Water-Resources Investigations in Wisconsin, 2004

Open-File Report 2004–1403

U.S. Department of the Interior
U.S. Geological Survey

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Compiled by Jennifer L. Bruce, Michelle M. Greenwood, and Susan Z. Jones

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U.S. Department of the Interior
Gale A. Norton, Secretary

U.S. Geological Survey
Charles G. Groat, Director

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Basic Mission and Projects

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:

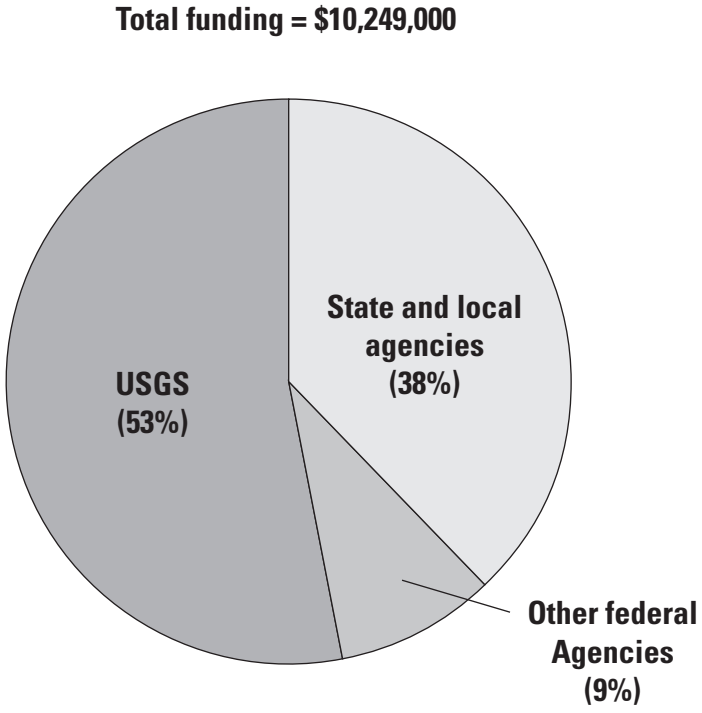
- Conducting detailed assessments of the energy and mineral potential of land and offshore areas.
- Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.
- Conducting research on the geologic structure of land and offshore areas.
- 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.
- Manage water, biological, energy, and mineral resources.

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 Discipline

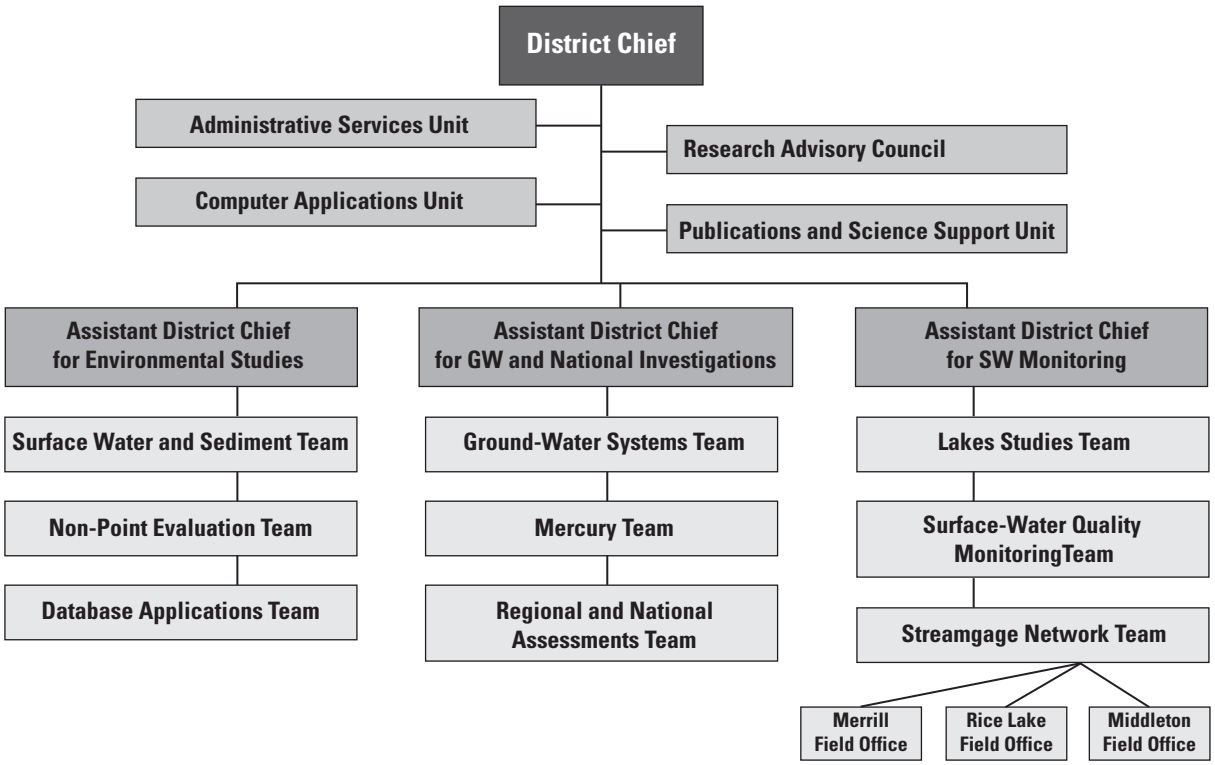
The mission of the Water Resources Discipline (WRD) is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States. This mission is accomplished, in large part, through 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.



Funding sources for the water-resources program in Wisconsin for the 2004 fiscal year.

Wisconsin District Organizational Chart



Organization chart of the U.S. Geological Survey, Water Resources Discipline, Wisconsin District.

Location of offices in Wisconsin District.

Cooperators

State agencies

Illinois Department of Natural Resources
University of Wisconsin–Madison
University of California–Davis
Wisconsin Department of Agriculture, Trade, and Consumer Protection
Wisconsin Department of Transportation
Wisconsin Department of Natural Resources
Wisconsin Geological and Natural History Survey
Wisconsin State Historical Society

Local agencies

City of Barron
City of Beaver Dam
City of Fond du Lac
City of Hillsboro
City of Madison
City of Middleton
City of Milwaukee
City of Peshtigo
City of Sparta
City of Thorp
City of Waupun
County of Bayfield
County of Milwaukee
Dane County Land Conservation Department
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
Kickapoo Valley Reserve
Madison Metropolitan Sewerage District
Milwaukee Metro Sewerage District
Rock County Public Works Department
Southeastern Wisconsin Regional Planning Commission
Village of Cross Plains
Village of Wittenberg
Walworth County Metropolitan Sewerage District

Other federal agencies

U.S. Army Corps of Engineers
  Detroit District
  Jacksonville, FL
  Rock Island District
  St. Paul District
  Vicksburg, MS
Federal Energy Regulatory Commission Licensees
  Black River Falls Municipal Utilities
  Stora Enso, Niagara Mill
  Dairyland Power Cooperative
  Northern States Power Company
  Northwoods Hydropower
  Wisconsin Electric Power Company
  Wisconsin Public Service Corporation
  Wisconsin Valley Improvement Company
National Park Service
  U.S. Department of Justice
  U.S. Environmental Protection Agency

Indian tribes

Bad River Band of Lake Superior Chippewa
Lac Courte Oreilles Tribe
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
Sokaogon Chippewa Indians of Wisconsin
Ho-Chunk Nation of Wisconsin

