WI-0099(?)

WISCONSIN

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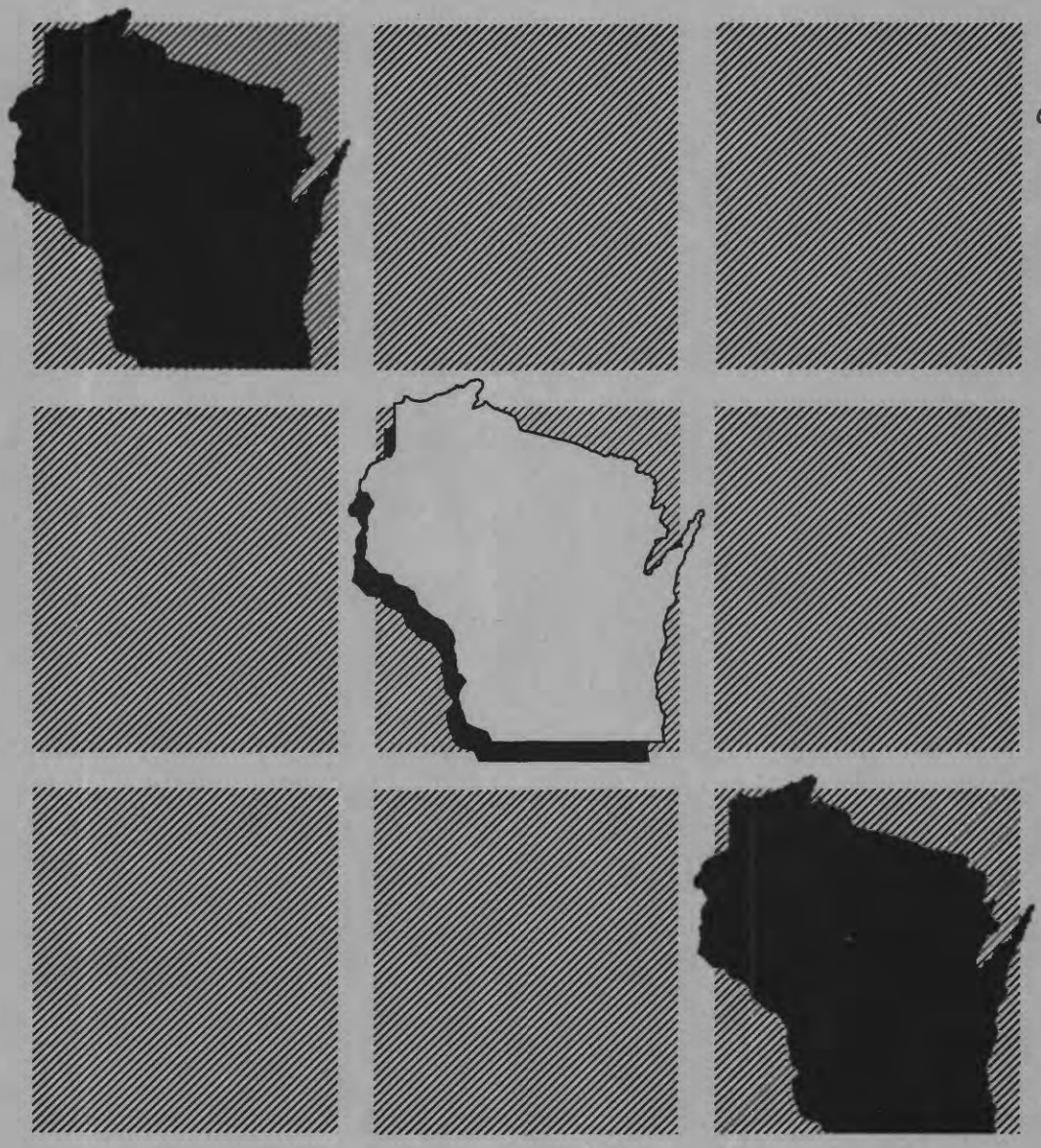
Water-Resources Investigations

■

U.S. GEOLOGICAL SURVEY
Open-File Report 98-295



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WATER-RESOURCES INVESTIGATIONS IN WISCONSIN

Compiled by D.E. Maertz

U.S. GEOLOGICAL SURVEY
Open-File Report 98-295

Middleton, Wisconsin
1998

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, *Secretary*

U.S. GEOLOGICAL SURVEY

Thomas J. Casadevall, *Acting Director*

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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.

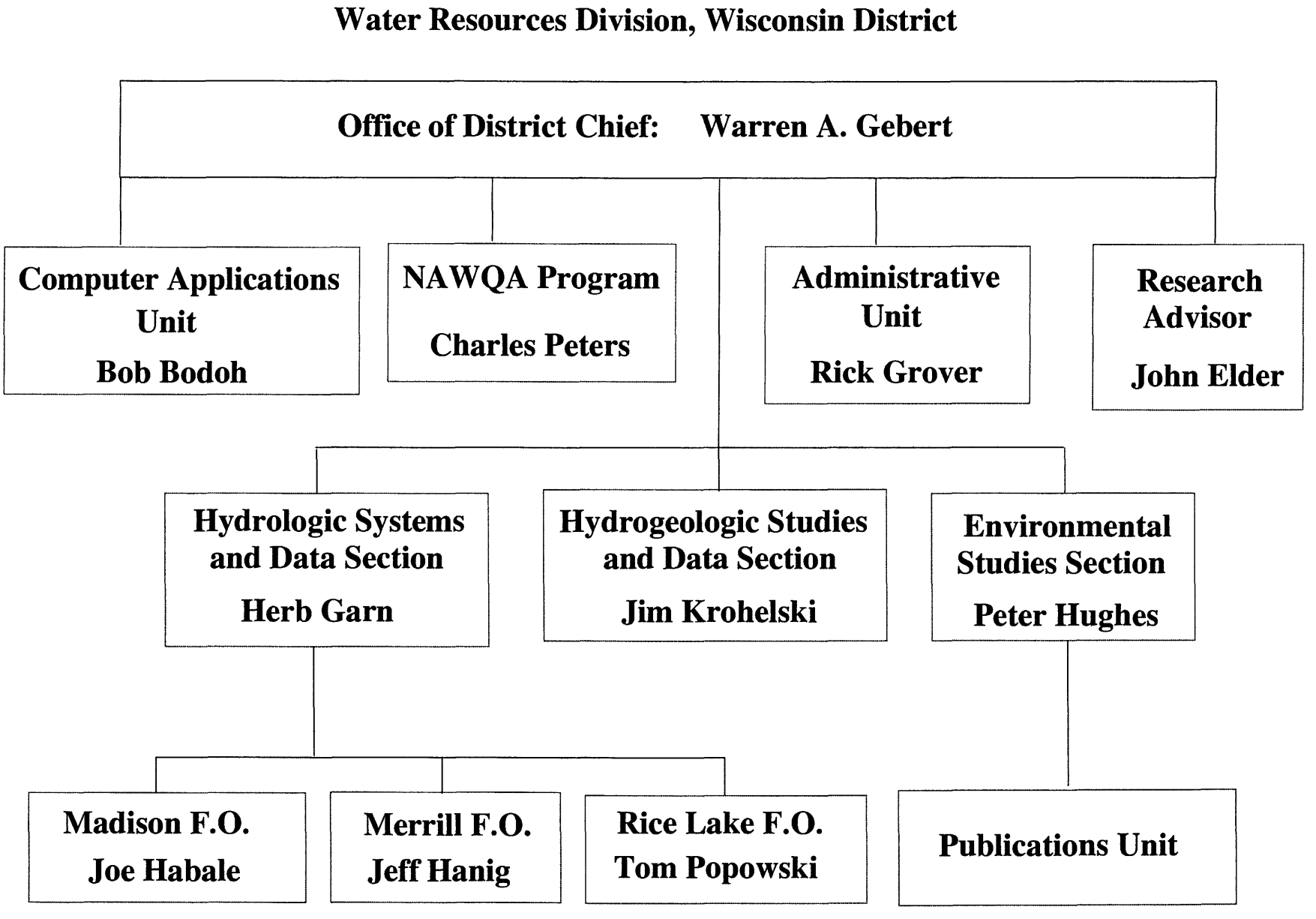


Figure 1. Organization chart of the U.S. Geological Survey, Water Resources Division, Wisconsin District.

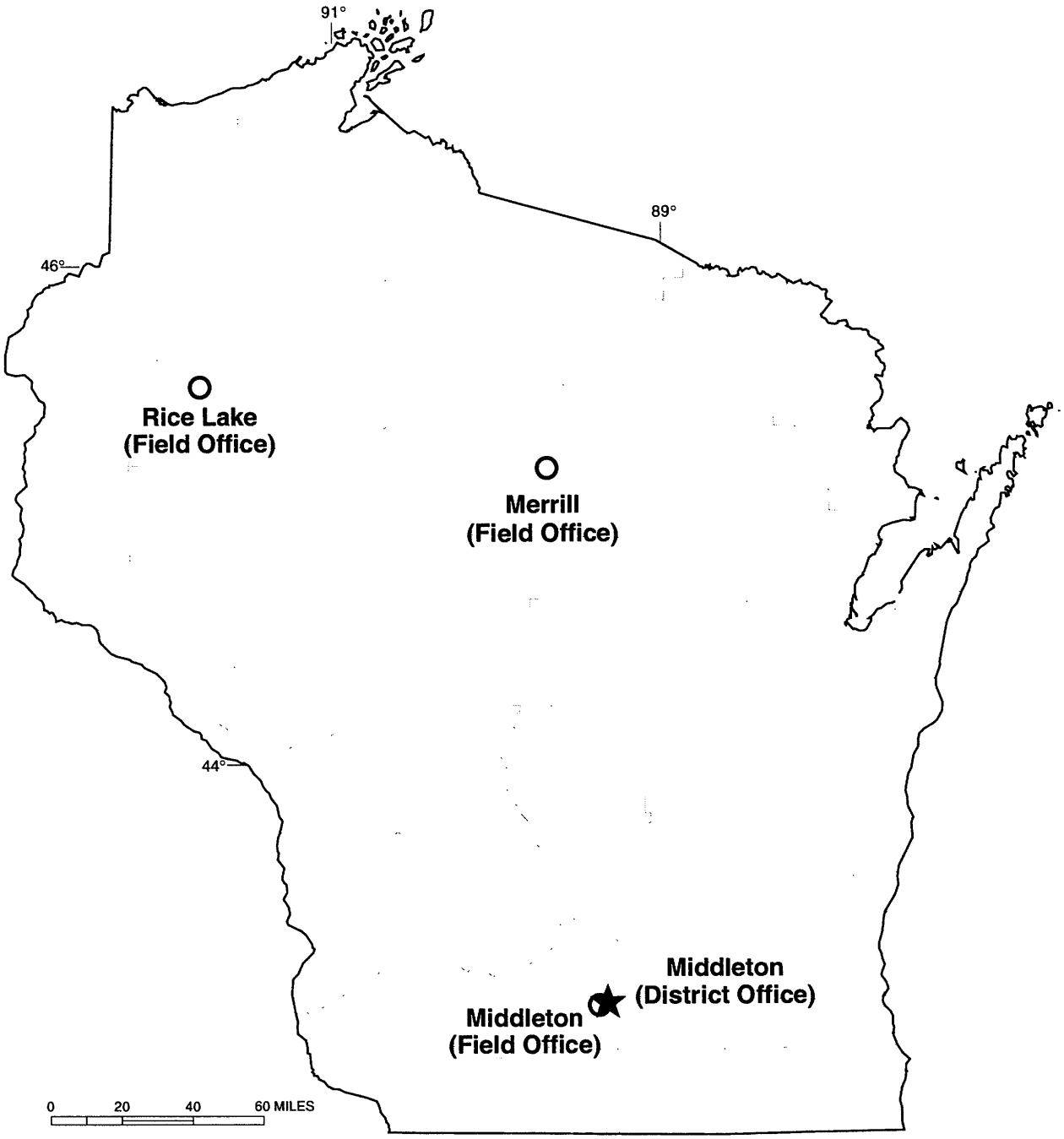


Figure 2. Location of offices in the Wisconsin District.

COOPERATORS

State Agencies
- Illinois Department of Transportation
- Minnesota Pollution Control Agency
- University of Wisconsin, Stevens Point
- Wisconsin Department of Agriculture, Trade, and Consumer Protection
- Wisconsin Department of Natural Resources
- Wisconsin Department of Tourism
- 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 Shell Lake
- City of Sparta
- City of Thorp
- City of Waupun
- County of Milwaukee
- Dane County Regional Planning Commission
- Dane County Department of Planning & Development
- Fontana/Walworth Water Pollution Control Commission
- Geneva Lake Environmental Agency
- Green Bay Metropolitan Sewerage District
- Madison Metropolitan Sewerage District
- Marathon County Highway Department
- 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
- Red Cliff Indians
- Stockbridge-Munsee Band of Mohican Indians

Lake Districts
- Benedict/Tombeau Lake Management District
- Buffalo Lake District
- City of Muskego
- Eagle Spring Lake Management District
- Green Lake Sanitary 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
- Powers Lake 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 Casey
- Town of Cedar Lake
- Town of Delavan
- Town of Namekagon
- Town of Sand Lake
- Town of Wascott
- Village of Oconomowoc Lake

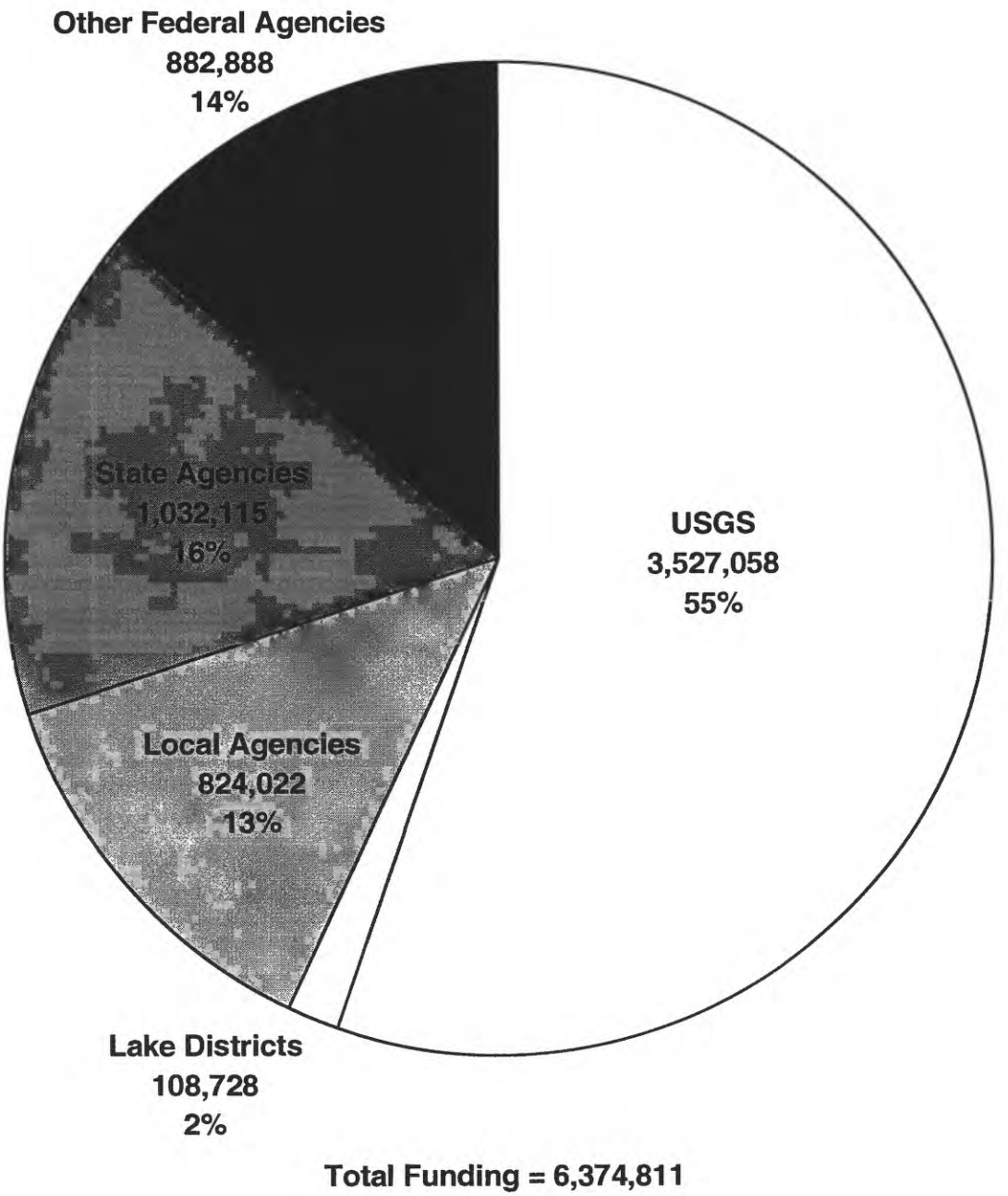


Figure 3. Funding sources for the water-resources program in Wisconsin for the 1998 fiscal year.

SUMMARY OF HYDROLOGIC CONDITIONS

Streamflow

The statewide average precipitation of 31.79 inches for the 1997 water year was the same as the normal annual precipitation of 31.79 inches for water years 1961-90. Average precipitation values ranged from 78 percent of normal at Mauston 1 SE WWTP weather station in central Wisconsin to 139 percent of normal at Menomonie WWTP weather station in west central Wisconsin (Matt Menne, Acting State Climatologist, UW-Extension, Geological and Natural History Survey, written commun., 1998).

Runoff differed for rivers throughout the State and ranged from 70 percent in southeast Wisconsin to 169 percent in west central and northwest Wisconsin. Runoff was lowest (70 percent of the average annual runoff from 1964-97) for the Root River Canal near Franklin and highest (169 percent of the average annual runoff from 1902-70, 1987-97) for the Apple River near Somerset. Departures of runoff in the 1997 water year as a percent of long-term average runoff in the State are shown in Figure 4.

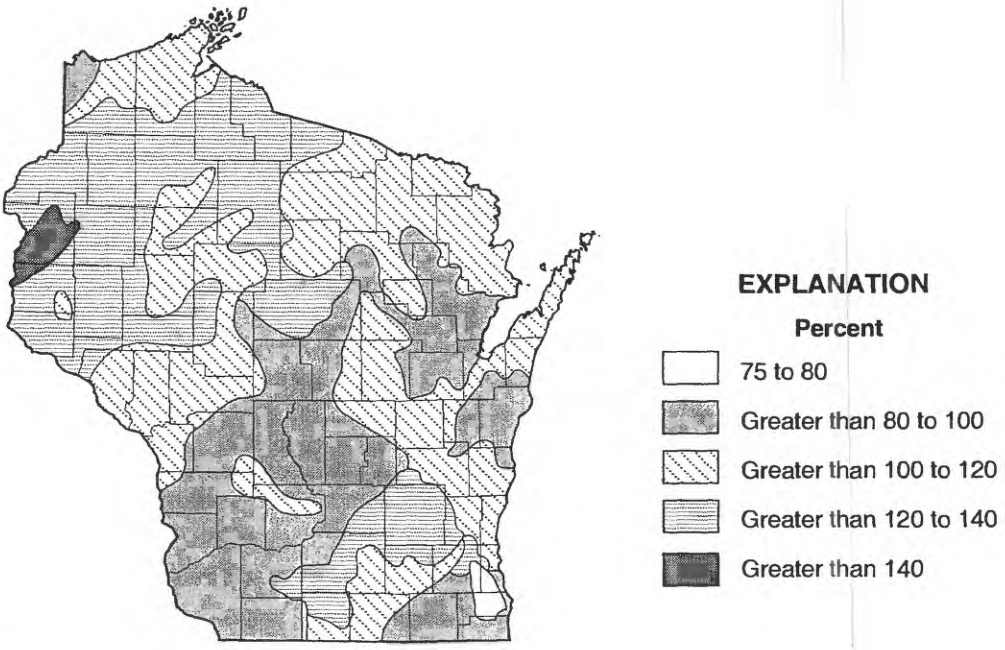


Figure 4. 1997 runoff as percent of long-term average runoff.

