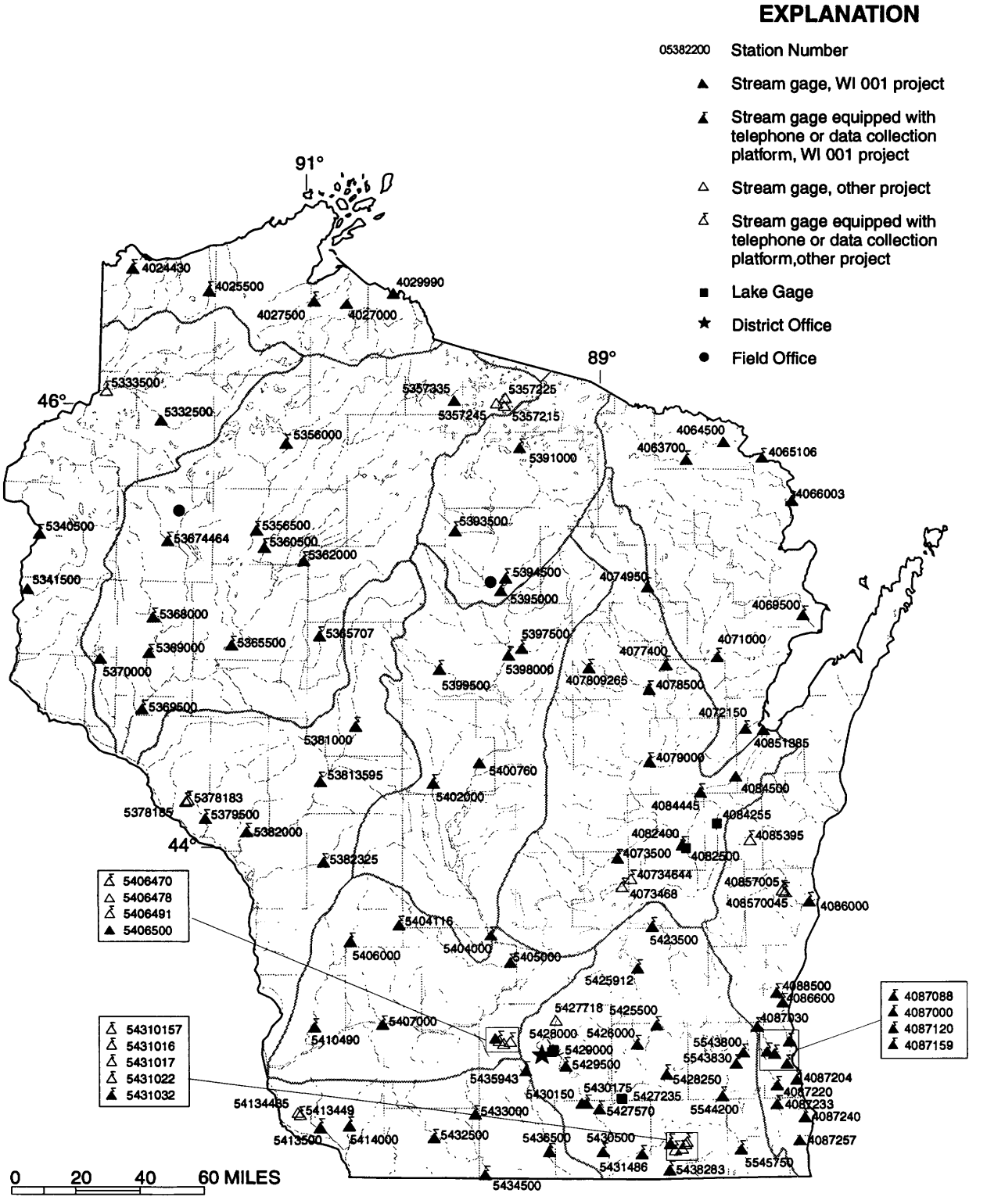


Figure 8. Location of continuous-record data-collection stations.

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 three 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 (square miles)	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, 1993-95
Peshtigo River at High Falls near Crivitz, WI	04068000	537	1912-57
Pensaukee River near Pensaukee, WI	04071858	134	1973-96
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, I982-85
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
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	04060976	0.04	1971-74
Waupaca River near Waupaca, WI	04081000	265	1916-66, 1983-85
Daggets Creek at Butte Des Morts, WI	04061800	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
Kewaunee River near Kewaunee, WI	04085200	127	1964-96
East Twin River at Mishicot, WI	04085281	110	1972-96
Manitowoc River at Manitowoc, WI	04085427	526	1972-96
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 (square miles)	Period of record
North Branch Milwaukee River near Fillmore, WI	04086340	148	1968-81
Milwaukee River at Waubeka, WI	04086360	432	1968-81, 1994
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	1960
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	05387500	1,100	1914-80, 1989-90
Eau Galle River near Woodville, WI	05369900	39.4	1978-83
Eau Galle River at low water bridge at Spring Valley, WI	05369945	47.9	1982-83, 1986-96
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 (square miles)	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, 1994
Hulbert Creek near Wisconsin Dells, WI	05403630*	11.2	1971-77
Dell Creek near Lake Delton, WI	05403700*	44.9	1957-65, 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 Creek 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
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

Discontinued surface-water discharge stations

Station name	Station number	Drainage area (square miles)	Period of record
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
Galena River at Buncombe, WI	05415000	125	1939-92
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
Rock River at Jefferson, WI	05426031	1,850	1978-94
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
Jackson Creek at Petrie Road near Elkhorn, WI	05431014	8.96	1984-95
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, 1973-78

COLLECTION OF BASIC RECORDS–GROUND WATER, WI 002

COOPERATOR:
Wisconsin Geological and Natural History Survey

LOCATION:
Statewide

PROJECT CHIEF:
Bernard R. Ellefson

PERIOD OF PROJECT:
July 1946-Continuing

PROBLEM: Ground-water data are needed to 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 155 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 1996 to June 1997): A report of findings from the slug tests and geophysical logging of selected wells in the network was prepared. All water-level and hydrograph data were put on the INTERNET (wwwdwimdn.er.usgs.gov). Funding levels were reduced by the cooperator so data collection at some wells had to be discontinued. Data for the annual report, "Water Resources Data–Wisconsin, water year 1996", was completed.

PLANS (July 1997 to June 1998): Plans include: (1) Continue measurements on observation-well network, (2) replace and hire new observers and make quality-assurance checks when possible, (3) slug test and geophysical log 20 wells in the network, and (4) attempt to find additional funding or alternate data-collection methods so data collection at discontinued wells can be resumed.

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.

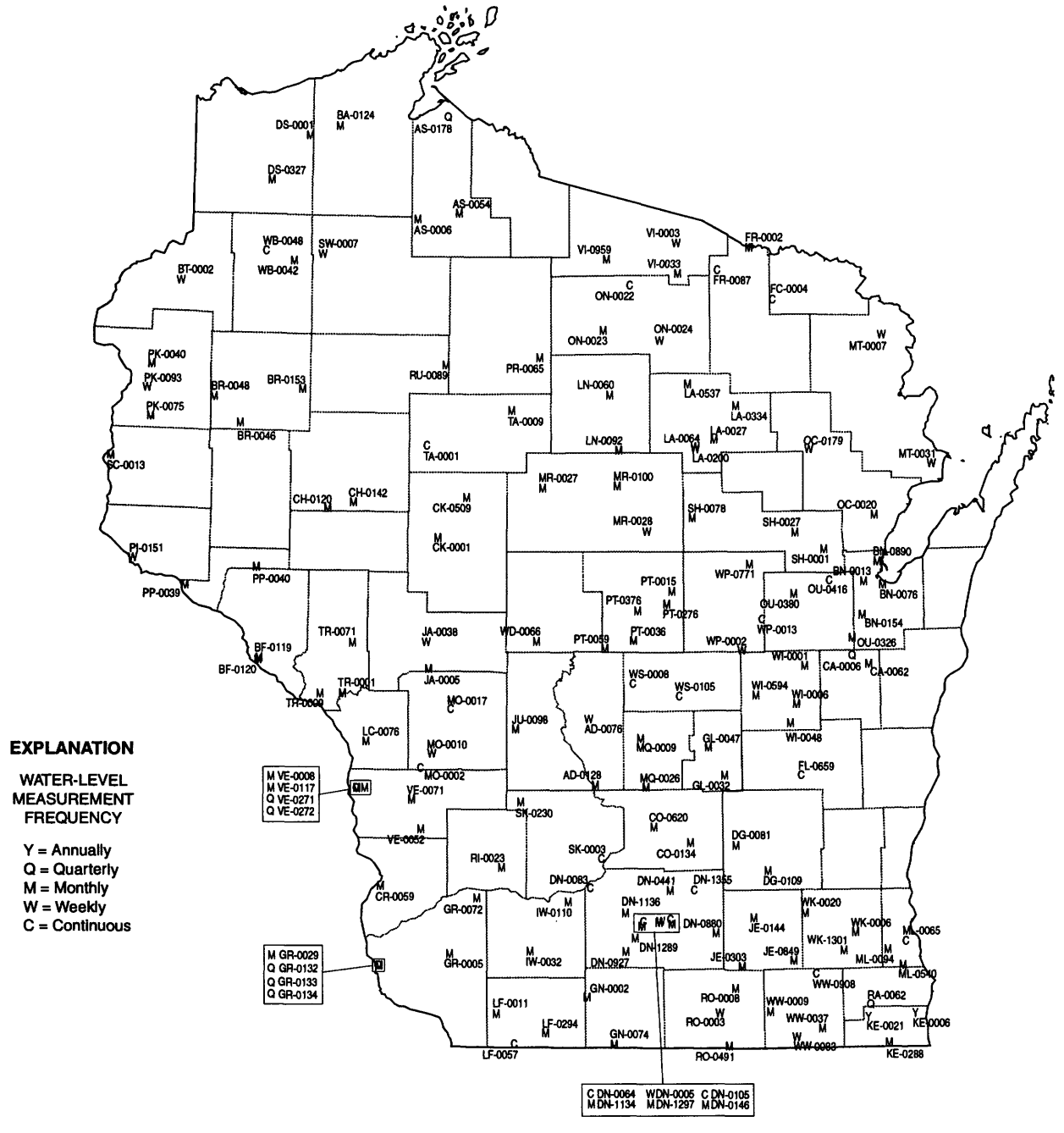


Figure 9. Location of network observation wells.

CRANDON GROUND WATER, WI 00201

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Forest County, Wisconsin

PROJECT CHIEF:
James T. Krohelski

PERIOD OF PROJECT:
October 1994-Continuing

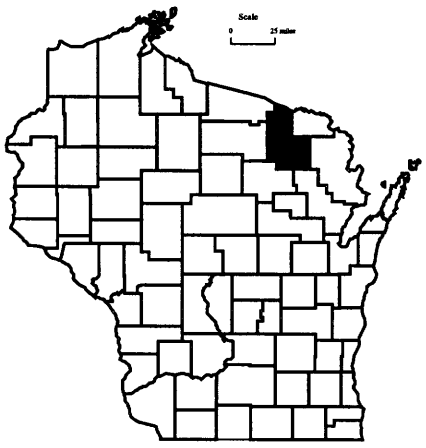
PROBLEM: A large underground zinc-copper mine is being proposed at a site about five miles south of Crandon, Wisconsin, in Forest County. The Wisconsin Department of Natural Resources (WDNR) requested that District staff review the development of a ground-water flow model and associated hydrologic documents as part of a permitting process for the proposed mine.

OBJECTIVE: The objective is to review documents related to water resources submitted to WDNR from the Crandon Mining Company (CMC) and their consultants and to make suggestions to WDNR on studies and approaches that will improve the understanding of the hydrology and effects of mining on the water resources in the vicinity of the proposed mine.

APPROACH: The schedule for review of documents will be mutually agreed upon between WDNR and USGS.

PROGRESS (July 1996 to June 1997): (1) The CMC ground-water flow model was delivered in August 1996. An initial review covering starting heads, convergence, and boundary conditions was made and a memo was submitted to WDNR describing the review. (2) The CMC solute transport model was delivered in September 1996. A meeting in which CMC presented the model was held on December 19, 1996. (3) Monitoring of lake stage and shallow ground-water levels adjacent to Little Sand Lake was continued.

PLANS (July 1997 to September 1997): (1) The ground-water flow model and the contaminant transport model reviews will be completed. (2) Additional documents will be reviewed and meetings attended at the request of WDNR. (3) Monitoring of lake stage and shallow ground-water levels adjacent to Little Sand Lake will be continued.



BROWNFIELDS, WI 00203

PROBLEM: The Wisconsin Department of Natural Resources has initiated a land recycling program. This program encourages the redevelopment and return to productive use of urban contaminated properties.

OBJECTIVES: The objective is to give field support to the Wisconsin Department of Natural Resources in determining the extent of contamination of urban contaminated properties.

APROACH: Support will be given by collecting soil and ground-water samples with a Geoprobe and/or analyzing the samples with a field gas chromatograph.

PROGRESS (July 1996 to June 1997): Soil and ground-water samples in the vicinity of several urban contaminated sites were collected and analyzed.

PLANS (July 1997 to June 1998): Support will continue at the request of the Wisconsin Department of Natural Resources.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Statewide

PROJECT CHIEF:
John F. DeWild

PERIOD OF PROJECT:
May 1996-Continuing

COLLECTION OF BASIC RECORDS–WATER QUALITY, WI 003

COOPERATOR:
Federal Program

LOCATION:
Northeastern Wisconsin

PROJECT CHIEF:
John F. Elder

PERIOD OF PROJECT:
July 1964-Continuing

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

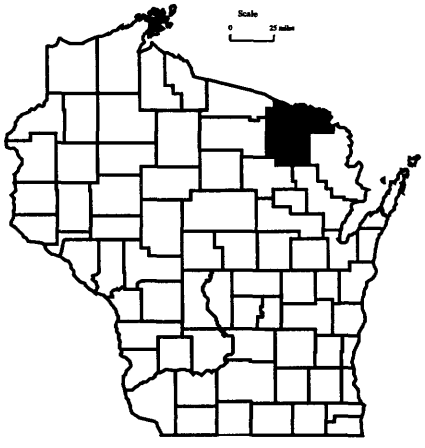
OBJECTIVE: The Federal program consists of the National Stream Quality Accounting Network (NASQAN) and the Hydrologic Benchmark Network (HBMN). All NASQAN stations in Wisconsin were discontinued at the end of the 1994 water year. The objectives of the NASQAN program are to (1) account for the quantity 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 human activities and will remain unaffected for the foreseeable future.

APPROACH: Chemical, bacteriological, and physical water-quality data are systematically collected at fixed-time intervals at stations for NASQAN and HBMN. Data collected is the same for both programs and includes measurements of water temperature, specific conductance, pH, and concentrations of dissolved oxygen, plant nutrients, common mineral constituents, trace constituents, fecal bacteria, and suspended sediment.

PROGRESS (July 1996 to June 1997): Data were collected quarterly at the HBMN station on the Popple River through September 1996. The HBMN sampling was temporarily discontinued in water year 1997 (October 1996–September 1997); however, stage and discharge measurements continued without interruption.

Data collected during the 1996 water year were processed for publication in the annual data release "Water Resources Data-Wisconsin, water year 1996."

PLANS (July 1997 to June 1998): Data collection will resume at the HBMN station on the Popple River.



CORN HERBICIDES IN SURFACE WATERS IN WISCONSIN, WI 00301

PROBLEM: There have not been many studies of Wisconsin watersheds in which surface-water run-off samples were collected with enough frequency to calculate the herbicide loads for entire watersheds. It has been estimated that 7.0 million pounds of corn herbicides were applied during 1996 in Wisconsin. The most common corn herbicides being used are alachlor, atrazine, cyanazine, dicamba, metolachlor and 2,4-D. Acetochlor, has been introduced to the market as replacement for some of the other corn herbicides. It is probable that acetochlor will be used extensively in the future with estimated statewide application rates approaching that of cyanazine and metolachlor. Very few water-column samples have been analyzed for acetochlor from surface-water streams in Wisconsin.

OBJECTIVE: The objectives of the study are to determine concentrations of corn herbicides in two streams in south central Wisconsin and determine the mass transport of corn herbicides from two watersheds in Wisconsin.

APPROACH: Two streams will be monitored in Wisconsin. These streams drain areas in south central Wisconsin that are extensively planted in corn and where corn herbicides are actively applied. The streams will be the Yahara River at Fulton and the Pecatonica River at Martintown. Samples will be collected weekly starting in mid-May and will conclude in mid-July. These samples will most likely represent low-flow conditions. Samples will be collected during periods of storm runoff. The low flow and runoff samples will be used to calculate mass transport of corn herbicides from these two watersheds for the period of data collection.

PROGRESS (July 1996 to June 1997): Atrazine was the most frequently detected herbicide at both streams. At the Pecatonica River, 88 percent of the samples had detectable concentrations of atrazine and 57 percent of samples collected at the Yahara River had detectable concentrations of atrazine. The median concentration of atrazine was 0.90 µg/l at the Pecatonica River and 0.18 µg/l at the Yahara River. The calculated herbicide loads at the Pecatonica River were 484 pounds for atrazine; 357 pounds of metolachlor; 326 pounds of cyanazine; 128 pounds of acetochlor and 47.2 pounds of alachlor. The Yahara River transported 289 pounds of atrazine; 243 pounds of cyanazine; 172 pounds of metolachlor; 73.3 pounds of acetochlor and 36.1 pounds of alachlor. All data was summarized and will be published in the report, "Water resources data–Wisconsin", water year 1996. A U.S. Geological Survey Fact Sheet was prepared and is being reviewed. This fact sheet compares herbicides concentrations and loads at the Pecatonica and Yahara River sites.

PLANS (July 1997 to June 1998): Samples will be collected at the Pecatonica and Yahara River and at two other sites during the 1997 growing season. All data will be published in the report, "Water Resources Data–Wisconsin,' water year 1997. The fact sheet, "Herbicides in the Pecatonica and Yahara Rivers in Southwestern Wisconsin, May 1996–July 1996," will be published. A second fact sheet will be prepared jointly by the U.S. Geological Survey and the Wisconsin Department of Agriculture, Trade, and Consumer Protection. This fact sheet will compare concentrations and loads at the four sites.

COOPERATOR:

Wisconsin Department of Agriculture, Trade and Consumer Protection

LOCATION:

Parts of Columbia, Dane, Grant, Green, Iowa, Lafayette and Rock Counties

PROJECT CHIEF:

David J. Graczyk

PERIOD OF PROJECT:

May 1996 to September 1998

COLLECTION OF BASIC RECORDS–DANE COUNTY PROGRAM, WI 00302

COOPERATOR:
Dane County Regional Planning Commission

LOCATION:
Dane County, Wisconsin

PROJECT CHIEF:
Herbert S. Garn

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 of 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 load for selected stations.

PROGRESS (July 1996 to June 1997): On-going streamflow and water-quality data collection at three continuous-record monitoring sites (Pheasant Branch at Middleton, Spring Harbor Storm Sewer at Madison, and Yahara River at Windsor) continued. Suspended-sediment loads were computed for Spring Harbor Storm Sewer, and suspended-sediment, total phosphorus, and dissolved orthophosphorus loads were computed for the Yahara River and Pheasant Branch for the 1996 water year. Continuous-streamflow monitoring at Black Earth Creek near Black Earth was added to the program in July 1996.

Base-flow water-quality sampling was completed at two sites in December 1996, and began in May at three new streams in the county that were sampled twice. Streamflow, load and concentration data were published in the annual data report "Water Resources Data–Wisconsin, water year 1996."

