WATER-RESOURCES INVESTIGATIONS IN WISCONSIN

Compiled by D.E. Maertz

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Madison, Wisconsin
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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.

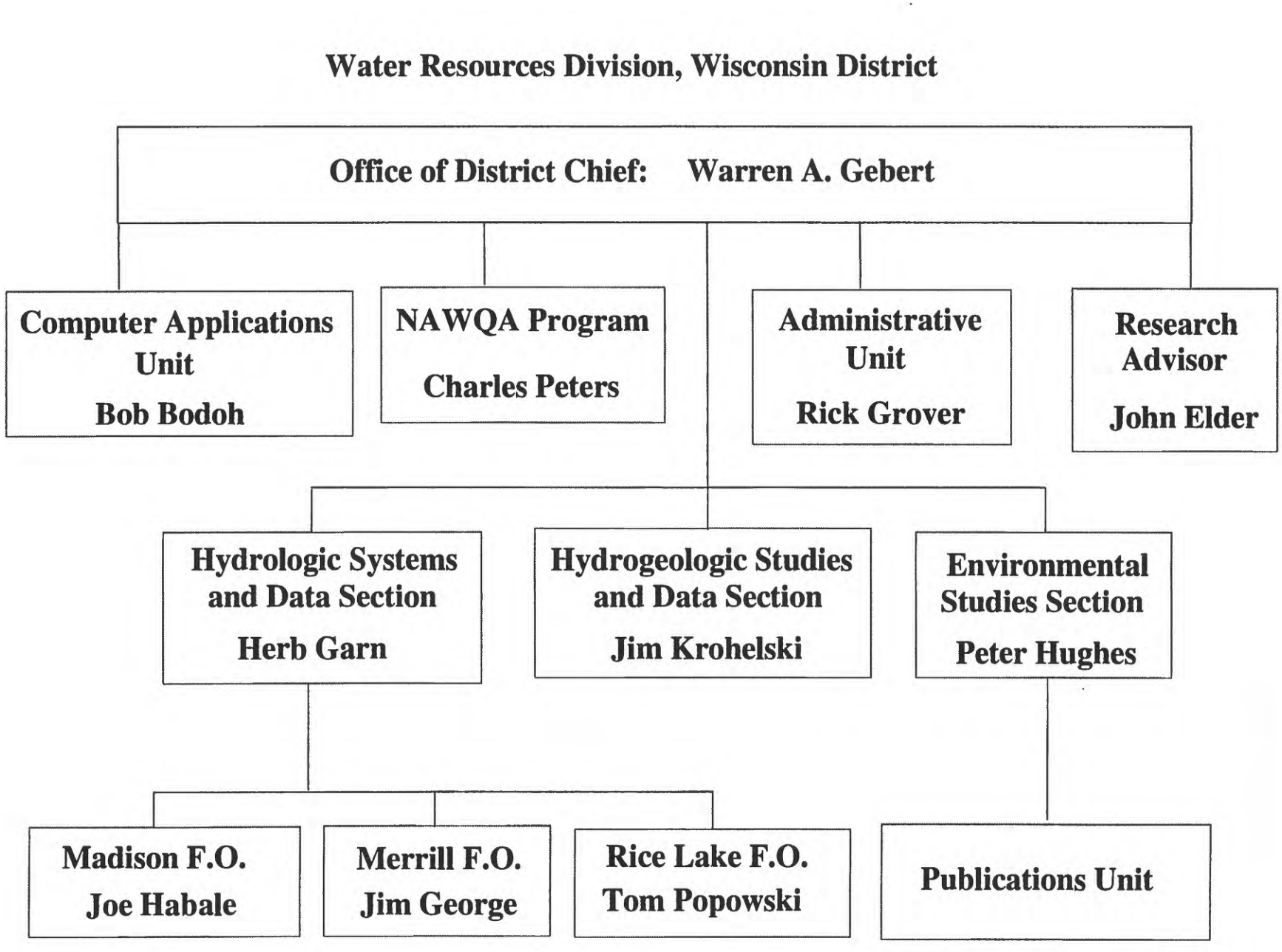


Figure 1. Organization chart of the U.S. Geological Survey, Water Resources Division, Wisconsin District.

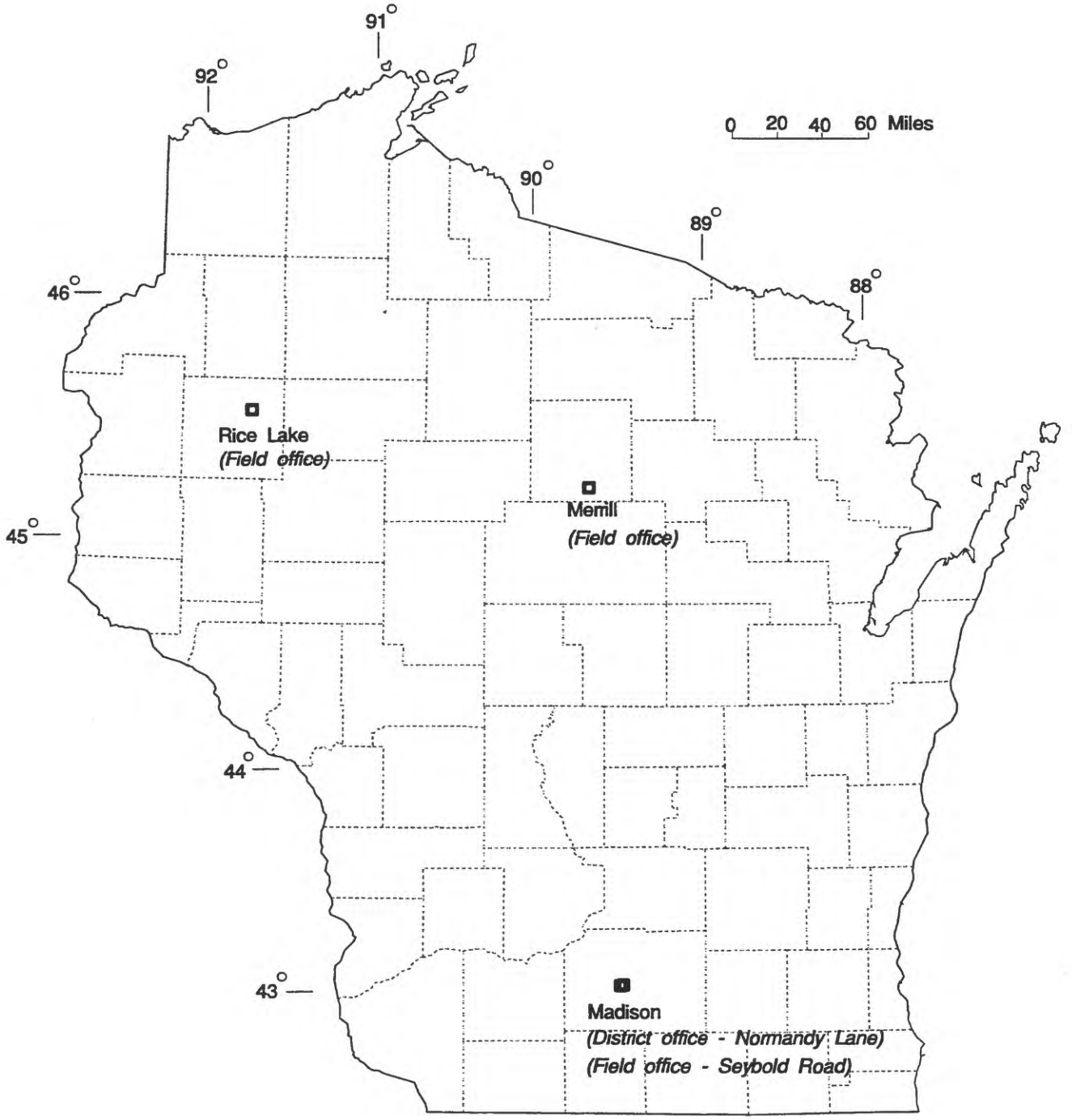


Figure 2. Location of offices in the Wisconsin District.

COOPERATORS

State Agencies

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

Local Agencies

Brown County Planning Commission
City of Barron
City of Beaver Dam
City of Brookfield
City of Fond du Lac
City of Hillsboro
City of Madison
City of Peshtigo
City of River Falls
City of Sparta
City of Thorp
City of Waupun
Dane County Regional Planning Commission
Dane County Department of Public Works
Fontana/Walworth Water Pollution Control Commission
Green Bay Metropolitan Sewerage District
Madison Metropolitan Sewerage District
Rock County Public Works Department
Southeastern Wisconsin Regional Planning Commission
Village of Little Chute
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
  Wisconsin Valley Improvement Company
U.S. Environmental Protection Agency

Indian Tribes

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

Lake Districts

Alma/Moon Lake District
Big Hills Lake Management District
City of Muskego
Druid Lake Protection and Rehabilitation District
Eagle Spring Lake Management District
Fowler Lake Management District
Green Lake Sanitary District
Lake Keesus Management District
Lauderdale Lakes Management District
Little Arbor Vitae Lake District
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 Management District
Pretty Lake Protection and Rehabilitation District
Twin Lakes Protection and Rehabilitation District
Upper Nemahbin Lake Management District
Wind Lake Management District
Wolf Lake Management District
Town of Auburn
Town of Cedar Lake
Town of Delavan
Town of Kansasville
Town of Norway
Town of Sand Lake
Town of St. Germain
Town of Summit
Town of Waterford
Village of Lake Nebagamon
Village of Oconomowoc Lake

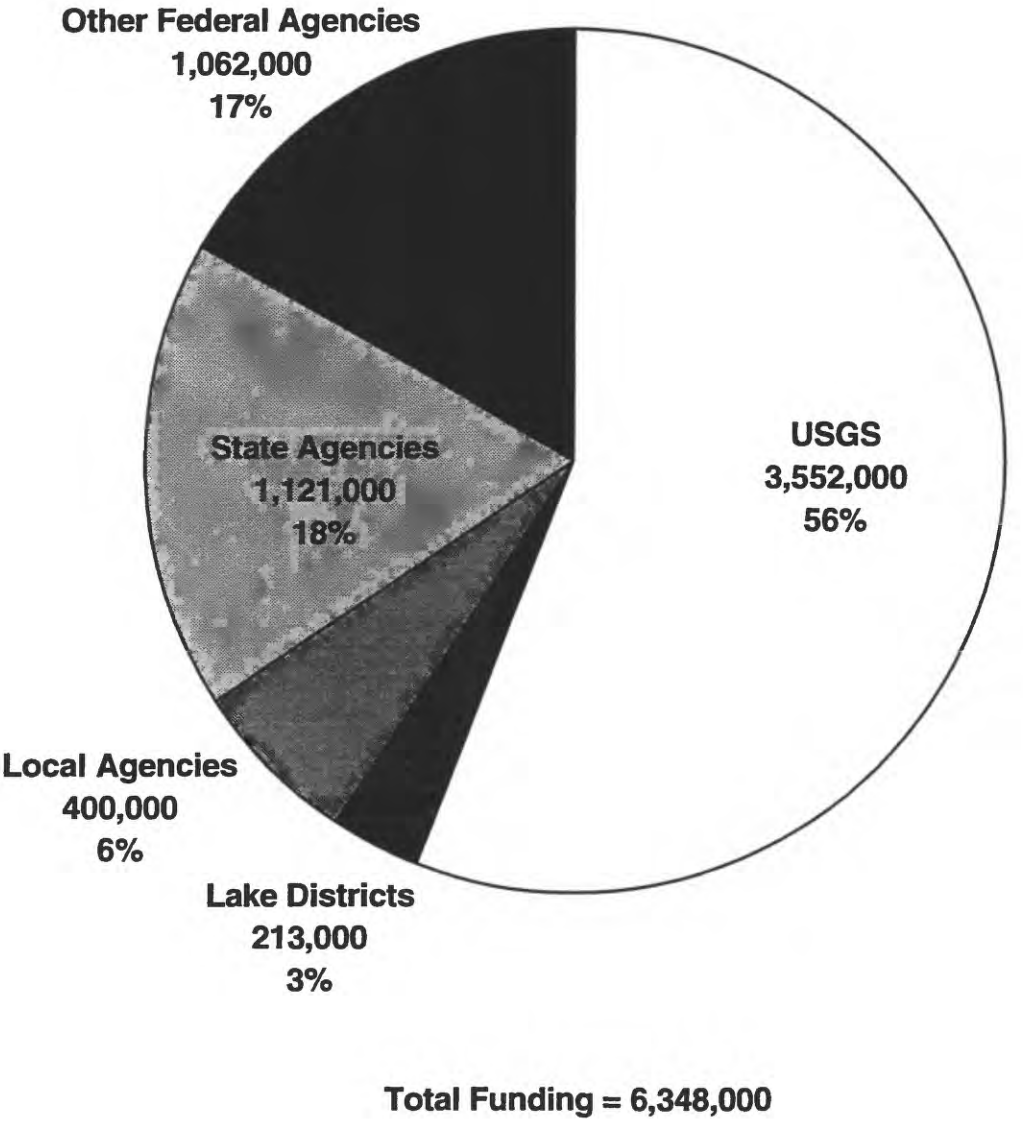


Figure 3. Funding sources for the water-resources program in Wisconsin for the 1996 fiscal year.

SUMMARY OF 1995 HYDROLOGIC CONDITIONS

Streamflow

The statewide average precipitation of 29.34 inches for the 1995 water year was 92 percent of the normal annual precipitation of 31.79 inches for water years 1961-90. Average precipitation values ranged from 61 percent of normal at Plymouth in east-central Wisconsin to 126 percent of normal at Grantsburg Department of Natural Resources ranger station in northwest Wisconsin (Pamela Nabor-Knox, UW-Extension, Geological and Natural History Survey, written commun., 1995).

Runoff was variable for rivers throughout the state ranging from 31 percent in east-central Wisconsin to 150 percent in northwest Wisconsin. Runoff was lowest (31 percent of the average annual runoff from 1973-95) for the Manitowoc River at Manitowoc and highest (150 percent of the average annual runoff from 1902-70, 1987-95) for Apple River near Somerset. Departures of runoff in the 1995 water year as a percent of long-term average runoff in the state are shown in Figure 4.