Annual discharges for the individual water years (1916-97) 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 1997 water year to discharge for a 82-year base period at the same three gaging stations are shown in Figure 6.

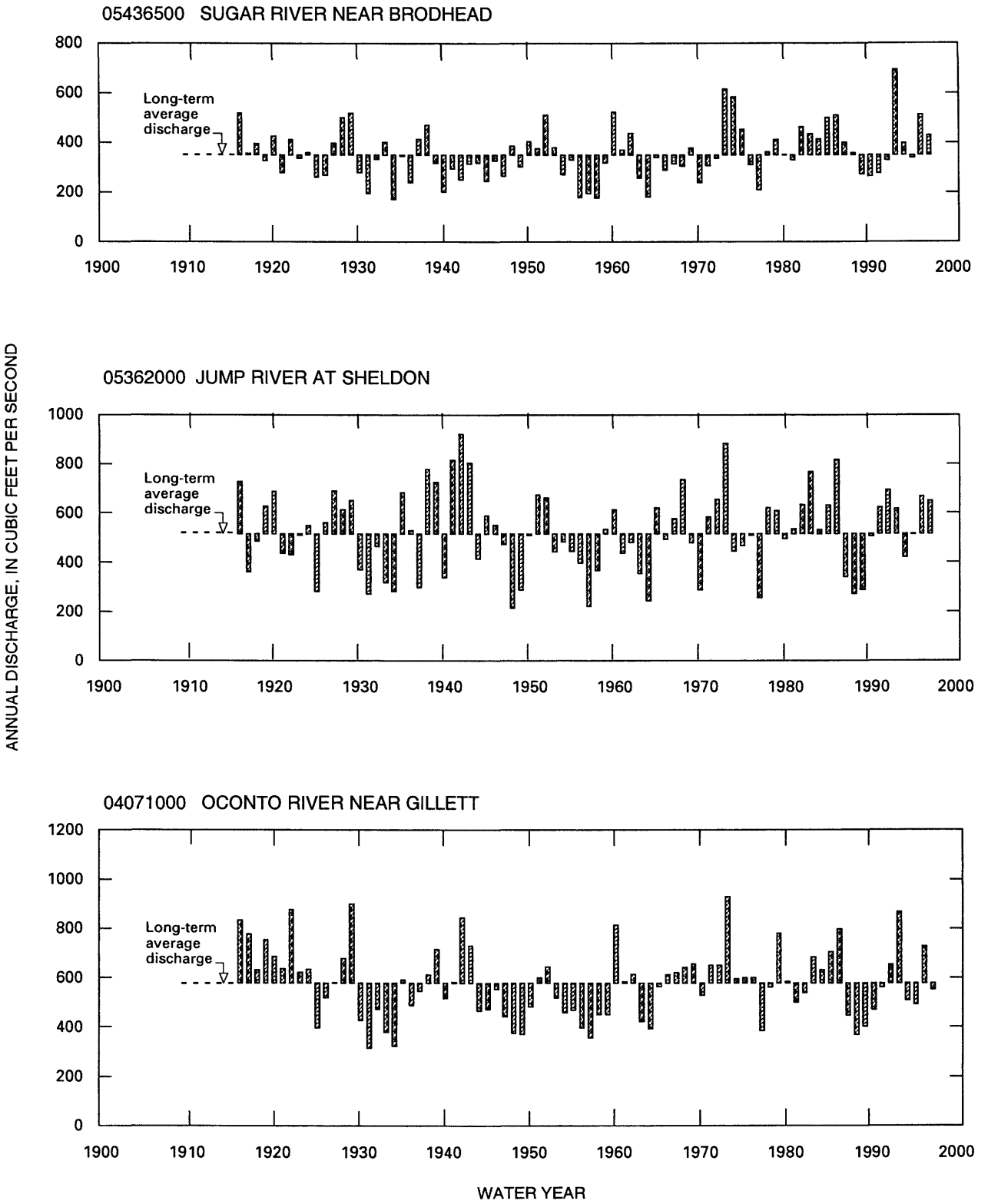


Figure 5. Comparison of annual discharge at representative gaging stations to the long-term average discharge for water years 1916–97.

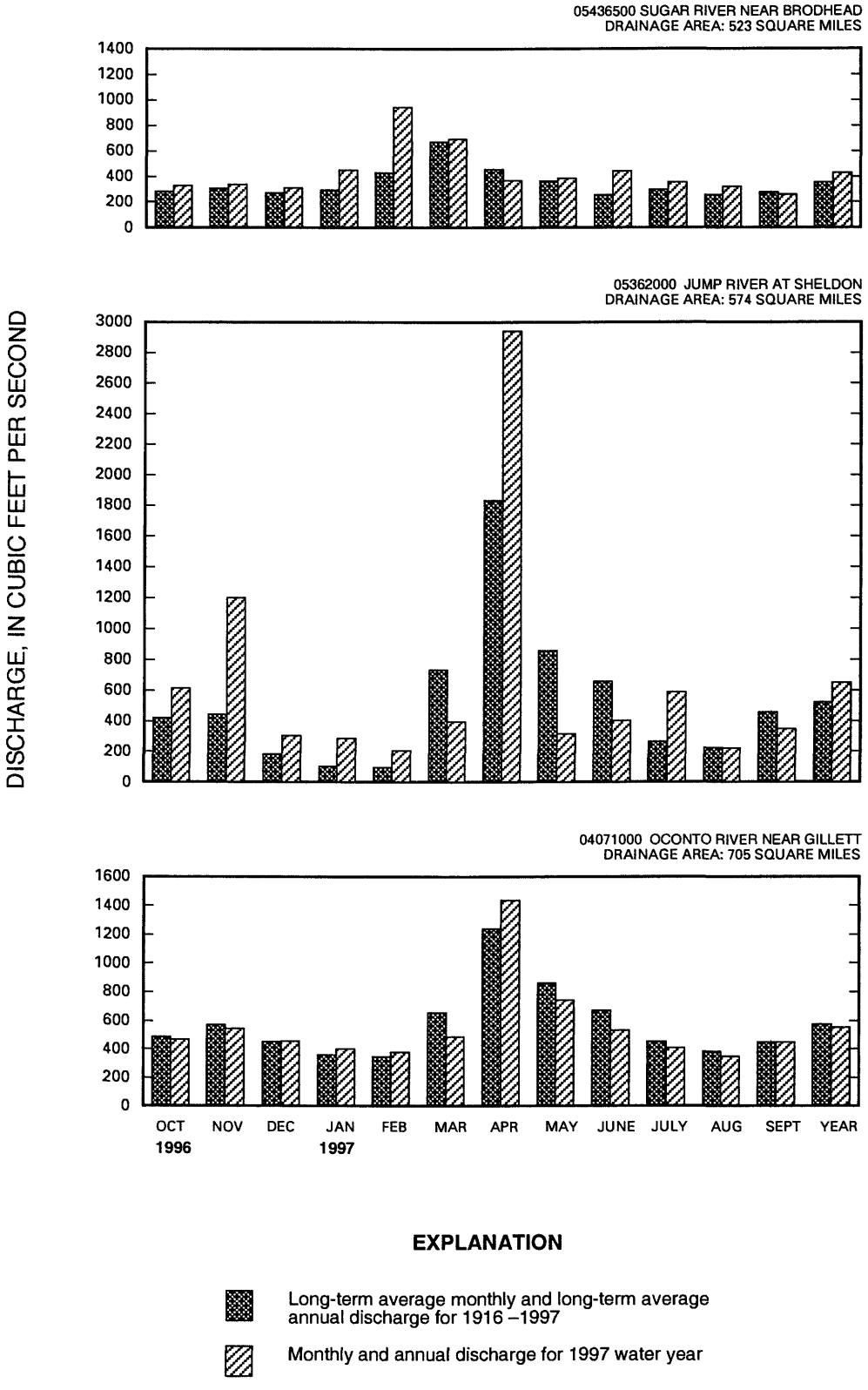


Figure 6. Comparison of discharge at representative gaging stations during 1997 water year with discharge for 1916–97.

Low flows occurred at three gaging stations where the annual minimum 7-consecutive day average flows (Q7) had recurrence intervals of 2 or more years. The three stations were located in southern 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)
04087223	Root River Canal near Franklin	Oct. 10-16	1.8	3
05414000	Platte River near Rockville	Dec. 19-25	36	2
05544200	Mukwonago River at Mukwonago	June 3-9	16	2

Runoff from snowmelt caused flooding in northern Wisconsin in early April. An isolated storm in July and major thunderstorms in June also caused floods with discharges that equalled or exceeded those with a recurrence interval of 10 years (Krug and others, 1991). Numerous thunderstorms moved through Milwaukee County on June 20 and 21 (Milwaukee Journal Sentinel, June 22, 1997) and caused major flooding. A number of communities in Milwaukee County recorded rainfall amounts of more than 6 inches for June 20 and 21, and the maximum recorded amount of 9.78 inches occurred at Brown Deer (Milwaukee Journal Sentinel, June 22, 1997). The rainfall in Brown Deer exceeded the 100-year 48-hour precipitation of between 7 and 8 inches for this area (Huff and Angel, 1992). The flooding caused at least $87.7 million in damage according to Governor Thompson. The Clinton administration declared the flooding a disaster, freeing money to help people and businesses in southeastern Wisconsin (Wisconsin State Journal, July 8, 1997). Peak discharges at 15 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)
04069700	North Fork Oconto River near Wabeno	Apr. 5	250	10
04073400	Bird Creek at Wautoma	July 17	142	15
04074850	Lily River near Lily	Apr. 5	152	15
04086000	Sheboygan River at Sheboygan	June 21	6,380	11
04087000	Milwaukee River at Milwaukee	June 21	16,500	>100
04087030	Menomonee River at Menomonee Falls	June 21	1,500	70
04087088	Underwood River at Wauwatosa	June 21	4,650	>100
04087100	Honey Creek at Milwaukee	June 21	1,100	>100
04087120	Menomonee River at Wauwatosa	June 21	13,500	85
04087204	Oak Creek at South Milwaukee	June 21	1,110	40
05332500	Namekagon River near Trego	Apr. 7	2,610	34
05340500	St. Croix River at St. Croix Falls	Apr. 8	41,200	11
05405600	Rowan Creek at Poynette	June 16	990	15
05436200	Gill Creek near Brooklyn	Feb. 19	210	15
05548150	North Branch Nippersink Creek near Genoa City	Feb. 21	295	12

References cited:

Huff, Floyd A., and Angel, James R., 1992, Rainfall Frequency Atlas of the Midwest: Midwestern Climate Center Research Report 92-03, Bulletin 71, p. 95.

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.

Milwaukee Journal Sentinel, Storm system was 'one-two punch': Milwaukee, Wis., June 22, 1997.

_____, The Big Flood of 97, Worst rain since '86 swamps metro area: Milwaukee, Wis., June 22, 1997.

Wisconsin State Journal, Flooding victims qualify for aid: Madison, Wis., July 8, 1997.

Water Quality

Suspended-sediment and total phosphorus yields for the 1997 water year at two monitoring stations in southern Wisconsin showed suspended sediment yields slightly higher than the long-term annual average and total phosphorus yields lower than the long-term average. The suspended-sediment yield at the Grant River at Burton in southwestern Wisconsin was 255 tons/mi2 (tons per square mile), or 104 percent of the average annual yield for 1978-97. The suspended-sediment yield for Jackson Creek Tributary near Elkhorn in southeastern Wisconsin for water year 1997 was 87 tons/mi2, which was 118 percent of the average annual yield for the period 1984-97. The total phosphorus yield for Jackson Creek Tributary was 318 lbs/mi2 (pounds per square mile), or 69 percent of the 1984-97 annual average.

Ground-Water Levels

Maps showing the season ground-water trends for the year (fig. 7) 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 1996; WINTER consists of measurements from January through March 1997; SPRING consists of measurements from April through June 1997; and SUMMER consists of measurements from July through September 1997. Mean seasonal water levels were compared to the long-term mean seasonal water levels. The 1997 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 1997 water year were normal to above normal for most of the wells in the State. Chippewa, Trempealeau, 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 1997 water year and normal rainfall during the previous water year.

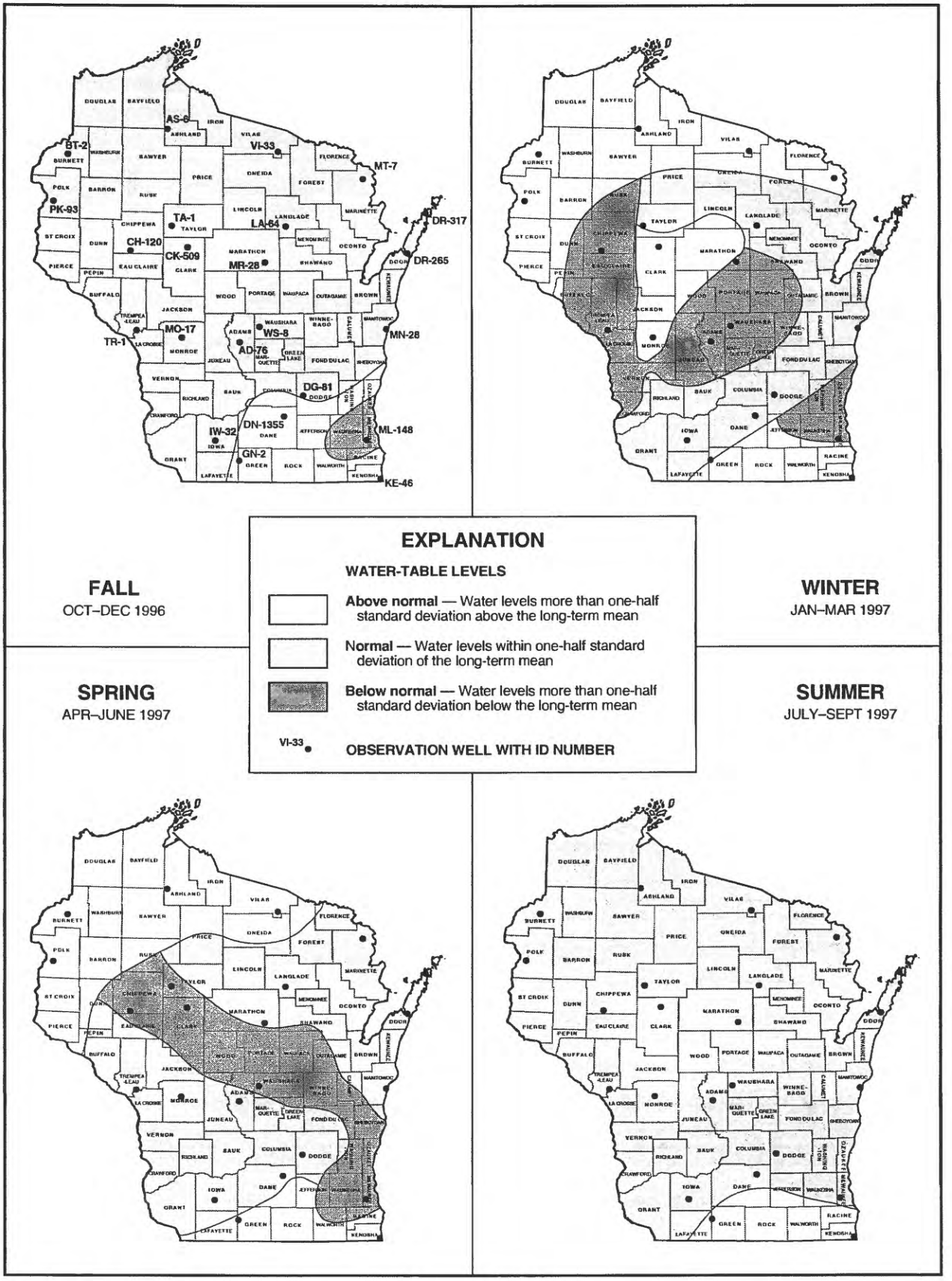


Figure 7. Relation of seasonal water-table levels to long-term means

COLLECTION OF BASIC RECORDS–SURFACE WATER, WI 001

COOPERATORS:

Wisconsin Department of Natural Resources
Wisconsin Department of Tourism
U.S. Army Corps of Engineers
Southeastern Wisconsin Regional Planning Commission
Federal (Regular)
Madison Metropolitan Sewerage District
Dane County Department of Planning and Development
Dane County Regional Planning Commission
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 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 sup-

ply 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 1997 to June 1998): During the current fiscal year, streamflow data were collected at a total of 98 sites: 32 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 Planning and Development, Walworth County Metropolitan Sewerage District, Dane County Regional Planning Commission, Wisconsin Department of Tourism, Federal Energy Commission Licensees, 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 Planning and Development, 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 location 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 1997 water year was completed, stored in our WATSTORE computer data base, and published in the annual report "Water Resources Data–Wisconsin, water year 1997". More than 100 requests for streamflow information were answered.

PLANS (July 1998 to June 1999): Data will be collected at 101 continuous-streamflow stations (see the following list) and lake levels at 6 stations. Streamflow records will be computed and data published for the 1998 water year. Requests for streamflow information will be answered.