PLANS (July 1997 to June 1998): Continue monitoring streamflow at Black Earth Creek and streamflow and water quality at the three continuous-record sites on tributaries to Lake Mendota. Conduct base-flow water-quality sampling at four new sites (starting in May 1997) for the remainder of the calendar year. Compute records and loads. Prepare final data and publish in the annual data report.

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 (July 1996 to June 1997): Sediment data have been collected at more than 200 stream sites in Wisconsin since 1968. 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 1970s when there was a Statewide network of sediment monitoring stations. All data have been published annually in the data report, "Water Resources Data–Wisconsin". The 1996 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.

PLANS (July 1997 to June 1998):

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

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

COOPERATORS:
Wisconsin Department of Natural Resources
U.S. Army Corps of Engineers

LOCATION:
Statewide

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
March 1968-Continuing

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.

Rose, William J., and Graczyk, David J., 1996, Sediment transport, particle size, and loads in North Fish Creek in Bayfield County, Wisconsin, water years 1990-91, U.S. Geological Survey Water-Resources Investigations Report 95-4222, 18 p.

FEMA FLOOD-INSURANCE STUDY, WI 006

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 as needed for the preparation of floodplain maps in areas selected by FEMA.

APPROACH: Flood-discharge frequency relations will be determined from local historical information, gaging station records, regional regression equations, rainfall-runoff models, or other applicable information. Water-surface profiles will be produced using step-backwater models or other acceptable methods, and the resultant information will be transferred to a contour map. A Digital Flood Insurance Rate Map (DFIRM) will then be created within a geographic information system (GIS) environment by overlaying existing roadway, hydrographic and political coverages with selected digitized FIRM information.

PROGRESS (July 1996 to June 1997): Hydraulic analyses were completed for Fond du Lac County study. Surveying and initial hydrologic analyses for LaCrosse County were completed.

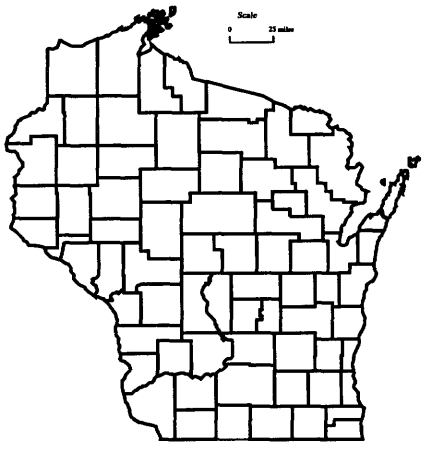
PLANS (July 1997 to June 1998): Response will be made to review comments on completed studies and data requests answered as needed. Work for the Fond du Lac and LaCrosse County studies will be completed.

COOPERATOR:
Federal Emergency Management Agency

LOCATION:
Statewide

PROJECT CHIEF:
Todd D. Stuntebeck

PERIOD OF PROJECT:
March 1984-Continuing



WISCONSIN WATER-USE DATA FILE, WI 007

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Statewide

PROJECT CHIEF:
Bernard R. Ellefson

PERIOD OF PROJECT:
March 1978-Continuing

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, store data in the State Water-Use Data System (SWUDS), and prepare periodic reports on water use in the State.

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

PROGRESS (July 1996 to June 1997): SWUDS was updated with current water-use information. 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 collection was completed for the 1995 water-use publication, "Water use in Wisconsin, 1995".

PLANS (July 1997 to June 1998): Plans include: (1) continue to update and maintain SWUDS with current water-use data, (2) supply water-use data for water-resources studies currently being conducted in the State, and (3) prepare and publish, "Water use in Wisconsin, 1995".

REPORTS:

Ellefson, B.R., Sabin, T.J., Krohelski, J.T., 1993, Water use in Wisconsin, 1990: U.S. Geological Survey Open-File Report 93-118, 1 sheet, scale 1:5,000,000.

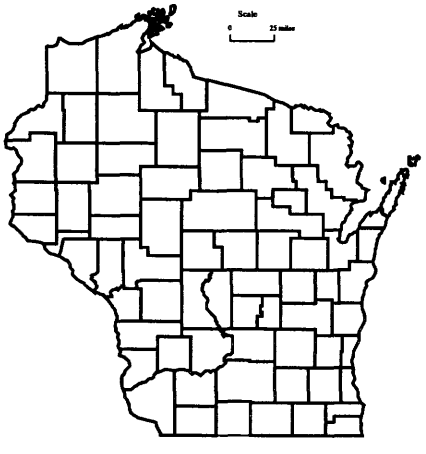
Ellefson, B.R., Rury, K.S., and Krohelski, J.T., 1988, Water-use in Wisconsin, 1985: U.S. Geological Survey Open-File Report 87-699, 1 sheet, scale 1:5,000,000.

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.



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

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: Objectives are to (1) operate a State-wide network of crest gages to obtain ongoing information on flood peaks; (2) develop improved regression equations for the State of Wisconsin; and (3) analyze and improve the network of crest-stage gages to obtain better data for developing improved regression equations.

APPROACH: A network of approximately 100 crest-stage gages will be maintained to gather flood peak information, especially on streams with small drainage areas. The information on annual flood peaks will be used to compute flood-frequency at these sites. Periodically, the expanded information on flood frequency at streams throughout the state will be used to compute regional flood-frequency equations to estimate flood frequency at ungaged sites.

PROGRESS (July 1996 to June 1997): Annual flood peaks were computed and published in the annual data report for 74 crest-stage stations, including 8 of the new stations. New stations have been installed in areas where the cooperator indicated the greatest need for more information on flooding. Significant effort has been made in measuring flood discharges at crest gages, especially at the newly installed gages, and improving ratings at crest gages.

PLANS (July 1997 to June 1998): The crest-stage-gage network will be monitored throughout the year. More new gages will have ratings developed for them as measurements and surveys are available. 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.

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.

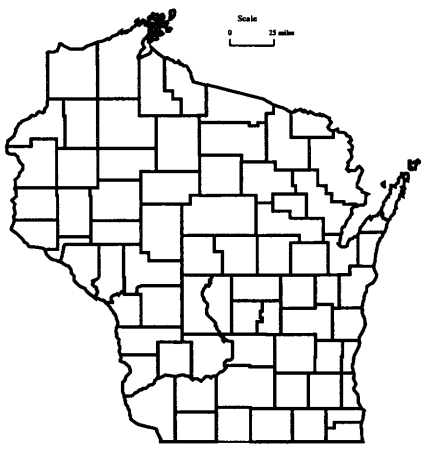
Conger, D.H., 1971, Estimating magnitude and frequency of floods in Wisconsin: U.S. Geological Survey Open-File Report, 200 p.

COOPERATOR:
Wisconsin Department of Transportation-Highways

LOCATION:
Statewide

PROJECT CHIEF:
William R. Krug

PERIOD OF PROJECT:
July 1985-Continuing



LIST OF CREST-STAGE GAGES

CHIPPEWA RIVER BASIN

05357360 Bear River near Powell, WI
05359600 Price Creek near Phillips, WI
05361400 Hay Creek near Prentice, WI
05361420 Douglas Creek near Prentice, WI
05361989 Jump River tributary near Jump River, WI
05363775 Babit Creek at Gilman, WI
05364000 Yellow River at Cadott, WI
05364100 Seth Creek near Cadott, WI
05364500 Duncan Creek at Bloomer, WI
05366500 Eau Claire River near Fall Creek, WI
05367030 Willow Creek near Eau Claire, WI
053674588 Rock Creek tributary near Canton, WI
05367700 Lightning Creek at Almena, WI
05370900 Spring Creek near Durand, WI

CENTRAL WISCONSIN RIVER BASIN

05395020 Lloyd Creek near Doering, WI
05395100 Trappe River Tributary near Merrill, 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
05403397 Allen Creek at Canary Drive near Oakdale, WI
05403700 Dell Creek near Lake Delton, WI

FOX-WOLF RIVER BASIN

04072792 Tagatz Creek near Westfield, WI
04073066 Grand River tributary near Manchester, WI
04073400 Bird Creek at Wautoma, WI
04074850 Lily River near Lily, WI
04075200 Evergreen Creek near Langlade, WI
04078891 Maple Creek near Sugar Bush, WI
04079700 Spaulding Creek near Big Falls, WI
04081900 Sawyer Creek at Oshkosh, WI

LAKE MICHIGAN BASIN

04085145 Red River at CTH A near Dyckesville, WI
04085400 Killsnake River near Chilton, WI
040854105 Mud Creek at Marken Road near Valders, WI
04086310 Mink Creek at CTH S near Beechwood, WI
04087100 Honey Creek at Milwaukee, WI
04087200 Oak Creek near South Milwaukee, 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

05405600 Rowan Creek at Poynette, WI
054062391 Otter Creek at Kings Corner Road near Prairie du Sac, WI
05406605 Lowery Creek near Spring Green, WI
05406754 Fancy Creek near Gillingham, WI
05406854 Willow Creek at CTH D near Loyd
05407039 Fennimore Fork near Fennimore, WI
05407200 Crooked Creek near Boscobel, WI
05409270 Reads Creek at Riley Road near Readstown, WI

MENOMINEE-OCONTO-PESHTIGO RIVER BASIN

04059900 Allen Creek Tributary near Alvin, WI
04063640 North Branch Pine River at Windsor Dam near Alvin, WI
04067760 Peshtigo River near Cavour, 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

05413060 Martin Branch near Mount Ida, WI
05413400 Pigeon Creek near Lancaster, WI
05414213 Little Platte River near Platteville, WI
05414900 Pats Creek near Elk Grove, WI
05432055 Livingston Branch near Livingston, WI
05432300 Rock Branch near Mineral Point, WI
05433500 Yellowstone River near Blanchardville, WI
05436200 Gill Creek near Brooklyn, WI

ROCK-FOX RIVER BASIN

05424007 Gill Creek at Farmersville, WI
05425806 Mud Creek near Danville, 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

05340300 Trade River near Frederic, WI
05341313 Bull Brook at CTH F near Amery, 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
05379187 Pine Creek at Taylor Road near Taylor, WI
05379288 Bruce Valley near Pleasantville, WI
05380900 Poplar River near Owen, WI
05380970 Cawley Creek near Neillsville, WI
05381383 Glenn Creek near Millston, WI
05382200 French Creek near Ettrick, WI
05387100 North Fork Bad Axe River near Genoa, WI

UPPER WISCONSIN RIVER BASIN

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, W

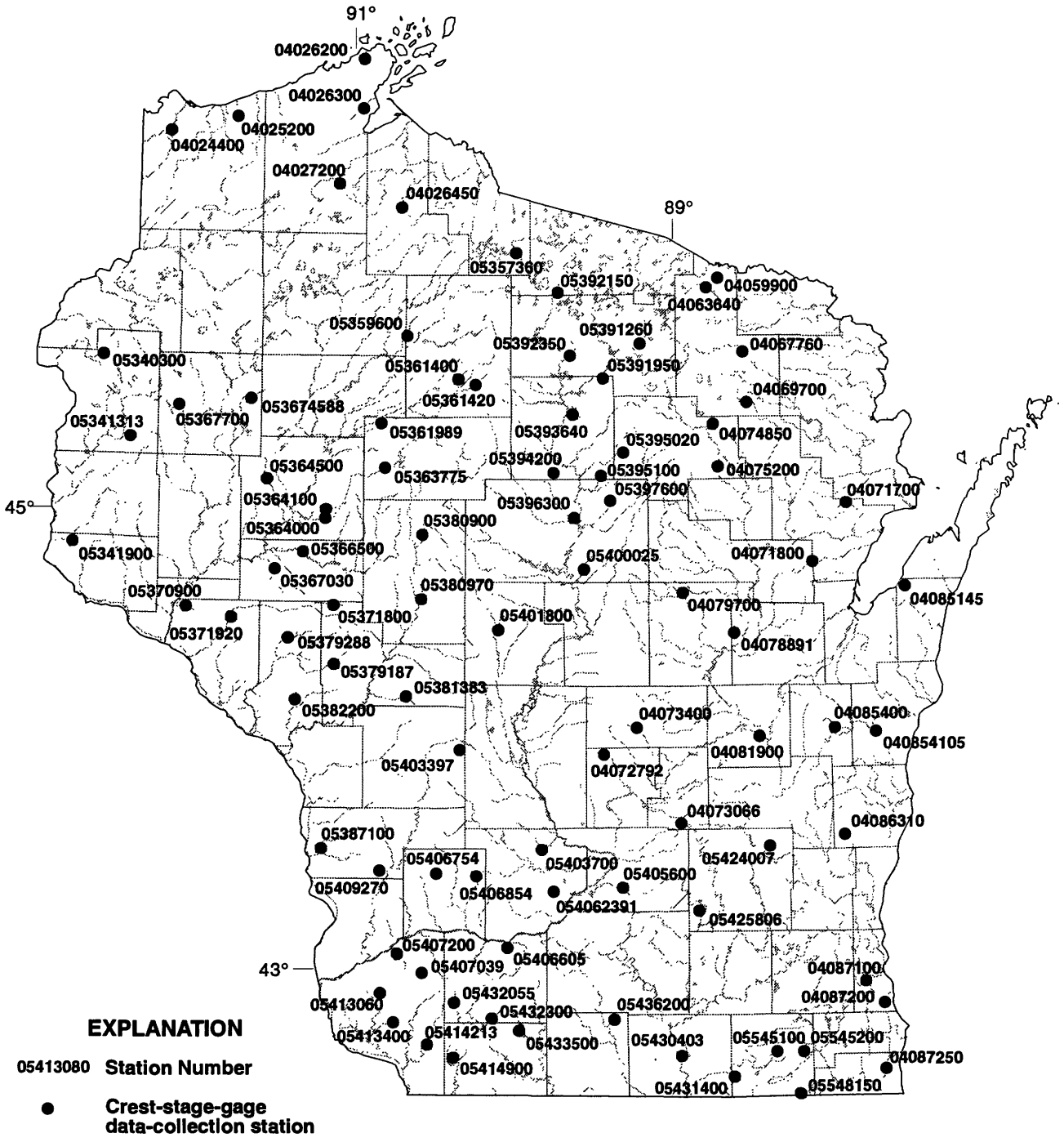


Figure 10. Location of crest-stage-gage data-collection stations.

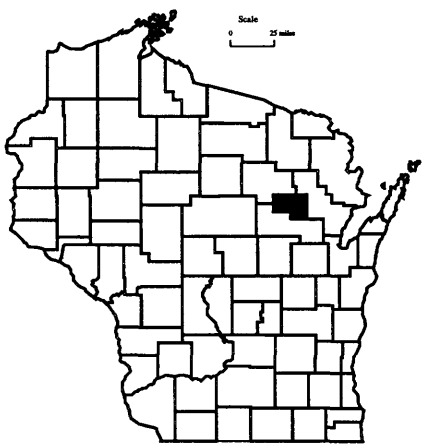
MENOMINEE TRACE ELEMENT MONITORING, WI 12301

COOPERATORS:
Menominee Indian Tribe of Wisconsin

LOCATION:
Menominee Indian Reservation

PROJECT CHIEF:
Herbert S. Garn

PERIOD OF PROJECT:
March 1996 to September 1977



PROBLEM: Maintaining the pristine quality of the Wolf River is extremely important to the Menominee Indian Tribe of Wisconsin and other tribes in the Upper Wolf River Basin. Information is needed to describe the current status of water quality and biotic conditions of the Wolf River within the Menominee Indian Reservation, and to determine the presence or absence of contaminants in water, sediments, and biota. Several years of data are available at USGS sites, including major ions, nutrients, and discharge data collected near the Menominee Indian Reservation boundaries. Sampling for major ions and nutrients is ongoing and will consist of about eight samples per year in 1996. Single samplings were conducted for trace metals and organics concentrations in water in September 1995, and for trace metals in water, fish livers, aquatic invertebrates, and streambed sediment in October 1995 near the Wolf River near Rangeland site. No data exist for trace element bioavailability and concentrations in water, aquatic biota, or streambed sediments at the other sites. A historical database is needed to evaluate present conditions and from which changes can be determined.

OBJECTIVES: The primary objective of the baseline monitoring is to establish a database describing water quality of the Wolf River near the upstream and downstream Menominee Indian Reservation boundaries. This database was specifically designed to: (1) determine concentrations of specific trace elements in water-column samples; (2) determine concentrations of specific trace elements in samples of fish livers, caddisfly larvae, and fine streambed sediments at the sampled sites; and (3) determine particle-size fractions of the fine streambed sediments at the sampled sites.

APPROACH: Sampling will be conducted to determine trace element concentrations in water, aquatic biota, and streambed sediments at the Wolf River near highway M near Langlade and the Wolf River at county highway VV near Keshena. Discharge data will be collected at the Wolf River near Langlade. Biological sampling will be conducted once per year at each of the sites.

Analyses of the water, biological, and sediment samples will include field parameters, major ions, nutrients, a broad suite of metals analyses, and analyses for selected pesticides. The USGS National Water-Quality Assessment protocols will be used for water, streambed sediments, and contaminants in tissues. Mercury analyses will be performed at the USGS Mercury Lab in Madison, Wisconsin, with all other analyses performed at the USGS National Water Quality Laboratory.

PROGRESS (July 1996 to June 1997)**:** Seven water samples and one biological sample were collected at each of the two sites.

PLANS (July 1997 to June 1998): Water samples from each of the two sites will be collected in August concurrent with the collection of biological and bed-sediment samples. Data from all samples collected from October 1996 through September 1997 will be published in the 1997 USGS Wisconsin Annual Data Report.

DELINEATION OF CONTRIBUTING AREAS OF SELECTED WELLS ON THE RED CLIFF INDIAN RESERVATION, WISCONSIN, WI 12305

PROBLEM: Well-head protection is required for areas using ground water for water supply within the Red Cliff Reservation. The concept of well-head protection is based on knowledge of areas that contribute water to wells and on the time of travel of the water from recharge at land surface to removal by the well. The contributing area of a pumping well is the land area that supplies the aquifer with ground water for pumping. Based on the contributing areas and estimates of time of travel, well-head protection areas will be defined correctly and can be set aside for future protection.

OBJECTIVES: The objective is to (1) help the Red Cliff staff responsible for well-head protection, (2) compile existing ground-water data, (3) plan future data collection, and (4) select and use appropriate methods to determine contributing areas and time of travel for water captured by wells within the reservation area.

APPROACH: A review of existing data that includes published reports and papers, available drillers' construction reports and geologic logs, and unpublished data will be conducted. A data base containing the hydrogeologic framework and hydraulic parameters will be created. During the review of existing data, the selection of a method(s) to determine contributing areas will be made and contributing areas of selected reservation wells will be estimated.

PROGRESS (July 1996 to June 1997): A review of existing data that includes published reports and papers, available drillers' construction reports and geologic logs, and unpublished data was conducted; a data base containing the hydrogeologic framework and hydraulic parameters was created; and a preliminary ground-water flow model was developed.

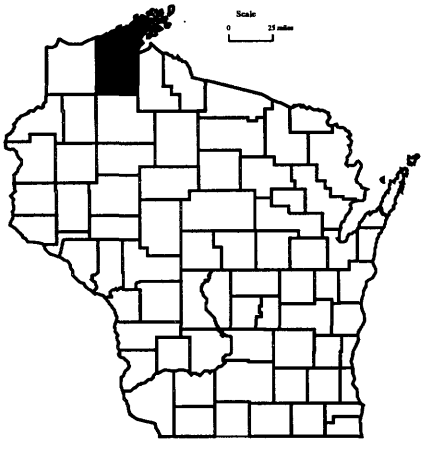
PLANS (July 1997 to September 1997): The contributing areas of selected reservation wells will be estimated and a short report documenting the methods used to delineate the capture zones will be written.