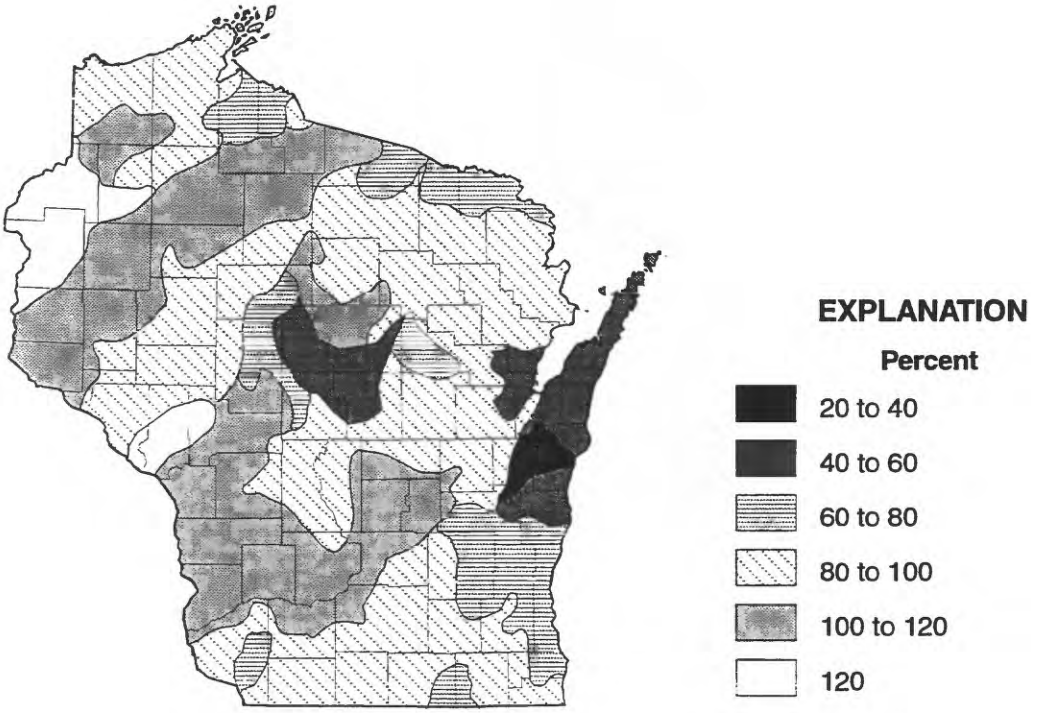


Figure 4. 1995 runoff as percent of long-term average runoff.

Annual discharges for the individual water years (1916-95) 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 1995 water year to discharge for a 80-year base period at the same three gaging stations is shown in Figure 6.

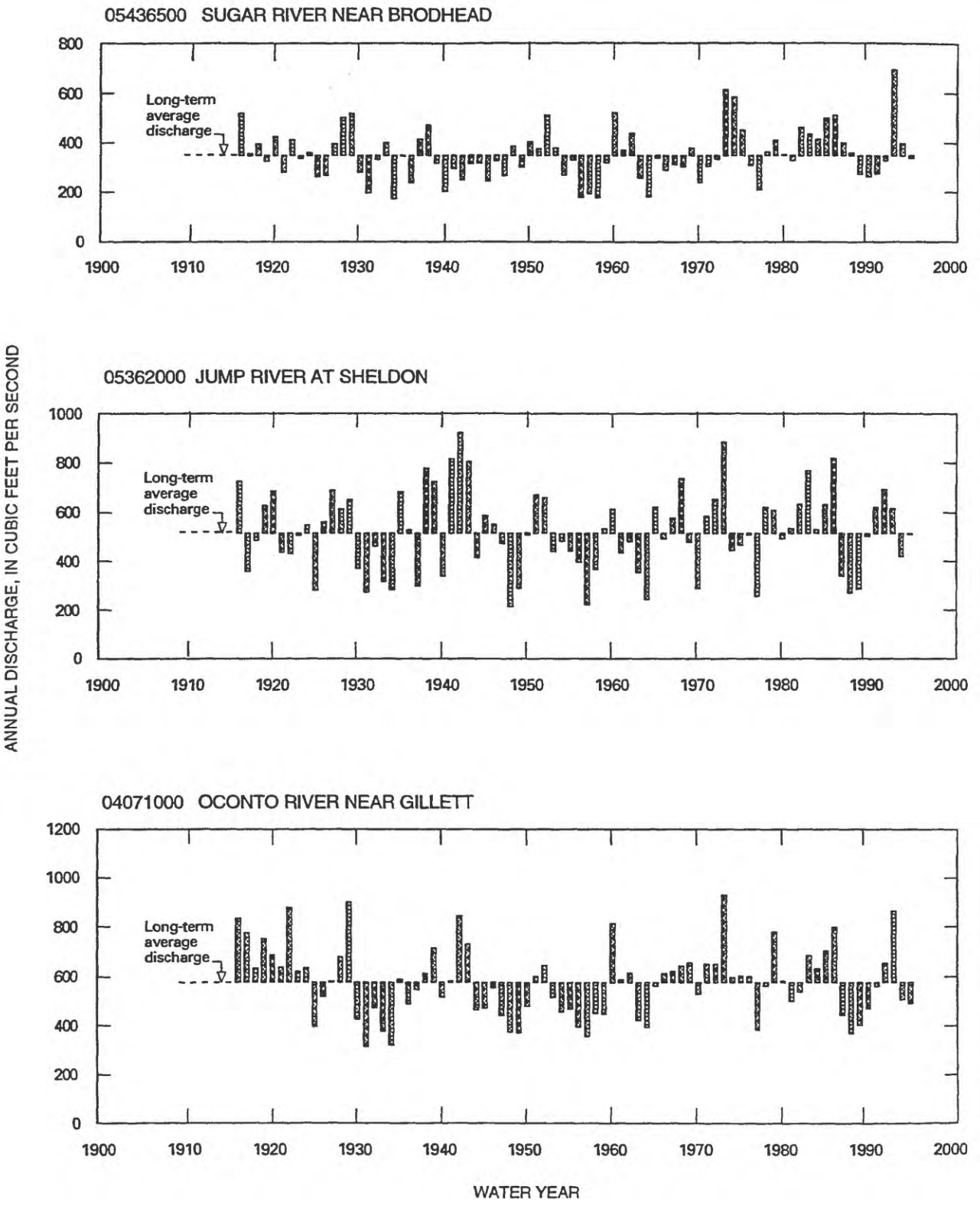


Figure 5. Comparison of annual discharge at representative gaging stations to the long-term average discharge for water years 1916-95.

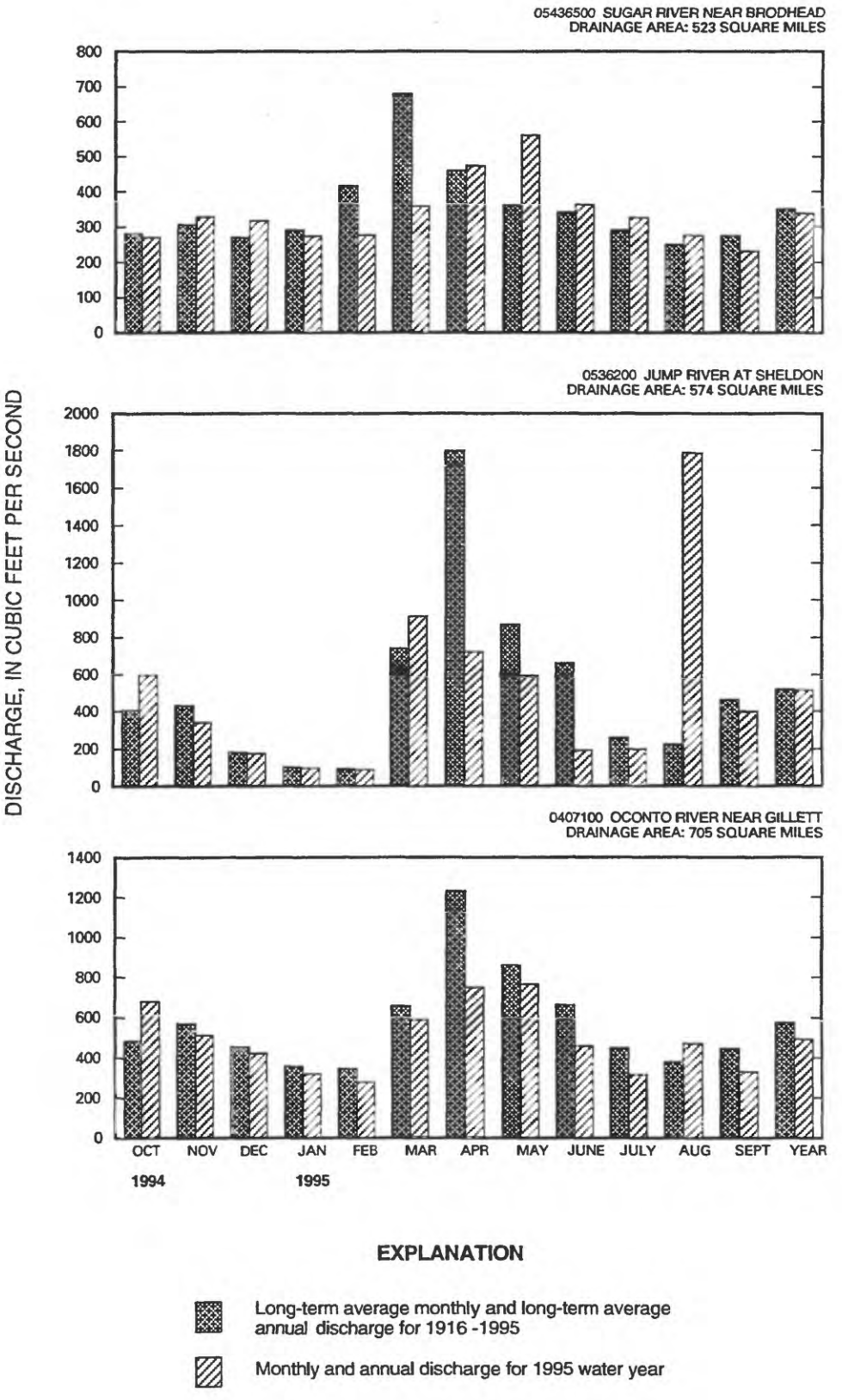


Figure 6. Comparison of discharge at representative gaging stations during water year 1995 with discharge for 1916-95.

The annual precipitation in the state was below normal for the 1995 water year, and low flows occurred at 21 gaging stations where the annual minimum 7-consecutive day average flows (Q7) had recurrence intervals of 2 or more years. The Q7 values typically occurred in July and early August, or in the winter months of February and March. The low-flow values which occurred in the summer were the result of below normal precipitation along with extremely high temperatures during the months of June and July. The extreme temperatures caused 120 heat-related deaths in Wisconsin by July 22. The heat also caused livestock and poultry deaths (Midwestern Climate Center, July 1995) along with crop damages which the Wisconsin Agricultural Statistics Service reported to have helped cause 1995 harvests to be 20 percent below the 1994 harvest (Midwestern Climate Center, January 1996). The Q7 values with the largest recurrence intervals occurred at stations draining into Lake Michigan in eastern 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)
04027000	Bad River near Odanah	Aug. 2-8	91	3
04027500	White River near Ashland	Feb. 4-10	136	4
04069500	Peshtigo River at Peshtigo	July 27-Aug. 2	295	3
04071858	Pensaukee River near Pensaukee	July 25-31	3.4	3
04078500	Embarrass River near Embarrass	July 27-Aug. 2	82	2
04079000	Wolf River at New London	July 30-Aug. 5	675	2
04085200	Kewaunee River near Kewaunee	July 15-21	11	3
04085281	East River at Mishicot	July 24-30	5.5	13
04085427	Manitowoc River at Manitowoc	July 25-31	14	7
04087030	Menomonee River at Menomonee Falls	July 27-Aug. 2	1.6	10
04087159	Kinnickinnic River at Milwaukee	Feb. 7-13	4.1	6
04087240	Root River at Racine	Oct. 18-24	5.5	3
05332500	Namekagon River near Trego	July 31-Aug. 6	284	2
05369500	Chippewa River at Durand	Feb. 13-19	2,740	3
05397500	Eau Claire River at Kelly	Feb. 28-Mar. 6	46	4
05398000	Wisconsin River at Rothschild	July 25-31	1,420	2
05400760	Wisconsin River at Wisconsin Rapids	July 24-30	1,870	2
05402000	Yellow River at Babcock	July 30-Aug. 5	5.9	3
05404000	Wisconsin River near Wisconsin Dells	July 28-Aug. 3	2,230	4
05407000	Wisconsin River at Muscoda	July 29-Aug. 4	3,680	2
05544200	Mukwonago River at Mukwonago	July 9-15	15	3

An isolated storm in June and widespread precipitation in August caused floods with discharges that equalled or exceeded those with a recurrence interval of 5 years (Krug and others, 1991) at six crest-stage gages. Precipitation throughout Wisconsin in August resulted in a statewide average of 7.10 inches, which was 175 percent of the normal August statewide precipitation of 4.06 inches for the period from 1961-90. The highest August precipitation total of 16.45 inches occurred at Rosholt in north-central Wisconsin (Pamela Nabor-Knox, UW-Extension, Geological and Natural History Survey, written commun., 1995), which was approximately 392 percent of the normal August precipitation of 4.2 inches for this station. Average precipitation in August was the highest value in the last 101 years. Heavy rains in August caused flooding that washed out some roads in west-central and north-central Wisconsin (Midwestern Climate Center, August 1995).

Peak discharges which had recurrence intervals that equalled or exceeded 5 years are summarized in the following table:

Station number	Station name	Date	Peak discharge (ft3/s)	Recurrence interval (years)
04087100	Honey Creek at Milwaukee	Aug. 16	500	6
05341900	Kinnickinnic River Tributary at River Falls	Aug. 13	3,040	15
05371800	Buffalo River Tributary near Osseo	Aug. 14	110	7
05382200	French Creek near Ettrick	Aug. 14	1,790	50
05397600	Big Sandy Creek near Wausau	Aug. 15	1,600	50
05430403	Fisher Creek Tributary at Janesville	June 27	796	10

References cited:

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.

Midwestern Climate Center, 1995, Weather and Climate Impacts in the Midwest-Major Climate Conditions for July, 1995-Regional Impacts-Wisconsin: Champaign, Ill., v. V, no. 8, p. 7.

_____, 1995, Weather and Climate Impacts in the Midwest-Major Climate Conditions for August, 1995: Champaign, Ill., v. V, no. 9, p. 2, 8.

_____, 1996, Weather and Climate Impacts in the Midwest-Major Climate Conditions for January, 1996-Regional Impacts-Wisconsin: Champaign, Ill., v. VI, no. 2, p. 7.

Water Quality

Suspended-sediment and total phosphorus yields for streams in southern Wisconsin for water year 1995 were low ranging from 23 to 60 percent of long-term annual average. The suspended-sediment yield at the Grant River at Burton in southwestern Wisconsin was 59 tons/mi^2 (tons per square mile), or 23 percent of the average annual yield for 1978-95. The suspended-sediment yield for Jackson Creek Tributary near Elkhorn in southeastern Wisconsin for water year 1995 was 42 tons/mi^2, which was 59 percent of the average annual yield for the period 1984-95. The total phosphorus yield for Jackson Creek Tributary was 201 lbs/mi^2 (pounds per square mile), or 42 percent of the 1984-95 annual average. At Silver Creek near Ripon suspended sediment yield was 12.3 tons/mi^2, or 52 percent of the 1988-95 annual average, and total phosphorus yield was 209 lbs/mi^2, or 60 percent of the 1988-95 annual average.