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

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 1999 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
04067000	Menominee River - Koss, MI	3,720	1907-09, 1913-81, 1998-	FERC
04067500	Menominee River - McAllister	3,930	1945-61, 1979-86 1988-90, 1993-95, 1998-	WDNR
04067958	Peshtigo River - Wabeno	447	1998-	WDNR
04069416	Peshtigo River - Porterfield		1998-	FERC
04069500	Peshtigo River - Peshtigo	1080	1953-	City of Peshtigo
04071000	Oconto River - Gillett	705	1906-09, 1914-	Fed.
04071765	Oconto River - Oconto	966	1989-90, 1998-	WDNR
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
04084500	Fox River - Rapide Croche Dam - Wrightstown	6010	1896-	WDNR
04085200	Kewaunee River - Kewaunee	127	1964-96, 1998-	WDNR
04085427	Manitowoc River - Manitowoc	526	1972-96, 1998-	WDNR
04086000	Sheboygan River - Sheboygan	418	1916-24, 1951-	WDNR
04086500	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
04087030	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
04087160	Kinnickinnic River - Milwaukee	20.4	1976-	SEWRPC
04087204	Oak Creek - South Milwaukee	25	1964-	SEWRPC
04087220	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

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 1999 FY

Station number	Name and location	Drainage Area	Period of record (water year)	Cooperator
05393500	Spirit River - Spirit Falls	81.6	1942-	WDNR
05394500	Prairie River - Merrill	184	1914-31, 1939	WDNR
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
05401050	Tenmile Creek - Nekoosa	73.3	1963-79, 1988-94 1998-	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-	DCRPC
05407000	Wisconsin River - Muscoda	10400	1903-04, 1914-	C of E, St. Paul
05408000	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-	DCDP&D
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
DCDP&D – Dane County Department of Planning and Development
DCRPC - Dane County Regional Planning Commission
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

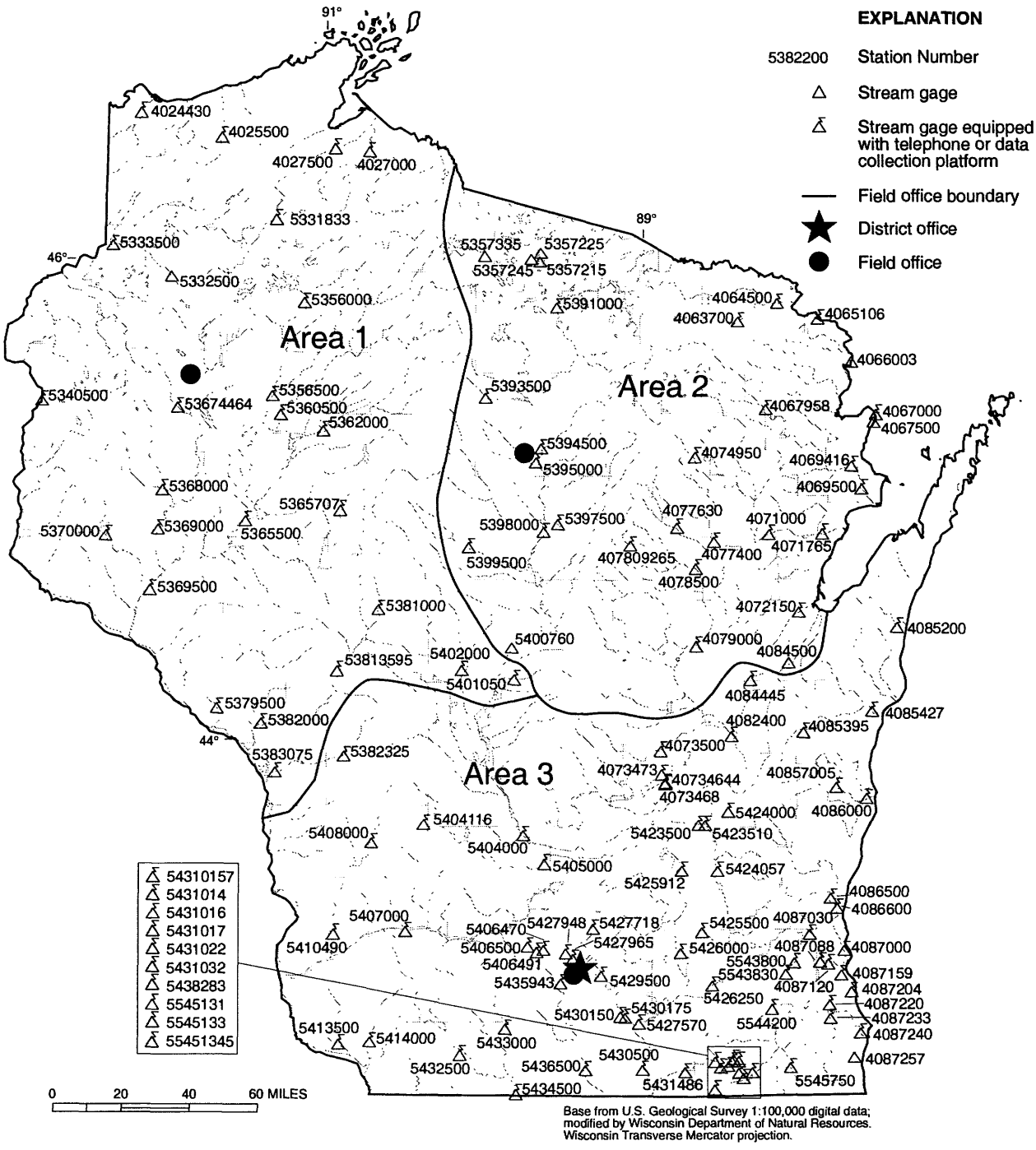


Figure 8. Location of continuous-record data-collection stations.

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
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, 1982-85
Wolf River near White Lake, WI	04075000	485	1935-38
Evergreen Creek near Langlade, WI	04075200*	8.09	1964-73
Wolf River above West Branch Wolf River, WI	04075500	616	1928-62
West Branch Wolf River at Neopit, WI	04076000	93.2	1911-17
West Branch Wolf River near Keshena, WI	04076500	163	1928-32
Little Wolf River near Galloway, WI	04079602	22.6	1974-79
Spaulding Creek near Big Falls, WI	04079700*	5.57	1964-66
Little Wolf River at Royalton, WI	04080000	507	1914-70, 1983-85
Emmons Creek near Rural, WI	04080950	25.1	1977
Storm Sewer to Mirror Lake at Waupaca, WI	04080976	0.04	1971-74
Waupaca River near Waupaca, WI	04081000	265	1916-66, 1983-85
Daggets Creek at Butte Des Morts, WI	04081800	10.6	1977
West Branch Fond du Lac River at Fond du Lac, WI	04083000	83.1	1939-54
East Branch Fond du Lac River near Fond du Lac, WI	04083500	78.4	1939-54
Brothertown Creek at Brothertown, WI	04084200	5.10	1976-77
East Twin River at Mishicot, WI	04085281	110	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	1980
Eau Claire River near Fall Creek, WI	05366500*	760	1943-55
Chippewa River at (near) Eau Claire, WI	05367000	6,620	1903-09, 1944-54
Red Cedar River near Cameron, WI	05367425	442	1966-70
Red Cedar River near Cameron, WI	05367426	443	1971-73
Red Cedar River near Colfax, WI	05367500	1,100	1914-80, 1989-90
Eau Galle River near Woodville, WI	05369900	39.4	1978-83
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 Ameson 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

Discontinued surface-water discharge stations

Station name	Station number	Drainage area (square miles)	Period of record
North Fork Nederlo Creek near Gays Mills, WI	05409830	2.21	1968-79
Nederlo Creek near Gays Mills, WI	05409890	9.46	1968-80
Kickapoo River at Gays Mills, WI	05410000	617	1914-34, 1964-77
GRANT RIVER BASIN			
Pigeon Creek near Lancaster, WI	**05413400***	**6.93**	**1964-66**
Rattlesnake Creek near Beetown, WI	05413451	45.2	1990-91
GALENA RIVER BASIN			
Little Platte River near Platteville, WI	05414213	79.7	1987-90
Sinsinawa River near Hazel Green, WI	05414800	24.9	1987-90
Pats Creek near Belmont, WI	05414894	5.42	1981-82
Madden Branch Tributary near Belmont, WI	05414915*	2.83	1981-82
Madden Branch near Meekers Grove, WI	05414920	15.04	1981-82
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 1997 to June 1998): Slug tests and geophysical logging were completed on 13 additional wells in an effort to better evaluate the network. Data routinely collected by USGS staff and data being collected by observers were evaluated. Data evaluation and preparation for the annual report, "Water Resources Data–Wisconsin", were completed.

PLANS (July 1998 to June 1999): 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 7 wells in the network, and (4) prepare a report of findings from the slug tests and geophysical logging of the 20 selected wells.

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 1997 to June 1998): Review of the ground-water flow model was completed and resulted in a revised model, which was submitted in December. Review of the revised model was initiated. Several other issues such as lakebed vertical hydraulic conductivity, reinterpretation of the glacial and saprolite pump tests to determine hydraulic parameters and the functioning of the LAK2 Code developed by GeoTrans have been addressed. Also a field investigation in the vicinity of the proposed mine to determine ambient levels of mercury in ground and surface waters was completed. Monitoring of lake stage and shallow ground-water levels adjacent to Little Sand Lake was continued.

PLANS (July 1998 to June 1999): Documents will be reviewed and meetings attended at the request of the WDNR. Review of the LAK2 Code will be completed. Initial review of the revised flow model and a revised contaminant transport model will be completed. Possibly the flow model will be revised and selected simulations run. Monitoring of lake stage and shallow ground-water levels adjacent to Little Sand Lake will be continued.

SAND CAPPING, WI 00202

PROBLEM: Contaminated subaqueous deposits are the consequence of industrial and agricultural activity along rivers and coastlines, and near harbors. Subaqueous capping is one remediation alternative for these deposits. It involves the placement of a capping layer of sediments in order to stabilize the contaminated deposits and isolate the contaminants from both the water column and bottom-feeding organisms.

The appropriateness of subaqueous capping as remediation for contaminated deposits depends, in part, on consideration of all the hydrogeological processes which are involved. To that end, USEPA Region V has requested that the USGS provide an assessment of hydrogeological parameters and processes that may be important in controlling contaminant flux through a subaqueous cap, and an evaluation of the field methods and mathematical techniques available to quantify the contaminant flux.

OBJECTIVE: The objectives are to (1) characterize the hydrogeologic settings that are favorable and unfavorable to the chemical isolation of contaminated subaqueous sediments by engineered caps, (2) establish the kind and amount of data collection needed to adequately define the pattern of solute transport from subaqueous contaminated sediments to surface water and, (3) evaluate the reliability of commonly applied analytical solutions in predicting solute transport from contaminated sediments through the cap to the surface water as a function of the hydrogeolgic setting, the site-specific data available, and the cap design.

APPROACH: An evaluation and description of the range of hydrogeologic settings that exhibit ground-water/surface-water interactions will be made by reviewing case studies. Data collection methods to define hydrogeologic parameters necessary for prediction of solute flux through a cap will be defined through a literature review. Data from existing capped sites will be compiled and used to establish uncertainty in parameter estimates arising from measurement error and natural variability.

PROGRESS (March 1998 to June 1998): The USGS conducted a literature study on ground-water/surface-water interactions pertinent to understanding the effect of a sand cap. The interactions included advection, dispersion, diffusion, hyporheic and convection processes. Case studies were assembled to show the types of data collection possible at lacustrine and fluvial sites. A preliminary first-order error analysis was performed on a typical case of PCB-contaminated deposits using an analytical transport model. Finally, a scheme for assessing the reliability of analytical models through numerical representations of diverse terrains was developed. The material was presented at the kick-off meeting before representatives of EPA, the Army Corps of Engineers and the academic community. The discussion at the meeting led to revised drafts of a detailed report outline.

PLANS (July 1998 to June 1999): The project outline and preparation of introductory sections of the report on the range of relevant hydrogeologic regimes will be completed. Construction of numerical models representative of distinct hydrogeologic regimes will be initiated.

COOPERATOR:
U.S. Environmental Protection Agency

LOCATION:
Project will draw on studies conducted throughout the United States and Canada

PROJECT CHIEF:
Daniel Feinstein

PERIOD OF PROJECT:
February 1998-September 1999

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 1997 to June 1998): The HBMN sampling was temporarily discontinued in water years 1997 and 1998 (October 1996–September 1998); however, stage and discharge measurements continued without interruption.

PLANS (July 1998 to June 1999): Data collection will resume in October 1998 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: Four streams will be monitored in Wisconsin. These streams drain areas in south central and west 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 Windsor, the Pecatonica River at Martintown and the Trempealeau River at Dodge. 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 1997 to June 1998): Water samples were collected from two streams in 1996 and four streams in 1997 to determine the concentration of diluted herbicides present during baseflow and streamflow conditions. In 1966, the two sampling sites were the Pecatonica River at Martintown and the Yahara River at Fulton. In 1997, the Yahara River at Windsor and the Trempealeau River at Dodge were added to the sampling program. During the 1996 data-collection period, atrazine was the most frequently detected herbicide. Concentrations of atrazine at the Pecatonica River ranged from 0.15 µg/L to 5.0 µg/L while atrazine concentrations at the Yahara River at Fulton ranged from 0.15 to 9.93 µg/L. During the 1997 data-collection period, concentrations of atrazine at the Pecatonica River ranged from 0.15 µg/L to 0.244 µg/L. In 1997, only one of 19 samples collected at the Yahara River at Fulton had atrazine concentrations above the detection limit compared with 8 of 14 samples above the detection limits in 1996. In 1997, all 20 samples collected at the Yahara River at Windsor and 13 of 18 samples collected at the Yahara River at Fulton had detectable concentrations of alachlor-esa. All data were summarized and published in the report "Water Resources Data–Wisconsin", water year 1997. A U.S. Geological Survey Fact Sheet 175-97 was published. This fact sheet compares herbicide concentrations and loads at the Pecatonica and Yahara River sites.

COOPERATOR:

Wisconsin Department of Agriculture, Trade and Consumer Protection

LOCATION:

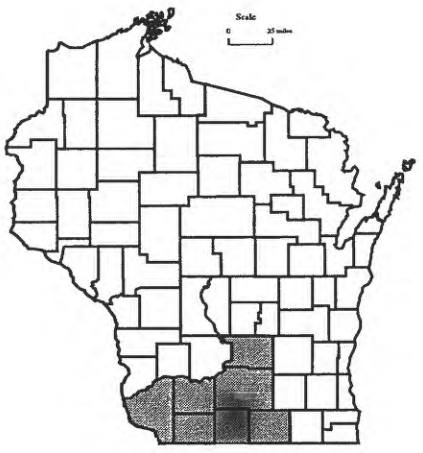
Parts of Columbia, Dane, Grant, Green, Iowa, Lafayette and Rock Counties

PROJECT CHIEF:

David J. Graczyk

PERIOD OF PROJECT:

May 1996 to September 1998



PLANS (July 1998 to June 1999): Samples will be collected at the Pecatonica, Yahara River at Fulton and Windsor, and Trempealeau River sites during the 1998 growing season. All data will be published in the report, "Water Resources Data–Wisconsin". Another 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.

REPORTS:

Graczyk, David J., and Vanden Brook, James P., 1997, Herbicides in the Pecatonica and Yahara Rivers in Southwestern Wisconsin, May 1996-July 1996, U.S. Geological Survey Fact Sheet 175-97, 4 p.

COLLECTION OF BASIC RECORDS–DANE COUNTY PROGRAM, WI 00302

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 loads for the three stations. Various water-quality constituents are measured six times during the year at base flow of selected streams in the county.

PROGRESS (July 1997 to June 1998): 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 1997 water year. Continuous-streamflow monitoring at Black Earth Creek near Black Earth was continued for the year.

Base-flow water-quality sampling was completed for Token Creek near Madison, Yahara River near Stoughton, Pheasant Branch at Middleton, and East Branch Starkweather Creek at Madison in December 1997. Base-flow sampling was begun at a new set of four streams in the county for 1998. All streamflow, load and concentration data were published in the annual data report "Water Resources Data–Wisconsin".

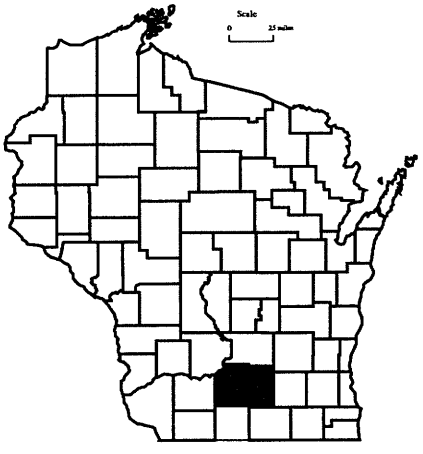
PLANS (July 1998 to June 1999): Streamflow monitoring will be continued at Black Earth Creek; streamflow and water quality monitoring will be continued at the three continuous-record sites on tributaries to Lake Mendota. Base-flow water-quality sampling will be conducted on Black Earth Creek at Black Earth, Sixmile Creek near Waunakee, Yahara River near Windsor, and Maunesha River near Sun Prairie (starting in May 1998) for the remainder of the calendar year. Records and loads will be computed. Final data will be prepared and published in the annual data report.

COOPERATOR:
Dane County Regional Planning Commission

LOCATION:
Dane County, Wisconsin

PROJECT CHIEF:
Herbert S. Garn

PERIOD OF PROJECT:
Continuing



GROUND-WATER AGE DATING IN THE LITTLE PLOVER RIVER BASIN, WISCONSIN, WI 00351

COOPERATOR:
University of Wisconsin-Stevens Point

LOCATION:
Wood County, Wisconsin

PROJECT CHIEF:
David A. Saad

PERIOD OF PROJECT:
July 1997 to June 1999

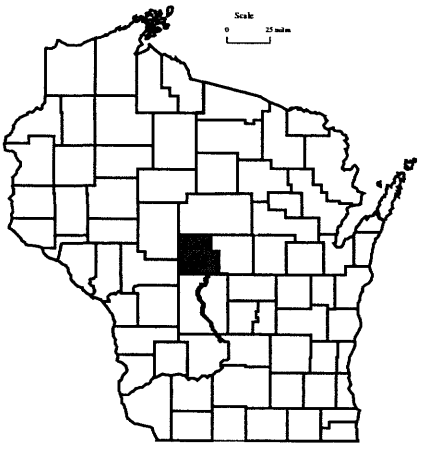
PROBLEM: The Little Plover River Basin is in one of the most highly productive irrigated agricultural regions of the Midwest United States. It has been the focus of studies relating to land use, hydrology, and water quality for over 30 years. The UW-Stevens Point, College of Natural Resources is trying to develop a way of using data from the ground-water/surface-water interface in the basin to obtain a synoptic historical view of land-use and water-quality relations at the watershed scale. Determination of ground-water ages at the ground-water/surface-water interface would provide useful information for understanding ground-water flow in the basin and for linking water quality with historic land uses.

OBJECTIVE: The objective of this study is to estimate age of ground water at the ground-water/surface-water interface at approximately 100 locations in the basin.

APPROACH: Ground-water ages will be estimated using chlorofluorocarbons (CFCs). CFCs will be collected from existing near- and in-stream networks of minipiezometers. CFC samples will be collected and analyzed using procedures and equipment developed by the USGS.

PROGRESS (July 1997 to June 1998): During July and August 1997, an initial set of 11 CFC and 4 dissolved gas samples were collected and analyzed. Dissolved gas samples are used to estimate ground-water recharge temperatures in the basin. Initial results provided reasonable ground-water ages and were included in a presentation at a meeting of the American Water Resources Association, Wisconsin Section, in March 1998.

PLANS (July 1998 to June 1999): Additional CFC and dissolved gas samples will be collected and analyzed.



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 1997 to June 1998): 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 1997 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 1998 to June 1999):

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.

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.

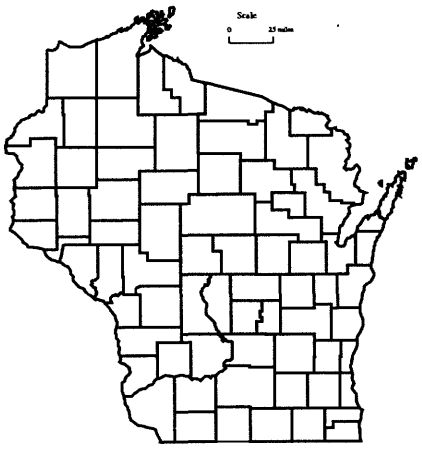
Rose, William J., and Graczyk, David J., 1996, Sediment transport, particle size, and loads in North Fish Creek in Bayfield County, Wisconsin, water years 1990-91, U.S. Geological Survey Water-Resources Investigations Report 95-4222, 18 p.

COOPERATORS:
U.S. Army Corps of Engineers

LOCATION:
Statewide

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
March 1968-Continuing



FEMA FLOOD-INSURANCE STUDY, WI 006

COOPERATOR:
Federal Emergency Management Agency

LOCATION:
Statewide

PROJECT CHIEF:
Todd D. Stuntebeck

PERIOD OF PROJECT:
March 1984-Continuing

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

OBJECTIVE: Hydrologic and hydraulic analyses will be performed 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 1997 to June 1998): Hydrologic and hydraulic analyses for Sand Lake Coulee in LaCrosse County were completed.

PLANS (July 1998 to June 1999): Response will be made to review comments on completed studies and data requests answered as needed. Work for the LaCrosse County study will be completed.

WISCONSIN WATER-USE DATA FILE, WI 007

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

OBJECTIVE: The purpose of this project is to collect accurate and complete data on Wisconsin's water use, 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 1997 to June 1998): 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. The report "Water use in Wisconsin, 1995" was published as a hydrologic atlas.

PLANS (July 1998 to June 1999): 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) estimate 1995 water use by aquifer as part of the national water-use summary.

REPORTS:

Ellefson, B.R., Fan, C.H., and Ripley, J.L., 1995, Water use in Wisconsin, 1995: U.S. Geological Survey Open-File Report 97-356, 1 sheet, scale 1:5,000,000.

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.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Statewide

PROJECT CHIEF:
Bernard R. Ellefson

PERIOD OF PROJECT:
March 1978-Continuing

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

COOPERATOR:
Wisconsin Department of Transportation-Highways

LOCATION:
Statewide

PROJECT CHIEF:
William R. Krug

PERIOD OF PROJECT:
July 1985-Continuing

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

OBJECTIVE: 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 1997 to June 1998): Annual flood peaks were computed and published in the annual data report for 66 crest-stage stations. Twenty-eight 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. A meeting was held with DOT to talk about future programs.

