For additional information write to:

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

Copies of this report can be purchased from:

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

U.S. Geological Survey

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

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

- Conducting detailed assessments of the energy and mineral potential of land and offshore areas.
- Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.
- Conducting research on the geologic structure of land and offshore areas.
- Studying the geologic features, structure, processes, and history of the other planets of our solar system.
- Conducting topographic surveys and preparing topographic and thematic maps and related cartographic products.
- Developing and producing digital cartographic data bases and products.
- Collecting data on a routine basis to determine the quantity, quality, and use of surface water and ground water.
- Conducting water-resource appraisals to describe the consequences of alternative plans for developing land and water resources.
- Conducting research in hydraulics and hydrology, and coordinating all Federal water-data acquisition.
- Using remotely sensed data to develop new cartographic, geologic, and hydrologic research techniques for natural resources planning and management.
- Providing earth-science information through an extensive publications program and a network of public access points.

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

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

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

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

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

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

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

Providing scientific and technical assistance in hydrologic fields to other federal, state, and local agencies, to licensees of the Federal Energy Regulatory Commission, and to international agencies on behalf of the U.S. Department of State.
Figure 1. Organization chart of the U.S. Geological Survey, Water Resources Division, Wisconsin District.
Figure 2. Location of offices in the Wisconsin District.
## COOPERATORS

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

### Local Agencies
- City of Barron
- City of Beaver Dam
- City of Brookfield
- City of Fond du Lac
- City of Hillsboro
- City of Madison
- City of Middleton
- City of Peshtigo
- City of Shell Lake
- City of Sparta
- City of Thorp
- City of Waupun
- County of Milwaukee
- Dane County Regional Planning Commission
- Dane County Department of Planning & Development
- Fontana/Walworth Water Pollution Control Commission
- Geneva Lake Environmental Agency
- Green Bay Metropolitan Sewerage District
- Marathon County Highway Department
- Rock County Public Works Department
- Southeastern Wisconsin Regional Planning Commission
- Village of Wittenberg
- Walworth County Metropolitan Sewerage District

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

### Other Federal Agencies (continued)
- Wisconsin Valley Improvement Company
- U.S. Environmental Protection Agency

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

### Lake Districts
- Benedict/Tombeau Lake Management District
- Buffalo Lake District
- City of Muskego
- Eagle Spring Lake Management District
- Green Lake Sanitary District
- Little Cedar Lake
- Little Green Lake Protection and Rehabilitation District
- Little St. Germain Protection and Rehabilitation District
- Middle Genesee Lake District
- Montello Lake Inland Protection and Rehabilitation District
- Okauchee Lake District
- Potter Lake Rehabilitation and Protection District
- Powers Lake District
- Pretty Lake Protection and Rehabilitation District
- Silver Lake Protection and Rehabilitation District
- Twin Lakes Protection and Rehabilitation District
- Wind Lake Management District
- Wolf Lake Management District
- Town of Casey
- Town of Cedar Lake
- Town of Delavan
- Town of Namekagon
- Town of Sand Lake
- Town of Wascott
- Village of Oconomowoc Lake
Figure 3. Funding sources for the water-resources program in Wisconsin for the 1998 fiscal year.
SUMMARY OF HYDROLOGIC CONDITIONS

Streamflow

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

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

![Figure 4. 1997 runoff as percent of long-term average runoff.](image)

Annual discharges for the individual water years (1916-97) at the Oconto River near Gillett, Jump River at Sheldon, and Sugar River near Brodhead are shown in Figure 5. The comparison of monthly and annual discharges for the 1997 water year to discharge for a 82-year base period at the same three gaging stations are shown in Figure 6.
Figure 5. Comparison of annual discharge at representative gaging stations to the long-term average discharge for water years 1916–97.
EXPLANATION

- Long-term average monthly and long-term average annual discharge for 1916–1997
- Monthly and annual discharge for 1997 water year

Figure 6. Comparison of discharge at representative gaging stations during 1997 water year with discharge for 1916–97.
Low flows occurred at three gaging stations where the annual minimum 7-consecutive day average flows (Q7) had recurrence intervals of 2 or more years. The three stations were located in southern Wisconsin. The Q7 values and recurrence intervals for gaging stations that equalled or exceeded 2 years are listed in the following table:

<table>
<thead>
<tr>
<th>Station number</th>
<th>Station name</th>
<th>Date</th>
<th>Q7 (ft³/s)</th>
<th>Recurrence interval (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>04087223</td>
<td>Root River Canal near Franklin</td>
<td>Oct. 10-16</td>
<td>1.8</td>
<td>3</td>
</tr>
<tr>
<td>05414000</td>
<td>Platte River near Rockville</td>
<td>Dec. 19-25</td>
<td>36</td>
<td>2</td>
</tr>
<tr>
<td>05544200</td>
<td>Mukwonago River at Mukwonago</td>
<td>June 3-9</td>
<td>16</td>
<td>2</td>
</tr>
</tbody>
</table>

Runoff from snowmelt caused flooding in northern Wisconsin in early April. An isolated storm in July and major thunderstorms in June also caused floods with discharges that equalled or exceeded those with a recurrence interval of 10 years (Krug and others, 1991). Numerous thunderstorms moved through Milwaukee County on June 20 and 21 (Milwaukee Journal Sentinel, June 22, 1997) and caused major flooding. A number of communities in Milwaukee County recorded rainfall amounts of more than 6 inches for June 20 and 21, and the maximum recorded amount of 9.78 inches occurred at Brown Deer (Milwaukee Journal Sentinel, June 22, 1997). The rainfall in Brown Deer exceeded the 100-year 48-hour precipitation of between 7 and 8 inches for this area (Huff and Angel, 1992). The flooding caused at least $87.7 million in damage according to Governor Thompson. The Clinton administration declared the flooding a disaster, freeing money to help people and businesses in southeastern Wisconsin (Wisconsin State Journal, July 8, 1997). Peak discharges at 15 stations which had recurrence intervals that equalled or exceed 10 years are summarized in the following table:

<table>
<thead>
<tr>
<th>Station number</th>
<th>Station name</th>
<th>Date</th>
<th>Peak discharge (ft³/s)</th>
<th>Recurrence interval (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>04069700</td>
<td>North Fork Oconto River near Wabeno</td>
<td>Apr. 5</td>
<td>250</td>
<td>10</td>
</tr>
<tr>
<td>04073400</td>
<td>Bird Creek at Wautoma</td>
<td>July 17</td>
<td>142</td>
<td>15</td>
</tr>
<tr>
<td>04074850</td>
<td>Lily River near Lily</td>
<td>Apr. 5</td>
<td>152</td>
<td>15</td>
</tr>
<tr>
<td>04086000</td>
<td>Sheboygan River at Sheboygan</td>
<td>June 21</td>
<td>6,380</td>
<td>11</td>
</tr>
<tr>
<td>04087000</td>
<td>Milwaukee River at Milwaukee</td>
<td>June 21</td>
<td>16,500</td>
<td>&gt;100</td>
</tr>
<tr>
<td>04087030</td>
<td>Menomonee River at Menomonee Falls</td>
<td>June 21</td>
<td>1,500</td>
<td>70</td>
</tr>
<tr>
<td>04087088</td>
<td>Underwood River at Wauwatosa</td>
<td>June 21</td>
<td>4,650</td>
<td>&gt;100</td>
</tr>
<tr>
<td>04087100</td>
<td>Honey Creek at Milwaukee</td>
<td>June 21</td>
<td>1,100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>04087120</td>
<td>Menomonee River at Wauwatosa</td>
<td>June 21</td>
<td>13,500</td>
<td>85</td>
</tr>
<tr>
<td>04087204</td>
<td>Oak Creek at South Milwaukee</td>
<td>June 21</td>
<td>1,110</td>
<td>40</td>
</tr>
<tr>
<td>05332500</td>
<td>Namekagon River near Trego</td>
<td>Apr. 7</td>
<td>2,610</td>
<td>34</td>
</tr>
<tr>
<td>05340500</td>
<td>St. Croix River at St. Croix Falls</td>
<td>Apr. 8</td>
<td>41,200</td>
<td>11</td>
</tr>
<tr>
<td>05405600</td>
<td>Rowan Creek at Pouyette</td>
<td>June 16</td>
<td>990</td>
<td>15</td>
</tr>
<tr>
<td>05436200</td>
<td>Gill Creek near Brooklyn</td>
<td>Feb. 19</td>
<td>210</td>
<td>15</td>
</tr>
<tr>
<td>05548150</td>
<td>North Branch Nippersink Creek near Genoa City</td>
<td>Feb. 21</td>
<td>295</td>
<td>12</td>
</tr>
</tbody>
</table>
Water Quality

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

Ground-Water Levels

Maps showing the season ground-water trends for the year (fig. 7) are based on water-level data from 23 shallow-aquifer wells, each having at least 15 years of record. Water-level measurements from each well are grouped so that FALL consists of measurements from October through December 1996; WINTER consists of measurements from January through March 1997; SPRING consists of measurements from April through June 1997; and SUMMER consists of measurements from July through September 1997. Mean seasonal water levels were compared to the long-term mean seasonal water levels. The 1997 water level was considered normal if it was within one-half of the standard deviation on the long-term mean.