Ground-Water Levels

Maps showing the seasonal ground-water trends for the year (fig. 4) are based on water-level data from 26 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 1994; WINTER consists of measurements from January through March 1995; SPRING consists of measurements from April through June 1995; and SUMMER consists of measurements from July through September 1995. Mean seasonal water levels were compared to the long-term mean seasonal water levels. The 1995 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 1995 water year were normal to above normal for most of the wells in the state. Several counties, Barron, Vilas, Door, and Milwaukee, 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 1995 water year and above normal rainfall during the previous water year.

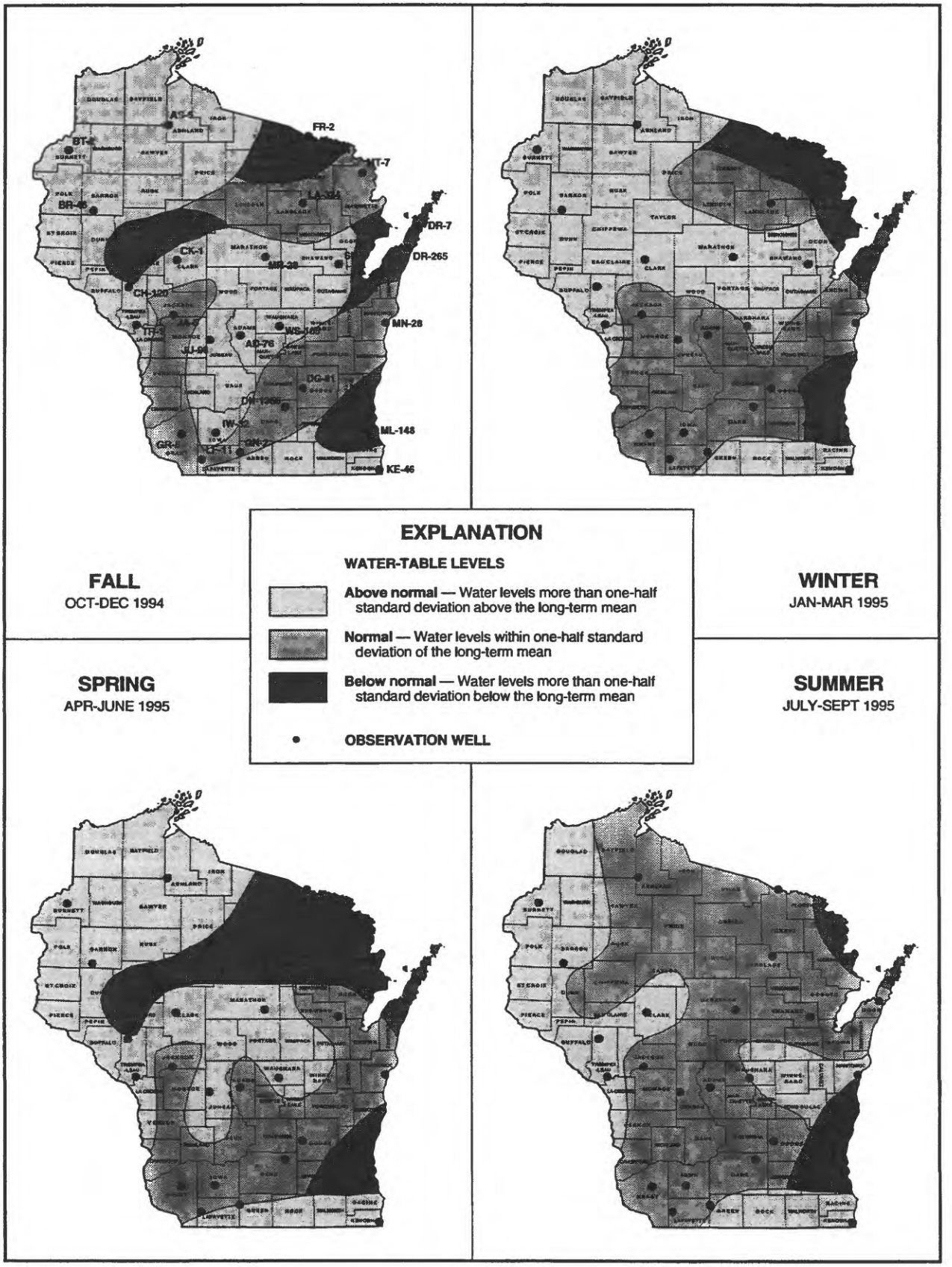


Figure 7. Relation of seasonal water-table levels to long-term means.

COLLECTION OF BASIC RECORDS–SURFACE WATER, WI 001

COOPERATORS:

Wisconsin Department of Natural Resources
U.S. Army Corps of Engineers
Southeastern Wisconsin Regional Planning Commission
Federal (Regular)
Madison Metropolitan Sewerage District
Dane County Department of Public Works
Federal Energy Regulatory Commission Licensees
- Dairyland Power Cooperative
- Niagara of Wisconsin Paper Corporation
- Northern States Power Company
- Wisconsin Electric Power Company
- Wisconsin Power and Light Company
- Wisconsin Public Service Corporation
- Wisconsin Valley Improvement Company

Lac du Flambeau Band of Lake Superior Chippewa
Illinois Department of Transportation
City of Barron
City of Beaver Dam
City of Brookfield
City of Hillsboro
City of Peshtigo
City of 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

LOCATION:

Statewide

PROJECT CHIEF:

Barry K. Holmstrom

PERIOD OF PROJECT:

July 1913-Continuing

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

OBJECTIVE: The objectives of this study are to provide continuous discharge records for selected rivers at specific sites to supply the needs for regulation, analytical studies, definition of statistical properties, trends analysis, determination of the occurrence, and distribution of water in streams for planning. The project is also

designed to determine lake levels and to provide discharge for floods, low-flow conditions, and for water-quality investigations. Requests for streamflow data and information relating to streamflow in Wisconsin are answered. Basic data are published annually in the report "Water Resources Data–Wisconsin."

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

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

PROGRESS (July 1995 to June 1996): During the current fiscal year, streamflow data were collected at a total of 96 sites: 33 sites for the Wisconsin Department of Natural Resources (WDNR), 19 sites for the Corps of Engineers, 14 sites for the Southeastern Wisconsin Regional Planning Commission, 6 sites for the Federal program, 2 sites for Federal Energy Commission Licensees, 2 sites for the Madison Metropolitan Sewerage District, and 1 site each for the Lac du Flambeau Band of Lake Superior Chippewa, Menominee Indian Tribe of Wisconsin, Oneida Tribe of Indians of Wisconsin, Stockbridge-Munsee Band of Mohican Indians, Illinois Department of Transportation, Rock County, Fontana/Walworth Water Pollution Control Commission, Dane County Department of Public Works, Walworth County Metropolitan Sewerage District, and cities of Barron, Beaver Dam, Brookfield, Hillsboro, Peshtigo, Sparta, Thorp, Waupun, and village of Wittenberg. Streamflow data were also collected at two sites for agencies working jointly with the USGS. Lake-level data were collected at two sites for the Dane County Department of Public Works, at two sites for the Corps of Engineers, at one site for the Rock County Public Works Department, and one site for the WDNR.

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

Computation of streamflow and lake-level records for all the network stations for the 1995 water year was completed, stored in our WATSTORE computer data base, and published in the annual report "Water Resources Data–Wisconsin, water year 1995". More than 100 requests for streamflow information were answered.

PLANS (July 1996 to June 1997): Data will be collected at 83 continuous-streamflow stations (see the following list) and lake levels at 6 stations. Streamflow records will be computed and data published for the 1996 water year. Requests for streamflow information will be answered.

Due to budget constraints by the WDNR, the operation of the following stations will be discontinued as of July 1, 1996, unless funding arrangements can be made with other cooperators.

04027000 Bad River near Odanah
04071858 Pensaukee River near Pensaukee
04078500 Embarrass River near Embarrass
04085200 Kewaunee River near Kewaunee
04085281 East Twin River at Mishicot
04085427 Manitowoc River at Manitowoc
04086000 Sheboygan River at Sheboygan
05362000 Jump River at Sheldon
05381000 Black River at Neillsville
05394500 Prairie River near Merrill
05397500 Eau Claire River at Kelly
05404000 Wisconsin River at Wisconsin Dells
05406500 Black Earth Creek at Black Earth
05408000 Kickapoo River at LaFarge

Partial funding will also be lost from the WDNR for the following stations as of July 1, 1996:

04073500 Fox River at Berlin
04079000 Wolf River at New London
05426000 Crawfish River at Milford

If funding arrangements can be made with other cooperators, it would be desirable to continue full operation of the 17 stations listed above.

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

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 1997 FY

Station number	Name and location	Drainage Area	Period of record (water year)	Cooperator
04025500	Bois Brule River - Brule	118	1943-81, 1984-	Fed.
04027500	White River - Ashland	301	1948-	WDNR
04029990	Montreal River - Saxon Falls	262	1987	WDNR
04063700	Popple River - Fence	139	1964-	Fed.
04064500	Pine River - Pine River Powerplant - Florence	533	1924-76, 1996-	WDNR
04065106	Menominee River - Niagara	2470	1993-	FERC
04066003	Menominee River - Pembine	3140	1950-	WDNR
04069500	Peshtigo River - Peshtigo	1080	1953-	City of Peshtigo
04071000	Oconto River - Gillett	705	1906-09, 1914-	Fed.
04072150	Duck Creek - Howard	108	1988-	Oneida Tribe of Indians of WI
04073500	Fox River - Berlin	1340	1898-	C of E, Detroit
04074950	Wolf River - Langlade	463	1966-79, 1981-	Menominee Indian Tribe of WI
04077400	Wolf River - Shawano	816	1907-09, 1911-	FERC
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
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
05369945	Eau Galle River - low water bridge - Spring Valley	47.9	1982-83, 1986-	C of E, Vicksburg
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

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 1997 FY

Station number	Name and location	Drainage Area	Period of record (water year)	Cooperator
05382000	Black River - Galesville	2080	1932-	C of E, St. Paul
05382325	La Crosse River - Sparta	167	1992-	City of Sparta
05391000	Wisconsin River - Lake Tomahawk	757	1936-	WDNR
05393500	Spirit River - Spirit Falls	81.6	1942-	WDNR
05395000	Wisconsin River - Merrill	2760	1903-	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
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.
05407000	Wisconsin River - Muscoda	10400	1903-04, 1914-	C of E, St. Paul
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-	C of E, R. Island
05426250	Bark River - Rome	122	1980-	SEWRPC
05427570	Rock River - Indianford	2630	1975-	Rock County
05429500	Yahara River - McFarland	327	1930-	DCDPW
05430150	Badfish Creek - Cooksville	82.6	1977-	MMSD
05430175	Yahara River - Fulton	517	1977	MMSD
05430500	Rock River - Afton	3340	1914-	Rock County
	Turtle Creek - Delavan		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
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

WDNR – Wisconsin Department of Natural Resources
C of E, Detroit – Corps of Engineers, Detroit, Michigan
C of E, R. Island – Corps of Engineers, Rock Island, Illinois
C of E, St. Paul – Corps of Engineers, St. Paul, Minnesota
SEWRPC – Southeastern Wisconsin Regional Planning Commission
Fed. – USGS Federal Program
FERC – Federal Energy Regulatory Commission Licensees
MMSD – Madison Metropolitan Sewerage District
DCDPW – Dane County Department of Public Works
IL. DOT – Illinois Department of Transportation
WALCOMET – Walworth County Metropolitan Sewerage District
Fontana/Walworth WPCC – Fontana/Walworth Water Pollution Control Commission

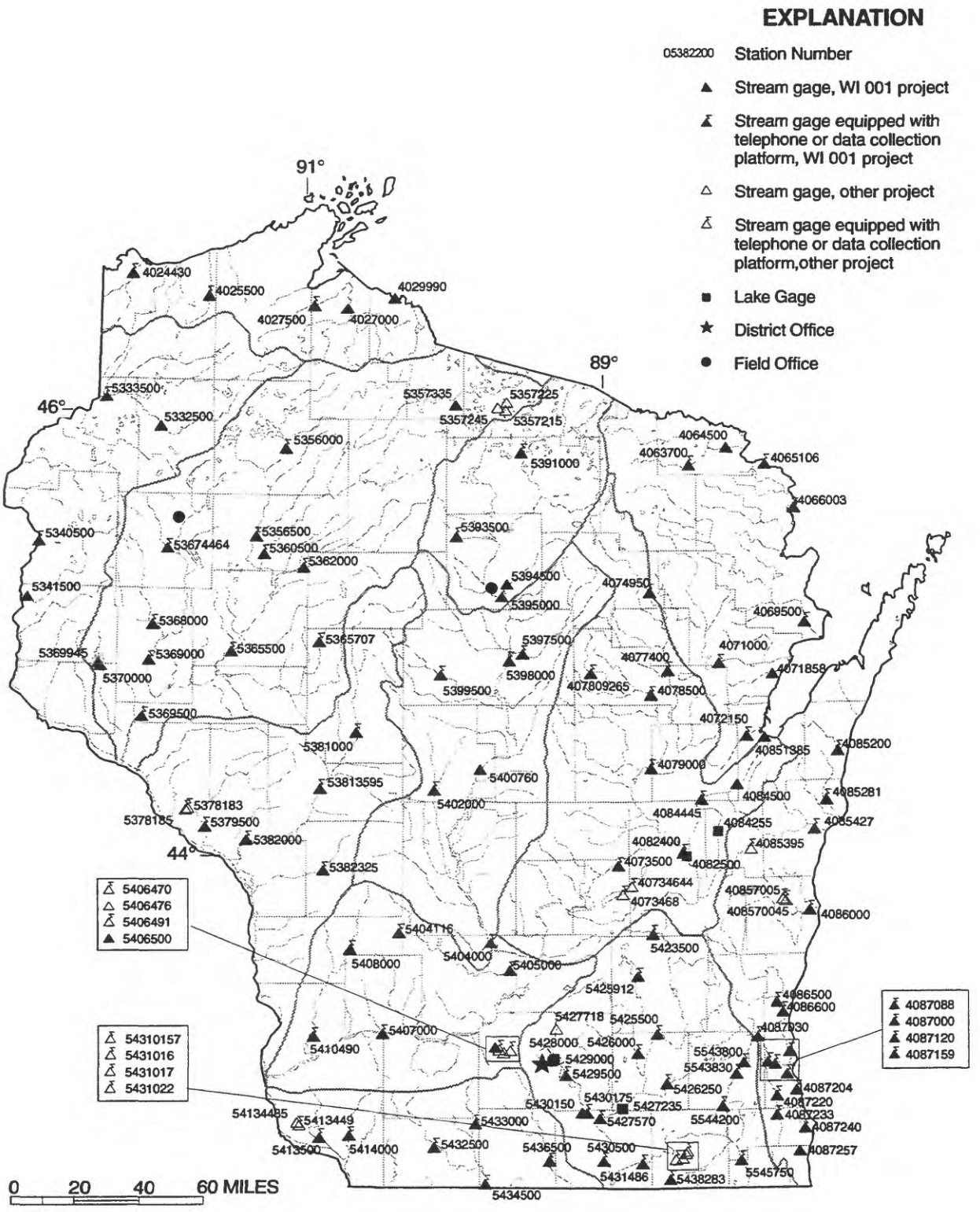


Figure 8. Location of continuous-record data-collection stations.