PLANS (July 1998 to June 1999): Another new crest-gage site in Pierce County will be selected. We will be looking for other appropriate sites for new crest gages as needs for data become apparent. As time and people are available, basin characteristics will be determined for the new crest-gage sites, as well as for regular gages that we have flood frequencies for but have not included in the regional analysis. Special efforts will be made to get measurements at the new crest-gage sites. A program will be developed in the future in consultation with DOT to develop better estimates of flood frequency at urban sites.

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.

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
04079700 Spaulding Creek near Big Falls, WI
04081900 Sawyer Creek at Oshkosh, WI

LAKE MICHIGAN BASIN

04078891 Maple Creek near Sugar Bush, WI
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
05413060 Martin Branch near Mount Ida, 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

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, WI

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

MENOMINEE TRACE ELEMENT MONITORING, WI 12301

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. 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.

OBJECTIVE: 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 1997 to June 1998)**:** Six water samples and one biological sample were collected at each of the two sites. The gaging station at Langlade was operated and discharge data published in the report, "Water Resources Data–Wisconsin". Water chemistry data collected during the 1997 water year was also published in the data report.

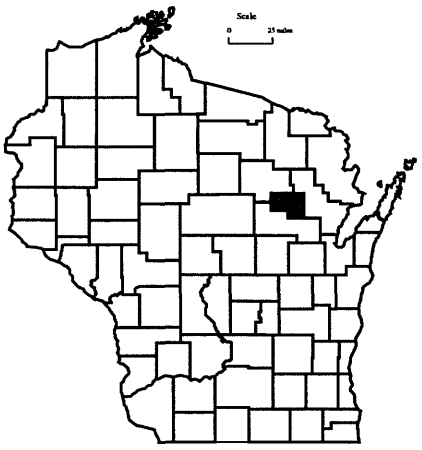
PLANS (July 1998 to June 1999): Water samples from each of the two sites will be collected in July and September. The September samples will be concurrent with the collection of biological and bed-sediment samples. This data along with the Langlade flow data will be published in the report, "Water Resources Data–Wisconsin". Sampling will be completed in September 1998. A water-resources investigations report will be published which will analyze and interpret the data collected.

COOPERATORS:
Menominee Indian Tribe of Wisconsin

LOCATION:
Menominee Indian Reservation

PROJECT CHIEF:
Kevin D. Richards
Herbert S. Garn

PERIOD OF PROJECT:
March 1996 to September 2000



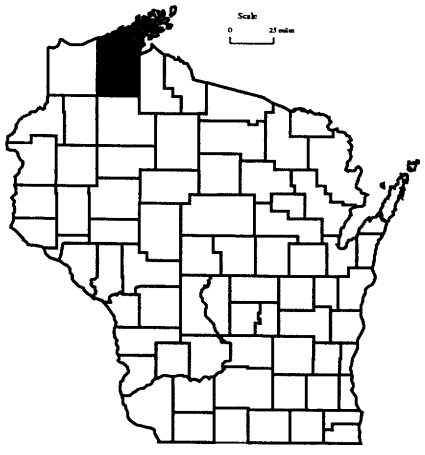
CHARACTERIZATION OF THE GROUND-WATER FLOW SYSTEM IN THE VICINITY OF THE RED CLIFF INDIAN RESERVATION, WISCONSIN, WI 12305

COOPERATOR:
Red Cliff Band of Lake Superior Chippewa Indians

LOCATION:
Bayfield County, Wisconsin

PROJECT CHIEF:
David A. Saad

PERIOD OF PROJECT:
October 1997 to September 1999



PROBLEM: Representatives of the Red Cliff Indian Tribe are interested in being able to approach water-resource management decisions with a greater understanding of the flow systems that exist in the Reservation area. Aquifer flow systems on the Bayfield Peninsula in Bayfield county are not well understood, and there has been little research to define the ground-water system in the vicinity of the Reservation. It is important for the Tribe to understand the character of the aquifers and their relation to each other and to surface-water features in order to effectively manage the resource.

Tribal representatives have expressed specific interest in an improved understanding of aquifer character and extent, a ground-water-flow model that includes the reservation area, the ability to use particle tracking for well-head protection, and the ability to address water-resource issues affecting culturally significant areas.

OBJECTIVE: It is the objective of this study to provide the Red Cliff Indian Tribe with a regional hydrogeologic framework as the basis for creating a ground-water flow model of the area in and near the Reservation. The hydrogeologic framework and flow model will aid in the understanding of ground- and surface-water systems, assist in wellhead protection programs, and be dynamic tools for managing Tribal water resources as investigations continue and future needs evolve.

APPROACH: The objectives of this study will be accomplished using a stepwise modeling approach which takes advantage of constructing a numerical ground-water-flow model early in the study to help direct the data acquisition needs. The initial flow model will be constructed based on existing geologic and hydrologic information in a large region surrounding the study area. Additional data is acquired only where the model results suggest it is needed to address the goals of the study. Acquired data will be used to improve the model input parameters and lead to a final flow model and interpretation of the flow system.

The initial ground-water-flow model will be based on the hydrogeologic framework created from existing data, including published reports and papers, available driller's construction reports and geologic logs, and unpublished data from other agencies such as the Wisconsin Geological and Natural History Survey and the Indian Health Service. Much of this work was started as part of the study entitled "Delineation of contributing areas and time of travel for water captured by wells within the Red Cliff Reservation" (project ended September 1997). However, the initial flow model for this study will incorporate an area including parts of several counties, so baseline data is needed to be collected from the entire area. The large initial flow model area is necessary to insure that proper boundary conditions are established for the larger-scale flow model in the study area of the Reservation. Analysis of results from the initial flow model will be used to determine what additional data is needed.

PROGRESS (October 1997 to June 1998): A summary of data collected and preliminary ground-water-flow modeling results for the study entitled "Delineation of contributing areas and time of travel for water captured by wells within the Red Cliff Reservation" as well as plans for the current study was presented to the Red Cliff Tribe on October 1, 1997. Available data for the regional ground-water-flow model was compiled. A summary of data collected, ground-water modeling framework, and plans for data collection was presented to the Wisconsin District Ground-Water Modeling Team (February 1998). Construction of the initial ground-water-flow model based on Ground-Water Modeling Team input began. Report outline with tentative title "Hydrogeology and simulation of ground-water flow in the vicinity of the Red Cliff Indian Reservation, Northwestern Wisconsin" was started. Planning for field work to fill in data gaps began.

PLANS (July 1998 to September 1999): Project has been suspended due to lack of funding.

ONEIDA NATION HYDROLOGIC INVESTIGATIONS, WI 12306

COOPERATOR:
Oneida Nation of Wisconsin

LOCATION:
Oneida Indian Reservation, Wisconsin

PROJECT CHIEF:
Kevin D. Richards

PERIOD OF PROJECT:
August 1997 to September 1998

PROBLEM: The Oneida Nation in Wisconsin has developed a seven-generation plan for their reservation that includes instituting land-use practices that will allow the surface-water system draining the reservation the opportunity to revert to its pre-colonial condition. Information is needed to describe the historic and current conditions of the Oneida Nation watershed. A retrospective data-base is needed to determine historic conditions and baseline water-quality sampling is needed to evaluate present surface-water conditions.

OBJECTIVE: The objective is to provide retrospective and baseline hydrologic information for the Oneida Reservation watershed. This information will be obtained from a retrospective analysis of existing literature, databases, and other information; existing geographic information system (GIS) coverages; and collection of water-quality samples to fill gaps in the retrospective database. This data will be used to determine what sites within the reservation will be chosen for ongoing, more intensive data collection in the future.

APPROACH: Sampling will be conducted at 15-17 sites to determine concentrations of major ions and nutrients. Samples will be collected at these sites during base-flow conditions at three different times of the year and during two run-off events. Sampling will be conducted at 15 sites during 2 post-planting run-off events for nutrients, major ions, and pesticides. Biological sampling and habitat studies will be conducted at five sites.

A historic database of existing water-quality information, GIS coverages, photographs and personal accounts of historic conditions will be compiled and described in a water-resources investigations report (WRIR).

PROGRESS (August 1997 to June 1998): Fifteen sites were selected to be sampled over a variety of flow and seasonal conditions. Samples were collected during late summer low flow (September), following harvest (November), and during spring break up/ snow melt (February) at 5 sites for field parameters, major ions, nutrients, immunoassays for triazine screens, and suspended sediments. Pesticides, dissolved and suspended organic carbons were collected at five of these sites. Pesticide samples, along with major ions and nutrients were collected at all 15 sites during the first major run-off event following planting (June). Literature search results, a summary of previously collected data in the watershed, and stiff diagrams for data collected from the summer low-flow sampling were included in an end of year summary report. Data collected in September 1997 was published in the report, "Water Resources Data–Wisconsin".

Biological data was collected in May at five sites for benthic invertebrate communities, algae, and habitat.

An outline for the Oneida retrospective report was prepared and approved. The Oneida Nation administered a survey related to past flow and water quality of the reservation to 206 tribal members. A number of questions included in the survey were prepared by the USGS. Survey results are being entered into a database by Oneida staff and will be summarized in the retrospective WRIR.

An informal meeting with U.S. Fish and Wildlife, the Oneida Nation, and study personnel to discuss ongoing work in the basin and common goals was held February 11, 1998.

PLANS (July 1998 to June 1999): Samples from 15 sites will be collected during summer baseflow, a summer storm runoff, and post-harvest baseflow for nutrients, triazine screens, and suspended sediment. Data from samples collected from October 1, 1997, through September 30, 1998, will be published in the report, "Water Resources Data–Wisconsin". A fish community survey will be conducted in August. A WRIR of retrospective data and a WRIR of analysis of data collected at the 15 sites will be published. Three to seven sites will be selected for continuous monitoring of flow and monthly water-quality sampling.

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 1998

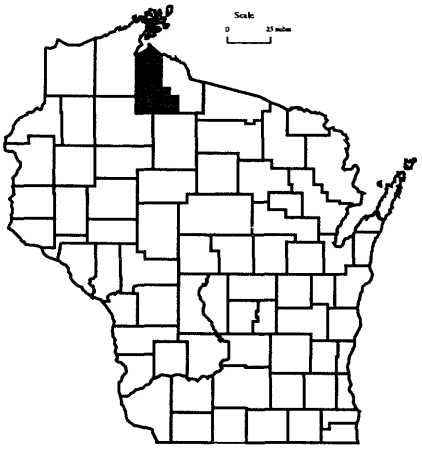
PROBLEM: There is a general need to characterize and define the hydrology and water quality of reservation areas. Current and future site-specific investigations concerned with long-term water-resource and water-quality trends require an adequate regional hydrogeologic framework.

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 1997 to June 1998): The approval process for drill sites has been completed by the Tribe. Boreholes have been drilled for aquifer characterization at three sites in the northern part of the reservation. Rock cores have been collected from one borehole and all have been geophysically logged.

PLANS (July 1998 to September 1998): Selected zones in boreholes at two sites will be packer tested to assess the hydrogeologic 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 1997 water year:
Eagle Spring, Little Cedar, Little Green, Middle Genesee, Montello, Okauchee, Potter, Pretty, Silver, Twin (Marie and Elizabeth), Wind, and Wolf Lake Districts; city of Muskego (Big Muskego, Denoon, and Little Muskego Lakes); townships of Casey (Big, Middle, and Lower McKenzie Lakes); and Cedar Lake (Balsam, Red Cedar and Hemlock Lakes); and village of Oconomowoc Lake (Oconomowoc Lake)

In the 1998 water year:
Benedict/Tombeau, Buffalo, Eagle Spring, Little Cedar, Little Green, Middle Genesee, Montello, Okauchee, Potter, Powers, and Wind Lake Districts; city of Muskego (Big Muskego and Little Muskego Lakes); townships of Casey (Big, Middle, and Lower McKenzie Lakes), Cedar Lake (Balsam, Red Cedar and Hemlock Lakes); Namekagon (Namekagon Lake); Sand Lake (Big Sissabagama); and Wascott (Whitefish 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 (1) 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:

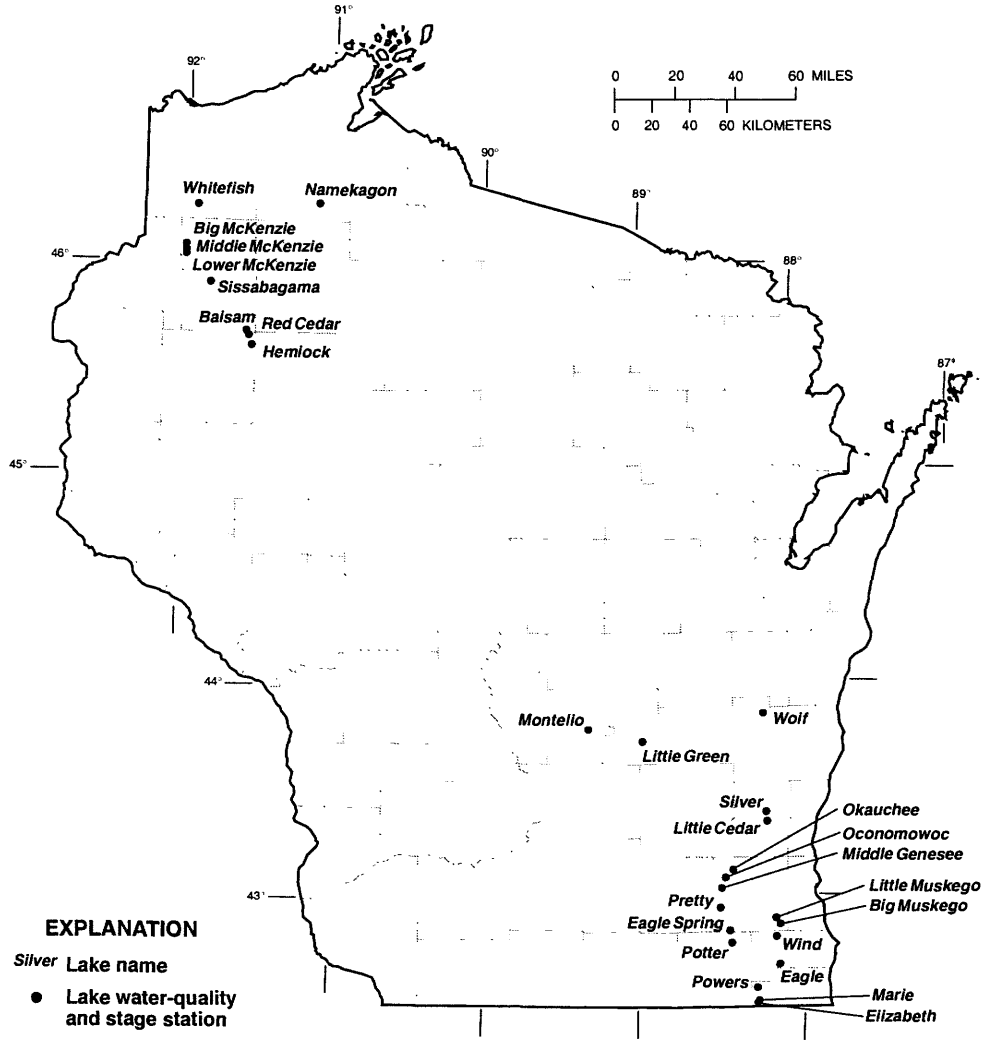
William J. Rose

PERIOD OF PROJECT:

June 1983-Continuing

PROGRESS (July 1997 to June 1998): In the 1997 water year, total phosphorus, chlorophyll *a*, dissolved oxygen, temperature, pH, specific conductance, and Secchi-depth data were collected and analyzed for 23 lakes. A letter evaluating the water quality of each lake was sent to the respective cooperator. In the 1998 water year, Benedict, Big Sissabagama, Buffalo, Namekagon, Powers, Tombeau, and Whitefish Lakes were added to the program. Balsam, Big Hills, Elizabeth, Hemlock, Mary, Pretty, Silver and Wolf Lakes were dropped from the program. The locations of lakes included in the monitoring program for water years 1997-98 are shown on the following map.

PLANS (July 1998 to June 1999): In the 1998 water year, 22 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 1998".



Note: at some lakes more than one site may be monitored.

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 1997 to June 1998): Work continues on a series of reports characterizing the Galena-Platteville bedrock unit of Wisconsin and northern Illinois.

PLANS (July 1998 to June 1999): 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.

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

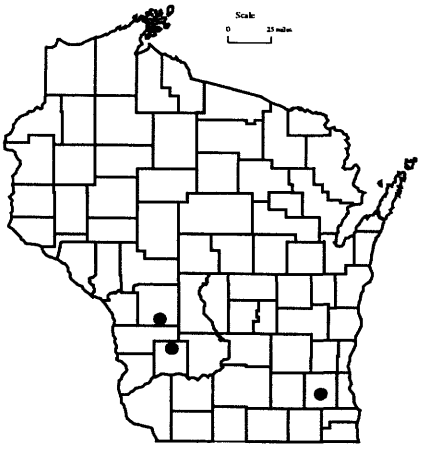
HYDROLOGIC INVESTIGATIONS OF WETLAND RESTORATION AND CREATION PROJECTS, WI 170

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 1997 to June 1998): Geochemical sampling and physical measurements continued and showed that, similar to other chemical constituents, methylmercury distributions had distinct trends in the wetland subsurface. The dissolved organic carbon from the constructed wetland was comprised of significantly different characteristic fractions than the adjoining natural wetland due presumably to different vegetation type and length of time for decomposition. Two journal articles describing the importance of hydrochemical heterogeneity and the use of stable isotopes to investigate wetlands were published. One additional journal article describing the importance of ground-water discharge to wetlands was approved for publication.

PLANS: The project is complete.

REPORTS:

Hunt, R.J., Bullen, T.D., Krabbenhoft, D.P., and Kendall, C., 1998, Using stable isotopes of water and strontium to investigate the hydrology of a natural and a constructed wetland, Ground Water 36(3), p. 434-443.

Hunt, R.J., Krabbenhoft, D.P., and Anderson, M.P., 1997, Assessing hydrogeochemical heterogeneity in natural and constructed wetlands, Biogeochemistry 39, p. 271-293.

Hunt, R.J., Krabbenhoft, D.P., and Anderson, M.P., 1996, Groundwater 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, 17213

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 1997 to June 1998): Streamflow and water-quality monitoring were continued at three sites in the priority watersheds. Dissolved oxygen was monitored at two sites in the priority watersheds. All the data were summarized and will be published in the report "Water-Resources Data–Wisconsin". Water-quality loads were calculated for selected parameters and storm periods. Land-use inventories were completed for each basin

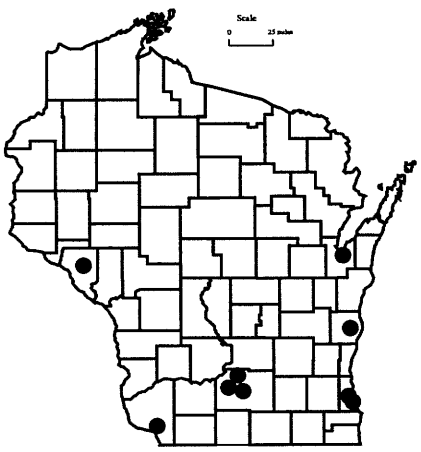
PLANS (July 1998 to June 1999): Streamflow and water quality will be continued at two sites until October 1998 and then discontinued. Water-quality loads for selected parameters and storm periods will be calculated and compared to data collected in previous years. The data will be analyzed to determine if there are any apparent trends in water quality during implementation of best-management plans. A report will be prepared. At one site water-quality samples will be collected weekly during the period of April-October, bi-weekly in March and November, and monthly during December, January, and February. Land use 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:

Wierl, J.A., Giddings, E.M., and Bannerman, R.T., 1998, Comparison of annual loads of phosphorus in storm runoff from barnyard and cropland sources to the Otter Creek Watershed, Wisconsin, U.S. Geological Survey Fact Sheet (in press).