COOPERATOR:
Red Cliff Indian Reservation, Wisconsin

LOCATION:
Bayfield County, Wisconsin

PROJECT CHIEF:
Randy J. Hunt

PERIOD OF PROJECT:
July 1996 to September 1997



WATER RESOURCES ON THE BAD RIVER BAND OF LAKE SUPERIOR TRIBE OF CHIPPEWA INDIANS RESERVATION, WI 12309

COOPERATOR:
Bad River Band of Lake Superior Tribe of Chippewa Indians

LOCATION:
Ashland County, Wisconsin

PROJECT CHIEF:
Charles Dunning

PERIOD OF PROJECT:
July 1996 to September 1997

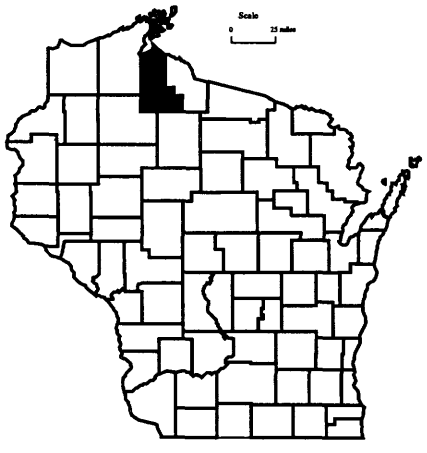
PROBLEM: There is a general need to characterize and define the hydrology and water quality of reservation areas. Current and future site-specific investigations concerned with long-term water-resource and water-quality trends require an adequate regional hydrogeologic framework.

OBJECTIVE: The objective is to further define the local and regional ground-water flow system in the northern part of the Bad River Indian Reservation.

APPROACH: The aquifers will be characterized by drilling boreholes at three sites, conducting geophysical surveys and rock core analyses, and packer testing at selected borehole intervals. Water quality will be evaluated at selected sites and depths.

PROGRESS (July 1, 1996 to June 30, 1997): Assistance was provided to the Tribe in identifying favorable drill sites. The approval process for drill sites is nearly complete.

PLANS (July 1, 1997 to September 30, 1997): Boreholes will be drilled for aquifer characterization at three sites in the northern part of the reservation. Rock core will be collected from one borehole and all will be geophysically logged. Selected zones in boreholes at two sites will be packer tested to assess the hydrogeological character of the aquifer. Water-quality analyses will be conducted on water samples from selected intervals.



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

COOPERATORS:

In the 1996 water year:
Alma/Moon, Big Hills, Druid, Eagle Spring, Fowler, Little Arbor Vitae, Little Green, Middle Genesee, Montello, Okauchee, Potter, Powers, Pretty, Twin (Marie and Elizabeth), Wind, and Wolf Lake Districts; city of Muskego (Big Muskego, Denoon, and Little Muskego Lakes); townships of Auburn (Forest Lake); Cedar Lake (Balsam, Red Cedar and Hemlock Lakes); Kansasville (Eagle Lake); Norway (Kee-Nong-Go-Mong and Waubeesee Lakes); Sand Lake (Big Sissabagama Lake); St. Germain (Big St. Germain Lake); Summit (Silver Lake); and Waterford (Tichigan Lake); and villages of Lake Nebagamon (Lake Nebagamon); and Oconomowoc Lake (Oconomowoc Lake)

In the 1997 water year:
Druid, Eagle Spring, Little Cedar, Little Green, Middle Genesee, Okauchee, Potter, Pretty, Twin (Marie and Elizabeth), Wind, and Wolf Lake Districts; city of Muskego (Big Muskego, Denoon, and Little Muskego Lakes); townships of Auburn (Forest Lake); Casey (Big, Middle, and Lower McKenzie Lakes), Cedar Lake (Balsam, Red Cedar and Hemlock Lakes); Kansasville (Eagle Lake); Norway (Kee-Nong-Go-Mong and Waubeesee Lakes); St. Germain (Big St. Germain Lake); Summit (Silver Lake); and Waterford (Tichigan Lake); and village of Oconomowoc Lake (Oconomowoc Lake)

PROBLEM: Lakes are a significant and valuable resource in the State of Wisconsin. Hence, their water quality needs to be assessed and documented.

OBJECTIVE: Objectives of this project are to determine the current water quality and trophic status of lakes; (2) assess the condition of specific lakes in comparison with other lakes of the same type in the region; and (3) build a quantitative data base so that any detrimental changes or trends that might occur in the future can be detected quickly and evaluated objectively.

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-depth measurements will be made for all months (except February), and total phosphorus and chlorophyll *a* samples will be collected and analyzed. Lake stage will be measured at each of the five visits to the lake.

LOCATION:

Selected lakes in Wisconsin

PROJECT CHIEF:

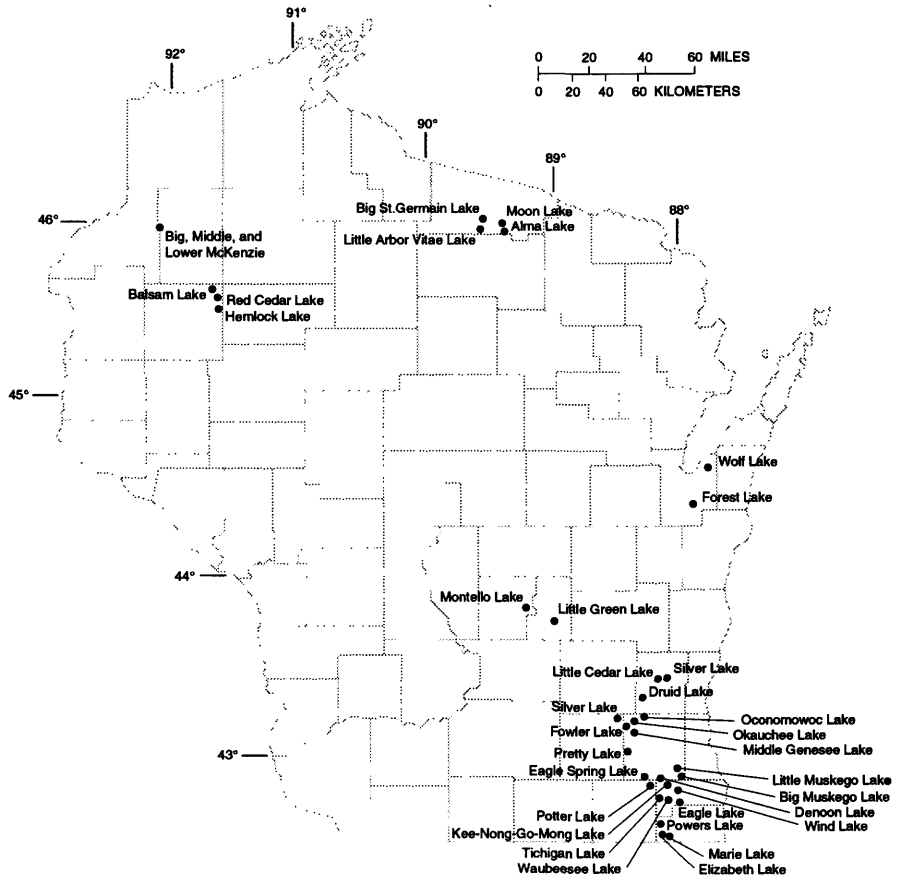
William J. Rose

PERIOD OF PROJECT:

June 1983-Continuing

PROGRESS (July 1996 to June 1997): In the 1996 water year, total phosphorus, chlorophyll *a*, dissolved oxygen, temperature, pH, specific conductance, and Secchi-depth data were collected and analyzed for 35 lakes. A letter evaluating the water quality of each lake was sent to the respective cooperator. In the 1997 water year, Big, Middle, and Lower McKenzie and Little Cedar Lakes were added to the program. Alma, Big Hills, Big Sissabagama, Big St. Germain, Denoon, Druid, Eagle, Forest, Fowler, Little Arbor Vitae, Long, Moon, Powers, Silver, Tichigan, and Waubeesee Lakes discontinued the program. The locations of lakes included in the monitoring program for water years 1996-97 are shown on the following map.

PLANS (July 1997 to June 1998): In the 1997 water year, 27 lakes will be monitored. Data will be compiled and transmitted to the respective cooperator after the August monitoring. The data will be prepared for publication in the annual report "Water Quality and Lake-Stage Data for Wisconsin Lakes, water year 1997".



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 present and future 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.

Water samples were analyzed to obtain PCB concentrations with congener resolution of hundreths of a nano-gram/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. Water-column data collected during the summer and fall of 1992, along with high-flow data collected during the summer of 1993, has been used to validate the transport model.

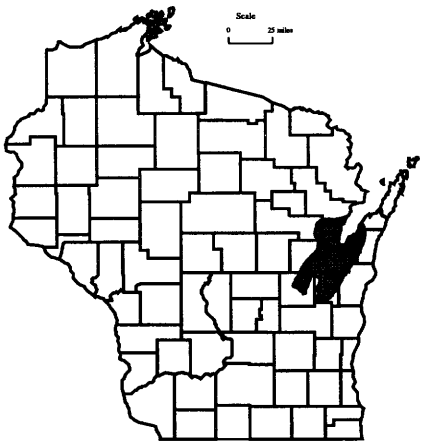
PROGRESS (July 1996 to June 1997): A fact sheet summarizing the Fox River effort was completed. We assisted the Fish and Wildlife Service in the Natural Resource Damage Assessment process.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Lower Fox River, East Central Wisconsin

PROJECT CHIEF:
Jeffrey J. Steuer

PERIOD OF PROJECT:
July 1985 to September 1997



PLANS (July 1997 to September 1997): We will continue to assist the Fish and Wildlife Service in the Natural Resource Damage Assessment process.

REPORTS:

Fitzgerald, Sharon and Steuer, Jeffrey, 1996, The Fox River PCB transport study—stepping stone to a healthy Great Lakes ecosystem, USGS Fact Sheet 116-96.

Velleux, M., Endicott, D., Steuer, Jeffrey J., Jaeger, S., and Patterson, D., 1995, Long-term simulation of PCB export from the Fox River to Green Bay, 1995, J. Great Lakes Research, International Association for Great Lakes Research, vol. 21, no. 3, p. 359-372.

Steuer, Jeffrey J., Jaeger, S., and Patterson, D., 1995, A deterministic PCB transport model for the Fox River between Lake Winnebago and the DePere Dam, Wisconsin Department of Natural Resources PUBL WR 389-95.

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.

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 objectives are to provide the requested assistance and broaden the knowledge 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 1995 to June 1996): Work was done at the following sites: Parsons Casket, Belvidere, Illinois; Better Brite, De Pere, Wisconsin, and near Waupun, Wisconsin. Work included packer-testing in selected test wells to collect water-level measurements, collection of water samples for analysis, and testing of formations to determine hydraulic conductivity at various depths. Nested piezometers were also installed in selected test wells to enable further collection of water samples as part of EPA efforts at these sites. A report titled, "Rock-stratigraphic nomenclature, lithology, and subcrop area of the Galena-Platteville bedrock unit in Illinois and Wisconsin", was approved.

PLANS (July 1997 to June 1998): Assistance will continue to be provided at sites in EPA Region V upon request.

REPORTS:

Sabin, T.J., Batten, W.G., and Dunning, C.P., Rock-stratigraphic nomenclature, lithology, and subcrop area of the Galena-Platteville Bedrock unit in Illinois and Wisconsin, U.S. Geological Survey Water-Resources Investigations Report 97-4054B (in press).

COOPERATOR:

U.S. Environmental Protection Agency, Office of Superfund

LOCATION:

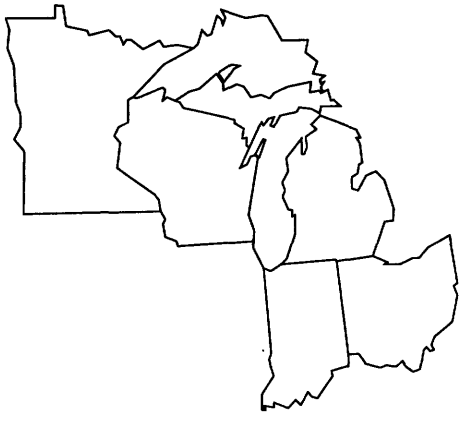
EPA-Region V (Wisconsin, Illinois, Michigan, Minnesota, Indiana and Ohio)

PROJECT CHIEF:

Ty Sabin

PERIOD OF PROJECT:

November 1988-Continuing



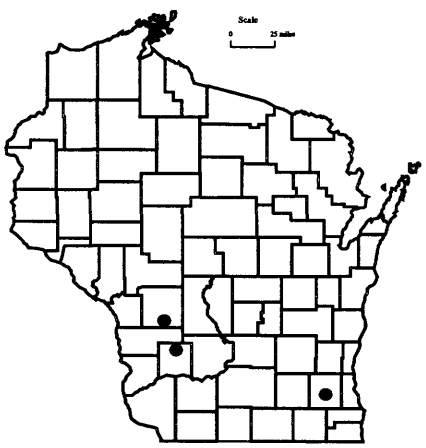
HYDROLOGIC INVESTIGATIONS OF WETLAND RESTORATION AND CREATION PROJECTS, WI 170

COOPERATOR:
Wisconsin Department of Transportation

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

PROJECT CHIEF:
Randy J. Hunt

PERIOD OF PROJECT:
November 1989 to September 1997



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 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 1996 to June 1997): Collection of environmental variables has continued at all three sites. Subsequent geochemical sampling and physical measurements support the initial evapotranspiration (ET) findings that there is a measurable difference in ET rate between the natural and constructed wetlands. This difference was not reflected in the traditional meteorological measurements of ET. Ground-water discharge was not important to the growing season's maximum or average root zone temperatures; however, it was important for the minimum root zone temperature and date of thaw. Finally, the geomorphologic setting can be used to explain the hydrology observed at the Driftless Area sites. This approach has implication for abiotic wetland classifications and has potential for Statewide application. Two journal articles describing the importance of hydrochemical heterogeneity and the use of stable isotopes to investigate wetlands have been approved for publication. In addition, a USGS Fact Sheet relating how the project's findings fit in the context of the national debate of wetland creation was published.

PLANS (July 1997 to June 1998): Low-level, baseline monitoring will continue. Results from this study will be published as two additional journal articles. One article will describe the evapotranspiration research; one article will demonstrate the importance of ground-water discharge to the natural and constructed wetlands.

REPORTS:
Hunt, R.J., Krabbenhoft, D.P., and Anderson, M.P., 1996, Ground-water inflow measurements in wetland systems, Water Resources Research 32(3), p. 495-507.

Hunt, R.J., 1996, Do created wetlands replace the wetlands that are destroyed?, USGS Fact Sheet 246-96, 4 pp.

TRENDS IN WATER QUALITY AND STREAM HABITAT FOR PRIORITY WATERSHEDS, WI 17202-17205, 17209-17210, 17213, 17221

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, relation 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 7 priority watersheds.

APPROACH: Ten streams were selected in seven 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. Land-use inventories will be taken each year to help determine the cause of any changes in water quality.

PROGRESS (July 1996 to June 1997): Streamflow and water-quality monitoring was continued at six sites in the priority watersheds. Dissolved oxygen was monitored at five sites in the priority watersheds. Data collection was suspended at four sites due to insufficient implementation of best management practices in these four watersheds. All data was summarized and will be published in the report "Water Resources Data–Wisconsin", water year 1996. Water-quality loads were calculated for selected parameters and storm periods for the six sites. Land-use inventories were completed for each basin. Streamflow and water-quality data collection was started at an urban reference site. Data from the urban reference site, which is a rural watershed with little agricultural activity in the basin, will be compared to the highly urbanized watersheds in the Milwaukee area.

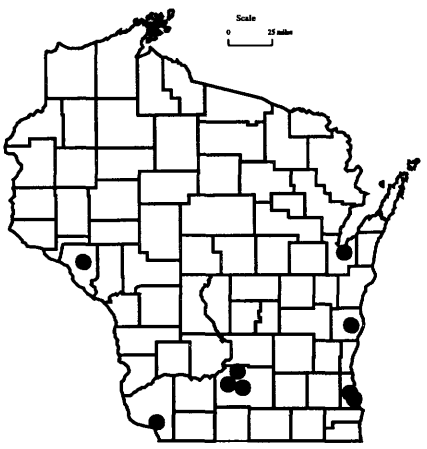
PLANS (July 1997 to June 1998): Streamflow, water-quality (for six sites), and dissolved-oxygen (for five sites) monitoring will be continued. Water-quality loads for selected parameters and storm periods will be calculated and compared to data collected in previous years. The data will be analyzed to determine if there are any apparent trends in water quality during implementation of the best management plans. Land-use inventories will be updated for each basin.

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
David W. Owens

PERIOD OF PROJECT:
October 1990 to September 1997



REPORTS:

Greb, Steven R., and Graczyk, David J., 1995, Frequency-duration analysis of dissolved-oxygen concentrations in two southwestern Wisconsin streams, Water Resources Bulletin (in press).

Walker, John F., and Graczyk, David J., 1993, Preliminary evaluation of effects of best management practices in the Black Earth Creek, Wisconsin, priority watershed: Water Science Technology, v. 28, no. 3-5, p. 539-548.

Bannerman, R.T., Owens, D.W., Dodds, R.B., and Hornewer, N.J., 1993, Sources of pollutants in Wisconsin stormwater: Water Science Technology, v. 28, no. 3-5, p. 241-259.

BEST MANAGEMENT PRACTICE EVALUATION, WI 17206

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 1996 to June 1997): Annual progress report describing data collected through water year 1996 was completed and published. Work began on progress report describing data collection through water year 1997. Oracle database design was completed and included all data through water year 1996. Access to database was provided over the world-wide-web through interactive, user-specified data queries. Urban regression analysis was completed and results published in the 1996 annual progress report. Preliminary statistical analysis for sites with transitional BMP-implementation data (Brewery, Garfoot, and Otter Creeks) was performed and published in 1996 annual progress report. Unit-area load analysis was completed.

PLANS (July 1997 to June 1998): Results from unit-area load analysis will be published in a fact sheet. Annual progress report describing data collected through water year 1997 will be completed and published; work on progress report describing data collection through water year 1998 will begin. Work incorporating snowmelt loads into regression analysis will be completed. All data through water year 1997 will be included in Oracle database.

REPORTS:

Walker, J.F., Corsi, S.R., Graczyk, D.J., and Wierl, J.A., 1997, Evaluation of nonpoint-source contamination, Wisconsin: selected data for water year 1996, U.S. Geological Survey Open-File Report (in press).

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION:

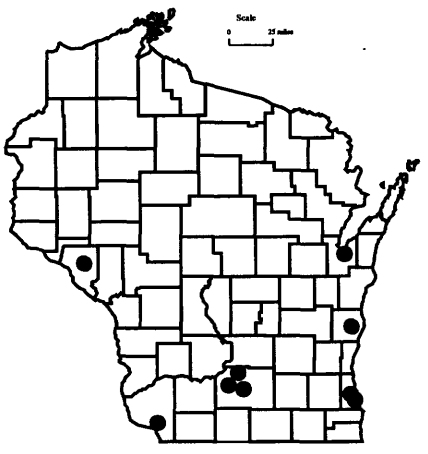
State of Wisconsin

PROJECT CHIEF:

John F. Walker

PERIOD OF PROJECT:

October 1989 to September 1997



Owens, D.W., Corsi, S.R., and Rappold, K.F., 1997, Evaluation of nonpoint-source contamination, Wisconsin: selected data for water year 1995, U.S. Geological Survey Open-File Report 96-661A.