Lake districts

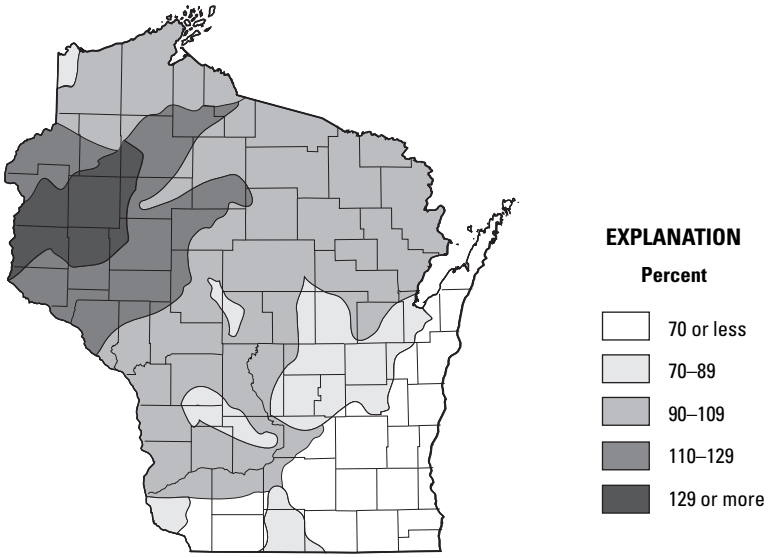
Big Cedar Lake Protection and Rehabilitation District
City of Delafield
City of Muskego
Delavan Lake Sanitary District
Green Lake Sanitary District
Jackson County
Lauderdale Lakes Lake Management District
Little Cedar Lake Protection and Rehabilitation District
Little St. Germain Protection and Rehabilitation District
Middle Genesee Lake District
Okauchee Lake District
Powers Lake District
Price County Land Conservation
Spooner Lake District
Town of Minoqua
Town of Rice Lake
Town of Springfield
Village of Oconomowoc Lake
Waterford Waterway Management District
Wind Lake Management District

Summary of Hydrologic Conditions

Precipitation

The statewide average precipitation for the 2003 water year was 27.42 inches, which was 5.22 inches less than the normal annual precipitation of 32.64 inches for water years 1971–2000. Average precipitation values affecting streamflow conditions ranged from 67 percent in southeast Wisconsin to 99 percent in northeast Wisconsin with a statewide average of 84 percent (summary tables provided by Ed Hopkins, State Climatology Office, University of Wisconsin, Madison, written commun., 2004).

The year started out with above normal precipitation for the state in October, especially the northern and central parts of the state. The only exception to this was the southeast region of the state, which had close to normal precipitation at 97 percent of the normal 1970–2000 October precipitation. The statewide October average precipitation was 159 percent of normal October precipitation. For the next 3 months all regions of the state were very dry. Statewide precipitation in November was only 18 percent of normal; December was 44 percent of normal and January was 31 percent of normal. In February, the statewide average precipitation was still only 66 percent of normal, but the north central (100 percent) and northeast (111 percent) regions were near normal while the south central (28 percent) and southeast (27 percent) were very dry. The remaining regions of the state were also quite dry, ranging from 44 percent of normal in the southwest region to 77 percent in the west central region. In March, the northern and central regions of the state had close to normal precipitation while the southern regions remained dry (71 percent of normal). In April, the southern regions of the state were again drier than normal (55 percent), the central regions were moderately drier than normal (85 percent) and the northern regions were slightly wetter than normal (135 percent), especially the north central region with precipitation 157 percent of normal. In May, the statewide average precipitation was 142 percent of normal. The southern part of the state finally got some relief with precipitation 159 percent of normal, the northern regions of the state had 131 percent of normal and the central regions of the state received 139 percent of the normal precipitation. In June, all regions of the state had below normal precipitation except for the northwest, which was near normal at 103 percent. The southern part of the state was again the driest part of the state at 66 percent of normal; the central part of the state had 85 percent and the northern part of the state had 89 percent



2003 runoff as percentage of long-term average runoff.

of normal precipitation. In July, the statewide average precipitation was 83 percent of normal with all regions falling below normal except for the east central region, which had 127 percent of normal precipitation. August statewide precipitation was 48 percent of normal with all regions falling below normal. In September, the statewide precipitation was 85 percent of normal with all regions falling below normal except the northeast which had 120 percent of normal precipitation. The southeast region (57 percent), the west central region (66 percent) and the north central regions (71 percent) were considerably below normal. To summarize the 2003 water year precipitation on a statewide basis, it was a near normal fall and spring with a very dry winter and a dry summer.

Runoff for rivers in the state ranged from 22 percent of the average annual runoff (1985–2003) at the Beaver Dam River station in the east-central part of the state to 167 percent of the average annual runoff (1914–1920 and 1986–2003) at the Apple River station near Somerset in the northwest part of the state. Water year 2003 was a dry year—it will be remembered more for low-flows than flooding. In mid-August, Governor Doyle declared a statewide emergency for farmers due to the dry conditions. Runoff in the 2003 water year for stations with drainage areas greater than 150 square miles and at least 20 years of record is shown in figure 1.

Water Quality

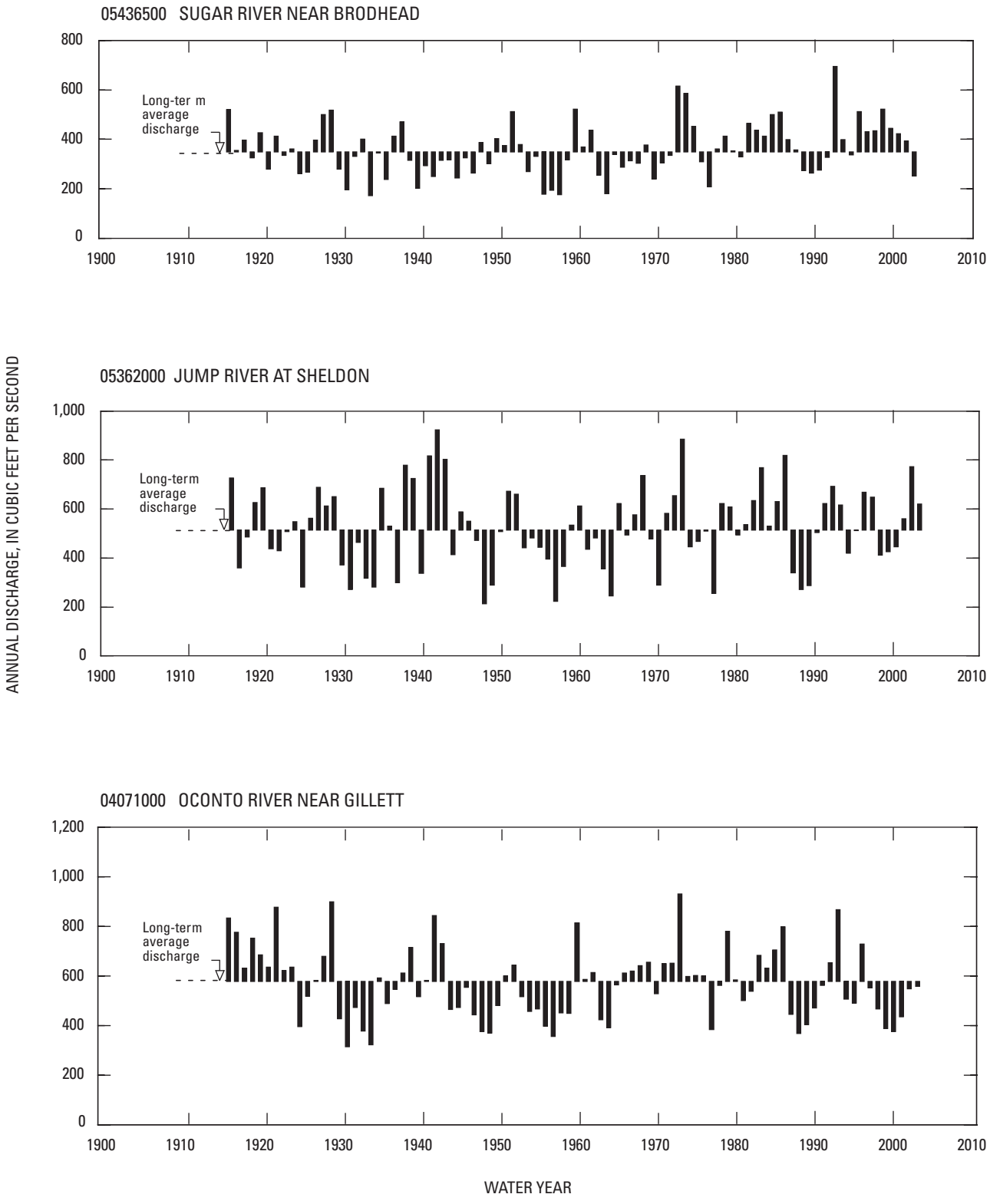
Suspended-sediment yields from four watersheds in southern Wisconsin in water year 2003 ranged from 12 to 53 percent of normal, as indicated by loads measured at relatively long-term monitoring sites on these watersheds. Sediment yields at Grant River in southwestern Wisconsin were only 12 percent of normal. The low yields at Grant River likely were caused by the absence of large storm-runoff events and generally less than normal runoff, as annual discharge was 71 percent of normal. Yahara River at Windsor in south-central Wisconsin experienced a 23 percent of normal sediment yield, and corresponding annual discharge, which was 64 percent of normal. Sediment yield at Jackson Creek Tributary near Elkhorn in southeastern Wisconsin was 35 percent of normal and discharge was 45 percent of normal. At Green Lake Inlet (Silver Creek) near Green Lake, sediment yield was 53 percent of normal, whereas discharge was only 52 percent of normal.