Corsi, S.R., Graczyk, D.J., Owens, D.W., and Bannerman, R.T., 1997, Unit-area loads of suspended sediment, suspended solids, and total phosphorus from small watersheds in Wisconsin: U.S. Geological Survey Fact Sheet 195-97, 4 p.

Greb, Steven R., and Graczyk, David J., 1995, Frequency-duration analysis of dissolved-oxygen concentrations in two southwestern Wisconsin streams, Water Resources Bulletin v. 31, no. 3, p. 431-438.

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 (BMPs) 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 BMPs 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 BMPs in several basins in Wisconsin.

PROGRESS (July 1997 to June 1998): Results from unit-area load analysis was published as a fact sheet and distributed. Results from investigation of sources of phosphorus load in Otter Creek were reviewed and approved for publication as a fact sheet. Annual progress report describing data collected through water year 1997 was reviewed and approved. Analysis synthesizing physical, chemical and biological data for one evaluation-monitoring watershed was begun. All data through water year 1997 was included in the Oracle database.

PLANS (July 1998 to June 1999): Otter Creek phosphorus load fact sheet will be published and distributed. Annual progress report describing data collected through water year 1997 will be completed and published. BMP synthesis open-file report will be published and distributed. Work incorporating snowmelt loads into regression analysis will be completed.

REPORTS:

Walker, J.F., Corsi, S.R., Graczyk, D.J., and Wierl, J.A., 1998, Evaluation of nonpoint-source contamination, Wisconsin: selected data for water year 1997, U.S. Geological Survey Open-File Report (in press).

Corsi, S.R., Graczyk, D.J., Owens, D.W., and Bannerman, R.T., 1997, Unit-area loads of suspended sediment, suspended solids, and total phosphorus from small watersheds in Wisconsin, U.S. Geological Survey Fact Sheet 195-97.

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION:

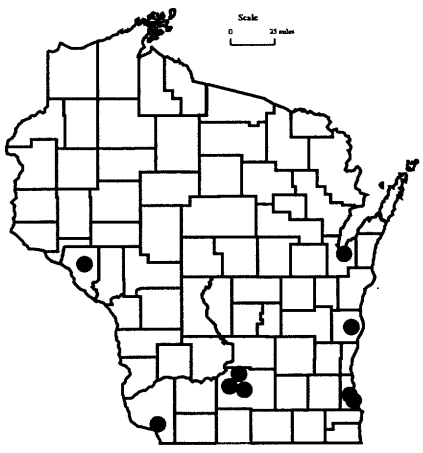
State of Wisconsin

PROJECT CHIEF:

John F. Walker

PERIOD OF PROJECT:

October 1989 to September 1997



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).

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

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.

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 (BMPs). 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 BMPs. 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 BMPs in treating that same source.

APPROACH: Water-quality samples will be collected upstream and downstream from a single nonpoint-pollution source before and after implementation of BMPs. Water-quality samples are generally collected bi-weekly during open-water periods, and monthly during the winter months. In addition, water-quality samples are collected with automated water samplers during selected periods of storm runoff. Water-surface levels are continuously monitored at the sites, and a continuous discharge record is determined from water-surface/discharge relations.

Two barnyard-runoff sites have been investigated—Otter Creek in the Sheboygan River Priority Watershed and Halfway Prairie Creek in the Black Earth Creek Priority Watershed. Parsons Creek, an additional single-source site that is currently under investigation in the Lake Winnebago Priority Watershed, is targeted at evaluating both a barnyard BMP system and a streambank erosion BMP.

PROGRESS (July 1997 to June 1998): Samples were collected for 12 storm-runoff periods at Otter Creek and 11 storm-runoff periods at Halfway Prairie Creek before BMP implementation. After BMP implementation, samples were collected for 15 storm-runoff periods at Otter Creek and 11 storm-runoff periods at Halfway Prairie Creek. The results from these two investigations have been published in a USGS fact sheet.

Results from statistical tests revealed that, for the pre-BMP period at both Otter and Halfway Prairie Creeks, downstream loads of total phosphorus, ammonia, biochemical oxygen demand (BOD), and microbial loads of fecal coliform bacteria were significantly greater than upstream loads. At Otter Creek, pre-BMP downstream loads of suspended solids also were significantly greater than those upstream.

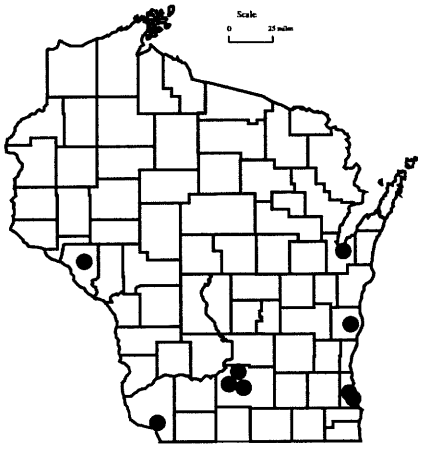
Since implementation of barnyard BMPs, the data collected have shown significant reductions in the loadings of most constituents coming from each barnyard. At both creeks, post-BMP loads of total phosphorus, ammonia, and BOD contributed by the barnyard were statistically lower than pre-BMP loads. In addition, post-

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
State of Wisconsin

PROJECT CHIEF:
Todd D. Stuntebeck

PERIOD OF PROJECT:
March 1994-Continuing



BMP loads of suspended solids and microbial loads of fecal coliform bacteria at Otter Creek were also statistically lower than in the pre-BMP period. The barnyard BMP system at Otter Creek has reduced loads of suspended solids by 85 percent, total phosphorus by 85 percent, ammonia by 94 percent, BOD by 83 percent, and microbial loads of fecal coliform bacteria by 81 percent; the respective loads at Halfway Prairie Creek have been reduced by 47, 87, 95, 92, and 9 percent.

Data collection for the project at Parsons Creek began in October 1997. To date, water samples for five storm-runoff periods have been collected, and eight base flow samples have been collected.

PLANS (July 1998 to June 1999): Bi-weekly baseflow and storm-runoff samples will be collected at Parsons Creek. We will search for more potential single-source sites.

REPORTS:

Stuntebeck, T.D., and Bannerman, R.T., 1998, Effectiveness of barnyard best management practices in Wisconsin: U.S. Geological Survey Fact Sheet 051-98, 4 p.

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.

DISTRIBUTION OF LOADING, WI 17222

PROBLEM: The distribution of daily constituent loading throughout the year is important for design and evaluation of best management practices. Is most of the annual constituent load generated by snowmelt runoff during a few days in spring of the year or is most of the annual constituent load generated by intense thunderstorms during the summer? How much does the distribution of daily constituent load vary from year to year and from site to site? Does the portion of the annual constituent load vary seasonally from year to year and from site to site?

OBJECTIVE: Objectives are to (1) determine the cumulative distribution of daily constituent loadings and examine the differences over time and between sites and (2) determine the seasonal distribution of annual loads.

APPROACH: Daily constituent loads from the evaluation monitoring sites will be used as the data set. Loads have been calculated at 8 rural evaluation monitoring sites with 6-8 years of data at each site. The cumulative distribution of daily constituent loadings will be determined for each site and for each year. The portion of annual load attributed to seasons selected will be determined and compared over time and between sites.

PROGRESS (July 1997 to June 1998): Data was compiled for the eight rural evaluation monitoring sites. Cumulative distribution of daily constituent loadings for each site and year was determined.

PLANS (July 1998 to June 1999): Analyses will be completed and final report prepared. Results will be published as a U.S. Geological Survey fact sheet.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Statewide

PROJECT CHIEF:
David J. Graczyk

PERIOD OF PROJECT:
July 1997 to June 1998

MULTI-STREAM EXPERIMENTAL DESIGN, WI 17223

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Fond du Lac, Manitowoc, Ozaukee, Sheboygan, Washington, and Walworth Counties

PROJECT CHIEF:
John F. Walker

PERIOD OF PROJECT:
October 1997 to June 1999

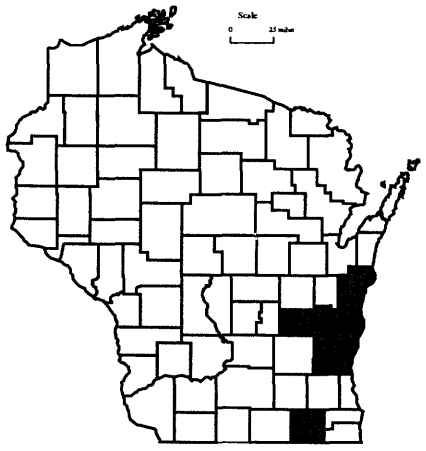
PROBLEM: The amount of best management practice (BMP) implementation at evaluation monitoring sites is currently much less than anticipated, and implementation is taking longer than expected. Results on a shorter time scale are needed to evaluate the overall nonpoint-source program.

OBJECTIVE: Objective is to investigate feasibility of sampling a large number of sites (20-60) for a short period of time (1-2 years) to determine the effectiveness of BMPs.

APPROACH: The sites to be considered are chosen to cover a wide range of BMP implementation. For selected evaluation-monitoring sites, annual loads will be computed with a reduced data set and compared to the actual load to determine uncertainty in annual loads for a particular sampling scheme. A statistical analysis will determine the minimum number of sites needed to demonstrate a significant relation between load reduction and BMP implementation.

PROGRESS (July 1997 to June 1998): Feasible sites were selected and the overall watershed characteristics, including BMP implementation status, were summarized. Uncertainty in annual loads based on various sampling strategies was determined for selected evaluation-monitoring sites. The overall statistical analysis was begun.

PLANS (July 1998 to June 1999): Statistical analysis will be completed. Results will be published in an open-file report.



EVALUATION OF SIPHON SAMPLERS, WI 17225

PROBLEM: Nonpoint water-quality studies have used automatic water samplers to collect samples for laboratory analysis. These analyses are subsequently used to calculate constituent-load and are used to evaluate the effectiveness of best management practices. Intense sampling during both the rising and falling limbs of the hydrograph are needed to calculate accurate storm loads. This approach is cost-effective for a limited number of evaluation sites. For evaluation work at a large number of sites, use of automatic water-quality samplers and estimation of storm loads would be cost prohibitive. Thus for evaluation work at numerous sites the use of single-stage (siphon) samplers and estimation of annual loads is more realistic.

Siphon samplers have been used and tested in other parts of the country. A test in New Mexico under controlled conditions found that suspended-sediment concentrations were all less than 5 percent different from actual stream concentrations. Concentrations of the suspended sediment were less than 30,000 mg/L and 90 percent of the material being transported was in the silt and clay-size fraction (Dewey, U.S. Geological Survey written communication, 1979). Several siphon samplers can be installed at a site to collect samples at varying stream stages. Siphon samplers have been used in Wisconsin but have not been rigorously tested for accuracy.

OBJECTIVE: The objectives are to test the accuracy of siphon samplers to collect samples in Wisconsin and determine if concentrations of suspended sediment, total phosphorus and ammonia nitrogen at nearly concurrent times and stream stages for siphon samplers are the same as the concentrations for samples collected with automatic samplers

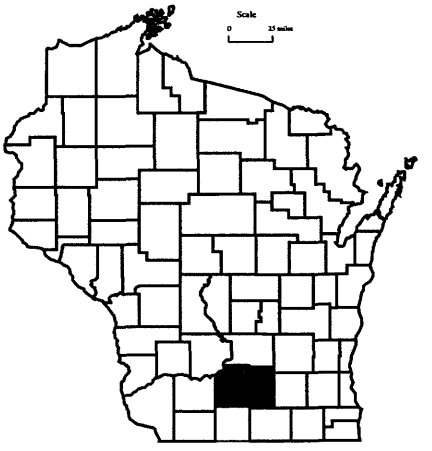
APPROACH: Siphon samplers will be installed at three sites: Garfoot, Brewery, and Pheasant Branch Creeks. Automatic water-quality samplers are operating and collecting water-quality samples for other studies at these sites. Samples collected by the siphon samplers will be compared to samples collected by the automatic water-quality samplers. Concentrations of suspended sediment, total phosphorus and ammonia nitrogen at nearly concurrent times and stream stages for the siphon samplers will be compared to concentrations for the automatic samplers. Additional evaluation of siphon samplers will be accomplished by employing a hand-held siphon sampler. This sampler will be used to collect samples manually, and compared to concurrent equal-width increment and automatic sampler samples. The concentrations of these three samples will then be compared.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Dane County, Wisconsin

PROJECT CHIEF:
David J. Graczyk

PERIOD OF PROJECT:
July 1997 to June 1998



PROGRESS (July 1997 to June 1998): Siphon samplers were installed at three sites, Garfoot Creek, Brewery Creek and Pheasant Branch Creek. Eighteen samples were collected at the three sites. For one storm at Pheasant Branch Creek, a sample collected by the siphon sampler had a concentration of 0.354 mg/L for ammonia nitrogen and 0.419 mg/L for total phosphorus. The concurrent samples from the automatic sampler had concentrations of 0.345 mg/L for ammonia nitrogen and 0.457 mg/L for total phosphorus. Another sample collected by the siphon sampler had a concentration of 0.188 mg/L for ammonia nitrogen and 0.321 mg/L for total phosphorus. The sample collected concurrently with the automatic sampler had an ammonia nitrogen concentration of 0.207 mg /L and a total phosphorus concentration of 0.471 mg/L.

PLANS (July 1998 to June 1999): Continue to collect samples until July 1, 1998. Results of the study will be summarized in a USGS fact sheet. Constituent concentration will be published in the report, "Water Resources Data–Wisconsin", and archived in the USGS water-quality and streamflow data bases.

CONCENTRATION OF SOLIDS AND PHOSPHORUS IN STREET GUTTERS, MADISON, WISCONSIN, WI 17227

PROBLEM: Previous studies conducted by the Wisconsin district utilized source-area samplers that were installed about 6 feet from street curbs to determine concentrations in street runoff. These samplers collected runoff that ran from the crown of the street to about 6 feet from the curb. Because of this placement, the runoff from the curb to 6 feet into the street was not monitored. Previous studies, visual inspections and modeling efforts have indicated that the area within a few feet of the curb could contain significantly higher pollutant levels. If the near-curb areas do contain higher amounts of pollutants, then the previous studies may be significantly underestimating the contributions from streets.

OBJECTIVE: The objectives of the investigation are to compare the solids and phosphorus concentrations found in street runoff collected using source-area samplers installed 6 feet out from street curbs to those collected using an ISCO sampler which collects water directly from street curbs and determine if source-area samplers located away from street curbs underestimate concentrations for the entire street.

APPROACH: Stormwater runoff samples will be collected from 12 storms at 5 street sites in Madison, Wisconsin. Each of these storms will have samples from an ISCO sampler collecting water directly from the gutter and from a source-area sampler collecting water from about 6 feet from the curb. The concentration values obtained from each of these samplers will be compared.

PROGRESS (July 1997 to February 1998): The sampling equipment was installed at all sites. Two event samples were collected at two of the sites, one sample was collected at one of the sites and no samples were collected at two of the sites before the sites were shut down for the winter.

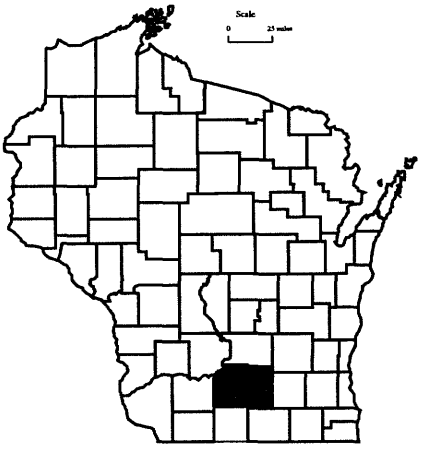
PLANS (March 1998 to September 1998): Reactivate the sites, collect the remaining runoff samples and compile the data in an Excel spreadsheet. The concentration data with a short description of the sampling equipment and locations will be provided to WDNR at the conclusion of the study.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Dane County, south-central Wisconsin

PROJECT CHIEF:
Robert J. Waschbusch

PERIOD OF PROJECT:
July 1997 to September 1998



HYDROLOGY AND WATER QUALITY OF THREE PASTURES IN SOUTHWESTERN WISCONSIN, WI 17229

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION
Sauk County, Wisconsin

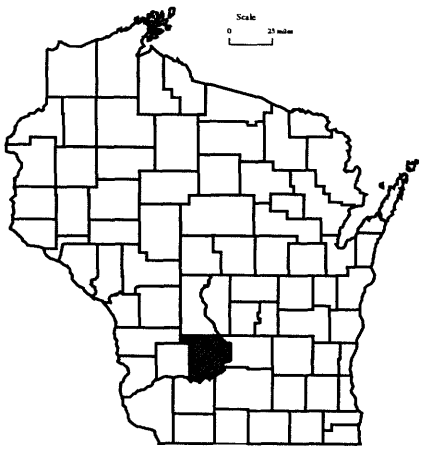
PROJECT CHIEF:
David J. Graczyk

PERIOD OF PROJECT:
October 1997 to September 1999

PROBLEM: Nonpoint source pollution is a major concern in Wisconsin. There are approximately 24,000 dairy farms in Wisconsin which may be a source of sediment, nutrients and pesticides to surface and ground water. Managed Intensive Rotational Grazing (MIRG) is a system that uses pastures as a major source of feed for milking cows (Jackson-Smith and others, 1996). MIRG farmers rely on pastures for their dairy herds' forage needs and move their cows to a new pasture at least once a week (Jackson-Smith and others, 1996). In 1992, roughly 7 percent of Wisconsin dairy farms used MIRG but, in 1994, 14 percent of Wisconsin dairy farms used MIRG (Jackson-Smith and others, 1996). MIRG can be used as a best management practice (BMP) and may reduce the amount of sediments, nutrients and pesticides to receiving waters. In a study in Oklahoma, there was a difference between rotational grazed pastures in average annual runoff and sediment discharges when compared to continuously grazed basin (Menzel and others, 1978).

This study will compare surface-water runoff and water quality from three small pastured watersheds. The pastures will be located at the USDA Dairy Forage Research Center at Prairie du Sac.

OBJECTIVE: The overall objective of this study is to determine differences in quantity and quality of surface-water runoff from three different pasture-management strategies. These strategies consist of a variety of practices which are available to pasture managers, both during the growing and dormant seasons. Combinations of management practices have been chosen to represent commonly used strategies. In addition to examining differences in overall management strategies, differences related to individual seasonal practices will be determined. A secondary objective will be to determine a water budget for each pasture. The water budget will be determined by measuring surface-water runoff and precipitation. Evaporation and transpiration will be estimated by using empirical equations and ground-water flow will be estimated as a residual.



APPROACH: The management practices to be examined include (1) intensive rotational grazing and continuous grazing during the growing season; (2) pasture "stockpiling" during late summer and continued grazing throughout the summer; and (3) two outwintering practices and no outwintering.

An artificial hydraulic control will be installed at each pasture outlet. The control will be a three-inch Parshall flume. Each site will use a pressure transducer to measure stage and a CR-10 data recorder. Daily, monthly and annual surface-water runoff will be calculated at each pasture.

A tipping-bucket raingage will be installed at each site. Evapotranspiration will be estimated at one of the pastures. Empirical equations will be used to estimate evapotranspiration. The input data to these equations will be air temperature and solar radiation and will be collected at one of the pastures. Meteorological data collected at

the USDA Research Station will supplement data collected at this pasture. Ground-water flow will be calculated as a residual. An ISCO automatic water-quality sampler will be installed at each site. The sampler will collect discrete samples. These samples will be composited on a flow-weighted basis. One composite sample per rainfall or snowmelt event will be sent to the Wisconsin State Laboratory of Hygiene for analysis. All events will be monitored. A gravity lysimeter will be installed in each pasture. This lysimeter will be sampled after recharge events. Approximately 5-10 samples per pasture will be collected. All samples will be analyzed for soluble reactive phosphorus, total phosphorus, ammonia nitrogen, nitrate and nitrite nitrogen, total kjeldahl nitrogen, total suspended solids, and volatile suspended solids.