In general, shallow ground-water levels during the 1997 water year were normal to above normal for most of the wells in the State. Chippewa, Trempealeau, and Milwaukee Counties had below normal ground-water levels at the beginning of the water year, and some of those levels remained below normal for the entire water year. The large extent of normal and above-normal ground-water levels can be attributed to near normal rainfall during the 1997 water year and normal rainfall during the previous water year.
Figure 7. Relation of seasonal water-table levels to long-term means
COLLECTION OF BASIC RECORDS—SURFACE WATER, WI 001

COOPERATORS:
Wisconsin Department of Natural Resources
Wisconsin Department of Tourism
U.S. Army Corps of Engineers
Southeastern Wisconsin Regional Planning Commission
Federal (Regular)
Madison Metropolitan Sewerage District
Dane County Department of Planning and Development
Dane County Regional Planning Commission
Federal Energy Regulatory Commission Licensees
   Dairyland Power Cooperative
   Niagara of Wisconsin Paper Corporation
   Northern States Power Company
   Wisconsin Electric Power Company
   Wisconsin Power and Light Company
   Wisconsin Public Service Corporation
   Wisconsin Valley Improvement Company
Lac du Flambeau Band of Lake Superior Chippewa
Illinois Department of Transportation
City of Barron
City of Beaver Dam
City of Brookfield
City of Hillsboro
City of Peshtigo
City of Sparta
City of Thorp
City of Waupun
Village of Wittenberg
Fontana/Walworth Water Pollution Control Commission
Rock County Public Works Department
Menominee Indian Tribe of Wisconsin
Oneida Tribe of Indians of Wisconsin
Stockbridge-Munsee Band of Mohican Indians
Walworth County Metropolitan Sewerage District
Bad River Band of Lake Superior Chippewa Indians

LOCATION:
Statewide

PROJECT CHIEF:
Barry K. Holmstrom

PERIOD OF PROJECT:
July 1913-Continuing

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

OBJECTIVE: The objectives of this study are to provide continuous discharge records for selected rivers at specific sites to sup-
ply the needs for regulation, analytical studies, definition of statistical properties, trends analysis, determination of the occurrence, and distribution of water in streams for planning. The project is also designed to determine lake levels and to provide discharge for floods, low-flow conditions, and for water-quality investigations. Requests for streamflow data and information relating to streamflow in Wisconsin are answered. Basic data are published annually in the report "Water Resources Data--Wisconsin".

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

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

**PROGRESS** (July 1997 to June 1998): During the current fiscal year, streamflow data were collected at a total of 98 sites: 32 sites for the Wisconsin Department of Natural Resources (WDNR), 17 sites for the Corps of Engineers, 14 sites for the Southeastern Wisconsin Regional Planning Commission, 6 sites for the Federal program, 3 sites for the Madison Metropolitan Sewerage District, and 1 site each for the Bad River Band of Lake Superior Chippewa Indians, Lac du Flambeau Band of Lake Superior Chippewa, Menominee Indian Tribe of Wisconsin, Oneida Tribe of Indians of Wisconsin, Stockbridge-Munsee Band of Mohican Indians, Illinois Department of Transportation, Rock County, Fontana/Walworth Water Pollution Control Commission, Dane County Department of Planning and Development, Walworth County Metropolitan Sewerage District, Dane County Regional Planning Commission, Wisconsin Department of Tourism, Federal Energy Commission Licensees, and cities of Barron, Beaver Dam, Brookfield, Hillsboro, Peshtigo, Sparta, Thorp, Waupun, and village of Wittenberg. Streamflow data were also collected at four sites for agencies working jointly with the USGS. Lake-level data were collected at two sites for the Dane County Department of Planning and Development, at two sites for the Corps of Engineers, at one site for the Rock County Public Works Department, and one site for the WDNR.

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

Computation of streamflow and lake-level records for all the network stations for the 1997 water year was completed, stored in our WATSTORE computer data base, and published in the annual report "Water Resources Data--Wisconsin, water year 1997". More than 100 requests for streamflow information were answered.

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

<table>
<thead>
<tr>
<th>Station number</th>
<th>Name and location</th>
<th>Drainage Area</th>
<th>Period of record (water year)</th>
<th>Cooperator</th>
</tr>
</thead>
<tbody>
<tr>
<td>04024430</td>
<td>Nemadji River - South Superior</td>
<td>420</td>
<td>1974-1988</td>
<td>WDNR</td>
</tr>
<tr>
<td>04027000</td>
<td>Bad River - Odanah</td>
<td>597</td>
<td>1914-22, 1948-1951</td>
<td>Bad River Band of Lake Superior Chippewa Indians</td>
</tr>
<tr>
<td>04027500</td>
<td>White River - Ashland</td>
<td>301</td>
<td>1948-1951</td>
<td>WDNR</td>
</tr>
<tr>
<td>04029990</td>
<td>Montreal River - Saxon Falls</td>
<td>262</td>
<td>1967-1982</td>
<td>WDNR</td>
</tr>
<tr>
<td>04065016</td>
<td>Menominee River - Niagara</td>
<td>2470</td>
<td>1993-1999</td>
<td>FERC</td>
</tr>
<tr>
<td>04065003</td>
<td>Menominee River - Pembine</td>
<td>3140</td>
<td>1950-1953</td>
<td>WDNR</td>
</tr>
<tr>
<td>04067000</td>
<td>Menominee River - Koss, MI</td>
<td>3,720</td>
<td>1907-9-1913-81, 1998-1999</td>
<td>FERC</td>
</tr>
<tr>
<td>04067500</td>
<td>Menominee River - McAllister</td>
<td>3,930</td>
<td>1945-81, 1979-86</td>
<td>WDNR</td>
</tr>
<tr>
<td>04067968</td>
<td>Peshtigo River - Wabeno</td>
<td>447</td>
<td>1996-1999</td>
<td>WDNR</td>
</tr>
<tr>
<td>04069416</td>
<td>Peshtigo River - Porterfield</td>
<td>1080</td>
<td>1953-1979</td>
<td>City of Peshtigo</td>
</tr>
<tr>
<td>04071765</td>
<td>Oconto River - Oconto</td>
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**LAKES**

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C of E, Detroit - Corps of Engineers, Detroit, Michigan
C of E, R. Island - Corps of Engineers, Rock Island, Illinois
C of E, St. Paul - Corps of Engineers, St. Paul, Minnesota
DCDP&D - Dane County Department of Planning and Development
DCRPC - Dane County Regional Planning Commission
Fed. - USGS Federal Program
FERC - Federal Energy Regulatory Commission Licensees
Fontana/Walworth WPCC - Fontana/Walworth Water Pollution Control Commission
IL. DOT - Illinois Department of Transportation
MMSD - Madison Metropolitan Sewerage District
SEWRPC - Southeastern Wisconsin Regional Planning Commission
WALCOMET - Walworth County Metropolitan Sewerage District
WDNR - Wisconsin Department of Natural Resources
WI Dept. Tourism - Wisconsin Department of Tourism
Figure 8. Location of continuous-record data-collection stations.
DISCONTINUED SURFACE-WATER DISCHARGE STATIONS

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

Discontinued surface-water discharge stations

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<td>Wolf River near White Lake, WI</td>
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<td>Evergreen Creek near Langlade, WI</td>
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<td>Wolf River above West Branch Wolf River, WI</td>
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<td>West Branch Wolf River at Neopit, WI</td>
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<td>West Branch Wolf River near Kashena, WI</td>
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<td>Little Wolf River near Galloway, WI</td>
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<td>Spaulding Creek near Big Falls, WI</td>
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<td>Little Wolf River at Royaltion, WI</td>
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<td>Emmons Creek near Rural, WI</td>
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<td>Storm Sewer to Mirror Lake at Waupaca, WI</td>
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<td>Waupaca River near Waupaca, WI</td>
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<td>Daggetts Creek at Butte Des Morts, WI</td>
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<td>Brothertown Creek at Brotherton, WI</td>
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<td>East Twin River at Mishicot, WI</td>
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<td>Onion River at Hingham, WI</td>
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<td>Onion River near Sheboygan Falls, WI</td>
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<td>Milwaukee River at Kewaskum, WI</td>
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<td>138</td>
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<td>East Branch Milwaukee River near New Fane, WI</td>
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## Discontinued surface-water discharge stations