Walker, J.F., Graczyk, D.J., Corsi, S.R., Owens, D.W., and Wierl, J.A., 1995, Evaluation of nonpoint-source contamination, Wisconsin: land-use and best management practices inventory, selected streamwater-quality data, urban-watershed quality assurance and quality control, constituent loads in rural streams, and snowmelt-runoff analysis, water year 1994: U.S. Geological Survey Open-File Report 95-320, 21 p.

Corsi, S.R., Walker, J.F., Graczyk, D.J., Greb, S.R., Owens, D.W., and Rappold, K.F., 1995, Evaluation of nonpoint-source contamination, Wisconsin: selected streamwater-quality data, land-use and best-management practices inventory, and quality assurance and quality control, water year 1993: U.S. Geological Survey Open-File Report 94-707, 57 p.

Walker, J.F., 1994, Statistical techniques for assessing water-quality effects of BMPs, ASCE J. of Irrigation and Drainage Engineering, v. 120, no. 2, p. 334-347.

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: U.S. Geological Survey Open-File Report 93-130, 16 p.

Graczyk, D.J., Walker, J.F., Greb, S.R., Corsi, S.R., Owens, D.W., 1993, Evaluation of nonpoint-source contamination, Wisconsin: Selected data for 1992 water year: U.S. Geological Survey Open-File Report 93-630, 48 p.

LAKE SUPERIOR URBAN STORM-WATER DEMONSTRATION PROJECT, WI 17212

PROBLEM: The Lake Superior Binational Program requires an understanding of the sources and amount of urban storm-water pollution in the Lake Superior Basin.

OBJECTIVE: The objective is to provide water-quality data necessary to construct storm-water management plans as required under the Binational Program. In addition to discharge, these data will include nutrients, metals, polycyclic-aromatic hydrocarbons (PAH's) and eight organic bioaccumulative substances identified by the Binational Program.

APPROACH: One storm sewer in each of two cities (Marquette, Michigan and Superior, Wisconsin) will be intensively monitored (15 events) for precipitation, runoff flow and constituent concentrations. Within the Marquette basin, runoff from nine discrete source areas (streets, parking lots, roof tops, driveways and lawns) will be sampled. These data will be used to calibrate an urban model for the Marquette flume site.

One storm sewer in each of eight smaller municipalities will be monitored over four events for constituent concentrations. Constituent concentrations will be monitored (6 events) at two bulk storage piles in the Duluth/Superior area.

In Duluth, Minnesota, and Superior, Wisconsin, water-quality sites will be installed at an urban undeveloped space, recreational park, golf course, and three gas stations. The concentration and discharge data collected at these sites will be used to further refine the source-area loading model (SLAMM).

PROGRESS (July 1996 to June 1997): Data collection from storm sewers in Marquette, Michigan, Superior, Wisconsin, and the eight smaller municipalities has been completed and the 2,887 samples analyzed. At Superior, Wisconsin, runoff from the Tower Avenue basin (22 acres), as measured during 91 events, was generally 50 percent. At Marquette, Michigan, runoff from the Tower Avenue basin (288 acres), as measured during 65 events, was generally 15 percent. At Marquette and Superior, event loadings for nutrients, metals, and polycyclic-aromatic hydrocarbons (PAH's) have been calculated based upon flume-measured discharge and flow-weighted composite sampling.

Within the Marquette basin, data collection from 8 source areas has been completed, resulting in 3,186 samples being analyzed. Initial assessment of these source-area data indicate that parking lots generate high concentrations of PAH's. Based upon the 1995 monitoring in Superior, the commercial site (Tower Avenue) generated total phosphorus loads (5-30 gm/acre-event), two times greater than the golf course and 40 times greater than the undeveloped site. The golf course and undeveloped sites were removed in September 1996.

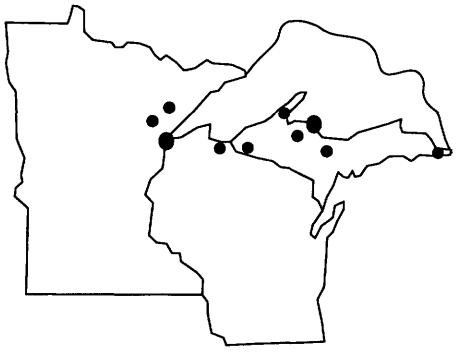
PLANS (July 1997 to June 1998): 1996 data for undeveloped and golf course sites will be published in the annual progress report. Source-area journal article will be completed.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Eleven cities in Lake Superior Basin (Minnesota, Wisconsin, Michigan)

PROJECT CHIEF:
Jeffrey J. Steuer

PERIOD OF PROJECT:
April 1993 to December 1997



REPORTS:

Steuer, J.J., Selbig, W.R., and Hornewer, N.J., 1996, Contaminant concentrations in stormwater from Eight Lake Superior basin cities, U.S. Geological Survey Open-File Report 96-122.

Steuer, J., and others, Sources of pollution in an urban basin located in Marquette, Michigan: an examination of concentrations, loads, and data quality (in process).

SINGLE SOURCE SITES, WI 17214

PROBLEM: Much work has been done to assess the effectiveness of nonpoint-source pollution-control strategies known as best management practices (BMP's). Most of this work to date has had a basin-wide scope and is focused on evaluating the cumulative effectiveness of several different types of BMP's. Research targeted at evaluating the effectiveness of a single type of BMP would assist resource managers responsible for planning BMP implementation programs.

OBJECTIVE: The objective is to determine the significance of a single nonpoint-pollution source and evaluate the effectiveness of BMP's in treating that same source.

APPROACH: Continuously monitor and/or sample streamwater upstream and downstream from a single nonpoint-pollution source before and after implementation of BMP's. Currently, two barnyard-runoff sites are being investigated: Otter Creek in the Sheboygan River Priority Watershed and Halfway Prairie Creek in the Black Earth Creek Priority Watershed. At each site, water-quality samples are collected biweekly and during periods of storm runoff, and stream discharge is monitored continuously.

PROGRESS (July 1996 to June 1997): Samples were collected for 12 runoff periods at Otter Creek and 11 runoff periods at Halfway Prairie Creek before BMP implementation. Since BMP implementation, samples have been collected for seven runoff periods at Otter Creek and eight runoff periods at Halfway Prairie Creek.

Before BMP implementation, downstream loadings of suspended solids, total phosphorus, ammonia nitrogen and biochemical oxygen demand (BOD) exceeded upstream loadings for each barnyard. The barnyard at Otter Creek contributed approximately 55, 40, 30 and 40 percent of the total stream load of suspended solids, total phosphorus, ammonia nitrogen and BOD for the runoff periods monitored; the barnyard at Halfway Prairie Creek contributed approximately 1, 35, 35 and 60 percent, respectively. Assuming that pollutants contributed from upstream sources were not greatly reduced by in-stream transport phenomenon, such as deposition, these barnyards were a significant source of total phosphorus, ammonia nitrogen and BOD within each watershed for the runoff periods monitored. Some seasonality effects were apparent for Otter Creek where, in general, the percent loading attributed to the barnyard was less during spring runoff events. In general, input from the barnyard was also less important during larger runoff events. Data supporting these observations were inconclusive for Halfway Prairie Creek.

Since implementation of barnyard BMP's, data have shown significant reductions in loadings coming from each barnyard. Loadings from Otter Creek have decreased by approximately 85, 95, 90 and 95 percent for suspended solids, total phosphorus, ammonia nitrogen and BOD; loadings at Halfway Prairie Creek have been reduced by 100, 90, 95 and 90 percent, respectively.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
State of Wisconsin

PROJECT CHIEF:
Todd D. Stuntebeck

PERIOD OF PROJECT:
March 1994-Continuing

PLANS (July 1997 to June 1998): Monitoring streamflow and collection of water-quality data in the post-BMP period at Otter Creek and Halfway Prairie Creek will be continued. Biweekly baseflow samples and samples for five more runoff periods at Otter Creek and Halfway Prairie Creek will be collected. Loads and event-mean concentrations for each constituent will be calculated and statistical analyses to determine the effectiveness of each BMP will be performed. A fact sheet and draft article for publication in journal will be prepared. Results will be presented at various conferences and meetings.

REPORTS:

Stuntebeck, T.D., 1995, Evaluating barnyard best management practices in Wisconsin using upstream-downstream monitoring: U.S. Geological Survey Fact Sheet 221-95, 4 p.

TRIBUTARY PHOSPHORUS LOADING TO LAKE MENDOTA AND EVALUATION OF LOAD DETERMINATION METHODS, WI 17217

PROBLEM: Traditionally, monitoring of streamflow and phosphorus loading is done upstream from the lake (sometimes several miles) where the hydraulic gradient is sufficiently steep to employ conventional stream-gaging techniques. These monitoring sites, equipped with automatic samplers, provide data for accurate load determination, but at considerable cost. Usually, the load at the stream's mouth is assumed to be the same as at the monitoring site or adjusted by the ratio of the watershed areas of the two sites. The validity of this assumption is open to question because it is unknown whether the stream reach and watershed between the upstream monitoring site and the lake is a source or a sink for phosphorus. Various data-collection and analysis techniques must be tested to determine the most cost-effective methods for estimating loading at mouths of tributaries to lakes. These methods would then be employed in long-term monitoring on tributaries to selected lakes in priority-watershed projects.

OBJECTIVE: The objectives are to (1) determine the most cost-effective method for estimating total-phosphorus loading at mouths of streams flowing into lakes and (2) determine the annual total-phosphorus loading to Lake Mendota.

APPROACH: Four major tributaries (Yahara River, Pheasant Branch Creek, Sixmile Creek, and Spring Creek) to Lake Mendota will be monitored. These tributaries account for 214 of the 233 square-mile-drainage basin of Lake Mendota. The lower reaches of all these tributaries are low gradient and flow through adjacent wetlands to Lake Mendota. Two of these tributaries, the Yahara River and Pheasant Branch, have continuous-discharge-gaging stations and automatic water-quality samplers upstream of reaches with adjacent wetlands. Water sampling for analysis of total-phosphorus concentration and determination of stream discharge will be done at or very near the mouths of these streams. Annual loads at the four major tributaries will be estimated. The annual loads will be estimated first by using the complete data set of all concentration data. Subsets of the complete data set will be used to estimate annual loads. The annual loads estimated using the subsets will be compared to the annual loads estimated using the complete data sets in order to determine the minimum sampling intensity that still yields sufficiently accurate load estimates. Pollutant loadings to Lake Mendota will be estimated by summing the loads from the four major tributaries and other sources to Lake Mendota. The other sources include loading from storm sewers, other smaller tributaries, ground-water inflow and direct precipitation to the lake. The loads from these sources will be provided by other agencies, programs and from literature reviews.

PROGRESS (July 1996 to June 1997): A Water-Resources Investigations Report (WRIR) was written and reviewed. The WRIR summarizes all data collected and the various data-collection and analyses techniques used to determine the most cost-effective methods for estimating loads at mouths of tributaries to lakes.

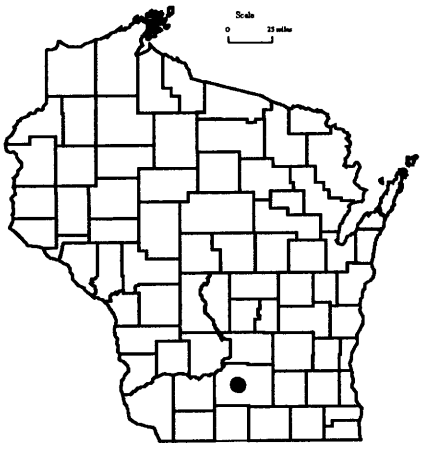
PLANS (July 1997 to September 1997): The WRIR will be printed and distributed.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Lake Mendota, Madison, Wisconsin

PROJECT CHIEF:
David J. Graczyk

PERIOD OF PROJECT:
October 1994 to June 1996



WISCONSIN LAKES, GREEN LAKE TRIBUTARY MONITORING
WI 17303

COOPERATOR:
Green Lake Sanitary District

LOCATION:
Green Lake County,
south-central Wisconsin

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
October 1977-Continuing

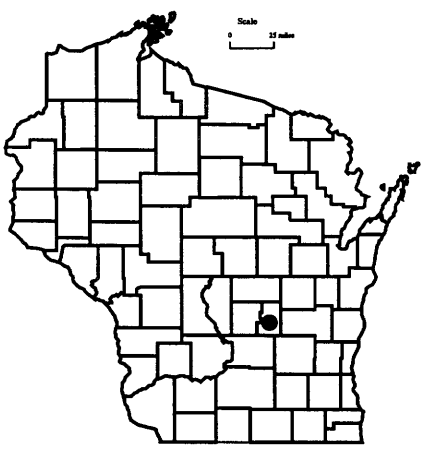
PROBLEM: Silver Creek is the primary source of phosphorus to Green Lake. Continued documentation of these loads from major tributaries helps to explain the lake's water quality. Data are needed to determine changes in loads over time and loading variability in relation to streamflow.

OBJECTIVE: The objectives of this project are to determine suspended sediment and phosphorus loads in relation to streamflow in selected tributaries to Green Lake where significant nonpoint-source pollution exists.

APPROACH: Streamflow will be monitored continuously at selected sites. Water-sediment samples will be collected manually 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 1996 to June 1997): Streamflow and water quality were monitored at two automated sites at Silver Creek near Ripon and Green Lake inlet near Green Lake through September 1996. The Ripon site has an automatic water sampler and the inlet site is equipped with an AVM for velocity measurements. The monitoring program was expanded significantly in October 1996. An automatic water sampler to collect water-quality samples was installed at Green Lake inlet gaging station to improve the definition of phosphorus and sediment loads coming into Green Lake. The gaging station and sampler at Silver Creek near Ripon was discontinued and moved in October 1996 to the old site at the mouth of White Creek. A new recording streamflow-gaging station on the Puchyan River below the dam at the outlet of Green Lake was also installed in October and will be operated in future years. Total phosphorus and suspended sediment loads were computed for the water year. Streamflow, load, and concentration data were published in the annual data report "Water Resources Data–Wisconsin, Water Year 1996".

PLANS (July 1997 to June 1998): Streamflow and water-quality monitoring at two inlet stations and monitoring of discharge at the outflow station will be continued. Final discharge records will be prepared and total phosphorus and suspended-sediment loads computed for the two inlet sites. All data will be published in the annual report, "Water Resources Data–Wisconsin".



ASSESSMENT OF HYDROLOGY, NUTRIENT LOADING, AND TROPHIC STATUS OF KIRBY LAKE NEAR CUMBERLAND, WI 17312

PROBLEM: A resource inventory of Kirby Lake that was done in 1993-94 suggested that a better understanding of several aspects of the lake and its surroundings was needed for preparation of a comprehensive lake management plan. Among these were (1) better definition of the lake's water budget, (2) definition of the relation between the lake and ground water, (3) identification of principal nutrient loading sources, and (4) an evaluation of the lake's sensitivity (water-quality response) to incremental increases or decreases in phosphorus loading.

OBJECTIVE: The primary objectives of the study are to (1) determine the lake's water budget, (2) define ground-water flow paths in the vicinity of the lake, (3) identify and quantify principal nutrient loading sources, and (4) evaluate lake water quality in relation to external nutrient loading and the aeration system.

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, determine major phosphorus sources and estimate the annual phosphorus loading to the lake, and describe the lake's trophic status and seasonal changes in water quality. Water samples for phosphorus analysis will be collected from about a dozen intermittently flowing, small tributaries to the lake (there are no perennially flowing streams). About 10 piezometers will be installed around the lake and measured quarterly to obtain data to define the exchange of water between the lake and the aquifer. Vertical profiles of temperature and dissolved oxygen will be measured through the winter at six locations in the lake to assess oxygen conditions and the effectiveness of the aeration system.

PROGRESS (July 1996 to June 1997): The data-collection phase of the study was completed in October 1996. Data from the piezometer network and domestic wells indicate that the lake is "perched" above the regional water table. Hence, there is virtually no ground water discharging to the lake. Dissolved-oxygen concentrations were quite low in late winter—concentrations ranged from 0-3.4 mg/L in mid March.

PLANS (July 1997 to June 1998): Data analysis will be completed and a final report prepared, printed, and distributed.

REPORTS:

Rose, W.J., and Robertson, D.M., 1997, Hydrology and water-quality of Kirby Lake near Cumberland, Barron County, Wisconsin: U.S. Geological Survey Open-File report (in preparation).

COOPERATOR:

Kirby Lake Management District

LOCATION:

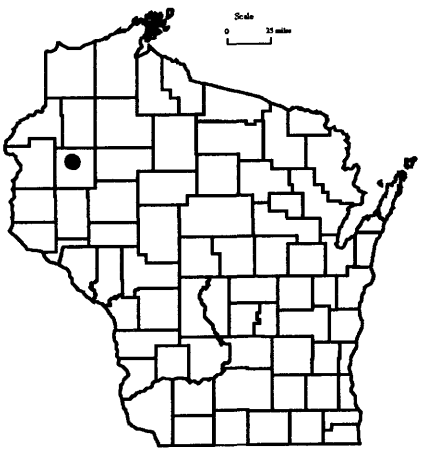
Five miles northwest of Cumberland, Wisconsin

PROJECT CHIEF:

William J. Rose

PERIOD OF PROJECT:

November 1995 to September 1997



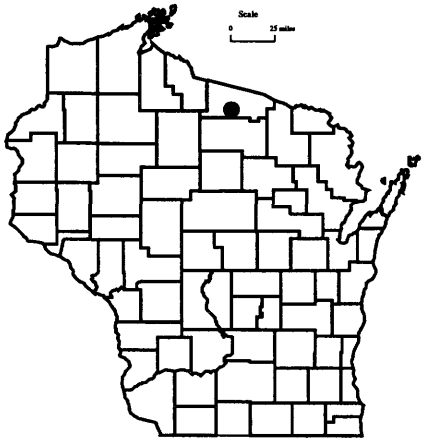
ASSESSMENT OF PHOSPHORUS LOADING, WINTER ANOXIA, AND STAGE REGULATION OF LITTLE ST. GERMAIN LAKE, VILAS COUNTY, WI 17313

COOPERATOR:
Little St. Germain Lake District

LOCATION:
10 miles west of Eagle River, Wisconsin

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
August 1996 to September 1998



PROBLEM: Little St. Germain Lake consists of three main basins (Northeast Bay, South Bay, and West Bay) separated by narrows. Muskellunge Creek, the lake's only inlet stream, enters Northeast Bay. A dam at the lake's outlet is used to regulate the lake's stage and flow from South Bay. Hence, the net flow of water is from Northeast Bay to South Bay. Summer water quality ranges from good to very good in the West Bay, fair to good in the South Bay, and very good in the West Bay, based on monitoring from 1992-94. Dissolved oxygen was absent at the South Bay monitoring site in lake winter each year from 1992-94. The areal extent and cause of the oxygen problem is not known. There is concern that the annual range of stage regulation (about 1.5 feet) has an adverse effect on lake water quality and possibly introduces nutrient to the West Bay.

OBJECTIVE: The primary objectives of the study are to (1) estimate the annual total-phosphorus loading from Muskellunge Creek and adjacent watershed area; (2) determine the extent of the dissolved-oxygen problem in South Bay; (3) estimate the extent of shore area dewatered and rewatered by the annual stage fluctuation cycle, and relate to macrophyte density and phosphorus concentration in sediment; and (4) estimate annual total-phosphorus loading to West Bay caused by current lake stage regulation policy.