PROGRESS (October 1997 to June 1998): Three continuous streamflow and rain gages were installed and operated. No runoff samples were collected because of below-normal snowfall.

PLANS (July 1998 to June 1999): Collect water-quality samples at the three sites for all storms. Determine a water budget for each site and calculate the nutrient and suspended solids loads for each site. All data will be summarized and published in the report, "Water Resources Data–Wisconsin".

BALSAM SCOUR, WI 17230

COOPERATOR:
Marathon County Highway Department

LOCATION:
Marathon County, Wisconsin

PROJECT CHIEF:
Peter E. Hughes

PERIOD OF PROJECT:
May 1998 to June 1999

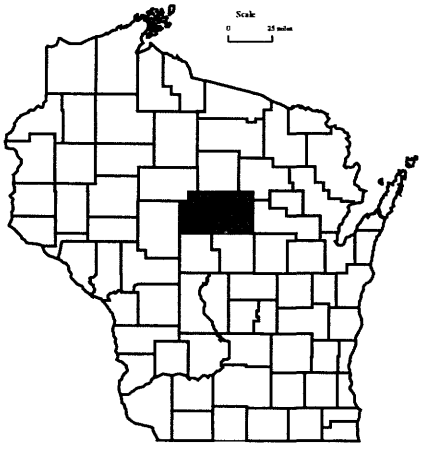
PROBLEM: Bridge scour has become a topic of nationwide interest in recent years but has not been identified as a serious problem for many bridges in Wisconsin. The Balsam Road bridge over the Big Eau Pleine River in Marathon County is one bridge, however, which has already been severely scoured with pier footings and pilings exposed. The scour hole is concentrated around the bridge location, beginning at approximately 200 feet upstream to approximately 200 feet downstream. An engineering assessment indicates that the 100-year return period discharge could undermine the east abutment and piers 1 and 2 and scour close to pile tip elevations on Pier 3 and the west abutment.

OBJECTIVE: The objective of this study is to install acoustic transducers to continuously monitor the scour depth on the upstream and downstream sides of the piers at the east side of the bridge. Discharge data from the streamflow gage at Stratford will be used to provide a high flow alert to the USGS and the Marathon County Highway offices to allow closure of the bridge if scour depths increase to dangerous levels.

APPROACH: Acoustic transducers will be attached to the upstream and downstream faces of the most eastern pier on the Balsam Road bridge. The scour depth data will be recorded on a datalogger and telemetered to the USGS office in Middleton, Wisconsin. This information will be automatically uploaded to the World Wide Web homepage for the USGS Wisconsin District (wwwdwimdn.er.usgs.gov). A voice modem will be installed at the Big Eau Pleine River streamflow gage at Stratford and will be programmed to provide an alert to the Marathon County Highway Department and USGS offices that a flood event is occurring. This alert will provide the opportunity to closely monitor the scour depths to determine whether the bridge should be closed due to hazardous conditions.

PROGRESS (July 1997 to June 1998): Equipment was installed in May 1998 and monitoring was initiated. A telephone line has been ordered and is awaiting installation.

PLANS (July 1998 to June 1999): After the telephone line is installed, the data will be telemetered to the USGS office in Middleton and uploaded to the Web. Monitoring will continue through June 1999.



WISCONSIN LAKES, GREEN LAKE TRIBUTARY MONITORING
WI 17303

PROBLEM: Silver Creek is the primary source of phosphorus to Green Lake. Continued documentation of suspended sediment and phosphorus 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 1997 to June 1998): Streamflow and water quality were monitored at the Silver Creek inlet to Green Lake and at a site near the mouth of White Creek. The Silver Creek site is equipped with an acoustic-velocity meter, a stage gage, and an automatic water sampler. The White Creek site is a conventional stream-gaging site and is equipped with an automatic water sampler. Streamflow, phosphorus, and suspended-sediment loading to the lake were determined for both sites.

A gage on the Puchyan River near the outlet of Green Lake was operated to monitor flow from the lake. Water samples were collected manually for phosphorus analysis. Streamflow, load and concentration data were published in the report "Water Resources Data–Wisconsin".

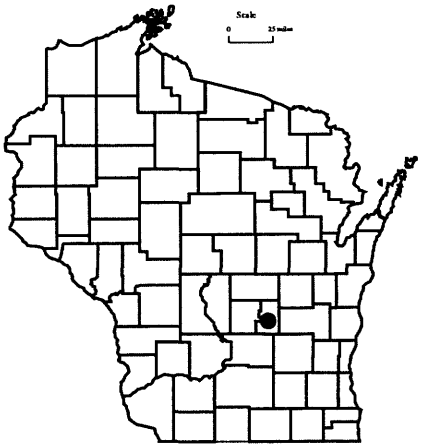
PLANS (July 1998 to June 1999): Streamflow and water-quality monitoring at the Silver Creek and White Creek inlets and at the Puchyan River outlet will be continued. Streamflow, phosphorus, and suspended-sediment loads will be published in the annual report, "Water Resources Data–Wisconsin".

COOPERATOR:
Green Lake Sanitary District

LOCATION:
Green Lake County,
south-central Wisconsin

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
October 1977-Continuing



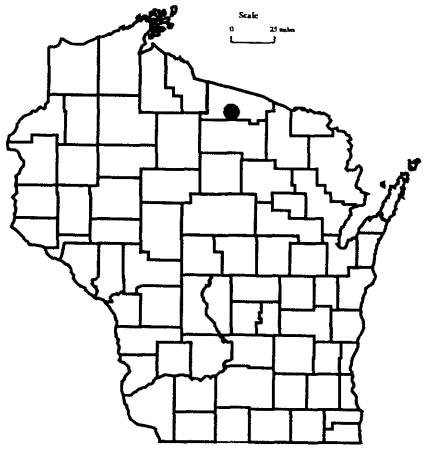
ASSESSMENT OF PHOSPHORUS LOADING, WINTER ANOXIA, AND STAGE REGULATION OF LITTLE ST. GERMAIN LAKE, VILAS COUNTY, WI 17313

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 late 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 winter drawdown will be calculated and used, along with phosphorus concentration data, to estimate phosphorus loading to the West Bay.

PROGRESS (July 1997 to June 1998): All data collection was completed in September 1997. A preliminary data summary was transmitted to the lake district.

PLANS (July 1998 to June 1999): A final data summary will be compiled and transmitted to the lake district.

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

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

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 biweekly at three locations within the lake during the summer and monthly during the winter during the second 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 analyzed to estimate sedimentation rates and the historical water quality of the lake.

PROGRESS (July 1997 to June 1998): Lake sampling at five locations was done monthly until November of 1997 and continued at three sites for the remainder of the period. Gaging stations were installed on two tributaries to the lake and at the outlet. Water samples were collected monthly at all stream sites. During storm runoff, samples were collected by an automatic sampler.

PLANS (July 1998 to June 1999): Lake sampling will continue throughout this period at three locations, biweekly during April through November and monthly the remainder of the time. 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.

USE OF ICE COVER ON LAKES AND RIVERS AS A CLIMATIC INDICATOR, WI 17315

COOPERATOR:
University of Wisconsin-Madison

LOCATION:
Lakes and rivers from around the world

PROJECT CHIEF:
Dale M. Robertson

PERIOD OF PROJECT:
October 1997-Continuing

PROBLEM: It is difficult to detect subtle climatic changes and patterns for many areas because long-term meteorological records are unavailable or the existing records are influenced by changes in observational techniques. Therefore, other climatic indicators are needed.

OBJECTIVE: The objectives of this project are to (1) describe changes in ice cover in lakes and rivers from around the world over the past 500 years, (2) statistically describe patterns in the changes in ice cover, (3) describe factors (such as El Nino events) causing the changes and variability in ice cover, and (4) determine what the changes in ice cover mean in terms of changes in air temperatures.

APPROACH: There are two components of this study—describing long-term changes in ice cover and describing shorter term variability in ice cover associated with global phenomena such as El Nino. ARIMA Intervention analyses will be used to describe the long-term changes in ice cover. Superposed Epoch analysis will be used to describe how ice cover varies in response to specific global phenomena, such as El Nino events.

PROGRESS: (July 1997 to June 1998): All ice data were assembled and put in data bases. Time series plots were prepared. Ice records were statistically evaluated for long-term trends and their relation to El Nino events.

PLANS (July 1998 to June 1999): El Nino evaluation will be completed. Findings of the portion of the study dealing with the El Nino relation will be presented at the SIL meetings in Dublin, Ireland. A manuscript describing long-term trends in ice records will be completed.

MISSISSIPPI RIVER SEDIMENT LOADING, POOLS 7 AND 8, WI 17316

PROBLEM: Tributary streams dump tons of sand into the Mississippi River, contributing to the gradual decline of side channels and backwaters that act as nurseries for river wildlife. As large quantities of sediment enter the river, permanently inundated areas will slowly be converted to shallow, sandy deltas or silty marshes.

Sediments also block the light aquatic plants need for photosynthesis, and can affect organisms that must see to locate prey, avoid predators, or find other members of their species to mate or care for offspring. Navigation is also impacted by the large amount of sand contributed by tributaries in the Upper Mississippi River basin.

OBJECTIVE: The objective is to collect sediment samples and quantify the annual sediment loads at selected locations on the Mississippi River and two of its tributaries. Annual loads will be calculated for the outflow from Pools 7 and 8, the LaCrosse and Black Rivers near LaCrosse, Wisconsin, and the Root River near Houston, Minnesota.

APPROACH: Bridge-mounted sediment samplers will be installed at bridges over the Mississippi River downstream from Lock and Dam 7, over the Black River, and over the Root River. Samples will be collected by an observer at regular intervals during base-flow conditions and more frequently during high flow. An observer will collect samples upstream of Lock and Dam 8 using a P61 sampler from a boat. An automated sediment sampler will be installed on the LaCrosse River to collect samples during storm runoff periods. The sediment samples will be analyzed by the USGS sedement lab in Iowa and the data will be used to compute the annual sediment loads at each of the monitored locations. The loads from the three tributaries and from Pool 7 will be compared to the load calculated leaving Pool 8 at Lock and Dam 8.

PROGRESS (October 1997 to June 1998): Equipment has been installed and sampling was started in October 1997. Initial calibration measurements for the bridge-mounted samplers have been completed. Data is being stored in the QWDATA system in the Wisconsin District office.

PLANS (June 1998 to July 1999): Data collection will end on September 30, 1998, unless funding is received to continue for another year. The data will be summarized and published in the report, "Water Resources Data–Wisconsin", and stored in the QWDATA system.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
LaCrosse to Genoa, Wisconsin

PROJECT CHIEF
Peter E. Hughes

PERIOD OF PROJECT:
October 1997 - Continuing

DETERMINATION OF STREAMFLOW, PHOSPHORUS, AND SOLIDS LOADS AT THREE SITES ABOVE SINISSIPPI LAKE IN DODGE COUNTY, WI 17317

PROBLEM: Sinissippi Lake was formed in 1845 by construction of a dam on the Rock River south of Horicon Marsh. The watershed area for the shallow (average depth 4.5 ft.) 2,855 acre lake is about 511 square miles. The lake is hyper-eutrophic with phosphorus concentrations ranging from 200 to 400 micrograms per liter. Secchi depths during summer average about 0.2 meters. Local, state, and federal resource agencies are concerned with the quality of the Horicon Marsh area, including Sinissippi Lake. Basic data are lacking to define the sources and magnitude of streamflow, phosphorus, and solids entering Sinissippi Lake.

OBJECTIVE: The primary objective of the study is to determine streamflow, phosphorus, and suspended-solids loading at East Branch Rock River near Mayville, West Branch Rock River near Waupun, and Rock River at Horicon.

APPROACH: Streamflow, phosphorus and suspended-solids load monitoring will be done at East Branch Rock River near Mayville, West Branch Rock River near Waupun, and Rock River at Horicon for at least a one-year period. Stream gages, employing conventional stage-discharge rating techniques, and equipped with automatic water samplers will be installed at East Branch Rock River near Mayville and West Branch Rock River near Waupun. The Rock River at Horicon site will be equipped with an acoustic-velocity-meter-type (AVM) gage because flat gradients preclude conventional gaging there. Samples will be collected manually by a local observer at the Horicon site. Loads will be calculated using streamflow-concentration-integration techniques.

PROGRESS (July 1997 to June 1998): Instrumentation was installed at the monitoring sites in October 1997; monitoring began November 1, 1997. All gages have functioned as planned. The AVM gage at Horicon has performed exceedingly well. High streamflow during March and April were well documented by streamflow measurements and water samples, which should result in accurate streamflow and load determinations.

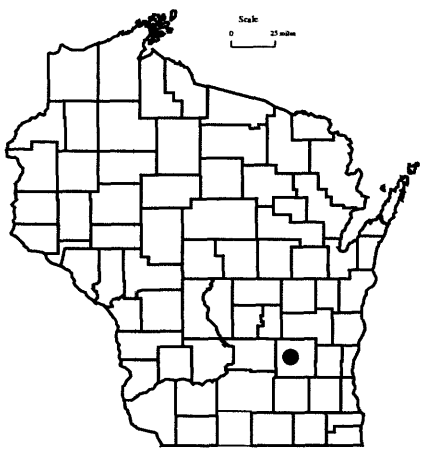
PLANS (July 1998 to June 1999): Continue operating monitoring site through October 31, 1998 (or longer if funding support can be provided). Daily streamflow and total-phosphorus and suspended-solids loads will be calculated and published. Data will be published in the annual report "Water Resources Data–Wisconsin".

COOPERATOR:
Town of Hubbard (Sinissippi Lake Improvement Association)

LOCATION:
Central Dodge County, Wisconsin

PROJECT CHIEF:
David J. Graczyk

PERIOD OF PROJECT:
October 1997 to June 1999



SHELL LAKE, WI 17318

PROBLEM: Shell Lake, located in Washburn County in northwestern Wisconsin, is a 2,580-acre seepage lake having a maximum depth of 36 feet. The city of Shell Lake, which encompasses the entire shoreline of the lake, is responsible for shoreline zoning. Concern over the flooding of several near-shore residences prompted the city to appoint a committee to investigate ways to mitigate the flooding. The committee has contemplated withdrawing lake water during high-stage periods but, before decisions can be made, a better understanding of the hydrology of the lake and the long-term effect of withdrawing lake water on lake stage are required.

OBJECTIVE: The objectives are to determine the hydraulic parameters and budget components of Shell Lake and simulate lake stage using estimated hydrologic budget components.

APPROACH: Historical data and data collected during this study will be used to develop a water-budget model and will include precipitation data, evaporation data, measured flows and hydraulic parameters. This model will be calibrated to lake stage; that is, adjustments will be made to estimated parameters until there is a reasonable match between measured and simulated lake stage.

PROGRESS (January 1998 to June 1998): Historic climatic and hydrologic data were compiled and used to develop a preliminary hydrologic-budget model. Runoff during spring snowmelt was measured in 5-6 intermittent streams. A gage was installed to continuously monitor lake stage, precipitation, and the water table in the vicinity of the gage.

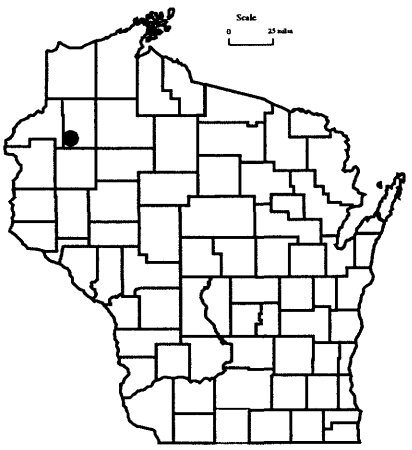
PLANS (July 1998 to June 1999): Lake stage, precipitation and the water table in the vicinity of the gage will be monitored. Piezometers will be installed around the perimeter of the lake to estimate ground-water flux.

COOPERATOR:
City of Shell Lake, Wisconsin

LOCATION:
Washburn County, Wisconsin

PROJECT CHIEF:
James T. Krohelski

PERIOD OF PROJECT:
January 1998 to September 1999



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

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 (WMIC), 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 was 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) were 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 (1991-93), followed by a high (1993-95) and then a low-phase (1996-2000) 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), are being conducted. These sites have been sampled monthly and augmented with event-related samples. A subset of these sites were extensively sampled for pesticides. Pesticide samples were collected approximately weekly during the early to mid-summer period and less frequently during the rest of the year. Synoptic studies were 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. Another synoptic study determined how representative the BFSs were of the entire WMIC drainage area. Other program components include an ecological survey (spring 1993) at 20 sites to evaluate the relation 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

COOPERATOR:

U.S. Geological Survey
Reston, Virginia

LOCATIONS:

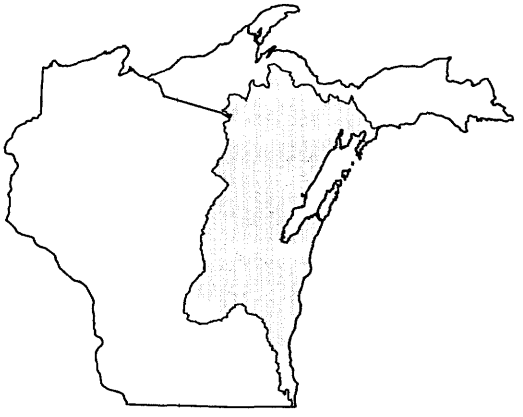
Upper peninsula of Michigan from the Menominee River basin in the west to the Fishdam River basin in the east; and the eastern portion of Wisconsin to include the Menominee, Oconto, Peshtigo, Fox-Wolf River basins discharging to Green Bay, and in Wisconsin that directly drain into Lake Michigan from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

PROJECT CHIEF:

Charles A. Peters

PERIOD OF PROJECT:

December 1990-Continuing



flow-path study examined transformations in various constituents through time and space. Surface-water/ground-water interactions were examined using shallow wells and lysimeters installed adjacent to the nearby stream. Effects of land use on ground-water quality were assessed through sampling in specific relatively homogeneous areas (1994 and 1995). A study unit survey provides an indication of water-quality conditions of the major aquifer (Cambrian-Ordovician sandstone) in the study unit.

PROGRESS (July 1997 to June 1998): Two low-intensity phase (LIP) basic fixed sites (BFS) were sampled monthly for discharge, field parameters, nutrients, pesticides, major ions, total and dissolved organic carbon, and suspended sediment. One of these sites was sampled for pesticides biweekly during the growing season.

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 archiving, for data collected during the high- and low-intensity phases, 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.

The environmental setting (WRIR), invertebrate database comparison (FS), and the study unit summary (circular) were published. Water Resources Investigations Reports on trace elements, water-quality applicability, GIS, QAQC, Basic Fixed Sites: Water Quality, Basic Fixed Sites:Fish, and Ground-Water Flow Path were published. One newsletter was published and distributed. Three abstracts, a book chapter, and a journal article were also prepared. All reports are available on the World Wide Web home page upon publication.

PLANS (July 1998 to June 1999): Two 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 two 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.

Data and information collected during the first high-intensity phase (HIP) will continue to be compiled, maintained and archived. Ancillary data for all ground-water wells will be compiled. The World Wide Web home page development and maintenance will continue.

Data from the high-intensity phase will continue to be analyzed and the results of analyses compiled in reports. Three water-resources investigations reports, a journal article, and a fact sheet will be completed for distribution.