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<td>North Branch Milwaukee River near Fillmore, WI</td>
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<td>Milwaukee River at Waubeka, WI</td>
<td>04086360</td>
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<td>Mud Lake Outlet near Decker Corner, WI</td>
<td>04086488</td>
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<td>Milwaukee River above North Ave., Dam at Milwaukee, WI</td>
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<td>Menomonee River at Germantown, WI</td>
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<td>Jefferson Park Drainageway at Germantown, WI</td>
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<td>Menomonee River at Butler, WI</td>
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<td>Little Menomonee River near Freistadt, WI</td>
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<td>Noyes Creek at Milwaukee, WI</td>
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<td>Little Menomonee River at Milwaukee, WI</td>
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<td>Honey Creek at Wauwatosa, WI</td>
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<td>Schoonmaker Creek at Wauwatosa, WI</td>
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<td>Hawley Road Storm Sewer at Milwaukee, WI</td>
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<td>Menomonee River at Milwaukee, WI</td>
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### ST. CROIX RIVER BASIN

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<td>Loon Creek near Danbury, WI</td>
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<tr>
<td>Bashaw Brook near Shell Lake, WI</td>
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<tr>
<td>Clam River near Webster, WI</td>
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<td>St. Croix River near Grantsburg, WI</td>
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<td>2,960</td>
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<td>Wood River near Grantsburg, WI</td>
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<td>Rice Creek near Balsam Lake, WI</td>
<td>05341375</td>
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<td>Balsam Branch at Balsam Lake, WI</td>
<td>05341402</td>
<td>52.8</td>
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<tr>
<td>Kinnickinnic River near River Falls, WI</td>
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### CHIPPEWA RIVER BASIN

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<td>05355500</td>
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<tr>
<td>Couderay River near Coudery, WI</td>
<td>05356121</td>
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<tr>
<td>Flambeau River at Flambeau Flowage (Flambeau Reservoir), WI</td>
<td>05357500</td>
<td>622</td>
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<tr>
<td>Flambeau River near Butternut, WI</td>
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<tr>
<td>Pine Creek near Oxbow, WI</td>
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<td>Flambeau River at Babbs Island near Winter, WI</td>
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<td>967</td>
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<tr>
<td>South Fork Flambeau River near Phillips, WI</td>
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<td>609</td>
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<tr>
<td>Price Creek near Phillips, WI</td>
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<td>Flambeau River near (at) Ladysmith, WI</td>
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<tr>
<td>Chippewa River near Holcombe, WI</td>
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<tr>
<td>South Fork Jump River near Ogerma, WI</td>
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<td>Chippewa River at Holcombe, WI</td>
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<tr>
<td>Fisher River at (near) Holcombe, WI</td>
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<td>O'Neill Creek near Chippewa Falls, WI</td>
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<td>78.1</td>
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<td>Yellow River near Hannibal, WI</td>
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<td>Yellow River at Cadott, WI</td>
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<td>Duncan Creek at Bloomer, WI</td>
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<td>Duncan Creek Tributary near Tilden, WI</td>
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<td>Duncan Creek at Chippewa Falls, WI</td>
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<td>Eau Claire River near Augusta, WI</td>
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<td>Bridge Creek at Augusta, WI</td>
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<td>Eau Claire River near Fall Creek, WI</td>
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<td>Chippewa River at (near) Eau Claire, WI</td>
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<td>Red Cedar River near Cameron, WI</td>
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<td>Red Cedar River near Colfax, WI</td>
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<td>Red Cedar River near Colfax, WI</td>
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<td>Eau Galle River near Woodville, WI</td>
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<td>Eau Galle River at low water bridge at Spring Valley, WI</td>
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<td>French Creek near Spring Valley, WI</td>
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<td>Lousy Creek near Spring Valley, WI</td>
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<td>Lohn Creek near Spring Valley, WI</td>
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<td>Eau Galle River at Elmwood, WI</td>
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### BUFFALO RIVER BASIN

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### Discontinued surface-water discharge stations

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<td>Elk Creek near Independence, WI</td>
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<td>Trempealeau River at Arcadia, WI</td>
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<td><strong>BLACK RIVER BASIN</strong></td>
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<td>Poplar River near Owen, WI</td>
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<td>LaCrosse River near West Salem, WI</td>
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<td>Buena Vista Creek near Kellner, WI</td>
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<td>Tenmile Creek Ditch 5 near Bancroft, WI</td>
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<td>Fourteenmile Creek near New Rome, WI</td>
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<td>Yellow River at Necedah, WI</td>
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<td>Knight Hollow Creek near Arena, WI</td>
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### Discontinued surface-water discharge stations

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<td>Rattlesnake Creek near Beetown, WI</td>
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<td>Little Platte River near Platteville, WI</td>
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<td>near Waupun, WI</td>
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<td>East Branch Rock River near Mayville, WI</td>
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<td>Rock River at Hustisford, WI</td>
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<td>Koskohkon Creek near Rockdale, WI</td>
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<td>Token Creek near Madison, WI</td>
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<td>Sixmile Creek near Waunakee, WI</td>
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<td>Pheasant Branch at Century Avenue at Middleton, WI</td>
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<td>Olbrich Park Storm Ditch at Madison, WI</td>
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<td>Lake Wingra Outlet at Madison, WI</td>
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<td>Door Creek near Cottage Grove, WI</td>
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<td>Badfish Creek near Stoughton, WI</td>
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<td>White River near Burlington, WI</td>
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</table>
COOPERATOR: Wisconsin Geological and Natural History Survey

LOCATION: Statewide

PROJECT CHIEF: Bernard R. Ellefson

PERIOD OF PROJECT: July 1946-Continuing

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

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

APPROACH: A basic network of about 155 wells is being maintained. The network will be constantly modified and improved to provide the best possible coverage of our ground-water resource. A subnetwork of key wells is included in this network. Key wells have long periods of record and are measured weekly or are equipped with continuous recorders.

PROGRESS (July 1997 to June 1998): Slug tests and geophysical logging were completed on 13 additional wells in an effort to better evaluate the network. Data routinely collected by USGS staff and data being collected by observers were evaluated. Data evaluation and preparation for the annual report, “Water Resources Data—Wisconsin”, were completed.

PLANS (July 1998 to June 1999): Plans include: (1) Continue measurements on observation-well network, (2) replace and hire new observers and make quality-assurance checks when possible, (3) slug test and geophysical log 7 wells in the network, and (4) prepare a report of findings from the slug tests and geophysical logging of the 20 selected wells.

REPORTS:


Figure 9. Location of network observation wells.
PROBLEM: A large underground zinc-copper mine is being proposed at a site about five miles south of Crandon, Wisconsin, in Forest County. The Wisconsin Department of Natural Resources (WDNR) requested that District staff review the development of a ground-water flow model and associated hydrologic documents as part of a permitting process for the proposed mine.

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

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

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

PLANS (July 1998 to June 1999): Documents will be reviewed and meetings attended at the request of the WDNR. Review of the LAK2 Code will be completed. Initial review of the revised flow model and a revised contaminant transport model will be completed. Possibly the flow model will be revised and selected simulations run. Monitoring of lake stage and shallow ground-water levels adjacent to Little Sand Lake will be continued.
PROBLEM: Contaminated subaqueous deposits are the consequence of industrial and agricultural activity along rivers and coastlines, and near harbors. Subaqueous capping is one remediation alternative for these deposits. It involves the placement of a capping layer of sediments in order to stabilize the contaminated deposits and isolate the contaminants from both the water column and bottom-feeding organisms.

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

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

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

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

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

COOPERATOR: 
U.S. Environmental Protection Agency

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

PROJECT CHIEF:
Daniel Feinstein

PERIOD OF PROJECT:
February 1998-September 1999
PROBLEM: A long-term base of water-quality data is needed for regional water-quality assessment and water-resource planning.

OBJECTIVE: The Federal program consists of the National Stream Quality Accounting Network (NASQAN) and the Hydrologic Benchmark Network (HBMN). All NASQAN stations in Wisconsin were discontinued at the end of the 1994 water year. The objectives of the NASQAN program are to (1) account for the quantity and quality of water moving within and from the United States, (2) depict areal water-quality variability, and (3) detect changes in stream quality with time. The objective of the HBMN program is to monitor hydrologic characteristics at sites where they are relatively unaffected by human activities and will remain unaffected for the foreseeable future.