APPROACH: Flow in Muskellunge Creek will be measured and sampled intermittently (about monthly). Samples will be analyzed for concentration of total phosphorus. The data will be used to calculate the water and phosphorus loading to Northeast Bay. Extent of anoxia in the South and Northeast Bays will be determined by measuring dissolved-oxygen profiles at monthly intervals throughout the ice period. The extent of shore area dewatered by current stage-regulation policy will be determined by detailed definition of near-shore, shallow (<3 feet) bathymetry by measuring about 50 transects transverse to the shoreline in the South and Northeast Bays. The amount of water moving from Northeast Bay into West Bay, during the stage recovery period following the winter drawdown, will be calculated, and used, along with phosphorus concentration data, to estimate phosphorus loading to the West Bay.

PROGRESS (July 1996 to June 1997): Lake sampling began in August; temperature and dissolved-oxygen profiles were measured monthly throughout the ice-covered period. Muskellunge Creek flow was measured and sampled for phosphorus analyses beginning in September at monthly intervals. Near-shore bathymetry was determined by measuring depth at 56 equally-spaced transects around the Northeast and South Bays.

PLANS (July 1997 to June 1998): Data collection will be completed in September. Data will be compiled and transmitted to the lake district.

ASSESSMENT OF THE WATER QUALITY, HYDROLOGY, AND BIOLOGY OF GENEVA LAKE, WI 17314

PROBLEM: Because of increased urban development and recreational use, concerns have arisen over the potential decline in the water quality of Geneva Lake. The public perception is that the water quality of Geneva Lake is declining; however, little direct evidence is available to support or deny the perceptions. To reduce the impact on the lake, efforts are being made to decrease the point and nonpoint-source pollution to the lake. However, more water-quality and biological information are needed to determine which pollution prevention strategies will be most cost effective.

OBJECTIVE: The objectives of this project are to (1) document the water-quality and planktonic populations in the lake, (2) estimate phosphorus and sediment loading to the lake, (3) determine the historical water quality of the lake by examining the lake's sediments, and (4) construct hydrologic and phosphorus budgets for the lake.

APPROACH: Phosphorus and streamflow will be monitored at two locations upstream of Geneva Lake and at the outlet from which loads of phosphorus to and from the lake will be estimated. Nutrient concentrations, dissolved oxygen, water temperature, pH, specific conductance, and phytoplankton and zooplankton populations will be monitored monthly at five locations within the lake during the first year of the study. Sampling locations and frequency will be modified in future years of the study. Nutrient and phosphorus budgets will be constructed for the lake using a dynamic simulation model. Sediment cores will be collected and analyzed to estimate sedimentation rates and the historical water quality of the lake.

PROGRESS (July 1996 to June 1997): Sampling sites were chosen for lake and stream sampling. Lake sampling began shortly after ice out in 1997. Sediment cores were collected.

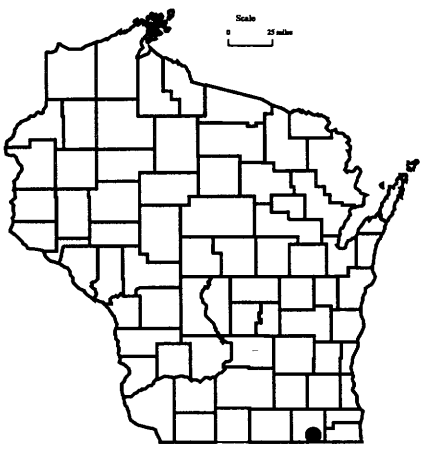
PLANS (July 1997 to June 1998): Lake sampling will continue throughout this period at five locations. After ice-out in 1998, lake sampling will be done at three locations on a biweekly sampling interval. Stream sampling sites will be installed in late summer of 1997. Streamflow and phosphorus samples will be collected monthly and during high flow events at the two inflow sites and approximately bimonthly at the outlet. Preliminary water and phosphorus budgets will be constructed. Sediment data will be analyzed.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Walworth County, southeast Wisconsin

PROJECT CHIEF:
Dale M. Robertson
William J. Rose
Sharon A. Fitzgerald

PERIOD OF PROJECT:
March 1997 to September 2000



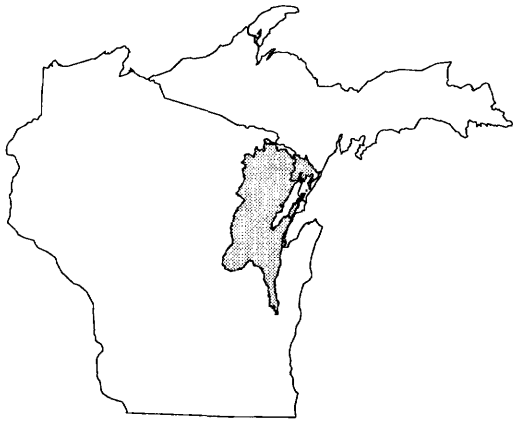
WESTERN LAKE MICHIGAN DRAINAGES NATIONAL WATER-QUALITY ASSESSMENT (NAWQA), WI 174

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:
Charles A. Peters

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 ground and surface 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 relatively homogeneous areas of specific land-use and environmental characteristics. Identification of these areas is accomplished by overlaying digital coverages of land use and various environmental variables using a geographical information system. Sampling sites completely contained in these relatively homogeneous areas (indicator sites) will be incorporated into a nested design of surface-water, streambed sediment, and biological sampling. The sampling strategy consists of a retrospective analysis of available water-quality data, followed by a high and then a low-phase data-collection effort. Monitoring of basic fixed sites (BFS) in selected areas (indicator sites), as well as downstream sites draining heterogeneous land uses and environmental characteristics (integrator sites), will be conducted. These sites will be sampled monthly and augmented with event-related samples. A subset of these sites will be extensively sampled for pesticides. Pesticide samples will be collected approximately weekly during the early to mid-summer period and less frequently during the rest of the year. Synoptic studies will be conducted during high- and low-flow conditions (spring and summer of 1994) to better delineate the sources of nutrients throughout the basins and describe the seasonal variability of these sources. Other program components include an ecological survey (spring 1993) at 20 sites to evaluate the relationship between community (fish and invertebrates), habitat structure, land-use practices, and environmental factors. Ground-water studies include a study-unit survey, a flow-path study and two land-use studies. The flow-path study will examine transformations in various constituents through

time and space. Surface-water/ground-water interactions will be examined using shallow wells and lysimeters installed adjacent to the nearby stream. Effects of land use on ground-water quality will be assessed through sampling in specific relatively homogeneous areas (1994 and 1995). A study unit survey will provide an indication of water-quality conditions of the major aquifer in the study unit.

PROGRESS (July 1996 to June 1997): Three low-intensity phase (LIP) basic fixed sites (BFS) were sampled monthly for discharge, field parameters, nutrients, major ions, total and dissolved organic carbon, and suspended sediment. Dissolved gas samples were collected from several flow-path wells.

Geographic information system (GIS) database development continued. The site location coverages were updated to include all new RHU synoptic sites and new ground-water study-unit survey and flow-path sites. The drainage-basin coverages were completed for all surface-water sites. A land-cover layer was completed for all the surface-water synoptic basins. Soils coverage (STATSGO) database was compiled for the WMIC study area. Data archiving, for data collected during the high-intensity phase, has continued. The study unit's world-wide-web page has been updated and maintained.

Data from the high-intensity phase was analyzed and the results of analyses compiled in reports.

During the FY, the biology retrospective (WRIR), nutrients in surface-water retrospective (FS), and the ground-water pesticide retrospective (FS) were published. Fact Sheets on loads in the Western Lake Michigan Drainages and on biological ITFM studies were published. Water Resources Investigations on Benchmark Streams:Invertebrates, Benchmark Streams:Fish, GIS, QAQC, Basic Fixed Sites: Water Quality, Basic Fixed Sites:Habitat, Ground-water Study Unit, and Ground-water Land Use were published. Two newsletters were published and distributed. Two abstracts, a proceedings paper, and a journal article were also prepared. All reports are available on the world-wide-web home page upon publication.

PLANS (July 1997 to June 1998): Three low-intensity phase (LIP) basic fixed sites (BFS) will be sampled monthly for discharge, field parameters, nutrients, major ions, total and dissolved organic carbon, and suspended sediment. The three BFS will have ecological assessments for fish, algae and invertebrate population and habitat conducted. Bed sediment and tissue samples will be collected for trace element and organic analyses.

The GIS coverages will continue to be compiled, including: labeling the clustered Landsat data, wetlands data from the WISCland inventory, Natural Resource Inventory, Toxic Release Inventory, etc. Data and information collected during the first high-intensity phase (HIP) will continue to be compiled, maintained and archived. The world-wide-web home page development and maintenance will continue.

Data from the high-intensity phase will be analyzed and the results of analyses compiled in reports. Six water-resources investigations reports, three journal articles, three fact sheets, a newsletter, and a circular will be completed for distribution.

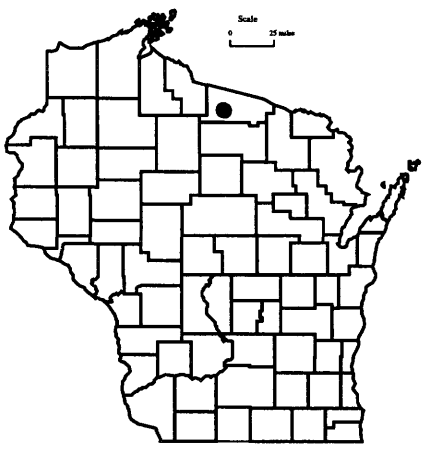
HYDROLOGIC AND BIOGEOCHEMICAL BUDGETS IN TEMPERATE LAKES AND THEIR WATERSHEDS, NORTHERN WISCONSIN, WI 175

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

LOCATION:
North-central Wisconsin

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

PERIOD OF PROJECT:
October 1990-Continuing



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: Objectives are to (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 hydrologic, biologic, 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.

PROGRESS (July 1996 to June 1997): Data collection and analysis proceeded at the three intensive monitoring sites on Allequash Creek. Additional wells were installed to better define the major ground-water flowpath from Big Muskellunge Lake to Allequash Creek. Analysis of stable isotope composition have been used to distinguish between sources of water in the stream. Water from precipitation that percolates through nearby hillslopes has isotopic signatures different from water that travels through relatively long flowpaths, often from lakes several kilometers distant from the stream. The data show an overall picture of the Allequash Creek flow system as a progression from a pure ground-water source at the headwaters to a mixture of relatively deep ground water, relatively shallow ground water, and evaporative (surface) water. Examination of strontium isotope ratios ($87_{Sr}/86_{Sr}$) provides further detail of the flow system on a smaller spatial scale, and indicates that the "shallow" flowpaths are still quite distant from the stream and do not predominantly originate as recharge on the adjacent hillslopes.

Sampling of Trout Lake tributaries continued with a frequency of five times per year through water year 1997. Analytical data from these samples indicate some seasonal differences in nutrient and carbon loads, with higher loads generally characterizing the late summer and fall seasons. The seasonal variation is probably associated with nutrient cycling mediated by biological growth and decomposition in the basin and wetland.

The nature of the carbon pools and transport pathways is the subject of much of the current research effort. The Allequash wetland contains large expanses of peat, upwards of 6 meters in depth, representing an extremely large carbon reservoir. The significance of this carbon pool as a factor in the overall carbon cycle is being examined by data collected from a transect of wetland wells, vegetation surveys, and determinations of areal extent and thickness of peat deposits. Other procedures to provide more information about carbon pools and fluxes in the system were continued and expanded, including measurement of greenhouse gases (carbon dioxide and methane) in ground water and stream samples, collection of leaf-litter samples in different forest types, and increased sampling and characterization of dissolved organic carbon.

The new database management system continues to provide improved organization and access to all data collected as part of the project. A world-wide-web home page was established to provide public access to project information and data.

PLANS (July 1997 to June 1998): Data collection at hillslope monitoring sites will continue. Intensity of sampling will decrease and more effort will be directed toward analyses, interpretation, and write-up of existing data. Stream- and ground-water monitoring will continue for further examination of seasonal and spatial variability. Measurements of gas-phase and aquatic-phase transport of carbon through the system will continue. Additional field work will continue to emphasize investigation of the carbon budget.

REPORTS:

Bullen, Thomas D., Krabbenhoft, D.P., and Kendall, Carol, 1996, Kinetic and mineralogic controls on the evolution of groundwater chemistry and $87_{Sr}/86_{Sr}$ in a sandy silicate aquifer, northern Wisconsin, U.S.A., Geochimica et Cosmochimica Acta, v. 60, no. 10, p. 1807-1821.

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.

Walker, J.F., and Krabbenhoft, D.P., Ground-water and surface-water interactions in riparian and lake-dominated systems (book chapter, "Isotope Tracers in Catchment Hydrology", edited by J.J. McDonnell and C. Kendall, Elsevier Publishers) (in press).

Elder, John F., Carter, Virginia, and Rybicki, N.B., Dissolved carbon mobilization in peatland/stream systems in northern Wisconsin (U.S.A.), Proceedings of Intecol V Wetland Symposium (in press).

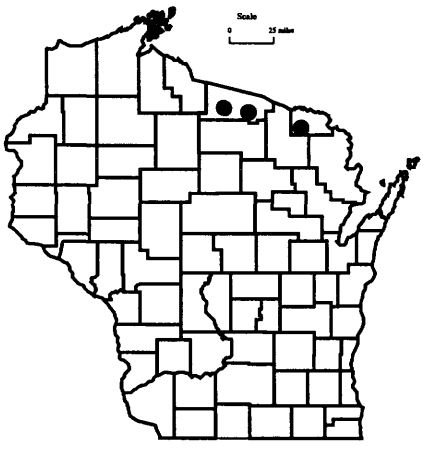
MERCURY CYCLING IN LAKES, WI 18001

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 1996



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 μeq/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 μeq/L.

OBJECTIVE: Objectives are to 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, and 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 flow paths 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 1996 to June 1997): Most monitoring emphasis was at Max Lake; lake stage and a single recorder-equipped well were monitored at Morgan Lake; and lake stage, precipitation, and the ground-water-well network were monitored at Vandercook Lake. Monitoring at Max Lake was discontinued November 22, 1996.

Ground water was pumped into Max Lake to raise and maintain its pH to 7.0. Ground water was pumped from May 16 to November 16 at a 20 gallons-per-minute pumping rate.

PLANS (July 1997 to June 1998): Routine data collection will continue at Vandercook and Morgan Lakes. Instrumentation will be removed from Max Lake.

REPORTS:

Webster, Katherine E., Kratz, Timothy K., Bowser, Carl J., Magnuson, John J., and Rose, William J., The influence of landscape position on lake chemical responses to drought in northern Wisconsin, USA: Limnology and Oceanography, v. 41, no. 5, p. 977-984.

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 goals of this project are 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 1996 to September 1996): Routine hydrologic monitoring continued through September 30, 1996. Data were published in the Wisconsin District's annual lake data report. The project is completed.

PLANS: Instrumentation will be removed.

REPORTS:

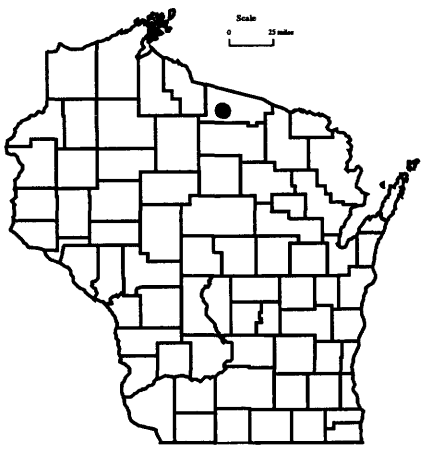
Rose, William J., 1993, Hydrology of Little Rock Lake in Vilas County, north-central Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 93-4139, 22 p.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Vilas County, northern Wisconsin

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
March 1987 to September 1997



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

COOPERATOR:
Town of Delavan

LOCATION:
Walworth County, southeast Wisconsin

PROJECT CHIEF:
Gerald L. Goddard
Dale M. Robertson

PERIOD OF PROJECT:
August 1983-Continuing

PROBLEM: Eutrophication of Delavan Lake has accelerated since the 1940s, resulting in it becoming hypereutrophic with extensive blue-green algae blooms. Extensive rehabilitation efforts were implemented in 1990-92 to improve the lake's water quality. Monitoring of the lake and nutrient and sediment loads to the lake is continuing to determine the effectiveness of the rehabilitation effort.

OBJECTIVE: The objectives are to quantify the effectiveness of each of the rehabilitation components by measuring streamflow and nutrient and suspended sediment loads at Jackson Creek tributary near Elkhorn, Jackson Creek at Mound Rd. (wetland outlet) and Highway 50 and at the lake's outlet; measuring water quality, and phytoplankton and zooplankton populations (during summer) in the lake; and determining the trapping efficiency of wetland for phosphorus and suspended sediment.

APPROACH: Nutrients, suspended sediments, and streamflow are monitored at Jackson Creek tributary, Jackson Creek wetland outlet, Highway 50, and the outlet. Phosphorus concentrations, dissolved oxygen, water temperature, pH, specific conductance, and planktonic populations are monitored within the lake. The effectiveness of the wetland is estimated by comparing the load of phosphorus and suspended sediment entering and leaving the wetland.

PROGRESS (July 1996 to June 1997): Streamflow was monitored continuously at three inflow sites and at one outflow site. Water samples were collected monthly at all stream sites. During storm runoff, samples were collected by an automatic sampler or an observer. Water samples were analyzed for nutrients and suspended sediment. The water quality at the center of the lake was monitored. The 1996 water-year data was compiled for publication in the report, "Water Resources Data–Wisconsin". Reports describing the phosphorus dynamics in Delavan Lake inlet and the trapping efficiency of Jackson Creek wetland were published. Summer phosphorus concentrations in the lake in 1995-1996 were similar to those prior to rehabilitation which was completed in 1993. However, summer water clarity was greater and chlorophyll *a* concentrations were less than prior to lake rehabilitation.

PLANS (July 1997 to June 1998): Monitoring program will be continued as scheduled. Data will be compiled for publication. Two reports describing the effectiveness of the Jackson Creek wetland and wetlands in general at reducing total-phosphorus and suspended-sediment loads will be published.

REPORTS:

Elder, J.F. and Goddard, G.L., 1996, Sediment and nutrient trapping efficiency of a constructed wetland near Delavan Lake, Wisconsin, 1993-1995: U.S. Geological Survey Fact Sheet 232-96.

Robertson, D.M., Field, S.J, Elder, J.F., Goddard, G.L., and James, W.F., 1996, Phosphorus dynamics of Delavan Lake inlet in southeastern Wisconsin. U.S. Geological Survey Water-Resources Investigations Report 96-4160, 18 p.

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.

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 for 11 Lake Michigan tributaries in the states of Wisconsin, Michigan, and Indiana to act as a baseline for evaluation of future remediation activities; estimate loads of PCB's, transnonachlor, atrazine, trace metals, nutrients, and suspended solids 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: The Wisconsin District will install acoustic-velocity-metering (AVM) stations at the mouths of the four Wisconsin tributaries, including the Milwaukee, Sheboygan, Fox, and Menominee Rivers to provide real-time flow and water-quality data. Field sampling will be scheduled to obtain approximately 75 percent of the samples during non-baseflow periods. Composited samples for analyses of congener-specific PCB's and pesticides will be field filtered and processed through XAD-2 resin columns. Composited samples for analyses of particulate and dissolved trace metals will be obtained using clean sampling protocols. Data will be entered into the WATSTORE and ADAPS data bases.