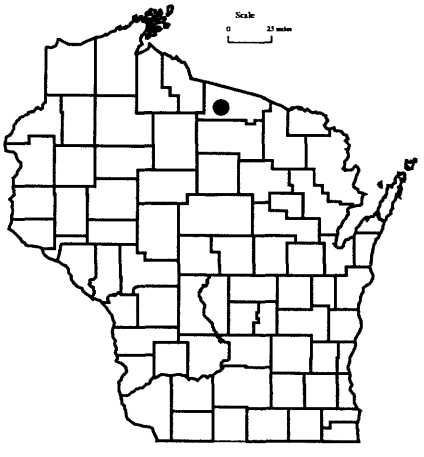
HYDROLOGIC AND BIOGEOCHEMICAL BUDGETS IN TEMPERATE LAKES AND THEIR WATERSHEDS, NORTHERN WISCONSIN, WI 175

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- 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 1997 to June 1998): Data collection and analysis proceeded at the three intensive monitoring sites on 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. Data and other information about the project are available on a world Wide Web home page (http://oraddwimdn.er.usgs.gov/doc/WEBB/index.hmtl).

PLANS (July 1998 to June 1999): 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:

Elder, John F., Carter, Virginia, and Rybicki, N.B., 1998, Dissolved carbon mobilization in peatland/stream systems in northern Wisconsin (U.S.A.), Proceedings of V INTECOL Wetlands Symposium, Perth, Australia (in press).

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.

Krabbenhoft, D.P., Benoit, J.M., Babiarz, D.L., Hurley, J.P., and Andren, A.W., 1995, Mercury cycling in the Allequash Creek Watershed, northern Wisconsin, Water, Air, and Soil Pollution, v. 80, p. 425-433.

Keating, E.H., 1995, Reactive transport modelling: an application to redox geochemistry of groundwater discharging to a stream in northern Wisconsin, Ph.D. thesis, University of Wisconsin-Madison, Madison, Wisconsin, 216 p.

Krabbenhoft, D.P., Bowser, Kendall, C., and Gat, J.R., 1994, Use of oxygen-18 and deuterium to assess the hydrology of groundwater-lake systems, in Environmental Chemistry of Lakes and Reservoirs (L.A. Baker, editor), American Chemical Society, p. 67-90.

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 wetland-dominated systems (book chapter, "Isotope Tracers in Catchment Hydrology", edited by J.J. McDonnell and C. Kendall, Elsevier Publishers) (in press).

Schindler, J.E., and Krabbenhoft, D.P., The hyporheic zone as a source of dissolved organic carbon and carbon gasses to a temperate forested stream: Biogeochemistry (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

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.

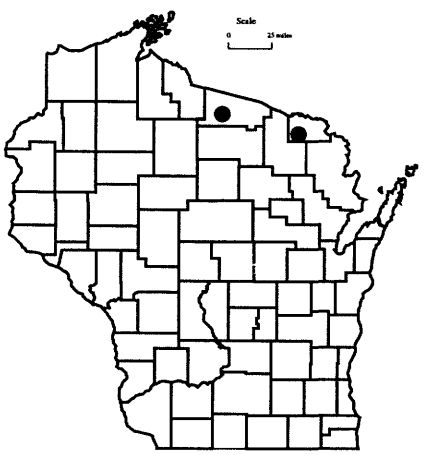
OBJECTIVE: Objectives are to determine the hydrologic and chemical budgets for Honeysuckle, Max, and Morgan Lakes in northern Wisconsin to provide information about mechanisms of acid loadings to these lakes, investigate differences between bog lakes and clear-water lakes, evaluate the feasibility of, 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 groundwater discharge, and lake outflows from evaporation and groundwater 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 1997 to June 1998): 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.

PLANS (July 1998 to June 1999): Routine data collection will continue at Vandercook and Morgan Lakes.



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.

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

PROBLEM: Eutrophication of Delavan Lake has accelerated since the 1940s, resulting in a hypereutrophic lake 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 Road (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 1997 to June 1998): 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 1997 water-year data was compiled for publication in the report, "Water Resources Data–Wisconsin". Two reports describing the effectiveness of the Jackson Creek wetland at reducing total phosphorus and sediment loads were published. Lake phosphorus concentrations in 1996-97 were similar to those prior to rehabilitation that was completed in 1993. However, summer water clarity was greater and chlorophyll *a* concentrations were less than prior to lake rehabilitation.

PLANS (July 1998 to June 1999): Monitoring program will be continued as scheduled. Data will be compiled for publication. A journal article describing the effectiveness of wetlands at reducing total phosphorus will be published.

REPORTS:

Elder, J.F., Manion, B.J., and Goddard, G.L., 1997, Mesocosm experiments to assess factors affecting phosphorus retention and release in an extended Wisconsin wetland: USGS Water-Resources Investigations Report 97-4272, 14 p.

COOPERATOR:

Town of Delavan

LOCATION:

Walworth County, southeast Wisconsin

PROJECT CHIEF:

Gerald L. Goddard
Dale M. Robertson

PERIOD OF PROJECT:

August 1983-Continuing

Goddard, G.L., and Elder, J.F., 1997, Retention of sediments and nutrients in Jackson Creek Wetland near Delavan Lake, Wisconsin, 1993-95, USGS Water-Resources Investigations Report 97-4014, 22 p

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 PCBs, 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 PCBs 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 1997 to June 1998): Sample collection was completed for all 11 stations in October 1995. Sample analyses were completed in October 1997. Analyses included congener-specific PCBs, 14 pesticides and pesticide degradation products, trace metals, nutrients, and major ions. Loads of atrazine, nutrients, and major ions have been computed for the monitored tributaries. A method that will be used to estimate contaminant loads from unmonitored tributaries is in draft. A USGS open-file report describing cross-sectional field data is in review.

PLANS (July 1998 to June 1999): Contaminant loads from the monitored tributaries will be completed. The method by which to estimate loads of contaminants from unmonitored tributaries will be reviewed and finalized. All load data from both monitored and unmonitored tributaries will be transmitted to the Environmental Protection Agency (EPA) for use in the Lake Michigan Mass Balance model. USGS water-resources investigations reports and USGS sections of EPA reports will be drafted and submitted for review.

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

TRACE METAL LOADING TO LAKES MICHIGAN AND SUPERIOR, WI 18301

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
United States portion of Lake Michigan and Lake Superior Basins

PROJECT CHIEF:
Dale M. Robertson

PERIOD OF PROJECT:
October 1997-Continuing

PROBLEM: The delivery of trace metals via tributaries from point and nonpoint sources poses serious concerns for the coastal and offshore ecosystem of the Great Lakes. Though point-source loadings can be significant, evidence suggests that nonpoint source contributions of metals exceed that of point sources. The tributary monitoring component of the Lake Michigan Mass Balance study will provide total loads of selected metals from the selected tributaries, but will not support source reconciliation and will not provide regional load estimates of the selected metals.

OBJECTIVE: Objectives are to (1) develop tributary load estimates of selected metal constituents to Lake Michigan and the U.S. portion of Lake Superior from both monitored and unmonitored watersheds, (2) describe what factors influence the relative loading, and (3) separate the load into the urban and nonurban components.

APPROACH: The approach used will be as follows: (1) Develop GIS coverages of the environmental factors thought to influence the distribution of the selected metals; (2) subdivide the entire basin into areas of relatively homogeneous environmental characteristics; (3) sample areas that have not been previously sampled; (4) compute loads for selected metals for the main tributaries and daily loads (high flow and base flow) for smaller indicator streams from relatively homogeneous areas; (5) use GIS to determine environmental characteristics of main tributary basins and smaller indicator streams; (6) use multiple regression to relate loads from indicator sites to environmental characteristics; (7) use loads from smaller indicator areas with regression relations to estimate loading from ungaged areas and total regional loading; and (8) subtract watershed load from tributary load to estimate the urban inputs.

PROGRESS (July 1997 to June 1998): GIS data were partially obtained for land use, surficial deposits, bedrock types for the complete Lake Michigan and U.S. part of Lake Superior. Michigan was preliminarily stratified into areas of relatively homogeneous units. Indicator sites were chosen from the Michigan RHUs. The indicator sites were sampled for a suite of trace elements by the University of Wisconsin-Madison in December base flow and spring high flow.

PLANS (July 1998 to June 1999): Complete basin characteristics will be obtained using GIS for all the tributaries (integrator sites) sampled in the Lake Michigan Mass Balance study. The entire area will be subdivided into Relatively Homogeneous Units. Each of the drainage areas of the tributaries sampled during the Lake Michigan Mass Balance Study will be divided into downstream urban areas and the rest of the basin. GIS will be used to describe the percentages of each land use, surficial deposits, and bedrock type in the basins of the tributaries sampled during the Lake Michigan Mass Balance Study. The new indicator sites in Michigan will be sampled during the summer of 1998 for a suite of trace elements by the University of Wisconsin-Madison.

LAKE SUPERIOR TRIBUTARY LOADING, WI 18302

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 District 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 1997 to June 1998): 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".

PLANS (July 1998 to June 1999): The gaging stations will be operated through September 1998. Operation beyond September 1998 will depend on finding alternative funding sources. Flow data will be finalized and published in the report, "Water Resources Data–Wisconsin".

COOPERATORS:

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

LOCATION:

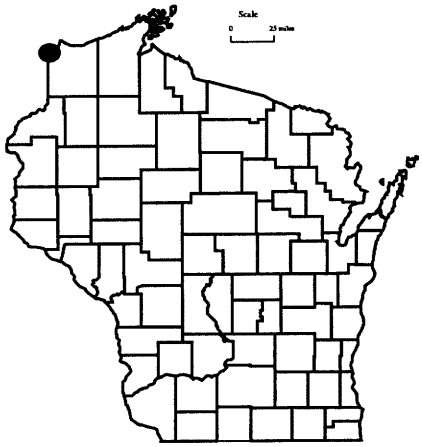
Cities of Duluth, Minnesota and Superior, Wisconsin

PROJECT CHIEF:

Peter E. Hughes

PERIOD OF PROJECT:

July 1993 to September 1998



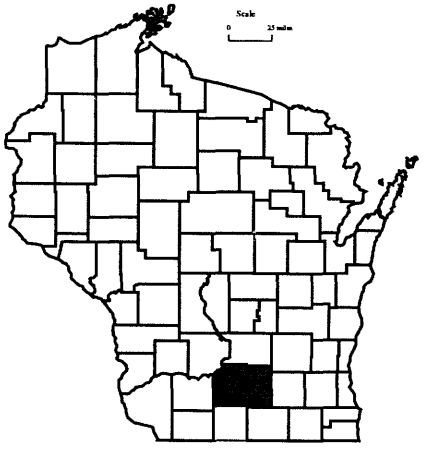
DANE COUNTY REGIONAL HYDROLOGIC STUDY, WI 189

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.

OBJECTIVE: 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 1997 to June 1998): A report describing phase 2 of the Dane County Hydrologic Study, a calibrated three-dimensional flow model, was completed and approved for publication. A report describing phase 1 of the Dane County Hydrologic Study, the hydrogeologic framework, was completed and is in review. 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 Information Circular (in press).

Bradbury, K.R., Swanson, S.C., Krohelski, J.T., and Fritz, A.K., 1997, Hydrogeology of Dane County, Wisconsin: Wisconsin Geological and Natural History Survey (in review)

TRANSPORT AND BIOGEOCHEMICAL CYCLING OF PCBs IN THE HAYTON MILLPOND, WISCONSIN, 19101

PROBLEM: High concentrations of polychlorinated biphenyls (PCBs) have been found in the Hayton Millpond bed sediments and fish tissues. Consequently, a plan is being developed to restore and revive the surface waters of this area. Knowledge of the processes that control cycling and transport of PCBs is essential to the remediation effort. Algal incorporation of PCBs 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 PCBs and concentration of PCBs in TSS and resuspendable surficial bottom sediments. PCB loading will be determined at the millpond outlet.

APPROACH: The millpond outlet 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. Eighteen manual organic samples (80 liters) 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.

Three water-column PCB samples will be collected at two Pine Creek sites.

PROGRESS (June 1997 to July 1998): The data-collection effort is complete. Water-column PCB concentrations ranged 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 1998 to June 1999): A report detailing the PCB loading, partitioning, algal PCB uptake and suspended-solids classification will be published. Continuous streamflow and temperature monitoring will be continued.

REPORTS:

Steuer, Jeffrey, Fitzgerald, Sharon, and Hall, David, Distribution and transport of polychlorinated biphenyls in Hayton Millpond, Wisconsin (in process).

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION:

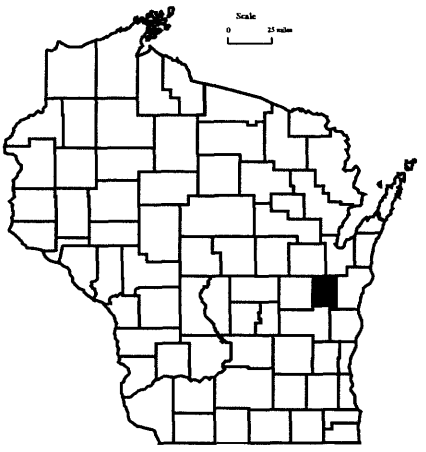
Calumet County, eastern Wisconsin

PROJECT CHIEF:

Jeffrey J. Steuer

PERIOD OF PROJECT:

February 1993 to July 1999



WILD ROSE STATE FISH HATCHERY AQUIFER TEST AND GROUND WATER FLOW MODEL, WI 19200

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Waushara County, Wisconsin

PROJECT CHIEF:
Charles Dunning

PERIOD OF PROJECT:
August 1997 to September 1998

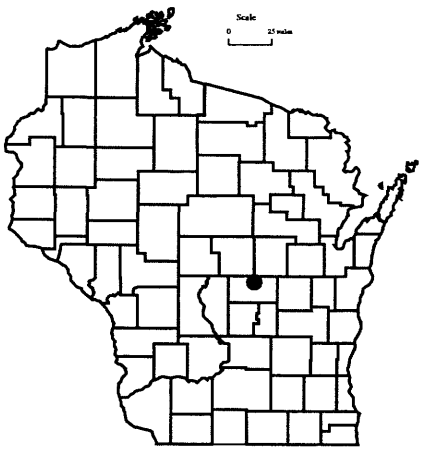
PROBLEM: The Wild Rose State Fish Hatchery is the state's largest cold-water fish hatchery, specializing in raising brown trout and chinook salmon. The hatchery also raises a large variety of cool-water species, including northern pike, muskellunge, hybrid muskellunge, walleye, suckers and sturgeon. All the water for the hatchery is supplied by ground water. Because the quality and quantity of this water is critical to the continued success of the hatchery, there is a need to characterize the ground-water aquifer in the vicinity of the hatchery. The ability of the aquifer to support high-capacity supply wells for future hatchery operations must be known. The effect on local and regional water resources of pumping high capacity wells must also be known.

OBJECTIVE: The objective of this project is to characterize the ground-water aquifer in the vicinity of the Wild Rose Fish Hatchery in order to predict the local and regional effect of supplying hatchery water needs with one or several high-capacity wells.

APPROACH: A pump test of a newly installed high-capacity well on the hatchery grounds will provide measured values for aquifer parameters which will be used in constructing a regional ground-water flow model. This model will be used to predict the effects of high capacity pumping rates and configurations.

PROGRESS (August 1997 to June 1998): At the end of August, a high-capacity pump test was conducted. The USGS collected data to evaluate the response of the aquifer to 24 hours of pumping (at 1500 gpm) and 6 hours of recovery. The test results were used to determine values for aquifer parameters and applied to a regional ground-water-flow model. This model has been delivered to the WDNR for their use in planning future activities at the Wild Rose State Fish Hatchery

PLANS: Project is completed.



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.

OBJECTIVE: 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 1997 to June 1998): Laboratory analyses on particle size were completed and radiocarbon sample analyses was semi-completed. A select number of organic material samples were analyzed for macrofossils. A WRIR containing significant results was begun as analyses of causes of geomorphic change continued. Modeling of the effects of detention basin storage on sediment transport continued. The streamflow-gaging station at Moquah, Wisconsin, continued to operate. The introduction and methods section of the planned dissertation was written.

Preliminary analyses of core and streambank data indicate that approximately 1 to 2 meters of sediment has accumulated in the flood plain and channel in the lower reach during the past 125 years. This human-influenced sedimentation rate is almost 10 times greater than pre-1870 rates. In addition, channel incision and slope steepening have occurred in the upper reach due to past increases in runoff caused by forest clearing. Since the mid 1940s, the channel has incised 1-3 meters in the upper reach and many of the eroded bluffs that also are sources for sediment have retreated 11 to 28 meters. Sedimentation appears to be decreasing since approximately 1950, corresponding to the decrease in agricultural activity and increase in extent and maturity of forested land.

PLANS (July 1998 to June 1999): The radiocarbon analyses will be completed; modeling effects of detention basin storage on sediment transport will be completed. Water-resources investigations report and dissertation will be approved and published.

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).

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 1997 to June 1998): Logistical preparations for the austral 1997-1998 field season were made. Three USGS volunteers were selected, hired, and processed for deployment to assist in stream monitoring activities.

All data collected by automated recorders and field meters from the austral 1996-1997 season were worked up and entered into the Wisconsin District Oracle database. This data was made available on the Web.

Installed temperature and conductivity probes on the Onyx River at Lake Vanda and Lower Wright Weir stations. Automated streamflow monitoring was conducted at 19 gages. Intermittent data collection was carried out at an additional 11 sites. A regular program of lake level monitoring in the Dry Valleys was continued in cooperation with the New Zealand Antarctic Research Program.

Since this will be our last season with involvement in the LTER program, all records and data have been turned over to the cooperator.

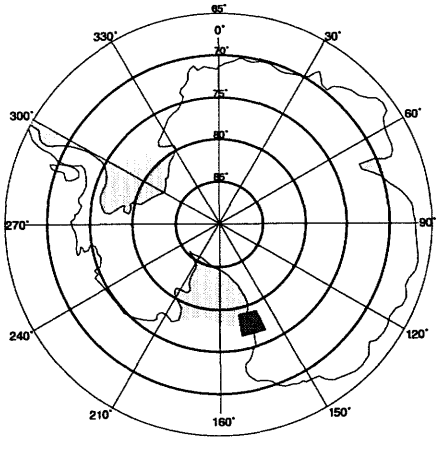
PLANS (July 1998 to June 1999): Three field volunteers have been deployed to maintain monitoring activities in Antarctica. Expect to complete work up of data from tail end of 1996-1997 field season retrieved during the present field season. If funds are available, will work up data recovered from the 1997-1998 field season. Continue to make all field data available on the Web via oracle.

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.

OBJECTIVE: 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 1997 to June 1998): Three field trips were conducted during this time period, each lasting 10 to 14 days in length and included the participation of 30 to 40 scientists from across the country representing the USGS and several universities and private research labs. During these field trips, approximately 15 sites in the northern Everglades were sampled for water, sediment and biota. During each of these field trips, diel sampling efforts at one or two sites were also conducted, whereby field crews (2 to 4 persons) sampled continuously for about 30 hours. These efforts are being conducted to evaluate the effect of natural diel cycles on the speciation and concentration of mercury in the surface water of the Everglades. Experiments are also being conducted under controlled light conditions to examine mercury reduction and methylmercury degradation rates for future modeling purposes. Our project contributed 12 abstracts for presentation at a special session titled "Hydrology and Biogeochemistry in the South Florida Environment", which was part of the national American Geophysical Union Meeting, May 26-29, 1998.

PLANS (July 1998 to June 1999): During this time period, Critical Ecosystem Program managers have requested that project personnel cease field sampling and synthesize results to date. Project staff will focus on eliminating all sample backlog and finalizing data in a data set that will be available on the Web. Individual project participants will be responsible for writing up their research results in the form of scientific journal publications, as well as one overall synthesis document.

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

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 1997 to June 1998): Results of computer simulations of management plans were presented to the appropriate planning agencies for the two main pumping centers, the Green Bay Metropolitan area and the Fox Cities area. The management plans were revised slightly and final simulations were completed. The final report was completed and distributed.

PLANS: Project is completed.