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

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

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

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

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

PROGRESS (July 1997 to June 1998): Water samples were collected from two streams in 1996 and four streams in 1997 to determine the concentration of diluted herbicides present during baseflow and streamflow conditions. In 1966, the two sampling sites were the Pecatonica River at Martintown and the Yahara River at Fulton. In 1997, the Yahara River at Windsor and the Trempealeau River at Dodge were added to the sampling program. During the 1996 data-collection period, atrazine was the most frequently detected herbicide. Concentrations of atrazine at the Pecatonica River ranged from 0.15 μg/L to 5.0 μg/L while atrazine concentrations at the Yahara River at Fulton ranged from 0.15 to 9.93 μg/L. During the 1997 data-collection period, concentrations of atrazine at the Pecatonica River ranged from 0.15 μg/L to 0.244 μg/L. In 1997, only one of 19 samples collected at the Yahara River at Fulton had atrazine concentrations above the detection limit compared with 8 of 14 samples above the detection limits in 1996. In 1997, all 20 samples collected at the Yahara River at Windsor and 13 of 18 samples collected at the Yahara River at Fulton had detectable concentrations of alachlor-esa. All data were summarized and published in the report “Water Resources Data—Wisconsin”, water year 1997. A U.S. Geological Survey Fact Sheet 175-97 was published. This fact sheet compares herbicide concentrations and loads at the Pecatonica and Yahara River sites.
PLANS (July 1998 to June 1999): Samples will be collected at the Pecatonica, Yahara River at Fulton and Windsor, and Trempealeau River sites during the 1998 growing season. All data will be published in the report, “Water Resources Data—Wisconsin”. Another fact sheet will be prepared jointly by the U.S. Geological Survey and the Wisconsin Department of Agriculture, Trade and Consumer Protection. This fact sheet will compare concentrations and loads at the four sites.

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

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

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

PROGRESS (July 1997 to June 1998): On-going streamflow and water-quality data collection at three continuous-record monitoring sites (Pheasant Branch at Middleton, Spring Harbor Storm Sewer at Madison, and Yahara River at Windsor) continued. Suspended-sediment loads were computed for Spring Harbor Storm Sewer, and suspended-sediment, total phosphorus, and dissolved orthophosphorus loads were computed for the Yahara River and Pheasant Branch for the 1997 water year. Continuous-streamflow monitoring at Black Earth Creek near Black Earth was continued for the year.

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

PLANS (July 1998 to June 1999): Streamflow monitoring will be continued at Black Earth Creek; streamflow and water quality monitoring will be continued at the three continuous-record sites on tributaries to Lake Mendota. Base-flow water-quality sampling will be conducted on Black Earth Creek at Black Earth, Sixmile Creek near Waunakee, Yahara River near Windsor, and Maunesha River near Sun Prairie (starting in May 1998) for the remainder of the calendar year. Records and loads will be computed. Final data will be prepared and published in the annual data report.
GROUND-WATER AGE DATING IN THE LITTLE PLOVER RIVER BASIN, WISCONSIN, WI 00351

COOPERATOR: University of Wisconsin-Stevens Point

LOCATION: Wood County, Wisconsin

PROJECT CHIEF: David A. Saad

PERIOD OF PROJECT: July 1997 to June 1999

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

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

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

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

PLANS (July 1998 to June 1999): Additional CFC and dissolved gas samples will be collected and analyzed.
COLLECTION OF BASIC RECORDS—SEDIMENT, WI 004

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

OBJECTIVE: This project will provide sediment data for use in specific planning and action programs and will develop a data base for determining trends in sediment discharge and yield. Streams will be characterized according to range of concentration and particle size of suspended sediment.

APPROACH: Sediment-monitoring stations will be operated at selected stream sites throughout the State, including sites of specific interest to cooperating agencies.

The extent of monitoring at a given site will depend on the characteristics of the basin and the needs of the cooperating agency. Some sites will be sampled manually at infrequent intervals; other sites, where flow responds rapidly to precipitation, will be sampled by automatic samplers.

At sites where bedload or unmeasured sediment discharge may be a significant part of the total sediment discharge, suspended- and bed-sediment particle size will be determined from samples collected concurrently with hydraulic data. These data will be used to estimate total sediment discharge using one of several techniques such as the modified Einstein procedure.

PROGRESS (July 1997 to June 1998): Sediment data have been collected at more than 200 stream sites in Wisconsin since 1968. Most sediment data collection has been in the southern one-third of the State and associated with local special problem studies except for about a five-year period in the early 1970s when there was a statewide network of sediment monitoring stations. All data have been published annually in the data report, "Water Resources Data—Wisconsin". The 1997 monitoring program is as follows:

CORPS OF ENGINEERS—Suspension sediment was sampled at the Grant River at Burton. Daily loads were determined from these data.

PLANS (July 1998 to June 1999):

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

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

REPORTS:


COOPERATORS:
U.S. Army Corps of Engineers

LOCATION:
Statewide

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
March 1968-Continuing

Hydrologic and hydraulic analyses will be performed as needed for the preparation of floodplain maps in areas selected by FEMA.

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.

Hydrologic and hydraulic analyses for Sand Lake Coulee in LaCrosse County were completed.

Response will be made to review comments on completed studies and data requests answered as needed. Work for the LaCrosse County study will be completed.
PROBLEM: The need for reliable water-use data by State and Federal planning agencies is increasing as the competition for use of the State's water resources increases. Water-use data in a standardized format needs to be available to assist in making decisions on future water use.

OBJECTIVE: The purpose of this project is to collect accurate and complete data on Wisconsin’s water use, store data in the State Water-Use Data System (SWUDS), and prepare periodic reports on water use in the State.

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

PROGRESS (July 1997 to June 1998): SWUDS was updated with current water-use information. These data included high-capacity well data and information on discharge from sewage-treatment plants in the State. Reformatting programs were written or updated as needed for entering data from other agencies into SWUDS. The report “Water use in Wisconsin, 1995” was published as a hydrologic atlas.

PLANS (July 1998 to June 1999): Plans include: (1) continue to update and maintain SWUDS with current water-use data, (2) supply water-use data for water-resources studies currently being conducted in the State and (3) estimate 1995 water use by aquifer as part of the national water-use summary.

REPORTS:


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

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

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

PROGRESS (July 1997 to June 1998): Annual flood peaks were computed and published in the annual data report for 66 crest-stage stations. Twenty-eight new stations have been installed in areas where the cooperator indicated the greatest need for more information on flooding. Significant effort has been made in measuring flood discharges at crest gages, especially at the newly installed gages, and improving ratings at crest gages. A meeting was held with DOT to talk about future programs.

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

REPORTS:
### LIST OF CREST-STAGE GAGES

#### CHIPPEWA RIVER BASIN

- **05357380** 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
- **05361420** 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

#### 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** Dell Creek near Lake Delton, WI

#### FOX-WOLF RIVER BASIN

- **04072792** Tagatz Creek near Westfield, WI
- **04073068** 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** Kilsnake 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

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#### 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
- **05371817** Pine Creek at Taylor Road near Taylor, WI
- **05372888** 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** Bearsin Creek near Harshaw, WI
- **05395640** Little Pine Creek near Irma, WI
- **05394200** Devil Creek near Merrill, WI
- **05430600** Martin Branch near Mount Ida, WI
- **05409270** Roads Creek at Riley Road near Readstown, WI

#### MENOMinee-Oconto-Peshitgo River Basin

- **04059900** Allen Creek Tributary near Alvin, WI
- **040585640** North Branch Pine River at Windsor Dam near Alvin, WI
- **04067760** Peshitgo River near Cavour, WI
- **04069700** North Branch Oconto River near Wabeno, WI
- **04071700** North Branch Little River near Coleman, WI
- **04071800** Pesquet 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
- **05546200** White River Tributary near Burlington, WI
- **05548150** North Branch Nippersink Creek Tributary near Genoa City, WI
Figure 10. Location of crest-stage-gage data-collection stations.
PROBLEM: Maintaining the pristine quality of the Wolf River is extremely important to the Menominee Indian Tribe of Wisconsin and other tribes in the Upper Wolf River Basin. Information is needed to describe the current status of water quality and biotic conditions of the Wolf River within the Menominee Indian Reservation, and to determine the presence or absence of contaminants in water, sediments, and biota. Several years of data are available at USGS sites, including major ions, nutrients, and discharge data collected near the Menominee Indian Reservation boundaries. No data exist for trace element bioavailability and concentrations in water, aquatic biota, or streambed sediments at the other sites. A historical database is needed to evaluate present conditions and from which changes can be determined.