PROGRESS (July 1996 to June 1997): Sample collection was completed for all of the 11 stations in October 1995. A total of 401 samples was collected from the 11 tributaries to Lake Michigan for analysis of congener-specific PCB's, 14 pesticides and pesticide degradation products, trace metals, nutrients, and major ions. Mean daily discharges measured at the eight acoustic-velocity meter equipped sites and three standard stage-discharge equipped sites have been computed. Preliminary, and when possible, final data analyses are in progress. A journal article discussing preliminary PCB results from the first samples analyzed by the Wisconsin State Lab of Hygiene is in draft form. An Open-File USGS report of cross-sectional field data collected from six stations across each tributary, including dissolved oxygen, conductance, temperature and pH data, is also in draft form.

PLANS (July 1997 to June 1998): After organics data have undergone Environmental Protection Agency (EPA) QA/QC checks, journal articles will be written to present project results, including discussions of factors affecting contaminant concentrations and quantification of contaminant loads. Project data will be formatted and electronically transmitted for storage in the EPA ORACLE database, prior to EPA use of the data in the Lake Michigan Mass Balance Model. The project will be extended through 1998 to allow additional time for lab work, database construction, and estimation of tributary contaminant loads.

COOPERATORS:
Environmental Protection Agency
Wisconsin Department of Natural Resources

LOCATION:
Cities of Marinette, Green Bay, Milwaukee and Sheboygan

PROJECT CHIEF:
David W. Hall

PERIOD OF PROJECT:
July 1992 to September 1997

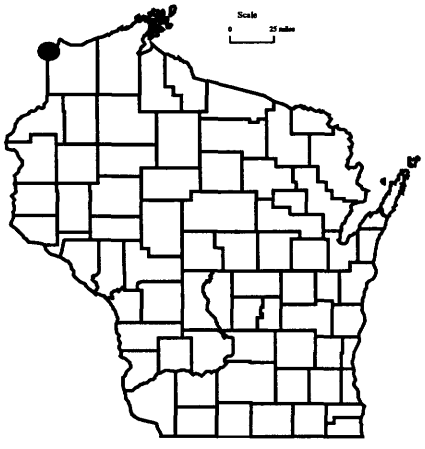
LAKE SUPERIOR TRIBUTARY LOADING, WI 18302

COOPERATORS:
U.S. Environmental Protection Agency
Wisconsin Department of Natural Resources
Minnesota Pollution Control Agency

LOCATION:
Cities of Duluth, Minnesota and Superior, Wisconsin

PROJECT CHIEF:
Peter E. Hughes

PERIOD OF PROJECT:
July 1993 to September 1997



PROBLEM: Concern about the potential negative health and biologic effects of toxic chemicals and heavy metals being transported into Lake Superior 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 for two Lake Superior tributaries to act as a baseline for evaluation of future remediation activities, estimate loads of targeted contaminants to Lake Superior, compare loads between tributaries to target basins of major concern, identify contaminants of greatest concern, and describe the mobility of contaminants.

APPROACH: The Wisconsin and Minnesota Districts will install acoustic-velocity-metering (AVM) stations at the two St. Louis River harbor exits to Lake Superior and instrument the Nemadji River for water-quality sampling. The AVM sites will be calibrated using Doppler discharge measurements. Infiltrex automated organic samplers will be installed to obtain flow-composited samples for organic analyses. Data will be entered into the WATSTORE and ADAPS data bases.

PROGRESS (July 1996 to June 1997): Gaging station operations were continued for the year. Several PCB samples were taken during this period using the Infiltrex samplers controlled by the flow-proportional sampling program. AVM data from the sites were calibrated with Doppler measurements to estimate discharge. Discharge data for Duluth and Superior AVM sites and the Nemadji River were published in the report, "Water Resources Data–Wisconsin", water year 1996.

PLANS (July 1997 to June 1998): The gaging stations will be operated through September 1997. Operation beyond September 1997 will depend on finding alternative funding sources. Flow data will be finalized and published in the report, "Water Resources Data–Wisconsin", water year 1997.

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

PROBLEM: Eutrophication is the most serious impairment to the beneficial uses of Madison lakes. Phosphorus is the nutrient most identified as a cause of eutrophication. Restoration of Madison lakes will require some reduction of phosphorus loadings. Since a few of the sources could produce a disproportionate amount of phosphorus loading, management programs should target the most critical sources of the phosphorus.

Existing urban runoff models need more calibration to accurately identify the important sources of the phosphorus. Insufficient data is available to calculate phosphorus loadings from each of the source areas. Runoff concentration data is needed from lawns, streets, roofs, parking lots and driveways.

OBJECTIVES: Objectives are to (1) determine the importance of annual and seasonal phosphorus loadings from lawns in Madison, (2) determine the contribution of lawn and leaf litter to the high phosphorus concentrations observed on Madison streets, (3) determine the amount of phosphorus in each particle-size fraction found on the streets, especially the size fractions most likely to be removed by street sweeping, (4) determine the benefits of improved leaf pick-up programs in the fall, and (5) develop a set of recommendations for reducing phosphorus loading to Madison lakes.

APPROACH: Stormwater-runoff samples will be collected and analyzed for total and dissolved phosphorus and suspended solids from different source areas. The source areas are lawns, residential roofs, flat roofs, driveways, parking lots, feeder streets, collector streets and arterial streets. Up to 25 samples will be collected from each source area. During 1994, the sampling basin was the Monroe Street basin on Madison's west side. During 1995, the sampling basin was the Harper Road basin on Madison's east side. Lawn runoff samples were also collected from the Lakeland Avenue basin on Madison's isthmus. These concentration results will be used to calibrate the Source Loading and Management Model (SLAMM) and estimate the storm, seasonal and annual loads from each source area. In addition to storm-water-runoff samples, six street dirt samples will be collected throughout the year (excluding winter) from each of the three different street types in the Monroe Street and Harper Road basins. These samples will be sieved into four different size fractions. Each of these size fractions will be analyzed for total phosphorus and microscopically analyzed for percent vegetative versus mineral material.

PROGRESS (July 1996 to June 1997): Source-area runoff concentration data has been used to improve the SLAMM calibration. Solids and phosphorus loads have been calculated for the various source areas in both the Harper Road and Monroe Street basins. Partial analysis has been completed at the University of Alabama-Birmingham on the street dirt.

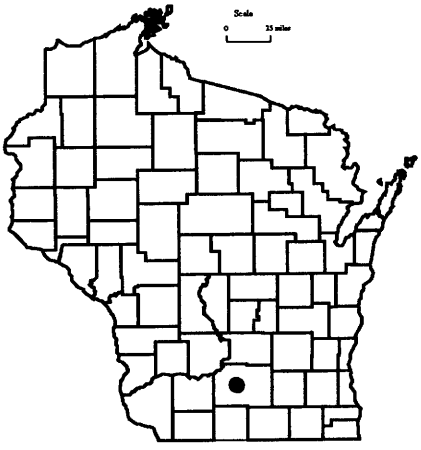
PLANS (July 1997 to June 1998): When the street dirt analyses are complete, the data will be interpreted to determine where the phosphorus on the street originated and how closely it follows concentrations seen in the water from the streets. A USGS interpretive report will be prepared discussing the findings.

COOPERATOR:
City of Madison

LOCATION:
Madison, Wisconsin

PROJECT CHIEF:
Robert J. Waschbusch

PERIOD OF PROJECT:
August 1992 to September 1996



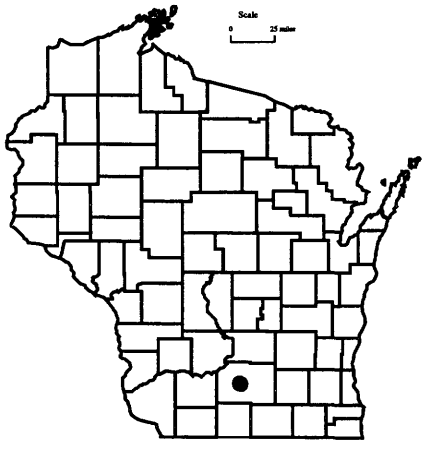
Evaluation of the Effectiveness of an Urban Stormwater Treatment System in Madison, Wisconsin, WI 18701

COOPERATOR:
City of Madison

LOCATION:
Madison, Wisconsin

PROJECT CHIEF:
Robert J. Waschbusch

PERIOD OF PROJECT:
April 1996 to September 1997



PROBLEM: The Stormceptor® is a recently designed BMP that includes a treatment chamber and a high-flow bypass. It could be a practical BMP for use in highly developed urban areas because it resides underground and does not require any above-ground space. The effectiveness of the Stormceptor® for reducing contaminant levels has been estimated using pollutant runoff models and measurements of sediment trapped in field installations. However, paired sampling at both the inlet and outlet is needed to measure the actual efficiency of the device at reducing stormwater pollutants. This information will help to evaluate if Stormceptor® is a cost-effective mechanism for urban water-quality improvement in Wisconsin and other urban areas.

OBJECTIVES: The goal of the project is to evaluate the effectiveness of the Stormceptor® in reducing contaminant levels of urban nonpoint-source pollution. Specific objectives are to (1) determine the efficiency of the treatment chamber at reducing a variety of constituents; (2) determine the efficiency of the device as a whole by including the pollutant loads that by-pass the system during periods of high flow in the efficiency analysis; (3) determine the particle size and chemical composition of the trapped material; (4) determine the amount of trapped material retained by the Stormceptor® by direct measurement; and (5) compare the measured removal efficiencies with current estimates by Stormceptor®.

APPROACH: An extensive runoff monitoring effort will be conducted during the spring and summer of 1996. A continuous-record stormflow-gaging station will be installed to monitor discharge and water quality. Discharge will be measured with Doppler-type velocity-area meters that measure the velocity and the level of the water. One of these meters will be installed in the 24-inch storm-sewer pipe that leads into the unit. The second meter will be installed in the pipe that exits the treatment chamber. The difference in volume between these meters will be the volume of water that bypasses the treatment chamber. Water-quality samples will be collected with refrigerated automatic-point samplers. Influent samples will be collected from the 24-inch pipe before the water enters the Stormceptor®. Treated samples will be collected from the pipe that exits the treatment chamber. Flow-composite samples will be collected throughout each runoff period and the samples will be analyzed for a variety of constituents. Untreated bypass samples will be collected from the bypass chamber before the water mixes with the treated water exiting from the treatment chamber and will be analyzed for solids only.

An attempt will be made to collect runoff samples from 15 consecutive runoff events. At the conclusion of 15 events, a measurement will be made to estimate the amount of solids retained by the treatment chamber. Trapped loads will be determined using a mass balance approach. Constituent loads passing the inlet, outlet and by-pass chambers will be calculated using the water-quality and flow data. The differences between the inlet, outlet and by-pass water-quality loads will be calculated to determine the efficiency of the

Stormceptor® treatment chamber and overall efficiency. Core samples will also be taken from the deposited solids in the treatment chamber and chemical analyses performed and deposited loads calculated. The water-quality loads will be compared to the corresponding deposited loads.

PROGRESS (July 1996 to June 1997): A Stormceptor® model STC 6000 with a modified disk-design inlet and outlet structure was installed in May at a city of Madison maintenance yard at Badger Road in Madison. Monitoring equipment was installed and tested and sample collection began in July. Thirty-six events have been sampled. Twelve of these have been suitable for analysis of all constituents while the other 24 were analyzed for solids only.

PLANS (July 1997 to June 1998): Three more events will be sampled and analyzed for all constituents. The material collected in the treatment chamber will be measured and analyzed. When lab analyses are available, data analyses will be performed to determine the effectiveness of the unit and a report will be prepared.

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:
James T. Krohelski

PERIOD OF PROJECT:
October 1992 to September 1996

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 relation 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 needed to provide government and planning agencies with a tool to aid in managing the water resources of the Dane County area.

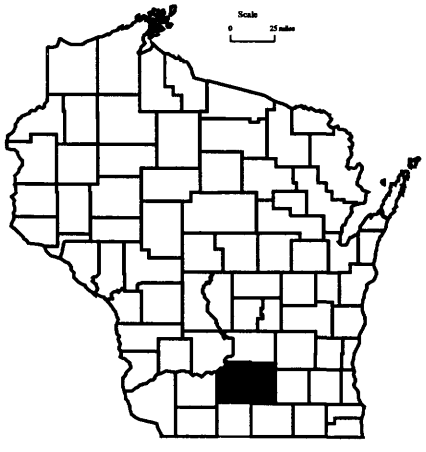
OBJECTIVES: The objective is to provide a better understanding of the regional ground-water system in relation to surface water and to provide a tool (ground-water flow model) that will be useful in water-resource management decision making on a continuing basis.

APPROACH: The study is divided into three phases: (1) establish conceptual framework of the ground-water system and data base, (2) develop and calibrate three-dimensional ground-water flow model, and (3) determine how land-use and management strategies effect water resources.

PROGRESS (July 1996 to June 1997): A report describing phase 2 of the Dane County Hydrologic Study, a calibrated three-dimensional flow model, was completed and approved for publication. Simulations incorporating potential land-use and management strategies were run and the results given to the Dane County Regional Planning Commission.

PLANS: Project is complete except for publication of report.

REPORTS: Krohelski, J.T., Bradbury, K.R., Hunt, R.J., and Swanson, S.K., 1997, Numerical simulation of ground-water flow in Dane County, Wisconsin: Wisconsin Geological and Natural History Survey Informational Circular (in press).



DANE COUNTY SURFACE WATER MODEL, WI 18901

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 relation between surface 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 needed to provide government and planning agencies with a tool to aid in managing the water resources of the Dane County area.

OBJECTIVES: Evaluate alternative operation plans for the lake system (Lakes Mendota, Monona, and Waubesa) in order to sustain downstream flows and provide adequate lake levels for recreation.

APPROACH: The model used in preparing the report, "Hydrologic effects of proposed changes in management practices, Winnebago Pool, Wisconsin" by William R. Krug (1981), will be used as a basis for developing a model for the Madison area lakes. This is a daily reservoir storage routing model used to simulate lake stage and outflow given the dam operating rules for the reservoir.

Net inflow to be used in the model will be computed from the measured outflow, observed changes in lake stages, and the record of past diversions. Outflow has been measured since September 1930 on the Yahara River near McFarland, Wisconsin. Daily lake stage for most periods of the same years has been measured on Lakes Monona and Mendota. Records of sewage diversion are available from the Madison Metropolitan Sewerage District.

The model will be used to evaluate the effects of various possible alternatives including various levels of minimum outflow requirements.

PROGRESS (July 1996 to June 1997): The model has been completed and used to simulate minimum outflows of 8.5, 10, 30, and 36 cubic feet per second. The model demonstrates that these levels of outflow can be maintained without reducing the levels of the lakes below levels observed in the recent past and without causing higher lake levels than have been observed.

PLANS: The final report will be reviewed and published.

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:

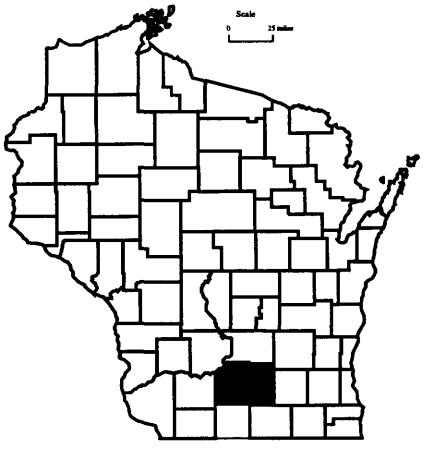
Dane County, Wisconsin

PROJECT CHIEF:

William R. Krug

PERIOD OF PROJECT:

October 1995 to December 1996



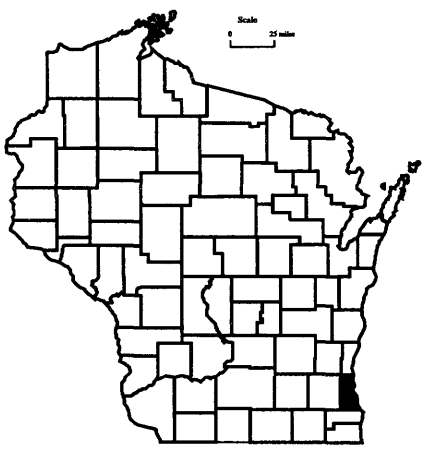
TRANSPORT AND BIOGEOCHEMICAL CYCLING OF PCB'S IN THE MILWAUKEE RIVER - THE IMPORTANCE OF ALGAL DYNAMICS, WI 19100, 19101

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Milwaukee County, eastern Wisconsin

PROJECT CHIEF:
Jeffrey J. Steuer

PERIOD OF PROJECT:
February 1993 to September 1997



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, determining PCB, organic carbon and lipid concentrations of each fraction, and 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, Thiensville, and Pioneer Road. PCB loading will also be determined on Cedar Creek, a tributary entering upstream of Pioneer Road. This monitoring will assist in evaluating the effectiveness of the Ruck Pond remediation. Due to high bottom sediment and fish PCB concentrations, a fourth site has been selected on the South Branch of the Manitowoc River at Hayton.

APPROACH: The three Milwaukee River sites, one Cedar Creek site, and one Manitowoc River site will be monitored for two years during event and base-flow conditions. Automated water-quality samplers will be used to obtain daily total suspended solids (TSS) samples; more intensive samples will be obtained on the rising hydrograph limb. Between June 1993 and June 1995, 26 manual organic samples (80 liters) will be collected at the Milwaukee sites and 18 samples will be collected at the Hayton site. Measured water-column characteristics include PCB (dissolved and particulate), TSS, VSS, particulate and dissolved organic carbon, chlorophyll *a*, sand/silt split and chloride.

Water column and bed algae will be seasonally collected and a biomass determined. Dominant algal species will be laboratory cultured and PCB uptake subsequently measured. These data will be used to calculate the algal and detrital PCB fractions.

Seasonal samples will also be collected from the surficial sediment layer at each of the four sites. Total organic carbon, congener-specific PCB, porosity, particle density, bulk density, and chlorophyll *a* will be determined during each of the four seasons.

PROGRESS (June 1996 to July 1997): The data-collection effort is complete. Water-column PCB concentrations on the Milwaukee River ranged from 3 to 168 ng/L resulting in transported PCB loads of 4 to 261 grams per day. Hayton system water-column PCB concentrations range from 38 to 564 ng/L, producing transported PCB loads of 4 to 136 grams per day. The algal identification effort and laboratory PCB uptake experiments are complete.

PLANS (July 1997 to September 1997): A report detailing the PCB loading, partitioning, algal PCB uptake and suspended-solids classification will be published.

REPORTS:

Swackhamer, Deborah, and others, 1996, PCB concentrations in algae from the Milwaukee and Manitowoc Rivers, Wisconsin

Fitzgerald, Sharon and Steuer, Jeffrey, 1996, The Fox River PCB transport study–stepping stone to a healthy Great Lakes ecosystem, U.S. Geological Survey Fact Sheet 116-96.

NORTH FISH CREEK SEDIMENT, WI 193

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
East-central Bayfield County near Ashland, Wisconsin

PROJECT CHIEF:
Faith Fitzpatrick

PERIOD OF PROJECT:
June 1994 to September 1997

PROBLEM: North Fish Creek has been identified as having an excessive sediment load that is causing major sedimentation problems in its lower reaches and in Chequamegon Bay. The sediment may be limiting spawning habitat for steelhead, coho salmon, and trout, and also may be impacting important wetland aquatic habitat in the coastal wetland located at the mouth of Fish Creek.

OBJECTIVES: The objectives of this study are to (1) identify sedimentation rates in the floodplain and channel prior to European settlement, (2) identify variations in historical sedimentation rates, (3) identify extrinsic and intrinsic factors leading to destabilization of the fluvial system, and (4) identify the effects of variations in storm runoff on channel hydraulic processes of sediment erosion, transport, and deposition.