Phosphorus yields in water year 2003 from three watersheds in southern Wisconsin on which there are long-term monitoring sites were below normal. Yields at these sites ranged from 28 to 46 percent of normal. The phosphorus yield for Yahara River at Windsor was 33 percent of normal, the yield for Jackson Creek Tributary was 28 percent of normal, and the yield for Green Lake Inlet was 46 percent of normal.

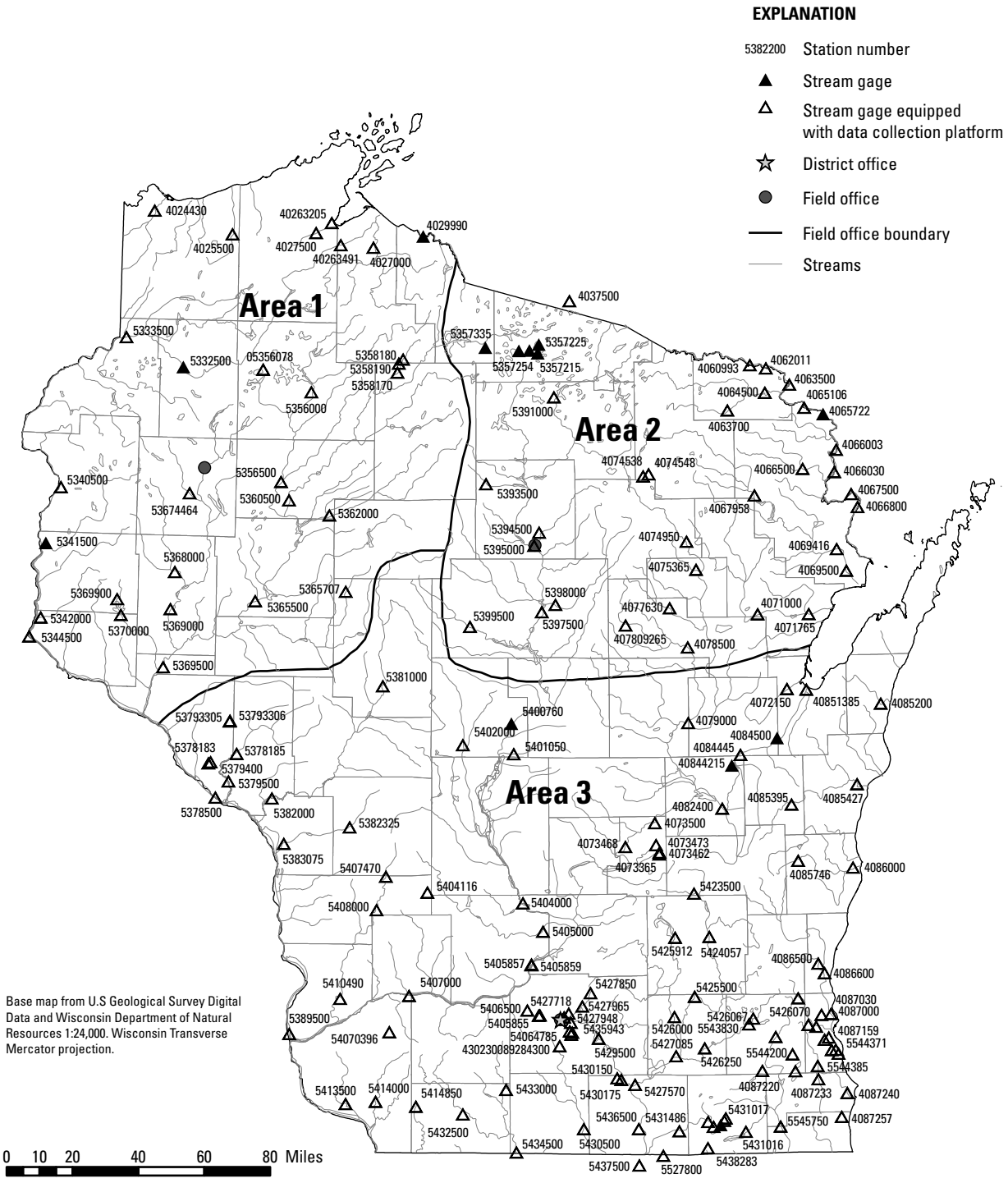
Ground-Water Levels

In general, shallow ground-water levels during the 2003 water year were normal to above normal for most of the wells in the State. Wells in Door, Jackson, and Marquette Counties had below normal ground-water levels at the beginning of the water year, and these 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 2003 water year and normal rainfall during the previous water year.

More detailed information about the summary of hydrologic conditions in water year 2003 can be found in “Water Resources Data—Wisconsin, Water Year 2003.”



Comparison of annual discharge at representative gaging stations to their long-term average discharge for water years 1916–2003.



Surface-water gaging stations operated in 2004 fiscal year.