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

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

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

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

PLANS (July 1998 to June 1999): Water samples from each of the two sites will be collected in July and September. The September samples will be concurrent with the collection of biological and bed-sediment samples. This data along with the Langlade flow data will be published in the report, "Water Resources Data–Wisconsin". Sampling will be completed in September 1998. A water-resources investigations report will be published which will analyze and interpret the data collected.
CHARACTERIZATION OF THE GROUND-WATER FLOW SYSTEM IN THE VICINITY OF THE RED CLIFF INDIAN RESERVATION, WISCONSIN, WI 12305

COOPERATOR: Red Cliff Band of Lake Superior Chippewa Indians

LOCATION: Bayfield County, Wisconsin

PROJECT CHIEF: David A. Saad

PERIOD OF PROJECT: October 1997 to September 1999

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

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

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

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

The initial ground-water-flow model will be based on the hydrogeologic framework created from existing data, including published reports and papers, available driller’s construction reports and geologic logs, and unpublished data from other agencies such as the Wisconsin Geological and Natural History Survey and the Indian Health Service. Much of this work was started as part of the study entitled “Delineation of contributing areas and time of travel for water captured by wells within the Red Cliff Reservation” (project ended September 1997). However, the initial flow model for this study will incorporate an area including parts of several counties, so baseline data is needed to be collected from the entire area. The large initial flow model area is necessary to insure that proper boundary conditions are established for the larger-scale flow model in the study area of the Reservation. Analysis of results from the initial flow model will be used to determine what additional data is needed.
PROGRESS (October 1997 to June 1998): A summary of data collected and preliminary ground-water-flow modeling results for the study entitled “Delineation of contributing areas and time of travel for water captured by wells within the Red Cliff Reservation” as well as plans for the current study was presented to the Red Cliff Tribe on October 1, 1997. Available data for the regional ground-water-flow model was compiled. A summary of data collected, ground-water modeling framework, and plans for data collection was presented to the Wisconsin District Ground-Water Modeling Team (February 1998). Construction of the initial ground-water-flow model based on Ground-Water Modeling Team input began. Report outline with tentative title “Hydrogeology and simulation of ground-water flow in the vicinity of the Red Cliff Indian Reservation, Northwestern Wisconsin” was started. Planning for field work to fill in data gaps began.

PLANS (July 1998 to September 1999): Project has been suspended due to lack of funding.
PROBLEM: The Oneida Nation in Wisconsin has developed a seven-generation plan for their reservation that includes instituting land-use practices that will allow the surface-water system draining the reservation the opportunity to revert to its pre-colonial condition. Information is needed to describe the historic and current conditions of the Oneida Nation watershed. A retrospective data-base is needed to determine historic conditions and baseline water-quality sampling is needed to evaluate present surface-water conditions.

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

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

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

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

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

An outline for the Oneida retrospective report was prepared and approved. The Oneida Nation administered a survey related to past flow and water quality of the reservation to 206 tribal members. A number of questions included in the survey were prepared by the USGS. Survey results are being entered into a database by Oneida staff and will be summarized in the retrospective WRIR.
An informal meeting with U.S. Fish and Wildlife, the Oneida Nation, and study personnel to discuss ongoing work in the basin and common goals was held February 11, 1998.

**PLANS (July 1998 to June 1999):** Samples from 15 sites will be collected during summer baseflow, a summer storm runoff, and post-harvest baseflow for nutrients, triazine screens, and suspended sediment. Data from samples collected from October 1, 1997, through September 30, 1998, will be published in the report, "Water Resources Data-Wisconsin". A fish community survey will be conducted in August. A WRIR of retrospective data and a WRIR of analysis of data collected at the 15 sites will be published. Three to seven sites will be selected for continuous monitoring of flow and monthly water-quality sampling.
PROBLEM: There is a general need to characterize and define the hydrology and water quality of reservation areas. Current and future site-specific investigations concerned with long-term water-resource and water-quality trends require an adequate regional hydrogeologic framework.

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

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

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

PLANS (July 1998 to September 1998): Selected zones in boreholes at two sites will be packer tested to assess the hydrogeologic character of the aquifer. Water-quality analyses will be conducted on water samples from selected intervals.
COOPERATORS:
In the 1997 water year:
Eagle Spring, Little Cedar, Little Green, Middle Genesee, Montello, Okauchee, Potter, Pretty, Silver, Twin (Marie and Elizabeth), Wind, and Wolf Lake Districts; city of Muskego (Big Muskego, Dueno, and Little Muskego Lakes); townships of Casey (Big, Middle, and Lower McKenzie Lakes); and Cedar Lake (Balsam, Red Cedar and Hemlock Lakes); and village of Oconomowoc Lake (Oconomowoc Lake)

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

LOCATION:
Selected lakes in Wisconsin

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
June 1983-Continuing

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

OBJECTIVE: Objectives of this project are to (1) determine the current water quality and trophic status of lakes, (2) assess the condition of specific lakes in comparison with other lakes of the same type in the region, and (3) build a quantitative data base so that any detrimental changes or trends that might occur in the future can be detected quickly and evaluated objectively.

APPROACH: Water quality at each lake will be monitored in February, April, June, July, and August. Depth profiles of dissolved-oxygen concentration, temperature, pH, and specific conductance will be determined. In April, the lakes will be sampled at the top and bottom for analysis of the major anions and cations, nitrogen, and dissolved phosphorus. Secchi-depth measurements will be made for all months (except February), and total phosphorus and chlorophyll a samples will be collected and analyzed. Lake stage will be measured at each of the five visits to the lake.
PROGRESS (July 1997 to June 1998): In the 1997 water year, total phosphorus, chlorophyll $a$, dissolved oxygen, temperature, pH, specific conductance, and Secchi-depth data were collected and analyzed for 23 lakes. A letter evaluating the water quality of each lake was sent to the respective cooperator. In the 1998 water year, Benedict, Big Sissabagama, Buffalo, Namekagon, Powers, Tombeau, and Whitefish Lakes were added to the program. Balsam, Big Hills, Elizabeth, Hemlock, Mary, Pretty, Silver and Wolf Lakes were dropped from the program. The locations of lakes included in the monitoring program for water years 1997-98 are shown on the following map.

PLANS (July 1998 to June 1999): In the 1998 water year, 22 lakes will be monitored. Data will be compiled and transmitted to the respective cooperator after the August monitoring. The data will be prepared for publication in the annual report “Water Quality and Lake-Stage Data for Wisconsin Lakes, water year 1998”.

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


PLANS (July 1998 to June 1999): Assistance will continue to be provided at sites in EPA Region V upon request.

HYDROLOGIC INVESTIGATIONS OF WETLAND RESTORATION AND CREATION PROJECTS, WI 170

COOPERATOR:
Wisconsin Department of Transportation

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

PROJECT CHIEF:
Randy J. Hunt

PERIOD OF PROJECT:
November 1989 to September 1997

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

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

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

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

PLANS: The project is complete.

REPORTS:


Hunt, R.J., 1996, Do created wetlands replace the wetlands that are destroyed?, USGS Fact Sheet 246-96, 4 pp.
PROBLEM: An evaluation strategy is needed to assess the effectiveness of nonpoint-source pollution control measures in priority watersheds. Several important processes require research including the role of ground water in nonpoint-source contamination, factors leading to dissolved-oxygen reduction in a stream during runoff events, and the impact of management practices on bedload transport. Several techniques need to be developed and/or refined, such as detecting trends in stream-water chemistry, sampling of fish and fish habitat, relation between fish/fish habitat and changes resulting from watershed management practices, and use of habitat models for determining impact of watershed management on fish populations.

OBJECTIVE: The overall objective of this project is to determine the trends in water quality for 10 sites during and after implementation of improved land-management practices in 7 priority watersheds.

APPROACH: Ten streams were selected in seven different priority watersheds. Continuous-record streamflow, water temperature, and dissolved-oxygen gaging stations were installed at each stream site. Water-quality samples will be collected during events and low flows and analyzed for selected constituents. Land-use inventories will be taken each year to help determine the cause of any changes in water quality.

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

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


BEST MANAGEMENT PRACTICE EVALUATION, WI 17206

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

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

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

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

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

REPORTS:


COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: State of Wisconsin

PROJECT CHIEF: John F. Walker

PERIOD OF PROJECT: October 1989 to September 1997


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

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

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

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

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

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

Since implementation of barnyard BMPs, the data collected have shown significant reductions in the loadings of most constituents coming from each barnyard. At both creeks, post-BMP loads of total phosphorus, ammonia, and BOD contributed by the barnyard were statistically lower than pre-BMP loads. In addition, post-
BMP loads of suspended solids and microbial loads of fecal coliform bacteria at Otter Creek were also statistically lower than in the pre-BMP period. The barnyard BMP system at Otter Creek has reduced loads of suspended solids by 85 percent, total phosphorus by 85 percent, ammonia by 94 percent, BOD by 83 percent, and microbial loads of fecal coliform bacteria by 81 percent; the respective loads at Halfway Prairie Creek have been reduced by 47, 87, 95, 92, and 9 percent.