APPROACH: Cores of channel, floodplain, and back-water sediment will be examined and dated using indirect and radiometric techniques. Channel geometry of relict cutoff meanders will be compared to channel geometry of the active channel along several reaches of the stream characterized by erosional, transitional, and depositional processes. Historical records such as Government Land Office Surveys, bridge designs, maps, aerial photographs, and field notes will be used to supplement field data. Rates of bluff retreat will be quantified using aerial photographs from 1938, 1950, and 1990.

PROGRESS (July 1996 to June 1997): Analyses of sediment and organic samples from floodplain cores continues. Approximately 25 samples have been analyzed for radiocarbon to quantify long-term sedimentation rates. Macrofossil samples are being examined for long-term change in vegetation. Analyses of change in low magnitude, high-frequency floods is complete. Analysis of rates of bluff retreat is complete. Particle-size analysis of channel and floodplain sediment is complete. Analyses of the effects of headwater detention basins on main-stem bluff erosion continues.

Preliminary results of analyses of relict cutoff meanders suggest that, in the upper part of North Fish Creek, the size of the bank-full flood has doubled in the last 50 years and parts of the channel have eroded up to 3 meters over that same time period. The channel capacity in the upper part has increased substantially, which causes less flooding upstream but more flooding and sedimentation downstream as flood water is routed downstream quicker than 50 years ago. Near the mouth, an average of 1 meter of sediment has accumulated in the channel and near-channel floodplain over the last 50 years. The main channel is seeking alternative routes through Fish Creek Slough as the accumulation of sediment in and near the channel raises the local water table above that in the surrounding slough. This results in a water surface slope away from the main channel and causes the channel to shift away from its present position toward areas of lower elevation.

PLANS (July 1997 to June 1998): Data analyses will be completed, model of effects of detention basin storage on sediment transport will be completed, and report and dissertation will be completed.

REPORTS:

Fitzpatrick, F.A., and Knox, J.C., Effects of Long-Term Land-Use Changes on Flooding and Sedimentation, North Fish Creek, Wisconsin: U.S. Geological Survey Water Resources Investigations Report (in preparation).

Fitzpatrick, F.A., Effects of Changes in Vegetation, Climate, and Isostatic Rebound on Sedimentation and Hydrology of a Northern Wisconsin Stream, Ph.D. dissertation, University of Wisconsin-Madison (in preparation).

FT. McCOY GROUND-WATER QUALITY, WI 194

COOPERATOR:
Department of Defense, Environmental Management Division, Fort McCoy

LOCATION:
Fort McCoy, Wisconsin

PROJECT CHIEF:
John F. DeWild

PERIOD OF PROJECT:
July 1994 to January 1997

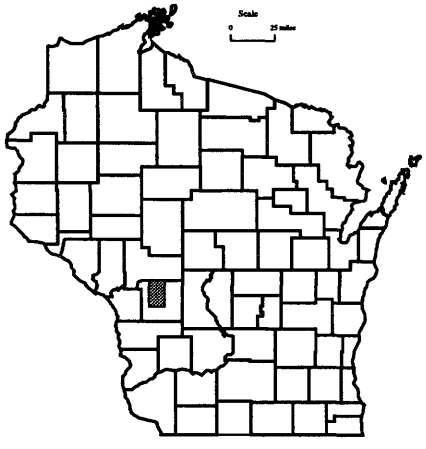
PROBLEM: Fort McCoy, a military base in north-central Monroe County, Wisconsin, has several sites contaminated with petroleum-based organic compounds which have leaked from underground storage tanks or pipelines.

OBJECTIVE: The objective of this study is to determine the vertical and areal extent of soil and ground-water contamination from leaking underground storage tanks and associated pipelines.

APPROACH: The distribution of contaminant will be determined by collecting soil and ground-water samples with a Geoprobe and analyzing the samples with a field gas chromatograph. Approximately 20 percent of the field-analyzed samples will be sent to a certified lab for verification of field analyses.

PROGRESS (July 1996 to June 1997): Three types of sites were identified and investigated: (1) buildings, (2) petroleum-oil-lubrication stations and (3) selected points along pipelines. Contaminant plumes have been delineated at the selected sites. Field and laboratory analyses have been tabulated along with plots of the site and sampling locations. A final summary listing analyses and site and sampling locations was written.

PLANS: Project is complete.



FORT SHERIDAN GROUND-WATER QUALITY, WI 19402

PROBLEM: Fort Sheridan, a military base located in northeastern Illinois, requested that sites in the vicinity of underground storage tanks be screened for the presence of petroleum-based organic compounds which may have leaked from the tanks.

OBJECTIVES: The objective of this study is to determine the extent of contamination from leaking underground storage tanks.

APPROACH: The distribution of contaminant will be determined by collecting soil samples with a Geoprobe and analyzing the samples with either a field gas chromatograph or photo-ionization detector.

PROGRESS (July 1996 to June 1997): Soil samples in the vicinity of all underground storage tanks requested to be investigated were collected and analyzed. A report summarizing the findings will be written by Illinois District staff.

PLANS: Project is completed.

COOPERATOR:
U.S. Army Corps of Engineers

LOCATION:
Fort Sheridan, Illinois

PROJECT CHIEF:
John F. DeWild

PERIOD OF PROJECT:
January 1996 to September 1997

FORT MC COY ENVIRONMENTAL MANAGEMENT DIVISION SUPPORT, WI 195

COOPERATOR:
Department of Defense, Environmental Management Division, Fort McCoy

LOCATION:
Fort McCoy, Wisconsin

PROJECT CHIEF:
Ty Sabin

PERIOD OF PROJECT:
October 1994 to September 1997

PROBLEM: The Fort McCoy Environmental Management Division (EMD) has requested technical assistance from the Wisconsin District to help in the hydrologic, hydrogeologic and geomorphic characterization of Fort McCoy-supported Army Reserve Centers in the six-state area including Iowa, Illinois, Indiana, Michigan, Minnesota and Wisconsin.

OBJECTIVE: The objective is to broaden the knowledge and understanding of hydrogeology and geomorphology in the vicinity of the Fort McCoy-supported Army Reserve Centers in the six-state area.

APPROACH: The Wisconsin District will provide hydrologic, and geomorphologic expertise and support to the Fort McCoy-supported Army Reserve Centers in the six-state area.

PROGRESS (July 1996 to June 1997): A series of products have been created to assist Fort McCoy EMD personnel in managing natural and cultural resources. Products include a geomorphologic and paleoenvironmental history of Fort McCoy, Wisconsin, and the Joliet Training Area, Joliet, Illinois. Supporting field work has included examining soil stratigraphy in trenches and soil coring along transects to establish the spatial distribution, thickness, and nature of soil strata. The geomorphologic and paleoenvironment information has been incorporated into a series of digital products within a geographic information system.

PLANS: Project is complete except for report.

REPORTS:
Late Cenozoic landscape evolution of Ft. McCoy, Monroe County, Wisconsin (in preparation).

ANTARCTIC HYDROLOGIC STUDIES, WI 196

PROBLEM: The understanding of biogeochemical processes in temperate zone lakes and streams is difficult due to the complex mixing and diversity of the processes involved.

OBJECTIVE: The objective is to enhance the understanding of biogeochemical processes that occur in temperate zone lakes, streams and rivers.

APPROACH: By focusing the study on the lakes and streams in the McMurdo Dry Valleys of Antarctica, we can take advantage of the closed systems with stable water columns, low organic inputs, and polar desert landscapes to conduct research that will lead to the understanding of biogeochemical processes in other, more complex environments.

PROGRESS (July 1996 to June 1997): Two volunteers were selected from Madison to assist in field activities. Two water temperature/conductivity probes were installed on the Onyx River, at Lake Vanda and Lower Wright weirs. Seventeen metal plaques describing the monitoring activities, etc., were added to 17 of the 19 stream gageboxes. Improvements in the wiring systems to the solar panels at the gages were put in. Additional storage modules were purchased, so stream workers will no longer need to dump data on site, but can switch out the modules and retrieve the data from field camps.

Automated streamflow monitoring was conducted at 19 sites and intermittent monitoring at an additional 11 sites. Brief field reconnaissance trips were made to Garwood and Meirs Valley as well as Lake Vida, the Alph River, and Pony Pond near Shackleton's hut.

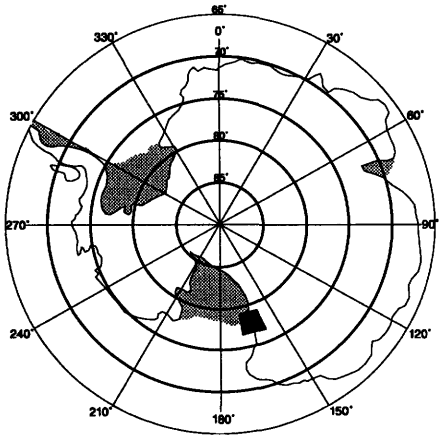
PLANS (July 1997 to June 1998): Two new volunteers will sign on–one from Colorado and one from Madison. Data will be reviewed, analyzed, and stored in an Oracle database. It will be made available on the web via the District web-enabled database. A temperature/conductivity probe may be installed at Lawson Creek at B4. Additional gages may be installed at two sites on the Alph River and two sites in Meirs Valley. Telemetry is being considered for the Vanda Weir station to avoid trips to the Onyx River during low-flow regimes.

COOPERATOR:
Desert Research Institute,
Reno, Nevada

LOCATION:
McMurdo Dry Valleys, Antarctica

PROJECT CHIEF:
Harry House

PERIOD OF PROJECT:
October 1994-Continuing



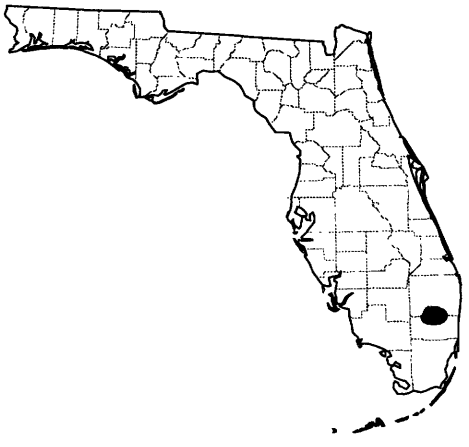
FLORIDA EVERGLADES MERCURY CYCLING, WI 197

COOPERATOR:
U.S. Geological Survey
Reston, Virginia

LOCATION:
Florida Everglades

PROJECT CHIEF:
David P. Krabbenhoft

PERIOD OF PROJECT:
January 1995 to September 1999



PROBLEM: Mercury contamination is one of the largest potential health risks to aquatic organisms, predatory animals, and humans. This great concern is the result of two observations: (1) mercury biomagnifies in the food chain to toxic concentrations even though it is found at very low aqueous concentrations and (2) the principal source to most areas is atmospheric deposition. Thus, almost any aquatic ecosystem with a food chain is potentially susceptible to mercury contamination.

OBJECTIVES: The overall objective of this project is to provide a better understanding of the mercury contamination problem in the Florida Everglades and other aquatic ecosystems. Specific processes will be investigated, including particle and dissolved transport, volatilization, methylation, and interactions with dissolved organic carbon.

APPROACH: The use of ultra-clean sampling techniques are requisite for all aspects of mercury research because of the very low concentrations present in the environment. Samples will be collected for analysis of total mercury, methylmercury, reactive mercury, and elemental mercury in water, sediments, and biota.

PROGRESS (July 1996 to June 1997): Three 10-day field trips were conducted during this time period (December 1996, March 1997, and June 1997) in which 20 to 40 scientists from across the country representing the USGS and several universities and private research labs participated. Approximately 15 sites were sampled during each field trip for water, sediment and biota. In addition, intensive sampling efforts were conducted over 36-hour periods to study short-term variability of mercury concentrations and speciation in the Everglades ecosystem. Several contemporaneous experiments were also conducted to determine important process rates, such as mercury methylation, demethylation, reduction, and volatilization. Several species of mercury were analyzed, including total mercury, methyl mercury, elemental mercury, and reactive mercury. In October 1996, a project meeting was held in Madison, Wisconsin, to discuss where the project currently stands, and what changes were necessary to meet original goals. About 25 scientists from across the country attended the meeting. In May 1997, an Everglades all-mercury-researchers meeting was held in Madison, Wisconsin. Scientists, program managers, and agency managers discussed technical accomplishments and future needs. Significant results to date are the observation that the highest concentrations of methyl mercury (the most toxic form) and elemental mercury occur in the most pristine areas of the Everglades, substantial variations in all mercury species occur on a diurnal basis that appear to be driven by sunlight-induced chemical reactions, and floating periphyton mats appear to be a dominant site for methylmercury production and entry into the food chain. Ten abstracts were presented and published in the proceedings of national and international meetings during this time period. Four manuscripts were prepared for journal submission and will be published in 1997.

PLANS (July 1997 to June 1998): Work plans call for continued execution of field trips on about a quarterly basis. With each succeeding field trip, sampling sites further south of our current sampling locations will be added, including regions of Everglades National Park. Results will continue to be presented at professional meetings and published in professional journals.

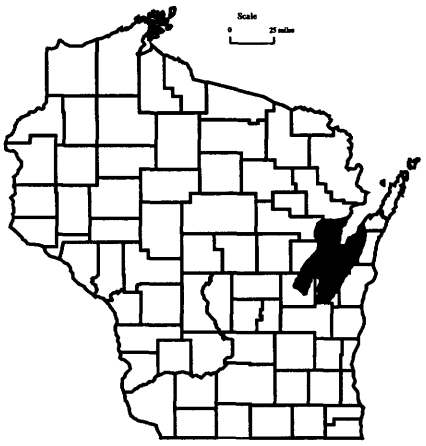
OPTIMUM MANAGEMENT OF GROUND-WATER RESOURCES IN THE LOWER FOX RIVER VALLEY, WI 198

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Lower Fox River Valley (Green Bay Metropolitan and Fox Cities area)

PROJECT CHIEF:
John F. Walker

PERIOD OF PROJECT:
October 1995 to September 1997



PROBLEM: Recent water-level measurements indicate that the cones of depression from two pumping centers, the Green Bay Metropolitan area and the Fox Cities area, have merged so that pumping in one area effects the other area. Water-use projections, used in a previously developed ground-water-flow model, indicate water levels near the center of the cone of depression at Green Bay will decline more than 250 feet below the top of the sandstone aquifer by the year 2015 and leave about 330 feet of saturated aquifer thickness. This would result in increased pumpage costs and a reduction in the amount of water that can be pumped from the sandstone aquifer. In response to the concern over declining water levels in the aquifer, proposals to build a pipeline to Lake Michigan have been discussed.

OBJECTIVE: The objective of this study is to determine whether ground water, under managed pumping conditions, is an alternative to Lake Michigan water for future water supply in the Lower Fox River Valley. An optimization model will be used to determine ground-water-management plans so that water yields are maximized, while water-level declines in the sandstone aquifer are constrained to remain within reasonable ranges.

APPROACH: A three-dimensional regional ground-water-flow model encompassing the entire Lower Fox River Valley was developed as part of an ongoing ground-water study. The flow model will provide the head response resulting from various management solutions. The goal of the optimization modeling will be to maximize well yield while maintaining reasonable water levels in the aquifer. Optimization modeling will be applied to several management scenarios, addressing relevant issues and questions concerning ground-water resources of the Lower Fox River Valley. Potential issues include ground-water availability in the sandstone aquifer, well placement and pumping strategies, quality of the water supply, and relation between ground and surface water.

PROGRESS (July 1996 to June 1997): Two sets of preliminary optimization scenarios were developed and solved using optimization techniques. The first set of scenarios optimized well rates in Brown County. The second set of scenarios optimized well rates in the Fox Cities area. The preliminary results were presented to planning agencies in Brown County and the Fox Cities area, respectively, as a demonstration of the potential use of optimization techniques. Based upon suggestions from the planning agencies, a final set of scenarios was developed and solved.

PLANS (July 1997 to June 1998): The results from the final optimization scenarios will be presented in a USGS Water-Resources Investigations Report.

EVALUATION OF THE EFFECTIVENESS OF VEGETATED FILTER STRIPS AS A MEANS OF REDUCING THE TRANSPORT OF NUTRIENTS AND SUSPENDED SEDIMENT IN AGRICULTURAL AREAS, WI 199

PROBLEM: Vegetated filter strips, also referred to as grass filter strips, have been used as a Best Management Practice (BMP) to reduce the loss of sediment and nutrients from agricultural land to adjacent streams. The extent of the reduction in sediment and nutrient transport associated with the installation of vegetated filter strips in areas is not well known, especially the extent of the reduction in areas with specific types of surficial deposits. Therefore, it is difficult to model and quantify the changes in water quality associated with installing vegetated filter strips.

OBJECTIVE: The objective of this project is to determine how vegetated filter strips affect the transport of nutrients and suspended sediment to streams in an area with extensive agriculture on clayey surficial deposits.

APPROACH: A paired-basin approach will be used to determine how vegetated filter strips reduce the loss of nutrients and suspended sediment from the watershed and how this reduction affects the water quality of the adjacent streams. Two similar basins will be chosen near Green Bay, Wisconsin. Each basin will be equipped with a station that will continuously measure streamflow and precipitation and also have a stage-activated, automatic ISCO sampler to collect storm-runoff samples. (An upstream-downstream approach will also be considered.) Daily nutrient and suspended sediment loads at each site will then be computed throughout the study using the integration method described by Porterfield (1972). For the first two years after installing the stations, no changes in land-use practice will occur in either basin–vegetated filter strips will not be installed. These data will be used to compare the sites during the pre-filter strip conditions. After this period, one basin, chosen as the reference basin, will continue to have minimal changes in land use allowed, while the other basin will have vegetated filter strips installed throughout. These data will be used to determine whether the relation between the amount of nutrients and suspended sediment transported during storm events has changed between the two basins and the quantitative affects of applying this BMP.

PROGRESS (October 1996 to June 1997): General areas have been chosen for the two basins.

PLANS (July 1997 to June 1998): Agreements with specific farmers will be made on whether to install filter strips or to maintain their agricultural practices as at the present. Sampling stations will be installed in both basins. Daily and monthly total phosphorus and suspended sediment loads will be computed.

COOPERATOR:
Wisconsin Department of Natural Resources
Fox-Wolf Basin 2000

LOCATION:
Outagamie County, northeast Wisconsin

PROJECT CHIEF:
Dale M. Robertson

PERIOD OF PROJECT:
October 1996 to September 2001

EFFECTS OF CRANBERRY BOG OPERATIONS ON THE HYDROLOGY AND WATER QUALITY OF A STREAM IN WEST-CENTRAL WISCONSIN, WI 201

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Near Tomah, Wisconsin

PROJECT CHIEF:
David J. Graczyk

PERIOD OF PROJECT:
July 1996 to June 1997

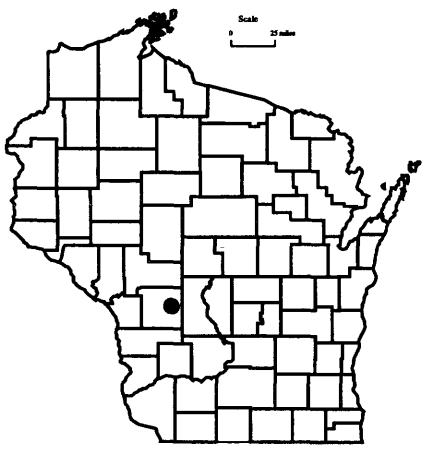
PROBLEM: The impacts of cranberry operations on wetlands and receiving waters has not been thoroughly assessed. Concern with both upland and wetland cranberry operations is based on a number of factors: (1) a number of beds are located directly in converted wetlands or in proximity to natural wetlands; (2) as with any agricultural operation, fertilizers and pesticides are used; and (3) cranberry operations commonly divert large amounts of water to beds from nearby streams and from the beds to nearby streams. This discharge water may transport excess nutrients and/or pesticides from the beds as well as alter the flow and thermal regimes of source and receiving waters.