Surface-Water and Sediment Studies Team

OFFICE OF THE ASSISTANT DISTRICT CHIEF FOR ENVIRONMENTAL STUDIES

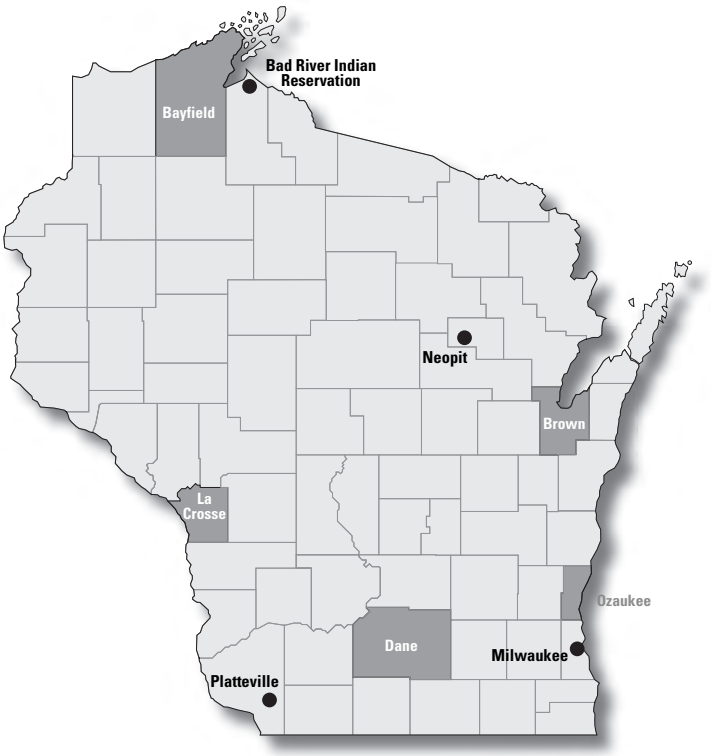
MISSION

The Surface-Water and Sediment Studies Team encompasses a variety of projects that involve monitoring or modeling of the quantity and/or quality of surface-water runoff. The products of these efforts provide critical information to local, state, national, and international managers necessary for making decisions regarding laws and regulations, urban development planning, and remediation activities. The team objectives are to: (1) efficiently manage projects from the conception and proposal stage on through management and operation, resulting in informative products, and (2) maintain a sufficient amount of funding and challenging work for the entire team. Through these objectives, it is our intent to continuously evolve with and develop new data-collection and analysis techniques, be proficient and respected modelers, plan for future projects, enhance the skills and growth of individual team members, and maintain a positive relationship with our cooperators.

TEAM MEMBERS

Peter E. Hughes, Assistant District Chief (Team Leader, Engineering)
Faith A. Fitzpatrick, Research Hydrologist (Geology)
John F. Walker, Research Hydrologist (Engineering)
Jeffrey J. Steuer, Hydrologist (Engineering)
David J. Gracyzk, Hydrologist (Forestry)
Steven A Westenbroek, Hydrologist (Engineering)
Gerald L. Goddard, Hydrologic Technician
Halward L. Hanson, Hydrologic Technician
David E. Housner, Hydrologic Technician
Judy A. Horwatich, Hydraulic Engineer
Timothy L. Hanson, Hydrologic Technician
Marie A. Peppler, Student Trainee (Geography)
Daniel S. Alessi, Hydrologic Technician (Student)

PROJECTS



STATEWIDE PROJECTS

00401 Collection of Basic Records–Sediment

9KO27 Regional Flood-Frequency Study for Urban and Rural Streams in Wisconsin

PROJECTS OUTSIDE OF WISCONSIN

Allegan County, Michigan

9KO24 Kalamazoo River Geomorphology Study

Duluth, Minnesota

AYL00 Geomorphic Assessment of Duluth Streams

LOCATION-SPECIFIC PROJECTS

TRIBAL

Bad River Indian Reservation

9KO32 Bad River Geomorphology/Streamflow Trends

COUNTY

Bayfield

9KO31 Geomorphic Assessment of Bayfield Streams

9KO33 Demonstration of Submerged Vanes, Fish Creek

Brown

9KO34 Fox River Shear Velocity

Dane

9KO13 Dane County Surface Water Model

9KO37 Yahara River Watershed Model Scoping Proposal

La Crosse

9KO35 Project Collaboration with the Biological Resources Discipline at La Crosse

MUNICIPAL

Milwaukee

9KO15 Lincoln Creek PCBs

Neopit, Menominee Indian Reservation

9K039 Neopit Mill Pond Sedimentation and Sediment Chemistry Study

Platteville

9KO38 Pioneer Farms Bank Erosion Study

Geomorphic Assessment of Duluth Streams

Cooperators: USGS–Minnesota, City of Duluth, and The Nature Conservancy

Project Chief: Faith A. Fitzpatrick

Location: Duluth, Minnesota

Project Number: AYL00

Period of Project: June 30, 2003–December 31, 2004

PROBLEM

The City of Duluth (City) and The Nature Conservancy (TNC) are concerned about changes to the geomorphic condition of streams in the Duluth, Minnesota area. Understanding the geomorphic processes within a stream network is important because they relate to the overall water and aquatic resource quality of the stream and to the plant and animal communities and habitat adjacent to the stream. The important geomorphic processes (including hydrologic characteristics and sediment loading, transport, and delivery) affecting the physical characteristics of Duluth streams are not well documented.

OBJECTIVES

The major goals of the study are to: (1) describe geomorphic conditions for Duluth-area streams, (2) identify major geomorphic processes and factors contributing to current conditions, (3) characterize historical changes in channel morphology and planform, and (4) classify streams based on geomorphic processes and sensitivity to geomorphic change.

APPROACH

A literature search was conducted and watershed characteristics (geology, land use/land cover, and soil characteristics, and population) were determined through a GIS. Longitudinal profiles of the streams were compiled. Air photos were gathered by TNC and USGS from 1839–1940, 1950–70, 1991, 2001, and 2002 and historical changes in channel morphology and planform were determined.

Streams were partitioned into segments based on channel slope and valley confinement. The segments formed the initial basis for assessing and documenting historical and current channel and riparian conditions as well as evaluating potential future changes in form and function.

Field surveys of 48 stream reaches were conducted to assess key stream channel and riparian characteristics that were useful for interpreting geomorphic condition and response potential. Sites surveyed included a range of segment types, of channel types representative of distinct geology/landforms, disturbed/developed and undisturbed conditions, those likely to be highly responsive to changes in upstream inputs (for example, prone to sediment deposition, scour or bank erosion). Data at 40 sites include photos and qualitative and semi-quantitative information on segment and channel types, geomorphic condition, riparian conditions (geology, land cover, wetlands, lakes), local variations in geologic setting, human modifications, potential sources for sediment, indications of bank erosion, entrenchment, sedimentation, lateral migration, and head-cutting. At 8 of the 48 sites, very detailed reach surveys were conducted and include quantitative data on channel morphology, water-surface and thalweg slope, bankfull stage, substrate characterization, floodplain sedimentation rates, large woody debris, and pools. Data from channel cross-section surveys will be used to determine channel adjustments (aggradation, degradation, or lateral migration), and movement of streambed or bank material. Permanent markers for one or both endpoints of the cross sections were established. Bankfull stage was determined through field indicators. Abandoned channels were cored for determining historical changes in bed elevation.

Faith Fitzpatrick, August 21, 2003

Bank erosion and channel widening on Lester River, a tributary to Lake Superior in Duluth, Minnesota. Kathy Lee (USGS, Minnesota) is in the photo for scale.

Based on the above information, a watershed-specific classification system will be developed for Duluth-area streams. Stream segments will be grouped into types (referred to as geomorphic map units or GMUs) that share similar geomorphic processes and historical sensitivity to changes in sediment load, particle size, woody debris, floods, riparian vegetation, and catastrophic disturbance). Using the information and insights summarized above, the potential pathways will be identified for which each GMU is likely to adjust (that is, sensitivity) in response to changes in key channel-forming processes. A USGS Scientific Investigations Report will be written with results from the study.

PROGRESS (JULY 2003–JUNE 2004)

During the first year a literature review was conducted, drainage basin boundaries were delineated, available GIS data for basin/landscape characteristics were collected, and longitudinal profiles for the streams based on 7.5-minute topographic maps were constructed. The Nature Conservancy delineated the streams into segments based on six categories of slope and three categories of valley confinement. Field-based reach surveys were conducted. Historical aerial photos were compiled and analyzed for channel changes.

PLANS (JULY 2004–JUNE 2005)

The classification scheme for Duluth-area streams will be finalized. The final report will be written.