REPORTS:

Walker, J.F., Saad, D.A., and Krohelski, J.T., 1998, Optimization of ground-water withdrawal in the lower Fox River communities, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 97-4218.

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION:

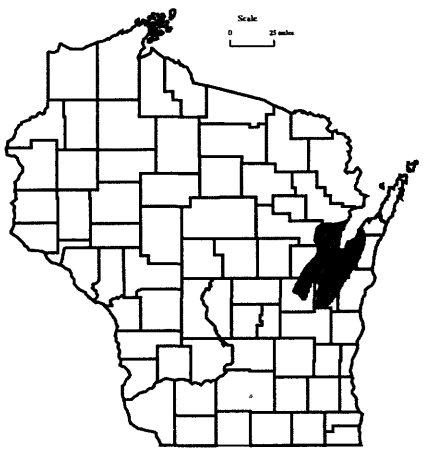
Lower Fox River Valley (Green Bay Metropolitan and Fox Cities area)

PROJECT CHIEF:

John F. Walker

PERIOD OF PROJECT:

October 1995 to September 1997



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

COOPERATOR:
City of Middleton

LOCATION:
Dane County, Wisconsin

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.

OBJECTIVE: 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, WRIR 85-4068). 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 and 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, etal., in press) to have the appropriate resolution for the stormwater control alternatives. Similar to Krohelski, etal., 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 (July 1997 to June 1998): Shallow well sites have been established in Pheasant Branch Marsh along with two continuous flow-monitoring and precipitation sites on the Pheasant Branch North and South Forks. Two additional raingages have been added to the network. Double-ring infiltration tests (36) have been conducted with the results incorporated into the preliminary surface-water model. Calibration has started on a 50-flow plane, 9-hydrologic-response unit model. Results from the initial modeling using the Dane County regional flow model showed that regional water (away from the immediate highlands) was needed to simulate measured spring flow. Porewaters within the wetland-creek complex were sampled for major ions and water isotopes.

PLANS (July 1998 to June 1999): Additional sites will be investigated using geochemical, temperature, and physical techniques. Springs and porewaters in the wetland complex will continue to be sampled for water isotopes and ion chemistry. The regional flow model will be updated using the additional data and insight gained. Results from the surface-water modeling will also be incorporated into the refined site flow model. Ground- and surface-water modeling will be completed. An investigative report will be prepared.

MITIGATION OF FUTURE IMPACTS OF URBANIZATION ON THE BADGER MILL CREEK HYDROLOGIC SYSTEM, WI 20201

COOPERATOR:
City of Middleton

LOCATION:
Dane County, Wisconsin

PROJECT CHIEF:
David W. Owens

PERIOD OF PROJECT:
October 1997 to September 1999

PROBLEM: Urban development of the Badger Creek Watershed by the cities of Madison and Verona and the townships of Verona and Middleton will result in higher flood peaks and increased pollutant loading within the watershed. Mitigating these effects after urban development can be expensive and administratively difficult. To reduce costs and difficulties associated with land acquisition, the local governing bodies desire a proactive approach that will locate regional runoff treatment or control sites prior to development. To complete this assessment, hydrologic information needs to be collected to calibrate a surface-water model.

OBJECTIVE: The three objectives for this project are (1) collect stream flow and rainfall data at three sites within the Badger Mill Creek sub-watershed, (2) collect rainfall data at two additional sites within the basin, and (3) construct a surface-water model to assess the impacts of urbanization.

APPROACH: The study has two components. (1) Field component—three new USGS gaging stations will be installed in the Badger Mill Creek sub-watershed. Flow will be continuously monitored and rainfall data will be collected. Water-quality samples will be taken during event flows to measure total and suspended solids, total and dissolved phosphorus and selected metals. Two additional remote raingage stations will be installed throughout the basin to determine the spatial variability of rainfall. (2) Surface-water model component—a surface-water model (SWMM) will be constructed and calibrated with field data collected by the USGS during the summer of 1997. The spatial resolution of the model will simulate approximately 1 to 4 developments per square mile. Raingage data will be used to estimate the spatial distribution of rainfall for the basin.

PROGRESS (July 1997 to June 1998): Three USGS gaging stations and two additional remote raingages have been installed in the Badger Mill Creek sub-watershed. Preliminary basin delineation has been completed for the three gaging-station sites. Land-use and GIS coverages have been obtained from the Dane County Land Conservation department.

PLANS (July 1998 to June 1999): Gaging stations will be operated until the fall of 1999. The SWMM model will be constructed and calibrated under current conditions.

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

PROBLEM: Milwaukee County is involved in an effort to reduce runoff of deicing chemicals from General Mitchell International Airport (GMIA) to Wilson Park Creek. Ethylene and Propylene Glycol based deicers are used during cold weather periods to deice aircraft, runways, and other paved areas used by aircraft. Glycol concentrations in stream samples collected during deicing events throughout the winter of 1996-97 ranged from less than detection limits to 15,000 mg/L in GMIA outfalls (well above toxicity limits). A second concern is that runoff from a portion of the GMIA runways drains to a tributary of Oak Creek. An assessment is needed to determine if there are any toxic effects in the Oak Creek watershed due to GMIA runoff.

OBJECTIVE: The overall goals of the project are to evaluate changes in water quality in Wilson Park Creek due to implementation of glycol deicer management at GMIA, assess the water-quality conditions in Oak Creek downstream from GMIA runoff, and fulfill obligations stated in the Wisconsin Department of Natural Resources (WDNR) stormwater permit for GMIA. Specific objectives are as follows: (1) Monitor surface water at four sites in the Wilson Park Creek watershed for water-quality and flow during dry weather and runoff conditions. This monitoring is to be conducted before and after implementation of glycol management. (2) Determine changes in water quality and toxicity levels in Wilson Park Creek due to implementation of glycol management. (3) Monitor water quality and flow in the Oak Creek watershed downstream from GMIA runoff beginning in summer 1998. This monitoring should quantify a suite of water-quality parameters that are of interest as stated in WPDES permit number WI-0046477-1 issued to GMIA by WDNR.

APPROACH: Five stream-gaging stations will be operated near GMIA during water year 1998 (October 1997 through September 1998). The monitoring approach for water year 1998 is outlined in this section along with a description of the analytical methods. Monitoring during the following years will be similar to that described below. Milwaukee County and the USGS will reevaluate the sampling design each year and changes will be made as needed.

PROGRESS (July 1998 to June 1999: An extensive runoff monitoring program has been in place since November 1996. All monitoring to date represents conditions before glycol management was implemented. Nine sites were monitored the first year and four sites are currently being monitored. Flow, dissolved oxygen, water temperature and rainfall are being monitored continuously. Water-quality constituents are sampled selectively during glycol application events, baseflow, and one summer rainfall event per year. Glycol, BOD, selected nutrients and selected metals analyses are being conducted. Microtox and bioassay analyses are being conducted for toxicity assessment.

COOPERATOR:
County of Milwaukee

LOCATION:
Milwaukee, Wisconsin

PROJECT CHIEF:
Steven R. Corsi

PERIOD OF PROJECT:
November 1996 to December 1997

PLANS (July 1998 to June 1999): Two more years of monitoring are planned after the implementation of glycol management in the fall of 1998. After monitoring of post-implementation runoff, statistical analyses will be conducted to determine the effectiveness of the glycol management practice. A direct comparison of pre- to post-implementation data will be done using paired-watershed and upstream-downstream analyses between sites. Two reports are planned. One report will be a summary of data from the first winter of monitoring and the second report will be an analyses of the effectiveness of the glycol management practice.

MODELING THE EFFECTS OF THE CRANDON MINE USING THE HSPF WATERSHED MODEL, WI 205

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 mine construction, operation, and closure. 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 (July 1997 to June 1998): Hydrologic, meteorologic, and land-use information were assembled. Preliminary model configurations were developed.

PLANS (July 1998 to June 1999): 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 mine construction, operation, and closure on the water levels of streams and lakes in the area.

COOPERATOR:

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

LOCATION:

Forest County, north-central Wisconsin

PROJECT CHIEF:

Jana Stewart

PERIOD OF PROJECT:

January 1997 to September 1998

REFINED CONTAMINANT TRANSPORT USING BERYLLIUM-7, WI 206

COOPERATOR:

U.S. Environmental Protection Agency (USEPA)
University of Wisconsin-Milwaukee (UWM)

LOCATION:

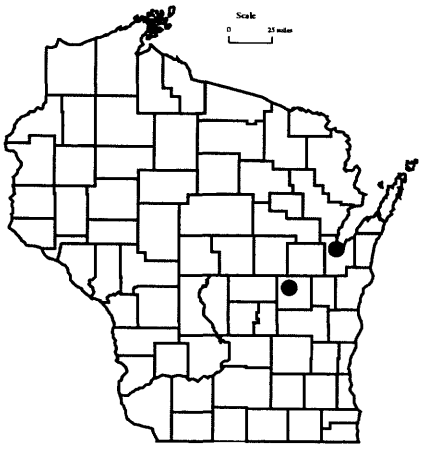
Fox River near DePere Dam and Little Lake Butte Des Morts near outlet

PROJECT CHIEF:

Charles A. Peters

PERIOD OF PROJECT:

October 1997 to September 1999



PROBLEM: Dynamic particle and toxics transport modeling (such as WASP4) of PCB transport relies on several assumptions dealing with predictions of sediment deposition sites and amounts, settling/resuspension rates on week/month time scales, mixing depth of surficial sediments, etc. ^{7}Be has the potential of refining predictions of these processes by providing actual rates and sites of deposition and possibly resuspension.

OBJECTIVE: The overall result will be to refine previous dynamic contaminant (PCB) dynamic transport models (WASP4) of the Fox and Milwaukee Rivers in Wisconsin by measuring critical processes. Specifically, we will measure resuspension rates and mixing rates/depths of surficial bed sediments in PCB-laden impoundments. Resuspension and mixing have previously only been estimated despite the fact that modeled contaminant transport is very sensitive to these parameters. We intend to measure them directly at two sites previously determined to have high levels of PCB contamination or concurrent sediment resuspension studies.

APPROACH: These sites are areas of recent historical net deposition although contaminated sediments from these areas are sources to points downstream under certain conditions. The DePere Dam site is an impoundment with a flow gage immediately downstream. Measured resuspension rates will be correlated with flow measured at this site. Resuspension rates of PCB-contaminated bed sediments will be determined from changes in ^{7}Be inventories over time (seasonally and after storms). Short-term mixing rates and depths of contaminated sediments will be modeled from the depth distribution of ^{7}Be, corrected for decay. In addition, duplicate sediment traps will be deployed at each of the two sites to directly sample suspended/sinking particles for subsequent ^{7}Be analysis. From changing inventories of ^{7}Be in bed sediment, flux of ^{7}Be to the sediment can be calculated. Knowing the activity of the particles in the water, grams of particulates required to support short-term flux can be calculated. Short-term residence times can also be calculated.

PROGRESS (July 1997 to June 1998): Two sites were chosen to sample for the length of the project. A Quality Assurance Project Plan was prepared for the study. Sediment traps were installed at the two locations. Three samples were collected from the sediment traps and Eckman cores at the two sites. Samples were submitted to the UW-Milwaukee laboratory for analyses.

PLANS (July 1998 to June 1999): Bed sediments and suspended/sinking particles will be sampled at two sites in July, August, and September and after one storm during the summer period. Laboratory analyses for Beryllium-7 in these samples will be completed by October 1998. Results will be interpreted and a journal article will be prepared.

CHARACTERIZATION OF GROUND- AND SURFACE-WATER SYSTEMS OF THE NECEDAH NATIONAL WILDLIFE REFUGE, WISCONSIN, WI 207

PROBLEM: Certain biological species and trophic interactions in the Necedah National Wildlife Refuge might be adversely affected by (1) pesticide contamination in waters that discharge to the Refuge from agricultural drainage, (2) nutrient loading from agricultural drainage, and/or (3) alteration of the water and sediment flows due to agricultural usage.

OBJECTIVE: The project objectives are to (1) quantify water fluxes into and out of the Refuge, (2) identify key ground-water recharge areas for the Refuge, (3) determine the hydraulic relation between ground and surface water, and (4) characterize sediment and water quality of the Refuge.

APPROACH: Historical data and data collected during this study will be used to develop a numerical ground-water flow model that incorporates the water-budget parameters and incorporates the surrounding. The parameters collected on or near the Refuge will include precipitation data, evapotranspiration data, measured water levels, ground-water/surface-water flows and hydrologic parameters. The model will be calibrated to ground-water elevation, pool stage, and stream discharges.

In addition to characterization of the physical hydrology, a synoptic sampling of ground and surface water, sediment, and biota will be conducted to characterize the environmental quality of the Refuge.

PROGRESS (February 1998 to June 1998): Collection of meteorological data, water levels, and surface-water flows at representative sites around the Refuge was initiated.

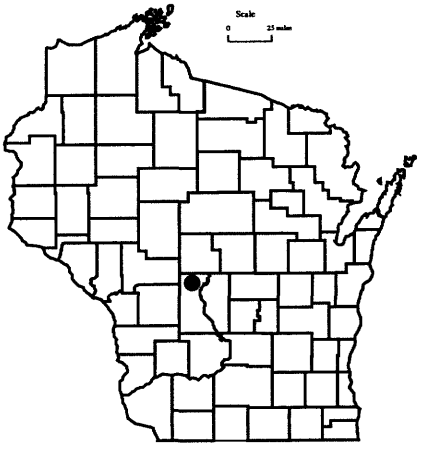
PLANS (July 1998 to June 1999): Collection of meteorological data, water levels, and surface-water flows and hydrologic parameters will continue at sites on or near the Refuge. A synoptic sampling of ground and surface water, sediment, and biota will be conducted. A two-dimensional, steady-state ground-water flow model will be constructed and calibrated.

COOPERATOR:
Fish and Wildlife Service,
Ft. Snelling, Minnesota

LOCATION:
Necedah Wildlife Refuge,
Wisconsin

PROJECT CHIEF:
Randy Hunt

PERIOD OF PROJECT:
February to September 1998



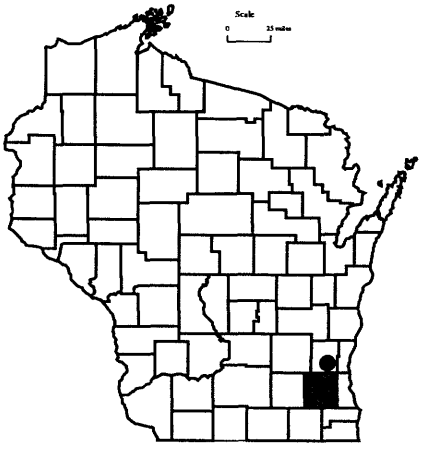
SOUTHEAST WISCONSIN GROUND-WATER, WI 208

COOPERATOR:
Wisconsin Geological and Natural History Survey

LOCATION:
Southeast Wisconsin

PROJECT CHIEF:
Daniel Feinstein

PERIOD OF PROJECT:
February 1998 to September 1998



PROBLEM: Much public attention has been focused in the last several years on the problem of insuring an adequate and inexpensive supply of water to southeastern Wisconsin in the next century. The southeastern Wisconsin communities of Waukesha, Brookfield, Germantown, Menominee Falls and Pewaukee are prohibited by the Great Lakes Charter from drawing water from Lake Michigan. Water utilities in these areas are concerned that rapidly falling ground-water levels in the sandstone aquifer indicate that water supply will not be able to keep pace with development.

OBJECTIVE: An initial phase of model construction will be conducted to focus on two elements of the ground-water system that have a disproportionate influence on the accuracy of the final model. These two elements are (1) boundary conditions around the region of interest and (2) three-dimensional geometry of the flow system. A literature review that encompasses stratigraphic, pumping, and water-level information available in past studies or stored in files will be done.

APPROACH: A simple areal representation of the sandstone aquifer will be constructed and used to test a conceptual model and determine interior and perimeter boundary conditions. Section models will be constructed to test the influence of high conductivity aquifers, confining beds, recharge zones, and the connection to Lake Michigan boundary on the vertical pattern of flow.

PROGRESS (January 1998 to June 1998): Extensive work has been performed to digitize hydrogeologic features and prepare base maps for the project. Work has begun on integrating the 3D RASA model with the 2D Boonstra model. RASA simulations have been performed to establish a preliminary selection of regional boundary conditions. The text and appendices accompanying the Boonstra model have been reviewed. Negotiations have begun with consulting firms to review past projects and collaborate on current well installation projects. Data arising from the Maquoketa shale project is being integrated into the southeast Wisconsin data base.

PLANS (July 1998 to June 1999): Historic water-use budget will be completed. The Boonstra model will be fully integrated in the RASA model.

MASTER WATER DATA INDEX, WI 21001

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

LOCATION:
United States

PROJECT CHIEF:
Harry House

PERIOD OF PROJECT:
April to September 1998

PROBLEM: Efficient and cost-effective approaches for the management and distribution of data products and development of application programs related to mission objectives for the Water Resources Division of the U.S. Geological Survey (USGS) need to be developed and deployed. As part of this mission, the USGS has been maintaining a Master Water Data Index (MWDI). The MWDI is a nationwide index of more than 450,000 sites which collect surface water, ground water, and limited meteorological data. It can be used to determine the availablity and location of such information in the data archiving systems of the participating groups. At present, there is no access to this index on the Web, which reduces its availability and usefulness.

OBJECTIVE: The MWDI needs to be redesigned to ensure it contains critical information that will be required for users to locate the data products they are interested in. Data administrators who manage these datasets will need to be given standards to guide them when they transfer metadata describing their datasets that are to be included in the MWDI. A dynamic interface will be developed that makes the MWDI queriable via the Web. Existing and new data from EPA and various state agencies will be included in the new MWDI.

APPROACH: A new PC running Microsoft NT will be purchased to provide a development platform for this application and will be run in the Wisconsin District. The MWDI will be maintained in an Oracle relational database system (RDBMS). New table(s) will be designed inside the RDBMS that will take advantage of modern indexing capabilities. Efforts will be made to anticipate what kinds of information might be supplied by end users to define what data products they would like to examine. Data sets will be pulled from NWIS, STORET, and other contributers and loaded into the Oracle system. Guidelines for future additions to the MWDI (metadata describing their data products) will be drawn up based on the final design. These guidelines will be distributed to participating database administrators so there will be uniformity in submissions and to facilitate uploading and/or updating of the data in the MWDI. Systems for performing these updates into Oracle will be created, using sql-plus and sql-loader, as well as any preliminary modification programming that may be required in perl or other appropriate languages.

PROGRESS (April 1998 to June 1998): A preliminary database design has been made based on input from USGS staff in Reston, Virginia, and EPA database administrators. It has been installed in Oracle. An initial demonstration website is available that provides an interface to the Oracle database. Meetings were attended in Reston, Virginia, to discuss details on the design of the database.

PLANS (July 1998 to June 1999): Data will be solicited from participating agencies and uploaded into Oracle. A demonstration of the system will be performed in Reno, Nevada, in July via the internet. Final adjustments to the database and/or Web interface will be made by the end of September.

Completed Projects

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

WI171	Application of habitat-suitability index models to assess effects of fine-grained sediment on brook trout and brown trout habitat
WI17217	Evaluation of total phosphorus load determination methods applied to three major tributaries to Lake Mendota, Dane County, Wisconsin, 1994-95
WI18700	Sources of phosphorus in stormwater from two urban residential basins in Madison, Wisconsin, 1994-95
WI 18901	Simulation of the effects of operating Lakes Mendota, Monona, and Waubesa as multi-purpose reservoirs to maintain low flow
WI191	Distribution and transport of polychlorinated biphenyls in Milwaukee River, Wisconsin
WI195	Late Cenozoic landscape evolution of Ft. McCoy, Monroe County, Wisconsin
WI195	Late Cenozoic landscape evolution of a Joliet Training Facility, Illinois

WISCONSIN DISTRICT PUBLICATIONS

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

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

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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.

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_____,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.

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

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

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

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

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

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

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

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

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