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

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

REPORTS:

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

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

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

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

PLANS (July 1998 to June 1999): Analyses will be completed and final report prepared. Results will be published as a U.S. Geological Survey fact sheet.
MULTI-STREAM EXPERIMENTAL DESIGN, WI 17223

COOPERATOR: Wisconsin Department of Natural Resources

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

PROJECT CHIEF: John F. Walker

PERIOD OF PROJECT: October 1997 to June 1999

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

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

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

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

PLANS (July 1998 to June 1999): Statistical analysis will be completed. Results will be published in an open-file report.
EVALUATION OF SIPHON SAMPLERS, WI 17225

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

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

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

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

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Dane County, Wisconsin

PROJECT CHIEF: David J. Graczyk

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

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

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

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

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

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

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

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Dane County, south-central Wisconsin

PROJECT CHIEF: Robert J. Waschbusch

PERIOD OF PROJECT: July 1997 to September 1998
HYDROLOGY AND WATER QUALITY OF THREE PASTURES IN SOUTHWESTERN WISCONSIN, WI 17229

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION
Sauk County, Wisconsin

PROJECT CHIEF:
David J. Graczyk

PERIOD OF PROJECT:
October 1997 to September 1999

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

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

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

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

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

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

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

**PLANS** (July 1998 to June 1999): Collect water-quality samples at the three sites for all storms. Determine a water budget for each site and calculate the nutrient and suspended solids loads for each site. All data will be summarized and published in the report, “Water Resources Data—Wisconsin”.
BALSAM SCOUR, WI 17230

COOPERATOR:
Marathon County Highway Department

LOCATION:
Marathon County, Wisconsin

PROJECT CHIEF:
Peter E. Hughes

PERIOD OF PROJECT:
May 1998 to June 1999

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

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

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

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

PLANS (July 1998 to June 1999): After the telephone line is installed, the data will be telemetered to the USGS office in Middleton and uploaded to the Web. Monitoring will continue through June 1999.
WISCONSIN LAKES, GREEN LAKE TRIBUTARY MONITORING
WI 17303

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

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

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

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

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

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

COOPERATOR:
Green Lake Sanitary District

LOCATION:
Green Lake County, south-central Wisconsin

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
October 1977-Continuing
ASSESSMENT OF PHOSPHORUS LOADING, WINTER ANOXIA, AND STAGE REGULATION OF LITTLE ST. GERMAIN LAKE, VILAS COUNTY, WI 17313

COORDINATOR:
Little St. Germain Lake District

LOCATION:
10 miles west of Eagle River, Wisconsin

PROJECT CHIEF:
William J. Rose

PERIOD OF PROJECT:
August 1996 to September 1998

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

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

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

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

PLANS (July 1998 to June 1999): A final data summary will be compiled and transmitted to the lake district.
ASSESSMENT OF THE WATER QUALITY, HYDROLOGY, AND BIOLOGY OF GENEVA LAKE, WI 17314

COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
Walworth County, southeast Wisconsin

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

PERIOD OF PROJECT:
March 1997 to September 2000

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

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

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

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

PLANS (July 1998 to June 1999): Lake sampling will continue throughout this period at three locations, biweekly during April through November and monthly the remainder of the time. Streamflow and phosphorus samples will be collected monthly and during high flow events at the two inflow sites and approximately bimonthly at the outlet. Preliminary water and phosphorus budgets will be constructed. Sediment data will be analyzed.
USE OF ICE COVER ON LAKES AND RIVERS AS A CLIMATIC INDICATOR, WI 17315

COOPERATOR: University of Wisconsin-Madison
LOCATION: Lakes and rivers from around the world
PROJECT CHIEF: Dale M. Robertson
PERIOD OF PROJECT: October 1997-Continuing

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

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

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

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

PLANS (July 1998 to June 1999): El Nino evaluation will be completed. Findings of the portion of the study dealing with the El Nino relation will be presented at the SIL meetings in Dublin, Ireland. A manuscript describing long-term trends in ice records will be completed.
MISSISSIPPI RIVER SEDIMENT LOADING, POOLS 7 AND 8, WI 17316

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

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

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

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

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

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

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: LaCrosse to Genoa, Wisconsin

PROJECT CHIEF: Peter E. Hughes

PERIOD OF PROJECT: October 1997 - Continuing
DETERMINATION OF STREAMFLOW, PHOSPHORUS, AND SOLIDS LOADS AT THREE SITES ABOVE SINISSIPPI LAKE IN DODGE COUNTY, WI 17317

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

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

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

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

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

COOPERATOR: Town of Hubbard (Sinissippi Lake Improvement Association)

LOCATION: Central Dodge County, Wisconsin

PROJECT CHIEF: David J. Graczyk

PERIOD OF PROJECT: October 1997 to June 1999
SHELL LAKE, WI 17318

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

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

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

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

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

COOPERATOR:
City of Shell Lake, Wisconsin

LOCATION:
Washburn County, Wisconsin

PROJECT CHIEF:
James T. Krohelski

PERIOD OF PROJECT:
January 1998 to September 1999
PROBLEM: Growing populations throughout the United States have resulted in increased development and use of our water resources. As our water resources become stressed, decisions on how to effectively utilize and manage these resources will need to be made. These decisions must be based on accurate assessments of the quality of the water resource and the factors affecting its use.

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

APPROACH: The foundation of the study approach is based upon identifying relatively homogeneous areas of specific land-use and environmental characteristics. Identification of these areas was accomplished by overlaying digital coverages of land use and various environmental variables using a geographical information system. Sampling sites completely contained in these relatively homogeneous areas (indicator sites) were incorporated into a nested design of surface-water, streambed sediment, and biological sampling. The sampling strategy consists of a retrospective analysis of available water-quality data (1991-93), followed by a high (1993-95) and then a low-phase (1996-2000) data-collection effort. Monitoring of basic fixed sites (BFS) in selected areas (indicator sites), as well as downstream sites draining heterogeneous land uses and environmental characteristics (integrator sites), are being conducted. These sites have been sampled monthly and augmented with event-related samples. A subset of these sites were extensively sampled for pesticides. Pesticide samples were collected approximately weekly during the early to mid-summer period and less frequently during the rest of the year. Synoptic studies were conducted during high- and low-flow conditions (spring and summer of 1994) to better delineate the sources of nutrients throughout the basins and describe the seasonal variability of these sources. Another synoptic study determined how representative the BFSs were of the entire WMIC drainage area. Other program components include an ecological survey (spring 1993) at 20 sites to evaluate the relation between community (fish and invertebrates), habitat structure, land-use practices, and environmental factors. Ground-water studies include a study-unit survey, a flow-path study and two land-use studies.
flow-path study examined transformations in various constituents through time and space. Surface-water/ground-water interactions were examined using shallow wells and lysimeters installed adjacent to the nearby stream. Effects of land use on ground-water quality were assessed through sampling in specific relatively homogeneous areas (1994 and 1995). A study unit survey provides an indication of water-quality conditions of the major aquifer (Cambrian-Ordovician sandstone) in the study unit.

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

The GIS coverages will continue to be compiled, including: labeling the clustered Landsat data, wetlands data from the WISCland inventory, Natural Resource Inventory, Toxic Release Inventory, etc. Data archiving, for data collected during the high- and low-intensity phases, has continued. The study unit’s World Wide Web page has been updated and maintained. Data from the high-intensity phase was analyzed and the results of analyses compiled in reports.

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

**PLANS** (July 1998 to June 1999): Two low-intensity phase (LIP) basic fixed sites (BFS) will be sampled monthly for discharge, field parameters, nutrients, major ions, total and dissolved organic carbon, and suspended sediment. The two BFS will have ecological assessments for fish, algae and invertebrate population and habitat conducted. Bed sediment and tissue samples will be collected for trace element and organic analyses.

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

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

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

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

Stream- and ground-water samples, collected at each of the Trout Lake tributaries and at different points in the Allequash system, undergo analysis for nitrogen species, phosphorus, silica, organic carbon, major ions, and metals. Tributary sampling is done on a monthly basis, supplemented with more intense sampling of particular storms. Coupled with hydrologic data, the water sampling provides a basis for describing chemical budgets.
Investigation of geochemical processes that control transport of important chemical species across stream and lake sediments involves fine-scale sampling at the sediment/water interface. This is done by a variety of techniques, including membrane equilibrators, core squeezing, microprobes, and seepage meters.