Collection of Basic Records–Sediment

Cooperator: U.S. Army Corps of Engineers

Project Chief: William J. Rose

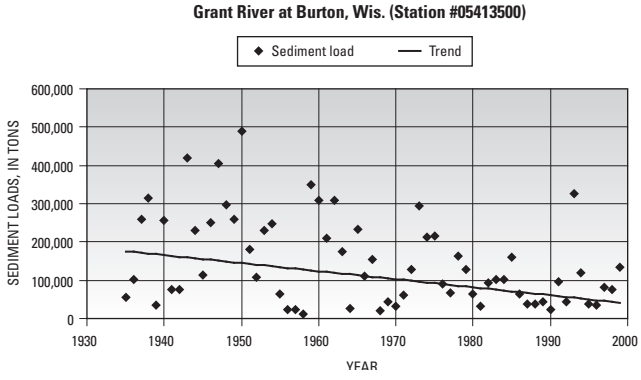
Location: Statewide

Project Number: WI 00401

Period of Project: March 1968–Continuing

PROBLEM

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



OBJECTIVE

This project will provide sediment data for use in specific planning and action programs and will develop a database 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; automatic samplers will sample other sites, where flow responds rapidly to precipitation.

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 2003–JUNE 2004)

Sediment data have been collected at more than 200 stream sites in Wisconsin since 1968. All data have been published annually in the data report, "Water Resources Data–Wisconsin." The 2004 program consisted of monitoring to determine daily-suspended sediment loads for Grant River at Burton. Suspended-sediment monitoring at this site has been continuous since 1978.

PLANS (JULY 2004–JUNE 2005)

U.S. Army Corps of Engineers—Operation of the Grant River monitoring station will continue.

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

REPORTS

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

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

Dane County Surface-Water Model

Cooperator: Dane County Regional Planning Commission

Project Chief: William R. Krug/Peter E. Hughes

Location: Dane County

Project Number: 9KO13

Period of Project: April 2001–September 2004

PROBLEM

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

OBJECTIVE

Evaluate alternative operation plans for the lake system (Lakes Mendota, Monona, and Waubesa), in order to control flooding on the lake system, while sustaining downstream flows and provide adequate lake levels for recreation.

APPROACH

The model used in preparing the report, "Simulation of the Effects of Operating Lakes Mendota, Monona, and Waubesa, South-Central Wisconsin, as Multipurpose Reservoirs to Maintain Dry-Weather Flow" by William Krug (1999), will be modified to reflect current conditions.

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

The model will be used to evaluate the effects of three possible operational alternatives for the period 1979–2001 when the current operational rules were in effect.

PROGRESS (JULY 2003–JUNE 2004)

The simulation of the three operational alternatives is complete and a draft report has been completed. The three alternatives were: (1) an extreme simulation essentially keeping lake levels as low as possible at all times, (2) a high-stage reduction simulation with early summer target levels closer to the middle of the regulatory lake level range, and (3) the low-flow simulation from the previous study. Alternative 1 intended to keep the lake levels as low as possible still had a significant number of days when water levels were above the maximum allowable stage. This clearly demonstrates that the limitations of the outflow channel make it impossible to keep lake levels below the maximum regulatory limits during a wet year.

PLANS (JULY 2004–SEPTEMBER 2004)

The final report will be reviewed and published.

Lincoln Creek PCBs

Cooperator: Wisconsin Department of Natural Resources

Project Chief: Peter E. Hughes

Location: City of Milwaukee

Project Number: 9KO15

Period of Project: June 2001–June 2003

PROBLEM

The Wisconsin Department of Natural Resources is evaluating alternatives for removing PCB-contaminated sediments from the Estabrook Impoundment on the Milwaukee River. Lincoln Creek empties into this impoundment and it is important to identify if there are continuing sources of PCBs coming from Lincoln Creek drainages.

OBJECTIVE

The primary objective of this study is to collect water-column samples during runoff events to quantify the PCB load being transported in Lincoln Creek.

APPROACH

The USGS will establish a gaging station on Lincoln Creek at 27th Street and install equipment to automatically collect water samples during runoff events. A total of 19 event composite samples will be collected and processed for analysis by the Wisconsin State Laboratory of Hygiene for particulate and dissolved PCBs. A total of 110 discrete suspended solids samples will also be analyzed. Streamflow will be continuously monitored and used to compute the PCB and suspended solids loads transported during runoff events.

PROGRESS (JULY 2003–JUNE 2004)

Sample collection was completed and laboratory data has been received. Preparation of a data summary is in progress.

PLANS (JULY 2004–JUNE 2005)

A data report will be prepared which will summarize the PCB and suspended solids concentrations for the monitored events.

REPORTS

Data report is pending.

Kalamazoo River Geomorphology Study

Cooperators: Michigan Department of Environmental Quality; U.S. Environmental Protection Agency, Region V

Project Chief: Faith A. Fitzpatrick

Location: Allegan County, Michigan

Project Number: 9KO24

Period of Project: October 2001–March 2004

PROBLEM

The Kalamazoo River has been designated as a Federal Superfund Site from the city of Kalamazoo to its mouth at Lake Michigan. Fluvial deposits from a variety of environments related to the Kalamazoo River contain elevated concentrations of polychlorinated biphenyls (PCBs) from paper mill carbonless copy paper production. There are four dams on the Kalamazoo River between Plainwell and Allegan. Pool levels behind the dams were lowered in the late 1960s and again in 1987, exposing previously inundated sediment with elevated PCB concentrations. PCB-laden sediment continues to be transported and deposited downstream of each dam as a new channel is cut through the previously impounded sediments. Bank erosion occurs in the sediment, which has elevated PCB concentrations. The effects from lowering of pool levels and possible dam removal on erosion and sediment transport needs to be determined.

OBJECTIVES

The primary objectives of the study were to: (1) determine historical geomorphic changes in the Kalamazoo River in a reach with two dams and PCB contamination from Plainwell to Otsego City, Michigan, (2) measure bank stability in the same reach, and (3) determine channel and bank stability in the same reach under possible scenarios of (a) current conditions with dams in place (b) catastrophic failure of the dams, (c) controlled removal of the dams combined with construction of a stable channel.

APPROACH

The approach for this study involved field data collection and modeling by the USGS offices in Michigan and Wisconsin, as well as the U.S. Department of Agriculture, Agricultural Research Service, Oxford Mississippi. The approach included: (1) conducting a literature review and describing the general watershed characteristics; (2) reviewing historical geomorphic data for the Kalamazoo River and determine if data are detailed enough to reconstruct pre-dam channel shape, substrate, and bed elevation; (3) quantifying the longitudinal profile of the Kalamazoo River from headwaters to its mouth (a) without dams, (b) with dams in full operation, and (c) with dam sills removed and identifying reaches with slope changes and investigate possible causes for changes (anthropogenic/dams versus geologic setting, historical relations with pre-glacial drainage); (4) determining channel planform/location for the Kalamazoo River from Kalamazoo/Calhoun County line to its mouth for the years 1827, 1938, 1960, and 2000; (5) evaluating digital representation of previously inundated surfaces for the Plainwell to Allegan reach of the Kalamazoo; (6) modeling bank stability under current conditions for the Plainwell to Trowbridge Dam reach; (7) conducting evaluation of channel stability under three scenarios for the Plainwell and possibly the Otsego City dam reach; and (8) writing a USGS Scientific Investigations Report.

PROGRESS (JULY 2003–JUNE 2004)

The USGS colleague review of the report was completed.

PLANS (JULY 2004–JUNE 2005)

The editorial review of the report will be completed and the report will be published through the USGS Michigan District.

Regional Flood-Frequency Study for Urban and Rural Streams in Wisconsin

Cooperators: City of Fond du Lac; Wisconsin Department of Transportation

Project Chief: John F. Walker

Location: Statewide

Project Number: 9KO27

Period of Project: July 1985–Continuing

PROBLEM

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

OBJECTIVE

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

APPROACH

A network of approximately 90 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 2003–JUNE 2004)

Annual flood peaks were computed and published in the annual data report for 85 crest-stage stations, including 19 of the new stations. Work began on a Fact Sheet related to bridge scour and an analysis of regression residuals and trends in the flood-peak records.