DISCONTINUED SURFACE-WATER DISCHARGE STATIONS

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

Discontinued surface-water discharge stations

Station name	Station number	Drainage area (square miles)	Period of record
STREAMS TRIBUTARY TO LAKE SUPERIOR			
Little Balsam Creek at Patzau, WI	04024314	4.89	1976-78
Little Balsam Creek near Patzau, WI	04024315	5.05	1976-78
Little Balsam Creek Tributary near Patzau, WI	04024318	0.60	1976-78
Little Balsam Creek near Foxboro, WI	04024320	3.27	1977-78
Amnicon River near Poplar (Amnicon Falls), WI	04025000	110	1914-16
Bois Brule (Brule) River near Brule, WI	04026000	160	1914-17
Sioux River near Washburn, WI	04026300*	33.9	1965-66
Pine Creek at Moquah, WI	04026347	6.20	1976-78
Pine Creek Tributary at Moquah, WI	04026348	0.48	1976-78
Pine Creek near Moquah, WI	04026349	19.9	1976-78
North Fish Creek near Moquah, WI	040263491	65.4	1990-91
Bad River near Mellen, WI	04026450*	82.0	1971-75
Bad River at Mellen, WI	04026500	98.3	1948-55
Alder Creek near Upson, WI	04026870	22.2	1972-77
Montreal River near Kimball, WI	04028500	100	1924-26
West Fork Montreal River at Gile, WI	04029000	75.0	1918-26, 1943-47
West Fork Montreal River near Kimball, WI	04029500	86.2	1924-26
STREAMS TRIBUTARY TO LAKE MICHIGAN			
North Branch Pine River at Windsor Dam nr Alvin, WI	04063640*	27.8	1967-68
Pine River near Florence, WI	04064000	510	1914-23
Pine River below Pine River Power Plant near Florence, WI	04064500	533	1924-76
Pike River at Amberg, WI	04066500	255	1914-70
Menominee River near McAllister, WI	04067500	3,930	1945-61, 1979-86, 1988-90
Peshtigo River at High Falls near Crivitz, WI	04068000	537	1912-57
Suamico River at Suamico, WI	04072000	60.7	1951-52
Lawrence Creek near Westfield, WI	04072750	13.4	1968-73
Grand River near Kingston, WI	04073050	73.5	1968-75
West Branch White River near Wautoma, WI	04073405	38.9	1964-75
White Creek at Forest Glen Beach near Green Lake, WI	04073462	3.05	1982-88
Swamp Creek above Rice Lake at Mole Lake, WI	04074538	46.3	1977-83, 1985-87
Swamp Creek below Rice Lake at Mole Lake, WI	04074548	56.8	1977-79, 1982-85
Wolf River near White Lake, WI	04075000	485	1935-38
Evergreen Creek near Langlade, WI	04075200*	8.09	1964-73
Wolf River above West Branch Wolf River, WI	04075500	616	1928-62
West Branch Wolf River at Neopit, WI	04076000	93.2	1911-17
West Branch Wolf River near Keshena, WI	04076500	163	1928-32
Little Wolf River near Galloway, WI	04079602	22.6	1974-79
Spaulding Creek near Big Falls, WI	04079700*	5.57	1964-66
Little Wolf River at Royalton, WI	04080000	507	1914-70, 1983-85
Emmons Creek near Rural, WI	04080950	25.1	1977
Storm Sewer to Mirror Lake at Waupaca, WI	04080976	0.04	1971-74
Waupaca River near Waupaca, WI	04081000	265	1916-66, 1983-85
Daggets Creek at Butte Des Morts, WI	04081800	10.6	1977
West Branch Fond du Lac River at Fond du Lac, WI	04083000	83.1	1939-54
East Branch Fond du Lac River near Fond du Lac, WI	04083500	78.4	1939-54
Brothertown Creek at Brothertown, WI	04084200	5.10	1976-77
Onion River at Hingham, WI	04085813	37.2	1979-80
Onion River near Sheboygan Falls, WI	04085845	94.1	1979-82
Milwaukee River at Kewaskum, WI	04086150	138	1968-81
East Branch Milwaukee River near New Fane, WI	04086200	54.1	1968-81
North Branch Milwaukee River near Fillmore, WI	04086340	148	1968-81

Discontinued surface-water discharge stations

Station name	Station number	Drainage area (square miles)	Period of record
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
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
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

Discontinued surface-water discharge stations

Station name	Station number	Drainage area (square miles)	Period of record
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 Crk nr Barneveld, WI	05406573	8.37	1976-78
Trout Creek at Twin Parks Dam 8 nr Barneveld, WI	05406574	9.02	1976-79
Trout Creek at County Highway T nr Barneveld, WI	05406575	12.1	1976-78
Trout Creek near Ridgeway, WI	05406577	13.5	1976-79
Knight Hollow Creek near Arena, WI	05406590	7.57	1976-78
Otter Creek near Highland, WI	05406640	16.8	1968-69, 1970-75
Kickapoo River at Ontario, WI	05407500	151	1939, 1973-77
Knapp Creek near Bloomingdale, WI	05408500	8.44	1955-69
West Fork Kickapoo River near Readstown, WI	05409000	106	1939
Kickapoo River at Soldiers Grove, WI	05409500	530	1939
North Fork Nederlo Creek near Gays Mills, WI	05409830	2.21	1968-79
Nederlo Creek near Gays Mills, WI	05409890	9.46	1968-80
Kickapoo River at Gays Mills, WI	05410000	617	1914-34, 1964-77
GRANT RIVER BASIN			
Pigeon Creek near Lancaster, WI	05413400*	6.93	1964-66
Rattlesnake Creek near Beetown, WI	05413451	45.2	1990-91

Discontinued surface-water discharge stations

Station Station name	Drainage area number	(square miles)	Period of record
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
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 better determine short-term changes and long-term trends in ground-water levels in the State. It is important to know if these changes are natural or man-induced and how these changes are effecting storage in the ground-water reservoirs.

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

APPROACH: A basic network of about 170 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 1995 to June 1996): Additional computer programs were written and are being used to make data entry of water levels more efficient. Local observers were visited and hired to collect water-level data. Slug tests and geophysical logs were completed on about 60 wells to improve the quality of the network. All digital recorders were replaced with data loggers. Data for the annual report, "Water Resources Data-Wisconsin, water year 1995", was completed.

PLANS (July 1996 to June 1997): Plans include: (1) Continue measurements on observation-well network, (2) replace and hire new observers and make quality-assurance checks when possible, (3) have water-level information and hydrograph data on the INTERNET for individuals requesting these types of data, and (4) compile and prepare a report of our findings from the slug tests and geophysical logging.

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.

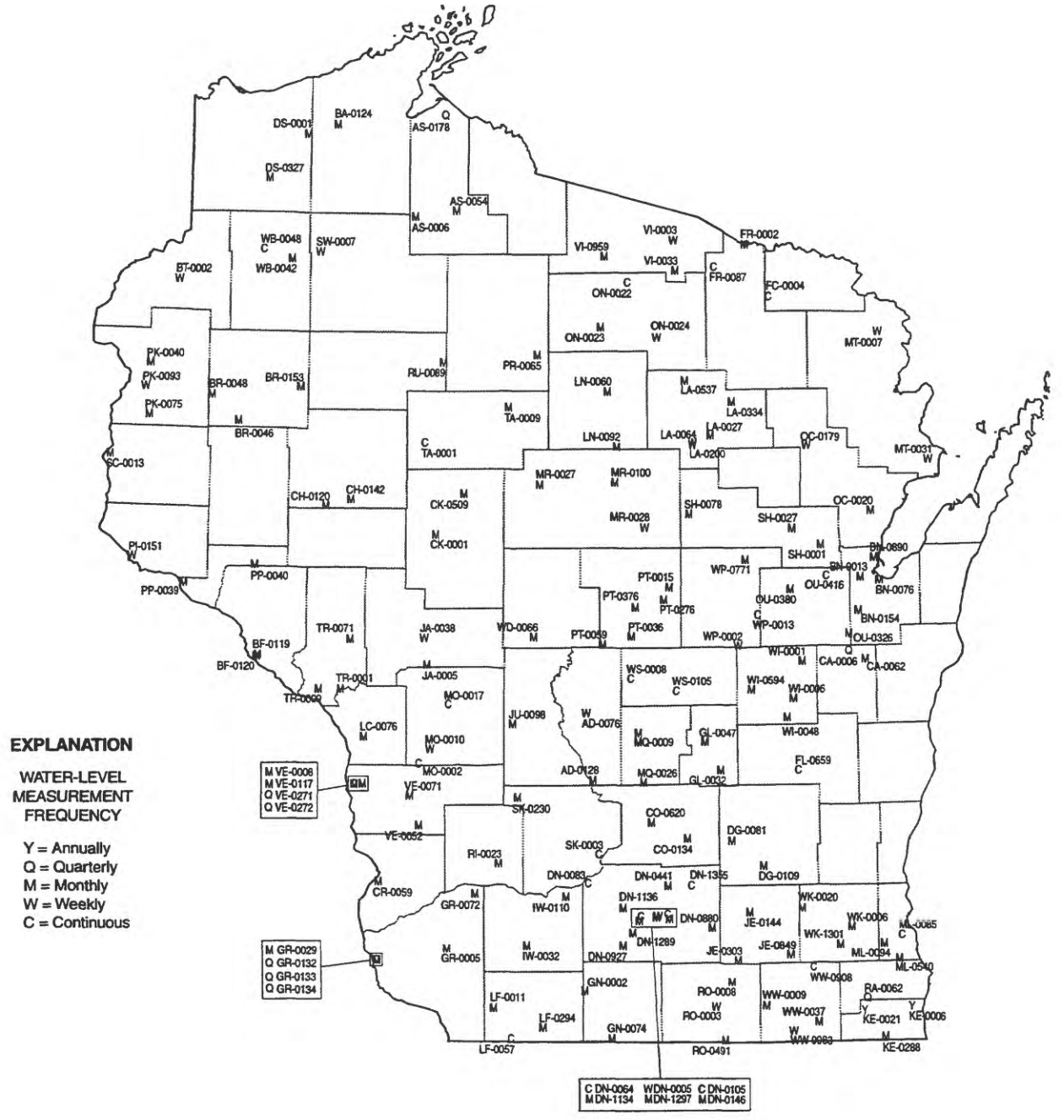


Figure 9. Location of network observation wells.

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 man's 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 1995 to June 1996): Data were collected quarterly at the HBMN station on the Popple River. Radiochemical data were collected semiannually at the Chippewa and Popple River stations.

Data collected during the 1995 water year were processed for publication in the annual data release "Water Resources Data-Wisconsin, water year 1995." Work began on a report that will summarize historical data from the NASQAN network.

PLANS (July 1996 to June 1997): Data collection will continue at the HBMN station on the Popple River. The summary of historical water-quality monitoring data will be completed.

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 on selected tributaries to Lake Mendota and to collect data to identify long-term changes in base-flow water quality in selected streams in Dane County.

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

PROGRESS (July 1995 to June 1996): Suspended-sediment loads for Spring Harbor Storm Sewer at Madison, and suspended-sediment and total-phosphorus loads for the Yahara River at Windsor and Pheasant Branch at Middleton were computed for the 1995 water year. Continuous-streamflow data were collected at all three stations. Streamflow, load and concentration data were published in the annual data report "Water Resources Data-Wisconsin, water year 1995."

Collection of water-quality data during base flow at sites on two streams was conducted four times.

PLANS (July 1996 to June 1997): Continue data collection and processing at the three stations on tributaries to Lake Mendota. Conduct base-flow water-quality sampling at four sites during the year.

COOPERATOR:
Dane County Regional Planning Commission

LOCATION:
Dane County, Wisconsin

PROJECT CHIEF:
Herbert S. Garn

PERIOD OF PROJECT:
Continuing

COLLECTION OF BASIC RECORDS–SEDIMENT, WI 004

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

LOCATION:
Statewide

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
March 1968-Continuing

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 1995 to June 1996): 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 1970's when there was a Statewide network of sediment monitoring stations. All data have been published annually in the data report, "Water Resources Data-Wisconsin."The 1995 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.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES (WDNR)–A study whose objective was to estimate the coarse-material sediment load at three sites on North Fork Fish Creek near Ashland, Wisconsin, began on July 1, 1989. Monitoring for this study was completed in October 1991 and a report summarizing the study was prepared.

PLANS (July 1996 to June 1997):

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

WISCONSIN DEPARTMENT OF NATURAL RESOURCES–The report summarizing the results of the North Fork Fish Creek study will be distributed.

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.

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 1995 to June 1996): Surveying and hydrologic analyses were completed for Fond du Lac County study. Surveying, initial hydrologic analyses, and FIRM digitizing began for LaCrosse County.

PLANS (July 1996 to June 1997): Response will be made to review comments on completed studies and data requests answered as needed. Hydrologic analyses and surveying for LaCrosse County 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, to store data in the State Water-Use Data System (SWUDS), and to prepare periodic reports on water use in the State.

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

PROGRESS (July 1995 to June 1996): The SWUDS was updated with current water-use information. Reformatting programs were written or updated as needed for entering data from other agencies into SWUDS. Data collection was started for the 1995 water-use publication, "Water use in Wisconsin, 1995".

PLANS (July 1996 to June 1997): Plans include (1) continue to update and maintain the SWUDS data base with current water-use data, (2) supply water-use data for water-resources studies currently being conducted in the State, and (3) continue data collection for the 1995 water-use publication, "Water use in Wisconsin, 1995".

REPORTS:

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

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

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

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

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

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

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.

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

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

PROGRESS (July 1995 to June 1996): A journal article was accepted for publication giving the results of the model study on the Coon Creek basin. Annual flood peaks were computed and published in the annual data report for 66 crest-stage stations. New stations have been installed in areas where the cooperator indicated the greatest need for more information on flooding. Significant effort has been made in measuring flood discharges at crest gages, especially at the newly installed gages, and improving ratings at crest gages.

PLANS (July 1996 to June 1997): The crest-stage-gage network will be monitored throughout the year. New gages will have ratings developed for them as measurements and surveys are available. Significant effort will be made to improve ratings at all of the gages.

REPORTS:

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

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

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

Conger, D.H., 1981, Techniques for estimating magnitude and frequency of floods for Wisconsin streams: U.S. Geological Survey Water-Resources Investigations Open-File Report 80-1214, 116 p., 2 pls.

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

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
05409270	Reads Creek at Riley Road near Readstown, WI
05413060	Martin Branch near Mount Ida, 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.