**PROGRESS** (July 1997 to June 1998): Data collection and analysis proceeded at the three intensive monitoring sites on Allequash Creek. Analysis of stable isotope composition have been used to distinguish between sources of water in the stream. Water from precipitation that percolates through nearby hillslopes has isotopic signatures different from water that travels through relatively long flowpaths, often from lakes several kilometers distant from the stream. The data show an overall picture of the Allequash Creek flow system as a progression from a pure ground-water source at the headwaters to a mixture of relatively deep ground water, relatively shallow ground water, and evaporative (surface) water. Examination of strontium isotope ratios ($^{87}$Sr/$^{86}$Sr) provides further detail of the flow system on a smaller spatial scale, and indicates that the “shallow” flowpaths are still quite distant from the stream and do not predominantly originate as recharge on the adjacent hillslopes.

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

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

The new database management system continues to provide improved organization and access to all data collected as part of the project. Data and other information about the project are available on a world Wide Web home page (http://oraddwimd.er.usgs.gov/doc/WEBB/index.html).

**PLANS** (July 1998 to June 1999): Data collection at hillslope monitoring sites will continue. Intensity of sampling will decrease and more effort will be directed toward analyses, interpretation, and write-up of existing data. Stream- and ground-water monitoring will continue for further examination of seasonal and spatial variability. Measurements of gas-phase and aquatic-phase transport of carbon through the system will continue. Additional field work will continue to emphasize investigation of the carbon budget.

**REPORTS:**


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 alkalinites 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 alkalinites less than 20 µeq/L.

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

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

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

PROGRESS (July 1997 to June 1998): Lake stage and a single recorder-equipped well were monitored at Morgan Lake; and lake stage, precipitation, and the ground-water-well network were monitored at Vandercook Lake.

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

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

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

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

PROGRESS (July 1997 to June 1998): Streamflow was monitored continuously at three inflow sites and at one outflow site. Water samples were collected monthly at all stream sites. During storm runoff, samples were collected by an automatic sampler or an observer. Water samples were analyzed for nutrients and suspended sediment. The water quality at the center of the lake was monitored. The 1997 water-year data was compiled for publication in the report, "Water Resources Data—Wisconsin". Two reports describing the effectiveness of the Jackson Creek wetland at reducing total phosphorus and sediment loads were published. Lake phosphorus concentrations in 1996-97 were similar to those prior to rehabilitation that was completed in 1993. However, summer water clarity was greater and chlorophyll a concentrations were less than prior to lake rehabilitation.

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

REPORTS:

COOPERATOR: Town of Delavan

LOCATION: Walworth County, southeast Wisconsin

PROJECT CHIEF: Gerald L. Goddard Dale M. Robertson

PERIOD OF PROJECT: August 1983-Continuing


LAKE MICHIGAN TRIBUTARY LOADING, WI 183

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

OBJECTIVE: Objectives of this project are to build a streamflow and water-quality data base for 11 Lake Michigan tributaries in the states of Wisconsin, Michigan, and Indiana to act as a baseline for evaluation of future remediation activities; estimate loads of PCBs, transnonachlor, atrazine, trace metals, nutrients, and suspended solids to Lake Michigan; compare loads between tributaries to target basins of major concern; identify contaminants of greatest concern; and describe the mobility of contaminants.

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

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

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

COOPERATORS:
Environmental Protection Agency
Wisconsin Department of Natural Resources

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

PROJECT CHIEF:
David W. Hall

PERIOD OF PROJECT:
July 1992 to September 1997
COOPERATOR: Wisconsin Department of Natural Resources

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

PROJECT CHIEF: Dale M. Robertson

PERIOD OF PROJECT: October 1997-Continuing

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

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

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

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

PLANS (July 1998 to June 1999): Complete basin characteristics will be obtained using GIS for all the tributaries (integrator sites) sampled in the Lake Michigan Mass Balance study. The entire area will be subdivided into Relatively Homogeneous Units. Each of the drainage areas of the tributaries sampled during the Lake Michigan Mass Balance Study will be divided into downstream urban areas and the rest of the basin. GIS will be used to describe the percentages of each land use, surficial deposits, and bedrock type in the basins of the tributaries sampled during the Lake Michigan Mass Balance Study. The new indicator sites in Michigan will be sampled during the summer of 1998 for a suite of trace elements by the University of Wisconsin-Madison.
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 database for two Lake Superior tributaries to act as a baseline for evaluation of future remediation activities, estimate loads of targeted contaminants to Lake Superior, compare loads between tributaries to target basins of major concern, identify contaminants of greatest concern, and describe the mobility of contaminants.

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

PROGRESS (July 1997 to June 1998): Gaging station operations were continued for the year. Several PCB samples were taken during this period using the Infiltrex samplers controlled by the flow-proportional sampling program. AVM data from the sites were calibrated with Doppler measurements to estimate discharge. Discharge data for Duluth and Superior AVM sites and the Nemadji River were published in the report, “Water Resources Data—Wisconsin”.


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

LOCATION:
Cities of Duluth, Minnesota and Superior, Wisconsin

PROJECT CHIEF:
Peter E. Hughes

PERIOD OF PROJECT:
July 1993 to September 1998
COOPERATORS:
City of Middleton
Dane County Regional Planning Commission
Madison Metropolitan Sewerage District
Wisconsin Department of Natural Resources
Wisconsin Geological and Natural History Survey

LOCATION:
Dane County and parts of surrounding counties

PROJECT CHIEF:
James T. Krohelski

PERIOD OF PROJECT:
October 1992 to September 1996

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

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

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

PROGRESS (July 1997 to June 1998): A report describing phase 2 of the Dane County Hydrologic Study, a calibrated three-dimensional flow model, was completed and approved for publication. A report describing phase 1 of the Dane County Hydrologic Study, the hydrogeologic framework, was completed and is in review. Simulations incorporating potential land-use and management strategies were run and the results given to the Dane County Regional Planning Commission.

PLANS: Project is complete except for publication of report.

REPORTS:

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

PROBLEM: High concentrations of polychlorinated biphenyls (PCBs) have been found in the Hayton Millpond bed sediments and fish tissues. Consequently, a plan is being developed to restore and revive the surface waters of this area. Knowledge of the processes that control cycling and transport of PCBs is essential to the remediation effort. Algal incorporation of PCBs may be a quantitatively important process in this transport.

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

APPROACH: The millpond outlet will be monitored for two years during event and base-flow conditions. Automated water-quality samplers will be used to obtain daily total suspended solids (TSS) samples; more intensive samples will be obtained on the rising hydrograph limb. Eighteen manual organic samples (80 liters) will be collected at the Hayton site. Measured water-column characteristics include PCB (dissolved and particulate), TSS, VSS, particulate and dissolved organic carbon, chlorophyll $a$, sand/silt split and chloride.

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

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

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

PROGRESS (June 1997 to July 1998): The data-collection effort is complete. Water-column PCB concentrations ranged from 38 to 564 ng/L, producing transported PCB loads of 4 to 136 grams per day. The algal identification effort and laboratory PCB uptake experiments are complete.

PLANS (July 1998 to June 1999): A report detailing the PCB loading, partitioning, algal PCB uptake and suspended-solids classification will be published. Continuous streamflow and temperature monitoring will be continued.

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

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

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

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

PLANS: Project is completed.
COOPERATOR:
Wisconsin Department of Natural Resources

LOCATION:
East-central Bayfield County near Ashland, Wisconsin

PROJECT CHIEF:
Faith Fitzpatrick

PERIOD OF PROJECT:
June 1994 to September 1997

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

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

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

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

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

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

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

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

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

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

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

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

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

PLANS (July 1998 to June 1999): Three field volunteers have been deployed to maintain monitoring activities in Antarctica. Expect to complete work up of data from tail end of 1996-1997 field season retrieved during the present field season. If funds are available, will work up data recovered from the 1997-1998 field season. Continue to make all field data available on the Web via oracle.
PROBLEM: Mercury contamination is one of the largest potential health risks to aquatic organisms, predatory animals, and humans. This great concern is the result of two observations—

(1) mercury biomagnifies in the food chain to toxic concentrations even though it is found at very low aqueous concentrations and

(2) the principal source to most areas is atmospheric deposition. Thus, almost any aquatic ecosystem with a food chain is potentially susceptible to mercury contamination.

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

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

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

PLANS (July 1998 to June 1999): During this time period, Critical Ecosystem Program managers have requested that project personnel cease field sampling and synthesize results to date. Project staff will focus on eliminating all sample backlog and finalizing data in a data set that will be available on the Web. Individual project participants will be responsible for writing up their research results in the form of scientific journal publications, as well as one overall synthesis document.
OPTIMUM MANAGEMENT OF GROUND-WATER RESOURCES IN THE LOWER FOX RIVER VALLEY, WI 198

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

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

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

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

PLANS: Project is completed.