PLANS (JULY 2004–JUNE 2005)

The crest-stage-gage network will be monitored throughout the year. More new gages will have ratings developed for them as measurements and surveys are available. Significant effort will be made to improve ratings at all the gages. Drainage-basin characteristics will be determined for the 312 stations in the stream-gaging network. A Fact Sheet related to bridge scour will be completed. Results of the residual and trend analyses will be transmitted to the cooperator.

REPORTS

Walker, J.F., and Krug, W.R., 2003, Flood-frequency characteristics of Wisconsin streams: U.S. Geological Survey Water-Resources Investigations Report 03–4250, 37 p. 2 pls.

Krug, W.R., 1996, Simulation of temporal changes in rainfall-runoff characteristics, Coon Creek Basin, Wisconsin: Journal of the American Water Resources Association, v. 32, no. 4, p. 745–752.

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

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

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

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

Bayfield Tributaries Geomorphic Assessment for Restoration

Cooperator: Wisconsin Department of Natural Resources

Project Chief: Faith A. Fitzpatrick

Location: Bayfield County

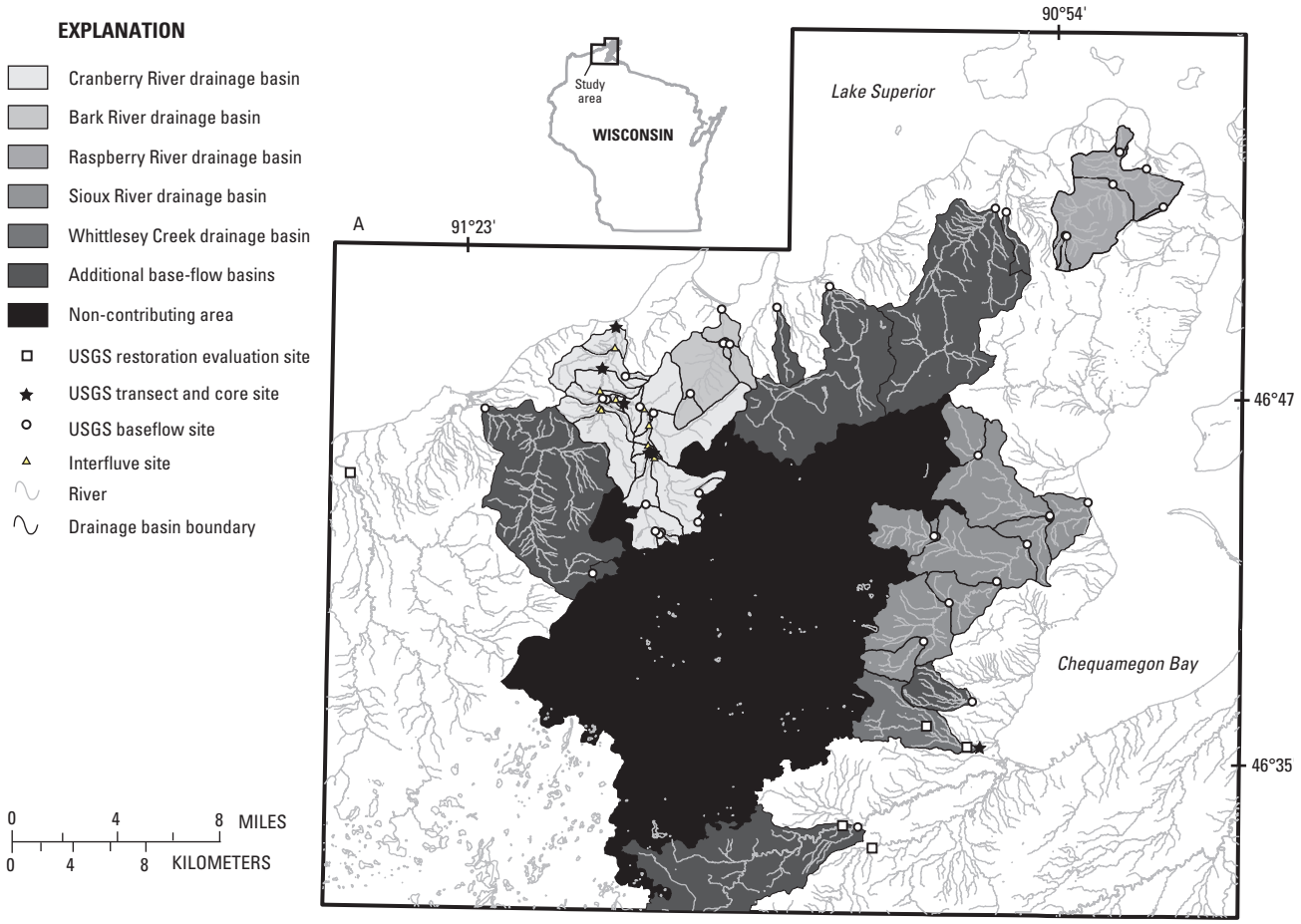
Project Number: 9KO31

Period of Project: October 2002–September 2004

PROBLEM

Tributaries to Lake Superior in Bayfield County, Wis., have accelerated erosion and sedimentation rates influenced by present and historical watershed land cover. Geomorphic conditions in the streams have been altered by changes in flood and sediment load characteristics. Flood magnitudes are elevated above those experienced prior to European settlement in the 1870s. These alterations are thought to be detrimentally affecting habitat for native brook trout populations. Accelerated sediment loads also may be impacting coastal wetlands along Lake Superior.

The USGS is working with Trout Unlimited, several government agencies, a conservation organization, and a private consulting firm to assess the geomorphic character of five tributaries to



Lake Superior in Bayfield Counties (Whittlesey Creek, Sioux River, Raspberry River, Bark River, and Cranberry River). The study involves identifying potential problem areas and assessing rehabilitation alternatives and watershed management strategies that relate specifically to rehabilitation of brook trout populations. Agencies involved in this study are the Wisconsin Department of Natural Resources (Great Lakes Protection Fund), U.S. Fish and Wildlife Service, Red Cliff Tribe, Bayfield County Land Conservation Department, Sigurd Olson Institute (Northland College), Inter-Fluve, Inc., and the U.S. Geological Survey.

OBJECTIVE

The main objectives of this study are to: (1) identify present and historical geomorphic and hydrologic conditions and causes for instability in the five example tributaries, (2) collect detailed data needed to quantify geomorphic and hydrologic background conditions needed for specific rehabilitation activities, and (3) suggest alternatives for rehabilitation.

APPROACH

The approach for the USGS component of the study was to provide Inter-Fluve and local government agencies with background geomorphic information that could be used to make sound management decisions. For all watersheds, drainage boundaries were constructed and watershed/landscape-scale land cover, soils, and geologic setting data were compiled. Longitudinal profiles were constructed. Video footage from helicopter surveys was analyzed for erosion and sedimentation hot spots. Reaches with past bank stabilization projects were evaluated. A ground-water model was completed for the Bayfield Peninsula. A rainfall/runoff model was completed for the Cranberry River. Valley cross sections, coring, and estimated sedimentation rates were established for reaches of the Cranberry River. A core also was collected near the mouth of Whittlesey Creek.

PROGRESS (JULY 2003–JUNE 2004)

Field data collection and analysis were completed. A draft USGS Scientific Investigations Report was written.

PLANS (JULY 2004–JUNE 2005)

The Scientific Investigations Report will be reviewed and printed.

REPORTS

Report to be published in 2005.