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

COOPERATORS:

In the 1995 water year:
Alma/Moon, Big Muskego, Druid, Eagle Spring, Fowler, Little Arbor Vitae, Little Green, Little Muskego, Little St. Germain, Montello, Okauchee, Potter, Powers, Pretty, Upper Nemahbin, Wind, Wolf, and Twin (Marie and Elizabeth) Lake Districts; city of Muskego (Denoon Lake); townships of Auburn (Forest Lake); Kansasville (Eagle Lake); Mead (Mead Lake); Merton (Keesus Lake); Norway (Kee-Nong-Go-Mong and Waubeesee Lakes); St. Germain (Big St. Germain Lake); Summit (Silver Lake); and Waterford (Tichigan Lake); villages of Lake Nebagamon (Lake Nebagamon); and Oconomowoc Lake (Oconomowoc Lake); and the Wisconsin Department of Justice (Big Sissabagama Lake)

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

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

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

APPROACH: Water quality at each lake will be monitored in February, April, June, July, and August. Depth profiles of dissolved-oxygen concentration, temperature, pH, and specific conductance will be determined. In April, the lakes will be sampled at the top and bottom for analysis of the major anions and cations, nitrogen, and dissolved phosphorus. Secchi-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:

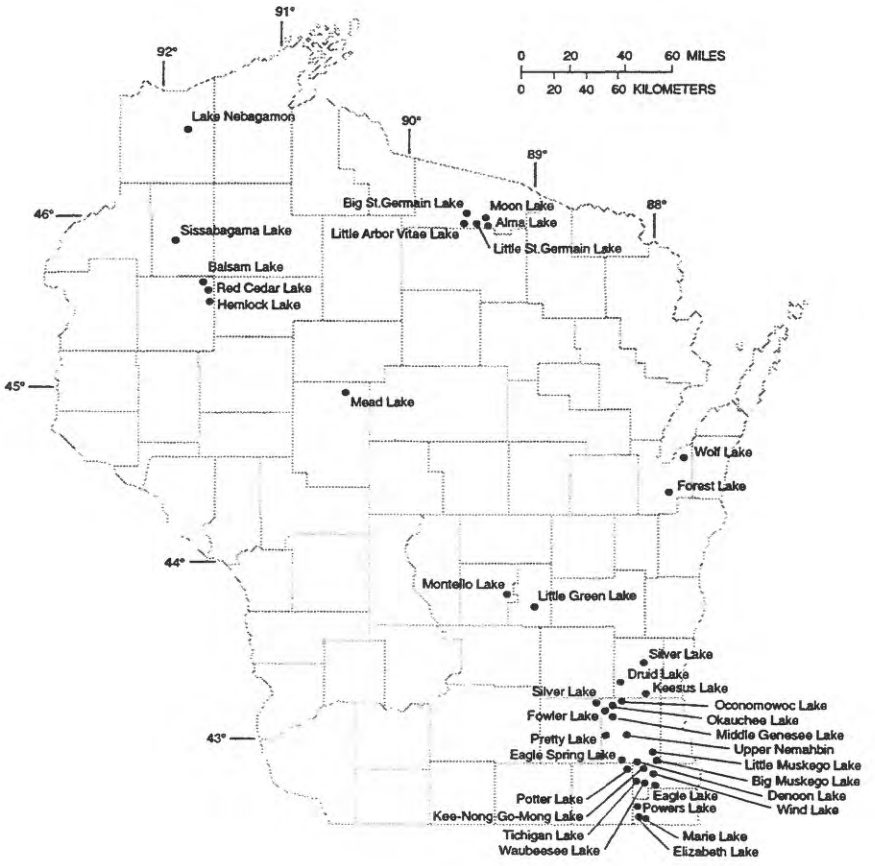
William J. Rose

PERIOD OF PROJECT:

June 1983-Continuing

PROGRESS (July 1995 to June 1996): In the 1995 water year, total phosphorus, chlorophyll *a*, dissolved oxygen, temperature, pH, specific conductance, and Secchi-depth data were collected and analyzed for 33 lakes. A letter evaluating the water quality of each lake was sent to the respective cooperator. In the 1996 water year, Middle Genesee and Silver (Washington County) Lakes were added to the program. Balsam, Red Cedar, and Hemlock Lakes (Barron County) reentered the program. Keesus, Mead, Nebagamon and Upper Nemahbin Lakes discontinued the program. The locations of lakes included in the monitoring program for water years 1995-96 are shown on the following map.

PLANS (July 1996 to June 1997): In the 1996 water year, 35 lakes will be monitored. We will compile the data and transmit it to the respective cooperator after the August monitoring. The data will be prepared for publication in the annual report "Water Quality and Lake-Stage Data for Wisconsin Lakes, water year 1996."



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

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

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

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

Water samples were analyzed to obtain PCB concentrations with congener resolution of hundreths of a nano-gram/liter. Dissolved and particulate PCB concentrations were determined separately so the PCB partition coefficients could be computed. Water samples were also analyzed to determine total and dissolved organic carbon and other parameters. Samples were collected every two weeks, except in winter. Winter sampling was done about once per month.

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

The Water Analysis Simulation Program (WASP) model has been used to simulate PCB kinetics and transport. Water-column data collected during the summer and fall of 1992, along with high-flow data collected during the summer of 1993, has been used to validate the transport model.

PROGRESS (July 1995 to June 1996): A fact sheet summarizing the Fox River effort is 75 percent completed. We have begun assisting the Fish and Wildlife Service in the Natural Resource Damage Assessment process.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Lower Fox River, East Central Wisconsin

PROJECT CHIEF:
Jeffrey J. Steuer

PERIOD OF PROJECT:
July 1985 to July 1996

PLANS (July 1996 to June 1997): The fact sheet summarizing the Fox River effort will be completed. We will continue to assist the Fish and Wildlife Service in the Natural Resource Damage Assessment process.

REPORTS:

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

Velleux, M., Endicott, D., Steuer, Jeffrey J., Jaeger, S., and Patterson, D., Long-term simulation of PCB export from the Fox River to Green Bay, 1995, J. Great Lakes Research.

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

SUPERFUND REMEDIAL RESPONSE SUPPORT, EPA REGION V, WI 164

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

OBJECTIVE: The objectives are to provide the requested assistance and broaden the knowledge of ground-water hydrology in the vicinity of Superfund sites.

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

PROGRESS (July 1995 to June 1996): Work was done at the following Superfund sites: Parsons Casket, Belvidere, Illinois; Better Brite, De Pere, Wisconsin, and Ottawa Radiation Site, Ottawa, Illinois. Work included packer-testing in selected test wells to collect water-level measurements, collection of water samples for analysis, and testing of formations to determine the hydraulic conductivity at various depths in these wells. Nested piezometers were also installed in selected test wells to provide wells for further collection of water samples as part of the Superfund efforts at these sites. An open-file report of detailed data collected from a test hole at the Better Brite site was written. Included in this report are results of formation tests, geologic core analysis, and water-quality sampling.

PLANS (July 1996 to June 1997): Assistance will continue to be provided at sites in EPA Region V upon request.

COOPERATOR:
U.S. Environmental Protection Agency, Office of Superfund

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

PROJECT CHIEF:
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 1995 to June 1996): Stable isotope sampling of the capillary fringe has shown that (1) the natural wetland has a greater rate of evapotranspiration than the constructed wetland, (2) macropore flow is not important in the shallow system, and (3) the isotopic composition of the wetland's water sources are relatively constant from year to year. The constructed wetland soils are still significantly warmer than the natural wetland soils, even three years after construction. Empirical estimates of potential evapotranspiration (Penman and Thornthwaite) show little difference between the natural and constructed wetland and are generally lower than what was expected from previous hydrologic investigation. Initial trace-metal sampling was performed at the Wilton site and instrumentation at a verification site in Waukesha County was completed. A journal article describing four methods of measuring ground-water inflow in wetland systems was published. Journal articles reporting the results of the stable isotope investigation and the geochemical investigation were also submitted for publication.

PLANS (July 1996 to June 1997): Hydrology and hydrogeochemistry of the initial research sites will be reevaluated to assess the changes that have occurred in the four years post-completion. The verification site in southeastern Wisconsin will continue to be investigated using hydrogeochemical and physical methods to test the transferability of the methods developed to date. In addition, the new research focused on estimating wetland evapotranspiration and delineating small-scale trace-metal chemistry will continue at the initial research sites.

REPORTS:
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.

TRENDS IN WATER QUALITY AND STREAM HABITAT FOR PRIORITY WATERSHEDS, WI 17201-17205, 17208-17210, 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 1995 to June 1996): Streamflow and water-quality monitoring was continued at 10 sites in the priority watersheds. Dissolved oxygen was monitored at seven sites in the priority watersheds. All data was summarized and will be published in the report "Water Resources Data-Wisconsin", water year 1995. Water-quality loads were calculated for selected parameters and storm periods for the 10 sites. Land-use inventories were done for each basin.

PLANS (July 1996 to June 1997): Streamflow, water-quality (for the 10 sites), and dissolved-oxygen (at 4 sites) monitoring will be continued. Water-quality loads for selected parameters and storm periods will be calculated and compared to data collected in previous years. The data will be analyzed to determine if there are any apparent trends in water quality during implementation of the best management plans. Land-use inventories will be updated for each basin.

REPORTS:

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

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

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

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION:

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

PROJECT CHIEF:

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

PERIOD OF PROJECT:

October 1990 to September 1997

BEST MANAGEMENT PRACTICE EVALUATION, WI 17206

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
State of Wisconsin

PROJECT CHIEF:
John F. Walker

PERIOD OF PROJECT:
October 1989 to September 1997

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

OBJECTIVE: Investigate statistical analysis techniques for assessing trends in water quality due to Best Management Practice (BMP) implementation using data from other States. The effectiveness of BMP's in two urban basins and seven rural basins in Wisconsin will be determined using the identified statistical techniques.

APPROACH: A comprehensive literature search will be conducted to identify viable statistical analysis techniques and identify needs for method modification or development. Data for several rural and urban basins in other States will be compiled and used to test the selected techniques. Storm loads of total-suspended solids and total phosphorus will be computed and used along with rainfall data and land-use information to assess the effectiveness of the BMP's in several basins in Wisconsin.

PROGRESS (July 1995 to June 1996): Annual progress report describing data collected through water year 1995 (Owens and others, 1996) was completed and published. Work began on progress report describing data collection through water year 1996. Work continued on incorporating snowmelt loads into statistical analysis. Work began on three new sub-projects to examine (1) Oracle database development and world-wide-web data query, (2) regression analysis for urban sites, and (3) comparison of unit-area loads for rural and urban sites. A comprehensive Oracle database containing all evaluation-monitoring data, including instantaneous concentrations, continuous precipitation and discharge time-series, and event-based summaries of precipitation, runoff and constituent loads was designed. Instantaneous concentrations and event-based data through water year 1995 were loaded and began loading remaining time-series data.

PLANS (July 1996 to June 1997): Annual progress report describing data collected through water year 1996 will be completed and published; work on progress report describing data collection through water year 1997 will begin. Work incorporating snowmelt loads into regression analysis will be completed. Oracle database design will be completed and all data through water year 1996 will be incorporated. Access to database through world-wide-web data queries will be provided. Urban regression analysis will be completed and results published in a fact sheet. Preliminary statistical analysis for sites with transitional BMP-implementation data (Brewery, Garfoot, and Otter Creeks) will be performed.

REPORTS:

Owens, D.W., Corsi, S.R., and Rappold, K.F., 1996, Evaluation of nonpoint-source contamination, Wisconsin: selected data for water year 1995, U.S. Geological Survey Open-File Report (in press).

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

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

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

Walker, J.F., 1993, Techniques for detecting effects of urban and rural land-use practices on stream-water chemistry in selected watersheds in Texas, Minnesota, and Illinois: U.S. Geological Survey Open-File Report 93-130, 16 p.

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

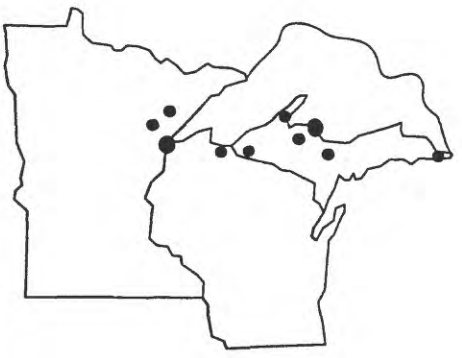
LAKE SUPERIOR URBAN STORM-WATER DEMONSTRATION PROJECT, WI 17212

COOPERATOR:
Wisconsin Department of Natural Resources

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

PROJECT CHIEF:
Jeffrey J. Steuer

PERIOD OF PROJECT:
April 1993 to December 1997



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

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

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

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

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

PROGRESS (July 1995 to June 1996): Data collection from storm sewers in Marquette, Michigan, Superior, Wisconsin, and the eight smaller municipalities has been completed and the 2,887 samples analyzed. At Superior, Wisconsin, runoff from the Tower Avenue basin (22 acres), as measured during 91 events, was generally 50 percent. At Marquette, Michigan, runoff from the Tower Avenue basin (288 acres), as measured during 65 events, was generally 15 percent. At Marquette and Superior, event loadings for nutrients, metals, and polycyclic-aromatic hydrocarbons (PAH's) have been calculated based upon flume-measured discharge and flow-weighted composite sampling.

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

PLANS (July 1996 to June 1997): Data will continue to be collected at the undeveloped urban and golf course sites.

REPORTS:

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

Steuer, J., and others, Source-area pollutant mass budgets in an urban basin, Marquette, Michigan (in process).

SINGLE SOURCE SITES, WI 17214

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

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

APPROACH: Continuously monitor and/or sample streamwater upstream and downstream from a single nonpoint-pollution source before and after implementation of BMP's. Currently, three barnyard-runoff sites are being investigated: Otter Creek in the Sheboygan River Priority Watershed, Halfway Prairie Creek in the Black Earth Creek Priority Watershed, and Kuenster Creek in the Lower Grant River Priority Watershed. Stream discharge is monitored and water-quality samples are collected at Otter and Halfway Prairie Creeks. Dissolved oxygen (DO) and water temperature are being monitored at Kuenster Creek.

PROGRESS (July 1995 to June 1996): Baseflow samples and samples during 10 storm periods were collected during pre-BMP conditions at Otter Creek and Halfway Prairie Creek. Event-mean concentrations of total phosphorus, ammonia nitrogen and biochemical oxygen demand were calculated for each storm and each site. Statistical comparisons (paired Student's t-tests) between upstream and downstream event-mean concentrations were performed to determine the significance of each investigated barnyard. Finally, minimum detectable changes (MDC's) were estimated to determine the minimum decrease in post-BMP downstream event-mean concentrations necessary to be considered statistically significant.

Statistical analyses revealed that, for each investigated barnyard and constituent, downstream event-mean concentrations were significantly greater than upstream event-mean concentrations. These barnyards were therefore important contributors to the concentrations of each constituent in each stream for the storms monitored. Estimation of MDC's showed that, at Otter Creek, a 50 percent decrease in the post-BMP average downstream event-mean concentration of total phosphorus was necessary to be statistically significant. MDC's were estimated to be 50 percent for ammonia nitrogen and 40 percent for biochemical oxygen demand. MDC's at Halfway Prairie Creek were 10, 30 and 40 percent, respectively. For each site and constituent, the estimated MDC's are smaller than the pollutant reductions expected following BMP implementation.