This study is designed to identify and quantify potential water quality, habitat and biological impacts associated with the flow and temperature alterations from cranberry operations and to better define large scale impacts of cranberry operations. Baseline data will be collected on flow, water temperature, water quality and biological communities.

OBJECTIVE: The objectives of the study will be to determine the hydrology, streamflow and water-quality characteristics of a stream with cranberry operations in its headwaters, a stream with a recreational reservoir in its headwaters, and a non-impacted stream that is hydrologically similar to the other two watersheds.

APPROACH: Three streams will be monitored in Jackson and Monroe Counties, Wisconsin. One stream will have a cranberry operation in its headwaters, one stream will have a recreational reservoir in its headwaters and a third stream will be a non-impacted stream without cranberry operations or recreational reservoirs in its headwaters. Data collection will begin July 1, 1996, and continue until June 30, 1997.

Continuous streamflow, water temperature and rainfall will be monitored at all three streams. At the cranberry bog stream, dissolved oxygen, air temperature and solar radiation will be monitored. An automatic sampler will be installed at the cranberry stream site. Samples will be collected during periods of overland runoff from rainfall and/or snowmelt. Also, samples will be collected when cranberry beds are being drained during normal operation of cranberry bogs. Water samples will be collected biweekly for nine months and monthly for the remaining three months. Streamflow will be measured and water-quality samples will be collected monthly at one site above the cranberry operation, one site above the recreational reservoir and one site in the headwaters of the non-impacted stream.



PROGRESS (July 1996 to June 1997): Continuous streamflow, water temperature and precipitation data were collected at three sites. Additional data was collected at Clear Creek which included dissolved oxygen, air temperature, and solar radiation. Biweekly water samples were collected at the three sites. These samples were analyzed for pH, ammonia nitrogen, total phosphorus and suspended solids. Water samples were also collected biweekly at three sites which are upstream of the three continuous stream gages. Water samples were collected monthly at two streams which are tributary to the cranberry bog. Runoff samples were collected at the Clear Creek gage which is the outlet of the cranberry bog. These samples will be analyzed for acute toxicity using microtox, and using *Hyalella azteca* (indigenous to the stream) and *Ceriodaphnia Dubia* as indicator species. All data was summarized and will be published in the report "Water Resources Data–Wisconsin", water year 1996.

PLANS (July 1997 to June 1998): Streamflow, water temperature and precipitation data collection will continue until October 1, 1997. Water-quality sampling will be discontinued in July 1997. All data collected in water year 1997 will be summarized and published in "Water Resources Data–Wisconsin", water year 1997.

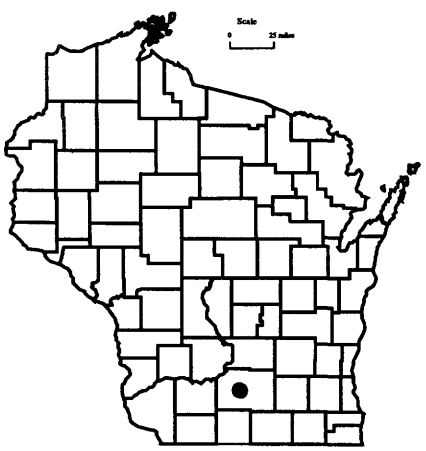
MITIGATION OF FUTURE NORTH FORK URBANIZATION IMPACTS ON THE PHEASANT BRANCH HYDROLOGIC SYSTEM, WI 202, 20202

COOPERATOR:
City of Middleton

LOCATION:
Dane County

PROJECT CHIEF:
Jeffrey J. Steuer

PERIOD OF PROJECT:
July 1996 to September 1997



PROBLEM: As Middleton and its surroundings continue to develop, the Pheasant Branch North Fork Basin is expected to undergo significant urbanization. For the downstream city of Middleton, headwater urbanization can mean increased flood peaks, increased water volume and increased pollutant loads. It may also adversely effect down-gradient ecosystems such as Pheasant Branch Marsh and reduce ground-water recharge. Whereas previous work has often not included the transient interaction between surface and ground water, the proposed work will combine ground- and surface-water modeling in the analysis of the Pheasant Branch system.

OBJECTIVES: Objectives are to (1) locate potential sites for runoff controls and/or enhanced infiltration to ensure future flood peaks do not exceed the present condition flood peaks, (2) quantify the flood peak and ground-water recharge differences resulting from a fully-urbanized condition with and without treatment or runoff controls, (3) use the ground-water model to assess North Fork basin urbanization impacts on Pheasant Branch Marsh, and (4) construct a ground-water model able to address future needs such as siting future water supply

APPROACH: The overall approach will combine ground- and surface-water models to locate an effective combination of stormwater treatment or control sites within the North Fork basin which may be developed to produce minimal effects on the Pheasant Branch hydrologic system. The surface-water component will build upon the simulations detailed in "Effects of urbanization on streamflow, sediment loads, and channel morphology in Pheasant Branch Basin near Middleton, Wisconsin" (Krug and Goddard, 1985). To achieve the objectives of this project, the model will contain a spatial resolution to simulate 1 to 4 developments per square mile (approximately 40 model sub-areas). Significant development has occurred in the South Fork basin since 1981. Two of the areas simulated as not generating runoff in 1981 have developed and presently drain to the South Fork. It will be necessary to update the South Fork basin model to ensure that shifting of the North Fork hydrograph peak (due to runoff controls) will not produce an enhanced peak downstream of the confluence (Krug & Goddard, pages 16, 17). The new model efforts will calibrate to recently collected Pheasant Branch discharge and precipitation data collected at Highway 12. Radar precipitation data will be interpreted to provide spatial resolution.

The ground-water component will use a model constructed at a smaller scale than the recently developed Dane County model (Krohelski and Bradbury, in press) to have the appropriate resolution for the stormwater control alternatives. Similar to Krohelski and Bradbury, the model will be constructed using MODFLOW (McDonald and Harbaugh, 1988). Infiltration used in the surface-water model will be input into the ground-water flow model to assess the effects of management alternatives on ground-water recharge distribution and magnitude. The model will also calculate the changes in ground-water-derived baseflow in the system for the different alternatives and assess the effectiveness of recharge enhancement scenarios.

PROGRESS (June 1996 to July 1997): Shallow well sites have been established in Pheasant Branch Marsh along with surface-water stage and precipitation sites on the Pheasant Branch North and South Forks.

PLANS (July 1997 to June 1998): Ground- and surface-water modeling will be conducted. An investigative report will be prepared.

MONITORING AND EVALUATION OF THE IMPACTS OF AIRCRAFT AND RUNWAY DEICERS ON THE KINNICKINNIC RIVER SURFACE-WATER RESOURCES, WI 204

COOPERATOR:
County of Milwaukee

LOCATION:
Milwaukee, Wisconsin

PROJECT CHIEF:
Steven R. Corsi

PERIOD OF PROJECT:
November 1996 to December 1997

PROBLEM: Milwaukee County is involved in an effort to evaluate impacts from General Mitchell International Airport (GMIA) deicing chemicals discharging to surface waters of the Kinnickinnic River watershed. Ethylene and propylene glycol-based chemicals are used during cold weather periods to deice aircraft, runways, and other paved areas used by aircraft. Both forms of glycol have an exceptionally high biochemical oxygen demand (BOD). A concern is that runoff from the airport during deicing periods may lower the dissolved oxygen in the receiving streams: Wilson Park Creek immediately downstream, the Kinnickinnic River, and the Milwaukee Harbor at the mouth of the Kinnickinnic river. A second concern is that additives to the glycol solutions may have toxic effects on the receiving streams.

OBJECTIVE: The overall goal of the monitoring effort is to collect data and evaluate effects from airport deicing chemicals discharging to surface waters of the Kinnickinnic River watershed. Specific objectives are as follows: (1) monitor surface water throughout the Kinnickinnic River watershed for water quality and flow during dry weather and runoff conditions to help quantify GMIA runoff as well as runoff from other sources; (2) use monitoring data to estimate the volume of deicing runoff discharged into tributaries of the Kinnickinnic River; (3) assess impacts of deicing chemical discharge on biochemical oxygen demand (BOD) and resulting dissolved-oxygen concentrations, and on toxicity of runoff to receiving waters; (4) provide the modeling effort with timely data for calibration and verification of the QUAL2E model.

APPROACH: An extensive runoff monitoring effort will be conducted during the winter of 1996-97. Nine streamflow-gaging stations will be installed throughout the Kinnickinnic River watershed to monitor flow and water quality. The nine sites will include two upstream sources, two airport outfalls, three sites on Wilson Park Creek downstream from GMIA outfalls, and two sites on the Kinnickinnic River downstream from the confluence with Wilson Park Creek. Flow, dissolved oxygen, water temperature, and rainfall will be monitored continuously. Water-quality constituents will be sampled selectively during six events and during baseflow. To establish a winter baseline, two rounds of low-flow samples will be collected and one event will be sampled during a non-deicing period. One event will be sampled during a controlled release of deicing chemicals from the airport, and four events will be sampled during deicing periods. Glycol, BOD, and nitrogen analyses will be conducted from all events to define loadings. Biotoxicity analyses will be conducted during all events from airport outfall sites.

PROGRESS: An extensive runoff monitoring effort was conducted during the winter of 1996-97. Nine streamflow-gaging stations were installed throughout the Kinnickinnic River watershed to monitor flow and water quality. The nine sites include two upstream sources, two airport outfalls, three sites on Wilson Park Creek downstream from GMIA outfalls, and two sites on the Kinnickinnic River downstream from the confluence with Wilson Park Creek. Flow, dissolved oxygen, water temperature, and rainfall were monitored continuously. Water-quality constituents were sampled selectively during five events and during baseflow. To establish a winter baseline, a round of low-flow samples was collected. One event was sampled during a controlled release of deicing chemicals from the airport, and four events were sampled during deicing periods. Glycol, BOD, and nitrogen analyses were conducted from all events to define loadings. Microtox analyses were conducted during all events from airport outfall sites and bioassays were conducted on several sites during two deicing events. Preliminary results are stored in an Oracle database and are available on the world-wide-web.

PLANS: Two reports are planned. One report will be a summary of data collected and the second report will be an analysis of the data including a site to site comparison of water quality, DO, water temperature, and biotoxicity.

MODELING THE EFFECTS OF THE CRANDON MINE USING THE HSPF WATERSHED MODEL, WI 20500

COOPERATOR:
U.S. Environmental Protection Agency
U.S. Geological Survey, Illinois District
AquaTerra Consultants, CA

LOCATION:
Forest County, north-central Wisconsin

PROJECT CHIEF:
Dale M. Robertson

PERIOD OF PROJECT:
January 1997 to September 1998

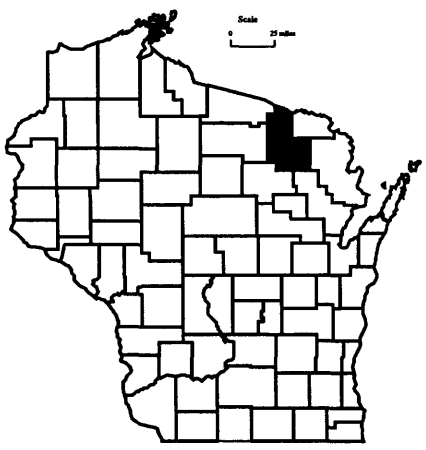
PROBLEM: The Crandon Mining Company has proposed construction of a zinc and copper mine near Crandon, Wisconsin. Before any operations can begin, an environmental impact assessment must be written and approved. At present, it is uncertain what specific effects the mine will have on the hydrology and water quality of the streams and lakes in the area.

OBJECTIVE: The objectives of this project are to (1) assemble hydrologic, meteorologic, and land-use information for the area near the proposed mine, (2) develop a watershed model for the Swamp Creek basin, and (3) use the model to determine what potential impacts the mine will have on the hydrology of Swamp Creek and nearby lakes.

APPROACH: Available hydrologic, meteorologic and land-use information will be obtained from the U.S. Geological Survey data bases, the Crandon Mining Company, the Mole Lake Tribe, the Wisconsin State Climatologist, the National Climatic Data Center, and the Wisconsin Department of Natural Resources. These data will be used to develop a watershed model for the Swamp Creek Basin using the Hydrologic Simulation Program Fortran (HSPF) watershed model. The model will be calibrated using a subset of data available for Swamp Creek and verified using an independent subset of the data. The model will be adjusted to simulate the mining operations. The output of the model will be used to quantify the effects of the mining operations on the water levels of streams and lakes in the area.

PROGRESS (January 1997 to June 1997): Hydrologic, meteorologic, and land-use information were assembled. Preliminary model configurations were developed.

PLANS (July 1997 to June 1998): Construct a watershed model for the Swamp Creek Basin using HSPF. The model will be calibrated and verified. The model will then be adjusted to quantify the effects of the mining operations on the water levels of streams and lakes in the area.



Completed Projects

The following is a list of completed projects with reports that are in various stages of preparation.

WI093	Geology, ground-water flow, and dissolved-solids concentrations along hydrogeologic sections through Wisconsin's aquifers
WI171	Application of habitat-suitability index models to assess effects of fine-grained sediment on brook trout and brown trout habitat
WI17211	Estimating stormwater contributions to contaminant concentrations in urban streams
WI17215	Relation between stormwater pollutant concentrations washed off city streets and traffic volume in Madison, Wisconsin, 1994-95
WI18003	Methylmercury dynamics in littoral zone sediments of a seepage lake
WI190	Microbial enhancement of PCB congener mobility at the sediment/water interface in the lower Fox River, Wisconsin

WISCONSIN DISTRICT PUBLICATIONS

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

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

WATER-SUPPLY PAPERS

Kammerer, P.A., Jr., and Krug, W.R., 1993, Wisconsin stream water quality, in U.S. Geological Survey, National water summary 1990–91—Hydrologic events and stream water quality: U.S. Geological Survey Water-Supply Paper 2400, p. 561–568.

Melcher, N.B., and Walker, J.F., 1992, Evaluation of selected methods for determining streamflow during periods of ice effect: U.S. Geological Survey Water-Supply Paper 2378, 47 p.

U.S. Geological Survey, 1991, National water summary 1988-89—Hydrologic Events and Floods and Droughts: U.S. Geological Survey Water-Supply Paper 2375, 591 p.

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.

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

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

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

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

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WISCONSIN DISTRICT PERSONNEL

DISTRICT OFFICE-MIDDLETON 53562
8505 Research Way
Phone: (608) 828-9901
FAX: (608) 821-3817
Office Hours: 0800 to 1630

Office of the District Chief

Gebert, Warren A., District Chief
(608) 821-3801 (wagebert@maildwimdn.er.usgs.gov)
Elder, John F., Research Hydrol/Biol
(608) 821-3854

Administrative Services Unit
Grover, Richard L., Admin Off
(608) 821-3803 (rlgrover@maildwimdn.er.usgs.gov)
Maertz, Diane E., Admin Opers Asst
(608) 821-3801
Evans, Kaye M., Admin Opers Asst
(608) 821-3802
Wolf, Julie A., Admin Opers Asst
(608) 821-3804

Computer Applications Unit
Bodoh, Robert B., Comp Prog Analyst
(608) 821-3805
Gill, Gary W., Comp Asst
(608) 821-3866

Environmental Studies Section
Hughes, Peter E., Chief Supv Hydrol/Biol
(608) 821-3833 (pehughes@maildwimdn.er.usgs.gov)
Walker, John F., Research Hydrol/Engr
(608) 821-3853
Graczyk, David J., Hydrol/For
(608) 821-3840
Hall, David W., Hydrol
(608) 821-3875
Krug, William R., Hydrol/Engr
(608) 821-3829
Steuer, Jeffrey J., Hydrol/Eng
(608) 821-3830
Corsi, Steven R., Hydrol/Eng
(608) 821-3835
House, Harold R., Hydrol/Eng
(608) 821-3876
Owens, David W., Hydr Engr
(608) 821-3863
Stuntebeck, Todd D., Phys Sci
(608) 821-3872
Waschbusch, Robert J., Hydrol
(608) 821-3868
Goddard, Gerald L., Hyd Tech
(608) 821-3841
Hanson, Halward L., Hyd Tech
(608) 821-3862
Housner, David E., Hyd Tech
(608) 274-3925
Rutter, Troy D., Hyd Tech
(608) 821-3848
Lonsdorf, Karen A., Pub Graph Spec
(608) 821-3814
Jones, Susan Z., Edit Asst
(608) 821-3815
Greenwood, Michelle M., Cartographer
(608) 821-3812
Fuller, Janice, Edit Asst
(608) 821-3813

Hydrogeologic Studies and Data Section
Krohelski, James T., Chief Supv Hydrol
(608) 821-3850 (jtkrohel@maildwimdn.er.usgs.gov)
Krabbenhoft, David P., Research Hydrol/GeoChem
(608) 821-3843
Feinstein, Daniel, Hydrologist
Hunt, Randall J., Hyrol/Geol
(608) 821-3847
Olson, Mark L., Biol
(608) 821-3878
Ellefson, Bernard R., Hyd Tech
(608) 821-3849
Sabin, Ty, Physical Scientist
(608) 821-3873
DeWild, John F., Hyd Tech
(608) 821-3846
Rauman, James M., Hyd Tech
(608) 821-3871

Hydrologic Systems and Data Section
Garn, Herbert, Chief Supv Hydrol
(608) 821-3828 (hsgarn@maildwimdn.er.usgs.gov)
Rose, William J., Hydrol/Engr
(608) 821-3834
Holmstrom, Barry K., Hydrol/Engr
(608) 821-3831
Olson, Daniel L., Hyd Tech
(608) 821-3852
Stark, Patricia A., Hyd Data Asst
(608) 821-3838

National Water Quality Assessment Program
Peters, Charles A., Chief Supv Hydrol
(608) 821-3810 (capeters@maildwimdn.er.usgs.gov)
Fitzgerald, Sharon A., Research Hydrol/Biol
(608) 821-3816
Robertson, Dale P., Research Hydrol/Chem
(608) 821-3867
Fitzpatrick, Faith A., Hydrol
(608) 821-3818
Sullivan, Daniel J., Hydrol
(608) 821-3869
Scudder, Barbara C., Research Hydrol/Biol
(608) 821-3832
Saad, David A., Hydrol/Geol
(608) 821-3865
Richards, Kevin E., Hyd Tech
(608) 821-3861
Stewart, Jana S., Geographer
(608) 821-3855

National Water-Quality Assessment Synthesis Study

Bauer, Daniel B., Hydrologist
(608) 821-3811 (dbauer@maildwimdn.er.usgs.gov)

FIELD HEADQUARTERS-MADISON 53719
6606 Seybold Road
Phone: (608) 274-3925
Office Hours: 0800 to 1630

Habale, Josef, Hyd Tech
Koenig, Kenneth R., Hyd Tech
March, Steven A., Hyd Tech
Wittwer, Thomas A., Hyd Tech

FIELD HEADQUARTERS-RICE LAKE 54868
313 W. Knapp St., P.O. Box 506
Phone: (715) 234-4015
Office Hours: 0800 to 1630

Popowski, Thomas J., Hyd Tech
Schuler, Josef G., Hyd Tech

FIELD HEADQUARTERS-MERRILL 54452
2011 East Main Street
Phone: (715) 536-2200
Office Hours: 0800 to 1630

Hanig, Jeffrey J., Hyd Tech
Esser, Brett M., Hyd Tech