Bad River Geomorphology/ Streamflow Trends

Cooperator: Bad River Tribe

Project Chief: Faith A. Fitzpatrick

Location: Bad River Reservation; Ashland County

Project Number: 9KO32

Period of Project: May 2001–December 2004

PROBLEM

A historical perspective of changes in the geomorphic and hydrologic conditions of the Bad River watershed is needed. Previous sediment load studies conducted by the USGS identified the Bad River as having the highest sediment load of all tributaries to Lake Superior. A large, highly valued coastal wetland complex exists at the mouth of the river and is threatened by excessive sediment. It is not known how accelerated erosion and deposition affect the main stem of the Bad River through the Bad River Indian Reservation and through the wetland at the mouth of the Bad River.

OBJECTIVE

The main objectives of this study are to understand the historical and modern impacts of land cover on streamflow, sedimentation and erosion rates, and geomorphic conditions in the Bad River and some of its key tributaries.

APPROACH

The approach involved two phases of work. The first phase was a reconnaissance study that included: (1) gathering available GIS coverages and defining watershed characteristics of major subbasins of the Bad River, (2) examining the streamflow record at U.S. Geological Survey gaging station for historical variations, (3) conducting field reconnaissance trips to identify hot spots of erosion/sedimentation, and (4) conducting a literature search of any publications or studies done on the Bad River Basin related to streamflow, sedimentation, erosion and historical land uses. The second phase involved establishing valley transects and collecting cores at key locations along the Bad River and Marengo River with erosion and sedimentation problems. These data will be used to establish long-term rates of erosion and sedimentation throughout the watershed.

PROGRESS (JULY 2003–JUNE 2004)

Coring and cross section surveying were conducted. Data analysis and report writing were continued. A poster for the study was presented at the Institute of Lake Superior Geology annual meeting in May 2004 in Duluth, Minnesota. Laboratory analysis of particle size and radiocarbon were performed.

Marie Peppler, August 2004

USGS and Bad River tribe personnel describe sediment cores from abandoned channel along the Bad River.

PLANS (JULY 2004–JUNE 2005)

The first draft of a USGS Scientific Investigations Report (SIR) will be completed. A valley transect on the upper Marengo River will be established in August.

REPORTS

A USGS Scientific Investigations Report will be published in 2005.

Demonstration of Submerged Vanes, Fish Creek

Cooperators: Wisconsin Department of Natural Resources; Bayfield County; U.S. Fish and Wildlife Service, University of Wisconsin-Madison

Project Chief: Faith A. Fitzpatrick

Location: Bayfield County

Project Number: 9KO33

Period of Project: July 2000–September 2003

PROBLEM

North Fish Creek has accelerated erosion and sedimentation problems that have potentially negatively impacted a highly valued fishery resource. Previous USGS studies identified bluff erosion along the upper main stem as the major source of sediment to downstream reaches. Bioremediation techniques for bluff stabilization were attempted but failed. Erosion control techniques are limited because of the remoteness of the site and lack of access.

OBJECTIVES

The main goal of this study is to monitor and assess the ability of an in-stream restoration technique (submerged vanes on the channel bed) to reduce bluff erosion along a flashy, high-energy stream, and ultimately reduce subsequent sedimentation problems in North Fish Creek and potentially Lake Superior. Reducing sediment loads of Lake Superior tributaries is important not only for protecting or restoring aquatic habitat, but also for dredging issues.

APPROACH

Submerged vanes were installed in the channel bed at two eroding bluff sites along the upper main stem of North Fish Creek in the summer of 2000 and 2001. The number, size, and layout of the vanes depend on the channel morphology, velocity, and depth at a meander bend. Typically, about 15 vanes are installed in groups of one to three. Vanes modify the secondary flows that cause erosion along the toe of a bank in a meander bend. Vanes stabilize a channel reach without inducing changes upstream or downstream of that reach. The vanes are not visible in time (they become buried by depositing sediments, yet remain effective), and aid the stream in doing the work by redistributing the flow energy to produce a more uniform cross-section without an appreciable increase in the energy loss through the reach.

Monitoring the success of the study was conducted through surveys of the bluff face, streamflow, and channel conditions before, during, and after installation of the submerged vanes. The bluff and channel are resurveyed after flood events. The bluff surveys were used to compare pre- and post-installation bluff retreat rates. Channel cross-section surveys are conducted at the site and in upstream and downstream locations to quantify changes in the shape and location of the channel. A streamflow-gaging station was reactivated downstream of the site to properly quantify flood magnitudes experienced during the demonstration. Stage recorders will be installed at the bluff sites.

PROGRESS (JULY 2003–JUNE 2004)

A draft of the report with monitoring results was completed and sent out for colleague review. A field reconnaissance trip was conducted with DNR and UW to locate a third site for evaluation. Continue operation of gaging station.

PLANS (JULY 2004–JUNE 2005)

Assist UW-Madison with installation of vanes and complete surveying at the third site. Re-survey sites 1 and 2 and continue the operation of the gaging station. Incorporate review comments and publish the report.

REPORTS

USGS Scientific Investigations Report to be published in 2004.

Fox River Shear Velocity

Cooperator: University of Wisconsin—Milwaukee

Project Chief: Steven M. Westenbroek/Peter E. Hughes

Location: Brown County

Project Number: 9KO34

Period of Project: July 2003–October 2004

PROBLEM

PCB concentrations in the bottom sediment deposits of the Lower Fox River have high concentrations of PCBs. Depending on the hydrodynamic conditions present at these deposits, the choices for remediation can include dredging and removal from the river, capping the sediments in place, or burial by natural sediment transport. The design of a capping system requires information about the stability of the bed sediments and the shear stress produced by high flow in the river. Measurement of velocity at the streambed interface is extremely difficult but recent advancements in the design of acoustic Doppler velocity profilers is making it possible to measure the velocity profile at a fine enough resolution to be able to provide accurate estimates of velocity at this streambed interface.

OBJECTIVE

The objective is to provide data for evaluation of river bed shear stresses arising from low frequency hydrologic events (that is, high flood flows) or seiche-induced currents. To accomplish this objective, this proposal includes the collection of velocity data at multiple cross sections and at different flow conditions in the Lower Fox River. Depending on wind and flow conditions during data acquisition, these data may also provide a basis for evaluation of wave and current action during reversals of flow

into the Lower Fox River from Green Bay and/or during related flow oscillations. These data will provide an additional measure for calibrating models used to predict such bed shear stresses.

APPROACH

Velocity data will be collected at multiple cross sections in Operating Unit 4 (OU-4) during a range of flow conditions in the Lower Fox River. Depending on wind and flow conditions during data acquisition, these data may also provide a basis for evaluation of wave and current action during reversals of flow into the Lower Fox River from Green Bay and/or during related flow oscillations. These data will provide an additional measure for calibrating models used to predict such bed shear stresses. Hydrodynamic data will be measured using an acoustic Doppler velocity profiler (ADCP). A complete discharge measurement will be made at the cross section locations and three vertical profiles will be made along each cross section to determine the bottom shear velocity. Data will be post-processed and provided to Sea Engineering, San Diego, for use in calibrating a hydrodynamic model for OU-4.

PROGRESS (JULY 2003–JUNE 2004)

Velocity measurements were completed for four events on the Lower Fox River. Flows for these measurements were: June 2003 greater than 4,000 cfs, November 2003 greater than 8,000 cfs, March 2004 greater than 10,000 cfs, and May 2004 greater than14,000 cfs. Measurement data have been compiled and forwarded to Sea Engineering for use in calibrating the hydrodynamic model for OU-4.

PLANS (JULY 2004–SEPTEMBER 2004)

A report will be written describing the utilization of ADCP technology for measuring shear velocity in a riverine environment. The hydrodynamic model being calibrated by Sea Engineering will be reviewed.

REPORTS

Pending.