COOPERATOR: Wisconsin Department of Natural Resources

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

PROJECT CHIEF: John F. Walker

PERIOD OF PROJECT: October 1995 to September 1997
MITIGATION OF FUTURE NORTH FORK URBANIZATION IMPACTS ON THE PHEASANT BRANCH HYDROLOGIC SYSTEM, WI 202, 20202

COOPERATOR:
City of Middleton

LOCATION:
Dane County, Wisconsin

PROJECT CHIEF:
Jeffrey J. Steuer

PERIOD OF PROJECT:
July 1996 to September 1997

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

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

APPROACH: The overall approach will combine ground- and surface-water models to locate an effective combination of stormwater treatment or control sites within the North Fork basin which may be developed to produce minimal effects on the Pheasant Branch hydrologic system. The surface-water component will build upon the simulations detailed in “Effects of urbanization on streamflow, sediment loads, and channel morphology in Pheasant Branch Basin near Middleton, Wisconsin” (Krug and Goddard, 1985, WRIR 85-4068). To achieve the objectives of this project, the model will contain a spatial resolution to simulate 1 to 4 developments per square mile (approximately 40 model sub-areas). Significant development has occurred in the South Fork basin since 1981. Two of the areas simulated as not generating runoff in 1981 have developed and presently drain to the South Fork. It will be necessary to update the South Fork basin model to ensure that shifting of the North Fork hydrograph peak (due to runoff controls) will not produce an enhanced peak downstream of the confluence (Krug and Goddard, pages 16, 17). The new model efforts will calibrate to recently collected Pheasant Branch discharge and precipitation data collected at Highway 12. Radar precipitation data will be interpreted to provide spatial resolution.
The ground-water component will use a model constructed at a smaller scale than the recently developed Dane County model (Krohelski, et al., in press) to have the appropriate resolution for the stormwater control alternatives. Similar to Krohelski, et al., the model will be constructed using MODFLOW (McDonald and Harbaugh, 1988). Infiltration used in the surface-water model will be input into the ground-water-flow model to assess the effects of management alternatives on ground-water recharge distribution and magnitude. The model will also calculate the changes in ground-water-derived baseflow in the system for the different alternatives and assess the effectiveness of recharge enhancement scenarios.

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

**PLANS** (July 1998 to June 1999): Additional sites will be investigated using geochemical, temperature, and physical techniques. Springs and porewaters in the wetland complex will continue to be sampled for water isotopes and ion chemistry. The regional flow model will be updated using the additional data and insight gained. Results from the surface-water modeling will also be incorporated into the refined site flow model. Ground- and surface-water modeling will be completed. An investigative report will be prepared.
MITIGATION OF FUTURE IMPACTS OF URBANIZATION ON THE BADGER MILL CREEK HYDROLOGIC SYSTEM, WI 20201

COOPERATOR:
City of Middleton

LOCATION:
Dane County, Wisconsin

PROJECT CHIEF:
David W. Owens

PERIOD OF PROJECT:
October 1997 to September 1999

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

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

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

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

PLANS (July 1998 to June 1999): Gaging stations will be operated until the fall of 1999. The SWMM model will be constructed and calibrated under current conditions.
MONITORING AND EVALUATION OF THE IMPACTS OF AIRCRAFT AND RUNWAY DEICERS ON THE KINNICKINNIC RIVER SURFACE-WATER RESOURCES, WI 204

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

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

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

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

COOPERATOR: County of Milwaukee

LOCATION: Milwaukee, Wisconsin

PROJECT CHIEF: Steven R. Corsi

PERIOD OF PROJECT: November 1996 to December 1997
PLANS (July 1998 to June 1999): Two more years of monitoring are planned after the implementation of glycol management in the fall of 1998. After monitoring of post-implementation runoff, statistical analyses will be conducted to determine the effectiveness of the glycol management practice. A direct comparison of pre- to post-implementation data will be done using paired-watershed and upstream-downstream analyses between sites. Two reports are planned. One report will be a summary of data from the first winter of monitoring and the second report will be an analyses of the effectiveness of the glycol management practice.
MODELING THE EFFECTS OF THE CRANDON MINE USING THE HSPF WATERSHED MODEL, WI 205

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

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

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

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

PLANS (July 1998 to June 1999): Construct a watershed model for the Swamp Creek Basin using HSPF. The model will be calibrated and verified. The model will then be adjusted to quantify the effects of the mine construction, operation, and closure on the water levels of streams and lakes in the area.

COOPERATOR:
U.S. Environmental Protection Agency
AquaTerra Consultants, CA

LOCATION:
Forest County, north-central Wisconsin

PROJECT CHIEF:
Jana Stewart

PERIOD OF PROJECT:
January 1997 to September 1998
PROBLEM: Dynamic particle and toxics transport modeling (such as WASP4) of PCB transport relies on several assumptions dealing with predictions of sediment deposition sites and amounts, settling/resuspension rates on week/month time scales, mixing depth of surficial sediments, etc. $^7$Be has the potential of refining predictions of these processes by providing actual rates and sites of deposition and possibly resuspension.

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

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

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

PLANS (July 1998 to June 1999): Bed sediments and suspended/sinking particles will be sampled at two sites in July, August, and September and after one storm during the summer period. Laboratory analyses for Beryllium-7 in these samples will be completed by October 1998. Results will be interpreted and a journal article will be prepared.
PROBLEM: Certain biological species and trophic interactions in the Necedah National Wildlife Refuge might be adversely affected by (1) pesticide contamination in waters that discharge to the Refuge from agricultural drainage, (2) nutrient loading from agricultural drainage, and/or (3) alteration of the water and sediment flows due to agricultural usage.

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

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

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

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

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

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

LOCATION: Necedah National Wildlife Refuge, Wisconsin

PROJECT CHIEF: Randy Hunt

PERIOD OF PROJECT: February to September 1998
PROBLEM: Much public attention has been focused in the last several years on the problem of insuring an adequate and inexpensive supply of water to southeastern Wisconsin in the next century. The southeastern Wisconsin communities of Waukesha, Brookfield, Germantown, Menominee Falls and Pewaukee are prohibited by the Great Lakes Charter from drawing water from Lake Michigan. Water utilities in these areas are concerned that rapidly falling ground-water levels in the sandstone aquifer indicate that water supply will not be able to keep pace with development.

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

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

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

PLANS (July 1998 to June 1999): Historic water-use budget will be completed. The Boonstra model will be fully integrated in the RASA model.
PROBLEM: Efficient and cost-effective approaches for the management and distribution of data products and development of application programs related to mission objectives for the Water Resources Division of the U.S. Geological Survey (USGS) need to be developed and deployed. As part of this mission, the USGS has been maintaining a Master Water Data Index (MWDI). The MWDI is a nationwide index of more than 450,000 sites which collect surface water, ground water, and limited meteorological data. It can be used to determine the availability and location of such information in the data archiving systems of the participating groups. At present, there is no access to this index on the Web, which reduces its availability and usefulness.

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

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

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

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

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

WI171 Application of habitat-suitability index models to assess effects of fine-grained sediment on brook trout and brown trout habitat

WI17217 Evaluation of total phosphorus load determination methods applied to three major tributaries to Lake Mendota, Dane County, Wisconsin, 1994-95

WI18700 Sources of phosphorus in stormwater from two urban residential basins in Madison, Wisconsin, 1994-95

WI 18901 Simulation of the effects of operating Lakes Mendota, Monona, and Waubesa as multi-purpose reservoirs to maintain low flow

WI191 Distribution and transport of polychlorinated biphenyls in Milwaukee River, Wisconsin

WI195 Late Cenozoic landscape evolution of Ft. McCoy, Monroe County, Wisconsin

WI195 Late Cenozoic landscape evolution of a Joliet Training Facility, Illinois
WISCONSIN DISTRICT PUBLICATIONS

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

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

WATER-SUPPLY PAPERS


**HYDROLOGIC INVESTIGATIONS ATLASES**


**PROFESSIONAL PAPERS**


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Water Resources Investigations in Wisconsin, 1998
Conlon, T.D., 1996, Hydrogeology of the sand and gravel aquifer in the

WATER-RESOURCES INVESTIGATIONS REPORTS


OPEN-FILE REPORTS


OPEN-FILE MAPS


ADMINISTRATIVE REPORTS


FACT SHEETS


WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY INFORMATION CIRCULARS


Gonthier, J.B., 1975, Ground-water resources of Waukesha County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 29, 47 p.


OTHER PUBLICATIONS


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