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
State of Wisconsin

PROJECT CHIEF:
Todd D. Stuntebeck

PERIOD OF PROJECT:
March 1994-Continuing

DO and water temperature were monitored at sites upstream and downstream from the investigated barnyard at Kuenster Creek for the period from July 7-October 10, 1995. Data were analyzed and shifts were applied as needed.

PLANS (July 1996 to June 1997): Monitoring streamflow and collection of water-quality data in the post-BMP period at Otter Creek and Halfway Prairie Creek will be continued. Event-mean concentrations for each constituent will be calculated and statistical analyses performed to determine the effectiveness of each BMP. A fact sheet and draft article for publication in journal will be prepared. DO and temperature at Kuenster Creek will continue to be monitored.

REPORTS:

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

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

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

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

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

PROGRESS (July 1995 to June 1996): Water samples were collected and discharge measurements were made weekly at the four tributaries to Lake Mendota. Samples were collected more frequently during storms. The water samples were analyzed for

COOPERATORS:

Wisconsin Department of Natural Resources

LOCATION:

Lake Mendota, Madison, Wisconsin

PROJECT CHIEF:

David J. Graczyk

PERIOD OF PROJECT:

October 1994 to June 1996

total phosphorus and dissolved phosphorus. Data collection ended on September 30, 1995. All data for water year 1995 were summarized and input into the USGS data base. An outline for a Water Resources Investigation Report (WRIR) was prepared and submitted to USGS Northeastern Region for approval. The WRIR will summarize all data collected and the various data-collection and analyses techniques used to determine the most cost-effective methods for estimating loads at mouths of tributaries to lakes.

PLANS (July 1996 to September 1996): The WRIR will be reviewed and approved for publication. The report will be sent to the printer in September 1996.

WISCONSIN LAKES, SILVER CREEK, WI 17303

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

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

APPROACH: Streamflow will be monitored continuously at two sites. Water-sediment samples will be collected manually on a monthly basis and by automatic samplers during storm runoff. Suspended-sediment and nutrient concentrations will be determined. Daily, monthly, and annual mean suspended-sediment and nutrient loads will be computed.

PROGRESS (July 1995 to June 1996): Streamflow and water quality were monitored at Silver Creek near Ripon, and Green Lake inlet near Green Lake. Loads for the 1995 water year were computed for suspended sediment and total phosphorus for both stations. Annual loads for Silver Creek near Ripon were 7,580 pounds for total phosphorus and 446 tons for suspended sediment. At Green Lake inlet near Green Lake, annual loads were 9,345 pounds for total phosphorus and 791 tons for suspended sediment.

PLANS (July 1996 to June 1997): Continue monitoring streamflow and water quality at Silver Creek near Ripon and Green Lake inlet near Green Lake. All data will be published in the annual report, "Water Resources Data–Wisconsin".

COOPERATOR:
Green Lake Sanitary District

LOCATION:
Green Lake County,
south-central Wisconsin

PROJECT CHIEF:
Herbert S. Garn

PERIOD OF PROJECT:
October 1977-Continuing

ASSESSMENT OF THE HYDROLOGY AND WATER QUALITY OF LAUDERDALE LAKES, WALWORTH COUNTY, WISCONSIN, WI 17310

COOPERATOR:
Lauderdale Lakes Lake Management District

LOCATION:
La Grange, Walworth County, Wisconsin

PROJECT CHIEF:
Herbert S. Garn

PERIOD OF PROJECT:
October 1993 to September 1996

PROBLEM: Lauderdale Lakes are a chain of three interconnected lakes with a surface area of about 807 acres that are located in the more populated southeastern part of Wisconsin north of Elkhorn. The area is experiencing much population growth and development. Members of the lake district have expressed concern over the deteriorating water quality of the lakes. The lakes also have had problems with increasing macrophyte growth in the past 5 years, and the district has had to harvest macrophytes. The lake-management district plans to prepare a waste-management plan to limit the input of phosphorus, which contributes to excessive algae and aquatic plant growth. An understanding of the hydrology of the lakes and determination of the sources and amounts of phosphorus entering and leaving the lakes is needed to develop a management plan. The present trophic condition of the lakes needs to be determined to evaluate the effectiveness of the management plan.

OBJECTIVE: The objectives of the study are to determine the hydrologic and phosphorus budgets for the Lauderdale chain of lakes, to describe and quantify present in-lake water quality, and to evaluate the trophic status of the lakes.

APPROACH: The study will consist of a year of data collection followed by data analysis and report preparation. Data collection will begin in October 1993 and go through October 1994 with emphasis on the open-water period. Hydrologic and water-quality data will be collected to describe the hydrology of the lake, to calculate an annual phosphorus budget for the lakes to determine major sources, and to describe the lakes' trophic status and seasonal changes in water quality. Major components of the hydrologic budget that will be measured directly include precipitation and evaporation, lake outflow (continuously), and lake stage (continuously). No perennial streams flow into the lake. Groundwater inflow and outflow will be estimated from head-difference values measured in piezometers installed around the lakes. Water samples for phosphorus analysis will be collected from ephemeral drainages entering the lake, from the piezometers, from lake outflow, and from within the lakes to define the phosphorus budget. In-lake water quality will be measured at three locations to describe the seasonal water-quality characteristics of the lakes and to evaluate the lakes' trophic status. The trophic status of the lakes will be evaluated using various indices and empirical models.

PROGRESS (July 1995 to June 1996): Data collection for the study was completed in November 1994. Data were summarized and presented to the lake district by letter and by a presentation at the annual meeting on September 2. All data were published in the annual data report "Water Resources Data–Wisconsin, water year 1994." Work on the first draft of the interpretive report describing the results of the study was completed. Data indicate that the water quality of Lauderdale Lakes is very good compared to other southeastern Wisconsin lakes and that the lakes are classified as oligo-mesotrophic.

PLANS (July 1996 to September 1996): Final report will be prepared, printed, and distributed.

REPORTS:

Garn, H.S., Seidel, T.L., and Rose, W.J., 1996, Water and phosphorus budgets of Lauderdale Lakes, Walworth County, Wisconsin, 1993-94 (abstract): In Proceedings, American Water Resources Association, Wisconsin Section, 20th annual meeting, February 29, 1996, Minocqua, Wisconsin.

Garn, H.S., Olson, D.L., Seidel, T.L., and Rose, W.J., 1996, Hydrology and water quality of Lauderdale Lakes, Walworth County, Wisconsin, 1993-94: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

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

COOPERATOR:
U.S. Geological Survey
Reston, Virginia

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

PROJECT CHIEF:
Charles A. Peters

PERIOD OF PROJECT:
December 1990-Continuing

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

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

APPROACH: The foundation of the study approach is based upon identifying relatively homogeneous areas of specific land-use and environmental characteristics. Identification of these areas is accomplished by overlaying digital coverages of land use and various environmental variables using a geographical information system. Sampling sites completely contained in these relatively homogeneous areas (indicator sites) will be incorporated into a nested design of surface-water, streambed sediment, and biological sampling. The sampling strategy consists of a retrospective analysis of available water-quality data, followed by a high and then a low-phase data-collection effort. Monitoring of basic fixed sites (BFS) in selected areas (indicator sites), as well as downstream sites draining heterogeneous land uses and environmental characteristics (integrator sites), will be conducted. These sites will be sampled monthly and augmented with event-related samples. A subset of these sites will be extensively sampled for pesticides. Pesticide samples will be collected approximately weekly during the early to mid-summer period and less frequently during the rest of the year. Synoptic studies will be conducted during high- and low-flow conditions (spring and summer of 1994) to better delineate the sources of nutrients throughout the basins and describe the seasonal variability of these sources. Other program components include an ecological survey (spring 1993) at approximately 40 sites to evaluate the relationship between community (fish and invertebrates), habitat structure, land-use practices, and environmental factors. Selected ground-water studies also will occur including a study-unit survey, a flow-path study and two land-use studies. The flow-path study will examine transformations in various constituents through time and space. Surface-water/ground-

water interactions will be examined using shallow wells and lysimeters installed adjacent to the nearby stream. Effects of land use on ground-water quality will be assessed through sampling in specific relatively homogeneous areas (1994 and 1995).

PROGRESS (July 1995 to June 1996): Water-quality and flow were measured at a limited number of the BFS beginning in October as a part of the low-intensity phase of the study. A synoptic study was conducted to provide information concerning how well the BFS represent water-quality conditions throughout the Western Lake Michigan drainages. In this survey, 5 sites within each of the 8 indicator BFS and 3 sites within each of the 20 relatively homogeneous units (RHUs) that don't have a BFS associated with them were sampled at low flow for field parameters, nutrients and suspended sediment.

Biology field work included sampling for trace elements and organics in bed sediment and biotic tissues at three indicator and three integrator BFS. A synoptic survey was completed at 20 relatively pristine streams in agricultural areas. This survey included the collection of fish population information and water-quality samples. Vegetation plots were established and surveyed at each of the eight indicator BFS. Elevation surveys were conducted at each of the indicator sites.

Ground-water field work included completing the flow-path and land-use studies and beginning work on a study-unit survey. Work at 56 agricultural land-use wells included performing slug tests to determine horizontal hydraulic conductivity and removal of some wells. Field work at the flow-path study area included the installation of seven mini-piezometers, and several suction lysimeters and the sampling of these installations and the eight previously installed PVC wells. Seepage runs were conducted in the stream at the end of the flow path to determine ground-water input to the stream. A geoprobe was used to collect four sets of cores along the flow path transect and several of these cores were analyzed for mineralogic composition. Additionally, water levels were determined in all wells and elevation levels were run to all wells. The study-unit survey was conducted to determine water-quality conditions in the most used aquifer in the study unit. Thirty wells were randomly selected for sampling to represent this aquifer. The selected wells were sampled for determination of numerous water-quality parameters.

The data base for surface- and ground-water quality and QA/QC for those data was updated through March 1996 samples. The bed-sediment and tissue data base was completed through September 1995. The habitat and fish community data bases were completed through September 1995.

Geographic information system (GIS) database development will continue. The site location coverage was updated to include all new RHU synoptic sites and new ground-water study-unit survey and flow-path sites. The drainage-basin coverage was completed for all surface-water sites. A land-cover layer was completed for all the surface-water synoptic basins. Soils and elevation coverages were examined for their utility for water-quality interpretation. Coverages for other anthropogenic features (landfill, sewage treatment plant, underground storage tank, etc., locations) were compiled where available.

Five water-resources investigations reports, four fact sheets, two newsletters, and five abstracts were prepared and distributed.

PLANS (July 1996 to June 1997): The low-intensity phase (LIP) basic fixed sites (BFS) will be sampled monthly for discharge, field parameters, nutrients, major ions, total and dissolved organic carbon, pesticides and suspended sediment. The three BFS will have ecological assessments for fish, algae and invertebrate population and habitat conducted. Bed sediment and tissue samples wiill be collected for trace element and organic analyses.

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

Data from the high-intensity phase will be analyzed and the results of analyses compiled in reports. During the FY, the environmental setting (WRIR), the biology retrospective (WRIR), and the ground-water pesticide retrospective (FS) will be published. Fact Sheets on GIS, on loads in the Western Lake Michigan Drainages, on the QA/QC results for the study unit, and on water quality and biological ITFM studies will be published. Water Resources Investigations on Benchmark Streams:Invertebrates, Benchmark Streams:Algae, Benchmark Streams:Fish, Basic Fixed Sites:Fish, Bed Sediment and Tissue Trace Elements, Basic Fixed Sites: Water Quality, Basic Fixed Sites:Habitat, Ground-water Study Unit, Ground-water Land Use and flow-path surveys will be published. Two newsletters will be published and distributed. Numerous abstracts and proceedings papers as well as journal articles will be prepared. All reports will be available on the world wide web home page upon publication.

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 and
John F. Walker

PERIOD OF PROJECT:
October 1990-Continuing

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

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

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

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

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

PROGRESS (July 1995 to June 1996): 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 (87Sr/86Sr) 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. 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. This type of data collection is now ongoing, and analysis of early results is in progress.

A new database management system was established providing improved organization and access to all data collected as part of the project.

PLANS (July 1996 to June 1997): 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-water and ground-water monitoring will continue for further examination of seasonal and spatial variability. Additional wells are to be installed to better define the major ground water flowpath from Big Muskellunge Lake to Allequash Creek. 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., Krabbenhoft, David P., and Walker, John F., 1992, Water, Energy, and Biogeochemical Budgets (WEBB) program: data availability and research at the Northern Temperate Lakes site, Wisconsin: U.S. Geological Survey Open-File Report 92-48.

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

MERCURY CYCLING IN LAKES, WI 18001

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Florence and Vilas Counties, northern Wisconsin

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
March 1987 to September 1996

ACIDIC LAKES

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

OBJECTIVE: Objectives are to determine the hydrologic and chemical budgets for Honeysuckle, Max, and Morgan Lakes in northern Wisconsin to provide information about mechanisms of acid loadings to these lakes, investigate differences between bog lakes and clear-water lakes, evaluate the feasibility of, and develop an approach for, pumping ground water in an acid lake to raise its pH and alkalinity, and continue limited hydrologic monitoring at Vandercook Lake, which has a data base going back to October 1980.

APPROACH: Lake inflows from precipitation and 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 1995 to June 1996): Most monitoring emphasis was at Max Lake; lake stage and a single recorder-equipped well were monitored at Morgan Lake; and lake stage, precipitation, and the ground-water-well network were monitored at Vandercook Lake.

Ground water was pumped into Max Lake to raise and maintain its pH to 7.0. Ground water was pumped from April 19 to July 27, and from September 26 to December 12 at a 25 gallons-per-minute pumping rate. A preliminary water budget for 1994 was computed for the lake.

PLANS (July 1996 to June 1997): Routine data collection will continue at approximately the same level as last year through September 30. Max Lake's pH will be maintained at 7.0 by i ntermittent ground-water pumping. A preliminary water budget for 1995 will be computed for Max Lake. Plans after September 30 are unknown owing to funding uncertainty.

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 (in press).

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

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

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

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

PROGRESS (July 1995 to June 1996): Routine hydrologic monitoring continued.

PLANS (July 1996 to September 1996): A skeleton hydrologic monitoring network will be maintained to track the exchange of lake and ground water. This network consists of continuous measurement of lake stage and precipitation and intermittent measurement of about six piezometers. Plans after September 30 are unknown owing to funding uncertainty.

REPORTS:

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

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Vilas County, northern Wisconsin

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
March 1987 to September 1997

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

COOPERATOR:
Town of Delavan

LOCATION:
Walworth County, southeast Wisconsin

PROJECT CHIEF:
Gerald L. Goddard,
Dale M. Robertson

PERIOD OF PROJECT:
August 1983-Continuing

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

OBJECTIVE:
1. Determine nutrient and suspended-sediment discharge at Jackson Creek tributary near Elkhorn, Jackson Creek at Mound Road (wetland outlet), and Delavan Lake Inlet. Determine phosphorus discharge from the lake at Delavan Lake outlet. Continuous streamflow is being determined at all sites.
2. Determine lake stage.
3. Determine phosphorus characteristics of the lake water and other physiochemical characteristics.
4. Determine the phytoplankton and zooplankton populations, May through August.
5. Determine effectiveness of wetland at reducing the discharge of phosphorus and suspended sediment.

APPROACH: Nutrients and suspended sediments are monitored at Jackson Creek tributary, Jackson Creek wetland outlet, and Delavan Lake inlet. Phosphorus is monitored at Delavan Lake outlet. Streamflow is monitored at all sites. Lake stage is monitored continuously. Phosphorus concentration of the lake water and dissolved oxygen, water temperature, pH, and specific conductance are monitored. Phytoplankton and zooplankton are monitored. The effectiveness of the wetland is estimated by comparing the load of phosphorus and suspended sediment entering and leaving the wetland.

PROGRESS (July 1995 to June 1996): Streamflow was monitored continuously at three inflow sites and at one outflow site from Delavan Lake. 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. Three sites within the lake were monitored to determine the physiochemical characteristics of the water. The 1995 water-year data was compiled for publication in the report, "Water Resources Data-Wisconsin." A report to describe the effectiveness of the wetland in decreasing nutrients and sediments to the lake was begun. Summer phosphorus concentrations in the lake in 1995 were similar to those prior to rehabilitation that was completed in 1993. However, summer water clarity is greater and chlorophyll *a* concentrations are less than prior to lake rehabilitation.

PLANS (July 1996 to June 1997): Monitoring program will be continued as scheduled. Data will be compiled for publication. A report describing the effectiveness of the wetland at reducing total-phosphorus and suspended-sediment discharges will be published.

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

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

PROBLEM: Declining water levels in the sandstone aquifer due to pumping is a regional water-quantity management issue for the Fox Cities, the area along the Fox River between Neenah and Kaukauna, and for the Green Bay area. This study will provide hydrogeologic information through developing data bases and models to help in addressing ground-water management issues.

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

APPROACH: The hydraulic properties of the aquifers and confining units will be compiled from a literature review, and geophysical and drillers' logs for wells. Packer testing of wells open to the Sinnipee Group will provide information about recharge in the Fox Cities area. Water samples from selected wells will be analyzed for isotopes to identify flow paths. The USGS ground-water-flow model, calibrated to past and present water levels, will be used to understand the regional hydrogeology and evaluate the aquifer response to future pumping and land-use changes.

PROGRESS (July 1995 to June 1996): Ground-water data for the model area, which includes all or parts of 16 counties, has been compiled in a Geographic Information System data base. A two-layer model, with more than 14,000 cells per layer, has been developed using the USGS finite difference ground-water flow model, MODFLOW. The upper layer represents an aquifer consisting of Silurian dolomite and glacial material. The lower layer represents the sandstone aquifer. Packer and isotope data indicate that the Sinnipee Group (Galena dolomite, Decorah shale and Platteville dolomite) acts as a confining unit and limits recharge to the sandstone aquifer. The Sinnipee group is simulated as a resistance to flow between the two aquifer layers. Cell area varies from 1/16 to 128 mi^2. Pumping data for the sandstone aquifer has been compiled for Brown, Outagamie, Winnebago and Fond du Lac counties. Steady-state pre-development and transient conditions from 1880 to the present have been simulated. Simulated fluxes were compared to stream flow in rivers and simulated water levels were compared to measured water levels in wells in 1915, 1957 and 1990 to evaluate accuracy of model.

Using the calibrated model, particle tracking was simulated to determine areas that contribute water to cells containing water-supply wells. The effect of present and future pumping on water levels in the sandstone aquifer was simulated to provide water managers with information concerning future water levels in the aquifer.

PLANS (July 1996 to June 1997): Funding has ended for this project. Results of the study will be published in a report.

COOPERATORS:

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

LOCATION:

East-central Wisconsin

PROJECT CHIEF:

Terrence Conlon

PERIOD OF PROJECT:

January 1992 to September 1995

REPORTS:

Conlon, T.D., 1995, Hydrologic importance of the Sinnipee Group in the lower Fox River Valley, Wisconsin, in Peter, C.A., ed., National Water-quality Assessment Program, Western Lake Michigan drainages--summaries of liaison committee meeting, March 28-29, 1995: U.S. Geological Survey Open-File Report 95-163, p. 51.

Conlon, T.D., 1995, Use of GIS to prepare input data for and evaluate results from a finite-difference ground-water flow model in northeastern Wisconsin, in Usery, E.L., ed., Proceedings of the workshop on Mapping and Environmental Applications of GIS Data, September 28-29, 1995: Madison, Wisconsin, International Society for Photogrammetry and Remote Sensing v. 30, part 4W2, p. 68-70.

Conlon, T.D., Hydrogeology of and simulation of ground-water flow in the sandstone aquifer, Fox Cities, Wisconsin, U.S. Geological Survey Water Resources Investigations Report (in preparation).

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 to act as a baseline for evaluation of future remediation activities; estimate loads of PCB's, transnonachlor, atrazine, trace metals, nutrients, and suspended solids to Lake Michigan; compare loads between tributaries to target basins of major concern; identify contaminants of greatest concern; and describe the mobility of contaminants.

APPROACH: The Wisconsin District will install acoustic-velocity-metering (AVM) stations at the mouths of the Milwaukee, Sheboygan, Fox, and Menominee Rivers to provide real-time flow and water-quality data. Field sampling will be scheduled to obtain approximately 75 percent of the samples during non-baseflow periods. Composited samples for analyses of congener-specific PCB's and pesticides will be field filtered and processed through XAD-2 resin columns. Composited samples for analyses of particulate and dissolved trace metals will be obtained using clean sampling protocols. Data will be entered into the WATSTORE and ADAPS data bases.

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

PLANS (July 1996 to June 1997): Mean daily discharge and inorganic data (including major ions and nutrients) from the 11 tributaries will be published in the Wisconsin, Michigan, and Indiana USGS annual data reports for water year 1995. Approximately 150 of the 401 organics samples have been analyzed at the Wisconsin State Lab of Hygiene, with the remaining samples to be analyzed by fall of 1997. After organics data have undergone Environmental Protection Agency (EPA) QA/QC checks, journal articles will be written to present project results, including discussions of factors effecting contaminant concentrations and quantification of contaminant loads. Project data will be formatted and electronically transmitted for storage in the EPA ORACLE database, prior to EPA use of the data in the Lake Michigan Mass Balance Model.

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 October 1996

LAKE SUPERIOR TRIBUTARY LOADING, WI 18302

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

LOCATION:
Cities of Duluth, Minnesota and Superior, Wisconsin

PROJECT CHIEF:
Peter E. Hughes

PERIOD OF PROJECT:
July 1993 to October 1996

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

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

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

PROGRESS (July 1995 to June 1996): Gaging stations were installed and operated since August 1996. The Superior AVM installation was damaged during a November 1994 storm and was back in operation in August 1995. Underwater transducers were damaged in an October 1995 storm and the site was back in operation in April 1996. The first PCB samples were taken in April 1995 using the Infiltrex samplers controlled by the flow-proportional sampling program. AVM data from the Duluth site were successfully calibrated with Doppler measurements to estimate discharge. Discharge data for Duluth site and the Nemadji River were published in the Water Resources Data Report, Water Year 1995.

PLANS (July 1996 to June 1997): The gaging stations will be operated through September 1996 and water-quality samples obtained. Operation beyond September 1996 will depend on finding alternative funding sources. Flow data will be finalized and published in the Water Resources Data Report, Water Year 1996.

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

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

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

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

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

PROGRESS (July 1995 to June 1996): Source-area samples were collected from the Harper Road and Lakeland Avenue basins. Twenty-five runoff events were sampled from June 26 to November 1. Five street dirt samples were collected from June 15 to October 26. All runoff samples have been analyzed by the city of Madison Department of Public Health Laboratory. Partial analysis has been completed at the University of Alabama-Birmingham on the street dirt.

PLANS (July 1996 to June 1997): All the sample equipment will be removed from the Harper and Lakeland basins. The runoff concentration data will be used to calibrate the SLAMM. The SLAMM will then be used to estimate the storm, seasonal and annual loads from each source area. A USGS interpretive report will be prepared discussing the findings. The street dirt analysis that are available will be included in this report.

COOPERATOR:
City of Madison

LOCATION:
Madison, Wisconsin

PROJECT CHIEF:
Robert J. Waschbusch

PERIOD OF PROJECT:
August 1992 to September 1996

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

COOPERATOR:
City of Madison

LOCATION:
Madison, Wisconsin

PROJECT CHIEF:
Robert J. Waschbusch

PERIOD OF PROJECT:
April 1996 to September 1997

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

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

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

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

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

PROGRESS (January 1996 to June 1996): The City of Madison maintenance yard on Badger Road in Madison has been selected as the test site and a "disk-design" Stormceptor® has been ordered.

PLANS (July 1996 to June 1997): All monitoring equipment will be installed and all samples will be collected and sent in for analysis.

DANE COUNTY REGIONAL HYDROLOGIC STUDY, WI 189

COOPERATORS:

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

LOCATION:

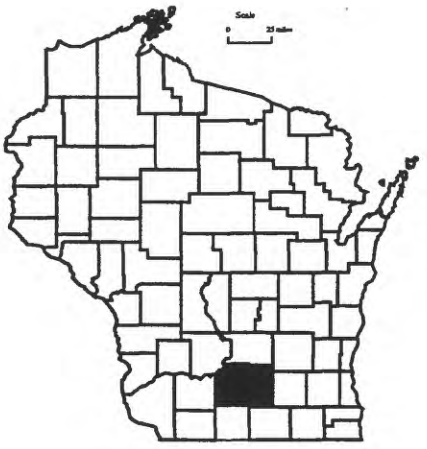
Dane County and parts of surrounding counties

PROJECT CHIEF:

James T. Krohelski

PERIOD OF PROJECT:

October 1992 to September 1996



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

OBJECTIVES: The objective is to provide a better understanding of the regional ground-water system and the effects of urban development, ground-water withdrawals and inter-basin diversions on Dane County's ground- and surface-water resources.

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

PROGRESS (July 1995 to June 1996): A draft report describing the three-dimensional model was written. The model and associated results were presented to local and State agencies.

PLANS (July 1996 to September 1996): The calibrated ground-water-flow model will be used with estimates of future ground-water pumpage rates and locations to simulate the effect these changes may have on water levels in the aquifer and on surface water in Dane County. A report describing the regional ground-water-flow model design, calibration, and results of model simulations of the flow system will be published.

DANE COUNTY SURFACE WATER MODEL, WI 18901

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

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

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

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

The model will be used to evaluate the effects of various possible alternatives including (1) diversions constant at the 1986 levels; (2) diversions constant at projected future levels; (3) reduction of the diversion; (4) complete cessation of the diversion; (5) present diversions + releasing water from the lakes to maintain some preset minimum flow in the Yahara River; (6) projected increases in diversions + releasing water from the lakes to maintain some preset minimum flow in the Yahara River; and (7) possible alternatives to be developed with the cooperator to share any deficiency in available water between reducing lake levels and reducing downstream flows.

PROGRESS (October 1995 to June 1996): Data on streamflow and lake stage have been transferred from historical records to working files. Missing data for lake stage has been estimated. Net inflow to the lakes has been estimated from observed outflow and changes in lake stage. The model code has been partially adapted from the Winnebago system to the Dane County system of lakes.

PLANS (July 1996 to December 1996): The model will be calibrated to existing operating rules, and checked against historic streamflow. Various operating rule adjustments will be simulated with the model to test the impacts on outflow and lake stage under various scenarios of constant, increased and decreased inflows.

COOPERATORS:

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

LOCATION:

Dane County Wisconsin

PROJECT CHIEF:

William R. Krug

PERIOD OF PROJECT:

October 1995 to December 1996

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

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Milwaukee County, eastern Wisconsin

PROJECT CHIEF:
Jeffrey J. Steuer

PERIOD OF PROJECT:
February 1993 to June 1997

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

OBJECTIVE: The objective is to determine the link between algal dynamics and PCB transport by characterizing total suspended solids (TSS) in the river as biogenic (algal) and detrital components, determining PCB, organic carbon and lipid concentrations of each fraction, and evaluating the link between algal uptake of PCB's and concentration of PCB's in TSS and resuspendable surficial bottom sediments. Milwaukee River PCB loading will be determined at Estabrook Park, Thiensville, and Pioneer Road. PCB loading will also be determined on Cedar Creek, a tributary entering upstream of Pioneer Road. This monitoring will assist in evaluating the effectiveness of the Ruck Pond remediation. Due to high bottom sediment and fish PCB concentrations, a fourth site has been selected on the South Branch of the Manitowoc River at Hayton.

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

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

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

PROGRESS (June 1995 to July 1996): The data-collection effort is complete. Water-column PCB concentrations on the Milwaukee River range from 3 to 168 ng/L resulting in transported PCB loads of 4 to 220 grams per day. Hayton water-column PCB concentrations range from 38 to 302 ng/L, producing transported PCB loads of 4 to 166 grams per day. The algal identification effort and laboratory PCB uptake experiments are complete.

PLANS (July 1996 to June 1997): A report detailing the PCB loading, partitioning, algal PCB uptake and suspended-solids classification will be published.

REPORTS:

Swackhamer, Deborah, and others, PCB concentrations in algae from the Milwaukee and Manitowoc Rivers, Wisconsin (in review).

WATER RESOURCES AT WILD ROSE FISH HATCHERY, WAUSHARA COUNTY, WISCONSIN, WI 192

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
2 miles north of Wild Rose, Waushara County, Wisconsin

PROJECT CHIEF:
Terrence Conlon

PERIOD OF PROJECT:
June 1993 to September 1996

PROBLEM: The Wild Rose State Fish Hatchery is one of the oldest and largest cold-water hatcheries in the State. The water supply for the hatchery consists of scattered springs, seeps, and many small-diameter flowing wells screened in sand and gravel. Combined flow from springs and wells is approximately 3 million gallons per day. Water from these sources requires treatment to remove nitrate. Water is treated at each raceway because of the diffuse nature of the water supply. Water from this supply system is expensive to treat and may be contaminated.

OBJECTIVE: The study will evaluate the ground-water system at the hatchery, provide estimates of the hydraulic properties of the sand and gravel aquifer, and recharge area for water captured by hatchery wells.

APPROACH: Using wells at the hatchery, slug and aquifer tests will be performed to estimate the hydraulic conductivity of the sand and gravel aquifer. Seismic-refraction data will be collected to determine the thickness of the aquifer.

PROGRESS (July 1994 to June 1995): A planned aquifer test was cancelled due to insufficient DNR funds to drill a well. Consequently, no new data for aquifer properties at the hatchery will be collected.

Preliminary results of the study include the following: the thickness of the glacial aquifer is approximately 200 feet based on seismic refraction data; although the bedrock geologic map of Wisconsin indicates sandstone underlying the area, seismic velocities suggest that the sandstone is absent or very thin at the hatchery; and hydraulic conductivity of the glacial aquifer is 15 ft^2/day based on slug tests.

PLANS (July 1996 to September 1996): Results of the study will be published in a report.

NORTH FISH CREEK SEDIMENT, WI 193

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

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

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

PROGRESS (July 1995 to June 1996): Data collection in 1995 concentrated on surveying channels at section lines, surveying relict channels, and collecting large core samples for analysis using the vibracorer, geoprobe, Livingston corer, and WDNR's piston corer. Fourteen piston cores were collected from Chequamegon Bay. Approximately 20 cores were collected from Chequamegon Slough. Lead and cesium dating were done on two cores from the slough; results have not been received yet. Approximately 40 large-diameter cores were collected from the channel, floodplain and relict channels of North Fish Creek. Near the mouth of North Fish Creek, cores from over 50 feet deep were collected to identify the degree of valley aggradation.

Preliminary analysis of the data suggests that (1) a pre-European settlement surface can be identified in floodplain deposits; (2) sedimentation is episodic and occurs almost exclusively during large floods; (3) episodic sedimentation in the lower reach of North Fish Creek occurred prior to European settlement but increased after European settlement; and (4) both the texture of the sediment and the rate of historical sedimentation has changed since the area was first settled by Europeans.

PLANS (July 1996 to June 1997): Data analyses will be completed, bluff erosion rates will be calculated using aerial photographs, and effects of detention basin storage on sediment transport will be modeled.

REPORTS:

Fitzpatrick, F.A., and Knox, J.C., Effects of variations in vegetation, climate, and isostatic rebound on hydrology and sedimentation of North Fish Creek, Bayfield County, Wis. (in preparation).

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 1996

FT. McCOY GROUND-WATER QUALITY, WI 194

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

LOCATION:
Fort McCoy, Wisconsin

PROJECT CHIEF:
John F. DeWild

PERIOD OF PROJECT:
July 1994 to October 1996

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

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

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

PROGRESS (July 1995 to June 1996): Three types of sites were identified and selected for investigation: (1) buildings, (2) petroleum-oil-lubrication stations and (3) selected points along pipelines. Contaminant plumes have been delineated at the selected sites. Field and laboratory analyses have been tabulated along with plots of the site and sampling locations. Several additional sites where soil or ground-water contamination may exist are being investigated.

PLANS (July 1996 to October 1996): Sample collection and analyses will continue until all of the selected sites are investigated. A final report listing analyses and site and sampling locations will be written.

FORT MC COY ENVIRONMENTAL MANAGEMENT DIVISION SUPPORT, WI 195

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

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

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

PROGRESS (July 1995 to June 1996): A series of products have been created to assist Fort McCoy EMD personnel in managing natural and cultural resources. Products include a geomorphologic and paleoenvironmental history of Fort McCoy, Wisconsin, and the Joliet Training Area, Joliet, Illinois. Supporting field work has included examining soil stratigraphy in trenches and soil coring along transects to establish the spatial distribution, thickness, and nature of soil strata. The geomorphologic and paleoenvironment information has been incorporated into a series of digital products within a geographic information system.

PLANS (July 1996 to June 1997): Assistance will continue to be provided to the Environmental Management Division of the Department of Defense upon request.

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

LOCATION:
Fort McCoy, Wisconsin

PROJECT CHIEF:
Ty Sabin

PERIOD OF PROJECT:
October 1994 to September 1996

ANTARCTIC HYDROLOGIC STUDIES, WI 196

COOPERATOR:
Desert Research Institute,
Reno, Nevada

LOCATION:
McMurdo Dry Valleys, Antarctica

PROJECT CHIEF:
Harry House

PERIOD OF PROJECT:
October 1994-Continuing

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.

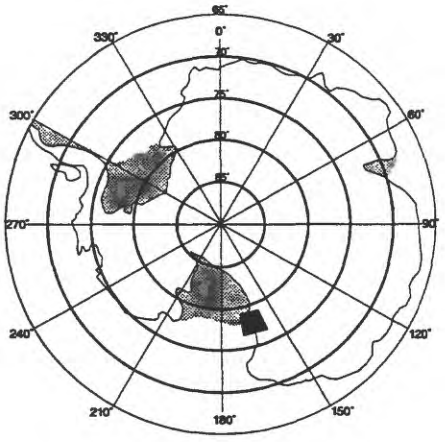
OBJECTIVE: The objective is to enhance the understanding of biogeochemical processes that occur in temperate zone lakes, streams and rivers.

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 (January 1995 to June 1996): Installation of two additional stream gages, one on the south side of the Taylor Glacier on Lyons Creek, and one on the stream reactivation channel on Lake Fryxell, were completed. A pressure transducer and temperature/conductivity probe were installed at Lyons Creek, and a temperature/conductivity probe only was included in the reactivation channel. A flume control was installed at the Lost Seal Stream gage. Solar panels were installed at all gages.

With the completion of the above-mentioned gages, 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 assumed in cooperation with the New Zealand Antarctic Research Program.

PLANS (July 1996 to June 1997): Data will be reviewed and stored in a relational database, to be made available to the long-term ecological research (LTER) data manager at Desert Research Institute. The data will also be made available to the world research community via world-wide web interface. A variety of analysis will be performed on the data to support LTER researchers in their efforts to publish scientific articles. Logistical preparations for the next field season will be made.



FLORIDA EVERGLADES MERCURY CYCLING, WI 197

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) it biomagnifies in the food chain to toxic concentrations even though it is found at very low aqueous concentrations and (2) the principal source to most areas is atmospheric deposition. Thus, almost any aquatic ecosystem with a food chain is potentially susceptible to mercury contamination.

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

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

PROGRESS (July 1995 to June 1996): Three 7-day field trips were conducted during this time period (July 1995, December 1995, and March 1996) in which 30 to 40 scientists from across the country representing the USGS and several universities and private research labs participated. Approximately 15 sites in the northern Everglades were sampled for water, sediment and biota during these field trips. In addition, diurnal sampling efforts at a single site were conducted in which 2- to 4-member field crews spent 24-hour continuous time spans, taking samples about every 90 minutes. These efforts are being conducted to evaluate the significance of diurnal effects on the speciation and concentration of various dissolved mercury species. Experiments are also being conducted to test the degradation susceptibility of methylmercury to sunlight exposure, which could be an important detoxification mechanism for natural ecosystems. About 20 people attended a project review meeting held at USGS Headquarters, Reston, Virginia, September 18-20, 1995. The primary purpose of the meeting was for information exchange among project participants, but two outside reviewers were also invited to provide outside comments to the group. Four abstracts have been drafted for submittal to the Fourth International Mercury Meeting, August 1996.

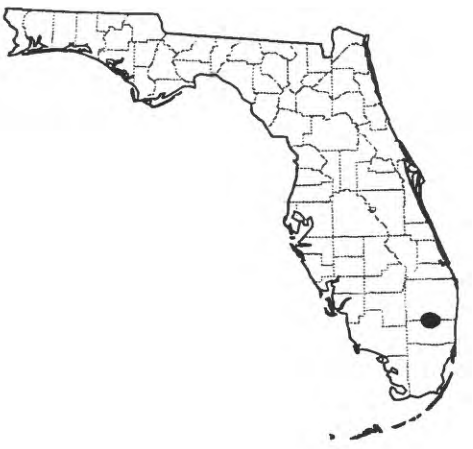
PLANS (July 1996 to June 1997): Work plans call for continued field trips on about a quarterly basis. The sampling sites will gradually include a greater number of sites to the south of our present sampling locations. Plans call for the project to be working in the Everglades National Park and Florida Bay. Several project scientists will be attending the Fourth International Mercury Meeting and the American Chemical Society Meeting (in August 1996) to present summaries of project accomplishments.

COOPERATOR:
U.S. Geological Survey
Reston, Virginia

LOCATION:
Florida Everglades

PROJECT CHIEF:
David P. Krabbenhoft

PERIOD OF PROJECT:
January 1995 to September 1999



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

COOPERATOR:
Wisconsin Department of Natural Resources

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

PROJECT CHIEF:
Terrence Conlon

PERIOD OF PROJECT:
October 1995 to September 1997

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

OBJECTIVE: The objective of this study is to determine whether ground water, under controlled 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 test ground-water-management plans so that water yields are optimized, while water-level declines in the sandstone aquifer are minimized.

APPROACH: A three-dimensional ground-water-flow model, developed as part of an ongoing ground-water study, that encompasses the entire Lower Fox River Valley, will be used for applying optimization techniques. The goal of the modeling will be to maximize well yield while maintaining minimum water levels in the aquifer. This objective function and constraint will be applied to several management plans. The flow model will provide the head response that will be used by the optimization solver. The results will include possible options to address relevant issues and questions concerning ground-water resources of the Lower Fox River Valley including ground-water availability in the sandstone aquifer, well placement and pumping strategies, relation between ground and surface water, and possible management plans.

PROGRESS (October 1995 to June 1996): Meetings have been held with WDNR and planning agencies in the area. The objective function constraints and possible management plans were discussed. Initially, optimization of the following management plans will be performed: the present pumping system, interconnection of wells and distribution systems within a water utility, and interconnection of wells and distribution system within the two pumping centers. Presently, the finite difference model is being coupled to the optimization software. Head responses are being generated for each well that will be used in optimization.

PLANS (July 1996 to June 1997): The data sets necessary for optimization modelling will be prepared, the management plan optimized and evaluated. The methodology and results will be summarized in a report.

Completed Projects

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

WI00301	A comparison of water-quality sample collection methods used by the U.S. Geological Survey and the Wisconsin Department of Natural Resources
WI093	Geology, ground-water flow, and dissolved-solids concentrations along hydrogeologic sections through Wisconsin's aquifers
WI123	Water resources of the Lac du Flambeau Indian Reservation, Wisconsin, 1981-86
	Water resources of the Stockbridge-Munsee Indian Reservation of Wisconsin
	Distribution of PCB and mercury in sediments of the Apostle Islands/Chequamegon Bay area of Lake Superior, Wisconsin
WI167	Mobility of 2,2'5,5' tetrachlorobiphenyl in model systems containing bottom sediments and water from an industrialized river basin in northeastern Wisconsin
WI169	Frequently detected contaminants in Wisconsin stormwater 1989-94
WI171	Application of habitat-suitability index models to assess effects of fine-grained sediment on brook trout and brown trout habitat
WI17211	Estimating stormwater contributions to contaminant concentrations in urban streams
WI17215	Relationship between stormwater pollutant concentrations washed off city streets and traffic volume in Madison, Wisconsin, 1994-95
WI17306	Hydrology and water quality of Park Lake in southcentral Wisconsin
WI17311	The application of an analytic element model to investigate groundwater-lake interactions at Pretty Lake, Wisconsin
WI18003	Contributions of methylmercury to a northern Wisconsin seepage lake from littoral zone sediments
WI18102	Phosphorus cycling experiments in mesocosms and potential phosphorus retention in a restored Wisconsin wetland
WI18103	Phosphorus dynamics of Delavan Lake inlet in southeastern Wisconsin, 1994
WI190	Microbial enhancement of PCB congener mobility at the sediment/water interface in the lower Fox River, Wisconsin

WISCONSIN DISTRICT PUBLICATIONS

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

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

WATER-SUPPLY PAPERS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

HYDROLOGIC INVESTIGATIONS ATLASES

Gebert, W.A., Graczyk, D.J., and Krug, W.R., 1987, Average annual runoff in the United States, 1951-80: U. S. Geological Survey Hydrologic Investigations Atlas HA-710, 1 sheet.

Hughes, P.E., Hannuksela, J. S., and Danchuk, W.J., 1981, Flood of July 1-5, 1978, on the Kickapoo River, South-western Wisconsin: U.S. Geological Survey Hydrologic Investigations Atlas HA-653, 7 sheets.

Oakes, E.L., and Cotter, R.D., 1975, Water resources of Wisconsin—upper Wisconsin River basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-536, 3 sheets.

Young, H.L., and Skinner, E.L., 1974, Water resources of Wisconsin—Lake Superior basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-524, 3 sheets.

Hindall, S.M., and Borman, R.G., 1974, Water resources of Wisconsin—lower Wisconsin River basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-479, 3 sheets.

Young, H.L., and Borman, R.D., 1973, Water resources of Wisconsin—Trempealeau-Black River basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-474, 4 sheets.

Oakes, E.L., and Hamilton, L.J., 1973, Water resources of Wisconsin—Menominee-Oconto-Peshtigo River basin, U.S. Geological Survey Hydrologic Investigations Atlas HA-470, 4 sheets.

Hindall, S.M., and Skinner, E.L., 1973, Water resources of Wisconsin—Pecatonica-Sugar River basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-453, 3 sheets.

Young, H.L., and Hindall, S.M., 1973, Water resources of Wisconsin—St. Croix River basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-451, 4 sheets.

Skinner, E.L., and Borman, R.G., 1973, Water resources of Wisconsin—Lake Michigan basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-432, 4 sheets.

Shearman, J.O., and Holmstrom, B.K., 1971, Floods on Rock River in southwestern Jefferson County, Wisconsin: U.S. Geological Survey Hydrologic Investigations Atlas HA-413, 1 sheet.

_____1971, Floods on Rock River in northeastern Jefferson County, Wisconsin: U.S. Geological Survey Hydrologic Investigations Atlas HA-394, 1 sheet.

Sherman, J.O., 1970, Floods on Rock River in northern Rock County, Wisconsin: U.S. Geological Survey Hydrologic Investigations Atlas HA-393, 1 sheet.

Gebert, W.A., 1971, Low-flow frequency of Wisconsin streams: U.S. Geological Survey Hydrologic Investigations Atlas HA- 390, 1 sheet.

Young, H.L., and Hindall, S.M., 1972, Water resources of Wisconsin—Chippewa River basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-386, 4 sheets.

Hindall, S.M., and Flint, R.F., 1970, Sediment yields of Wisconsin streams: U.S. Geological Survey Hydrologic Investigations Atlas HA-376, 1 sheet.

Devaul, R.W., and Green, J.H., 1971, Water resources of Wisconsin—central Wisconsin River basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-367, 4 sheets.

Cotter, R.D., Hutchinson, R.D., Skinner, E.L., and Wentz, D.A., 1969, Water resources of Wisconsin—Rock-Fox River basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-360, 4 sheets.

Olcott, P.G., 1968, Water resources of Wisconsin—Fox-Wolf River basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-321, 4 sheets.

U.S. Geological Survey, 1965, Preliminary map of the conterminous United States showing depth to and quality of shallowest ground water containing more than 1,000 parts per million dissolved solids: U.S. Geological Survey Hydrologic Investigations Atlas HA-199, 31 p., 2 sheets.

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