Project Collaboration with the Biological Resources Discipline at La Crosse

Cooperator: Biological Resources Discipline, La Crosse, Wisconsin

Project Chief: Jeffrey J. Steuer

Location: La Crosse County

Project Number: 9KO35

Period of Project: October 2000–September 2005

PROBLEM

The Mississippi River is one of the world's major river systems in size, habitat diversity, and biological productivity. The Biological Resources Discipline (BRD) Environmental Science Center in La Crosse, Wisconsin, provides scientific understanding, information, and technologies needed to support sound management of biological resources on the Upper Mississippi River. There is a need to bring the BRD expertise into the Wisconsin District (WRD) projects and in return provide hydrologic expertise and experience into the BRD investigations. This project will increase collaboration between the two disciplines.

OBJECTIVE

The purpose of the project is to enhance BRD and WRD collaboration in investigations such as nitrogen budgets and the resulting biological impacts; urbanization effects on backwater area biota; mercury, PCB, cadmium, and pesticide impacts in zebra mussels; sedimentation patterns and the resulting effects on mussels, paddlefish, and navigation; and hydrologic assistance in assessing trends in the Upper Mississippi River long-term monitoring program.

APPROACH

From October 2000 through September 2001, one WRD hydrologist worked in the La Crosse BRD office on a half-time basis. This physical relocation of the hydrologist established communication and enhanced collaboration for the interdiscipline personnel. The WRD hydrologist continues to work with the mussel landscape team on a quarter-time basis while located in the Middleton Office.

PROGRESS (JULY 2003–JUNE 2004)

Much of the present-day effort provides the mussel landscape team with hydrologic and hydraulic expertise in the effort to understand why endangered mussel species form their beds in specific locations. These hydraulic efforts have included: conducting bottom roughness and shear calculations in selected Mississippi River pools and an accompanying comparison to historical mussel data; assisting with evaluation of an elec-

tronic method (RoxAnn) to inventory mussel beds and bottom substrate; and utilizing acoustic Doppler profiles to determine bottom roughness and shear velocity.

Work on the mussel landscape team has moved in two directions. A retrospective analysis using data from the 1985 Mississippi River pool 10 Prairie du Chien mussel study has been completed. The updated analysis combined calculated hydraulic variables such as bottom shear stress, Froude number, and Reynolds number with classification and regression tree analysis to help predict mussel abundance. A first draft of the paper entitled "Use of complex hydrologic variables to determine the distribution of unionids of a main channel border habitat of the Upper Mississippi River".

During the summer of 2003, divers surveyed mussel abundance in 6 areas of the Mississippi River in the vicinity and south of La Crosse, Wisconsin (pool 8). In conjunction with that effort the USGS WRD office utilized an Acoustic Doppler Profiler (ADCP) to collect water velocity profile data at approximately 180 of the mussel survey sites. These ADCP are being utilized to calculated hydraulic variables such as bottom shear stress, Froude number, Reynold's number and bottom roughness. This information will be used to help explain mussel abundance or lack thereof.

PLANS (JULY 2003–JUNE 2004)

In addition, work will continue to process and analyze the pool 8 ADCP data in conjunction with the mussel specie abundance data with intended submission the Journal of the North American Benthological Society.

The Middleton WRD hydrologist will continue to work on the mussel landscape team on a quarter-time basis.

REPORTS

Pending.

Yahara River Watershed Model Scoping Proposal

Cooperator: Dane County

Project Chief: Steven M. Westenbroek

Location: Dane County

Project Number: 9KO37

Period of Project: June 2004–December 2004

PROBLEM

The Yahara River Watershed in Dane County, Wisconsin is one of the most rapidly urbanizing areas within the state and the water-resource problems in the watershed are accelerating along with the increasing development. The Yahara River is part of a chain of lakes including Lake Mendota, Lake Monona, Lake Waubesa, and Lake Kegonsa. Dams at the outlets of Lake Mendota, Lake Waubesa, and Lake Kegonsa are operated to maintain stable lake levels, to provide flood protection benefits, and to enhance aquatic resources in the river and associated wetlands. The urban areas—including the cities of Madison, Middleton, Monona, McFarland, and Stoughton and the suburban area in Dane County—are all experiencing dramatic increases in the amount of impervious area, resulting in increasing stormwater runoff to the lakes and decreasing infiltration to the ground-water system. This development is creating a potential for more frequent and more severe flooding during wet periods and is also creating a water demand that results in more frequent and more severe drought conditions during periods of low flow. Increasing amounts of storm runoff also transport higher loads of sediment and nutrients from the impervious areas into the lakes.

In order to address these issues, the existing forecasting model used to manage the Yahara River system (operational model) needs to be updated. Further, there is a need for a long-range watershed model capable of evaluating the impact of future development on the Yahara River system (planning model).

OBJECTIVE

The overall goal for this work is to develop a range of scope, schedule, and budget options associated with updating the current operational model and developing a comprehensive watershed planning model. Associated objectives of this study are to: (1) determine what data exists, and what data needs to be collected, (2) determine the most appropriate approach for updating the operational model, and (3) determine the approach required to develop the planning model.

APPROACH

To meet the objectives stated above, a screening model will be developed using the USGS Modular Modeling System (MMS). The screening model will be subjected to a sensitivity analysis. The results of the screening model sensitivity analysis will yield important information on what types of data are most important to any future model development activities. Such a sensitivity analysis will be useful regardless of what model framework is ultimately selected for the larger watershed modeling effort. The existing real-time operational model will be examined to determine the enhancements required to provide a functional tool for making decisions regarding the day-to-day operation of the dam control structures in the system.

The results of our examination of the existing operational model will be combined with sensitivity analysis results from the screening model. This will yield a set of criteria that can be used to select the type and complexity of a comprehensive watershed model needed to evaluate the surface-water resources of the Yahara River system.

PROGRESS (JULY 2003 TO JUNE 2004)

A scoping-level watershed model for the Yahara River system was completed. Daily precipitation, lake level, and streamflow records were assembled and reviewed for the period 1954–2004. Analysis of the existing datasets suggests that additional streamgaging is needed at the outlets of Six-Mile and Starkweather Creeks.

Sensitivity analysis was performed for over 300 model parameters. The sensitivity analysis underscores that there are numerous sets of parameters that result in approximately the same model calibration statistics. This suggests that future model development efforts must include an exploration and quantification of the effects of non-unique model parameter sets.

PLANS (JULY 2004–DECEMBER 2004)

There are no plans to continue this work. Dane County will be issuing a request for proposals (RFP) for further model development work.

REPORTS

A letter report will be prepared summarizing the screening model results and defining the requirements for the comprehensive watershed model development.

Pioneer Farms Bank Erosion Study

Cooperator: University of Wisconsin–Platteville

Project Chief: Faith A. Fitzpatrick

Location: Platteville, Wisconsin

Project Number: 9KO38

Period of Project: June 2004–September 2006 (ongoing)

PROBLEM

The research component of Pioneer Farm (University of Wisconsin-Platteville) is part of the Wisconsin Agricultural Stewardship Initiative (WASI). WASI is a collaborative, research-oriented effort among farmers, university researchers, agricultural and environmental organizations and governmental agencies. Their mission is the infusing of production agriculture with environmentally compatible and economically sustainable management practices. Pioneer Farm helps address these challenges through on-farm systems research that measures environmental impacts, documents research results and provides science-based information, training, and education related to agriculture and the environment.

The Galena River runs through seven intensive rotational grazing pastures that are part of Pioneer Farm. Traditional styles of riparian grazing that allow cattle free access to streams may accelerate natural processes of erosion in a meandering stream by removal or trampling of vegetation. Fencing off buffer strips along streams has been shown to reduce local bank erosion but has a high cost to farmers because alternative pastures, water sources, and additional fencing are needed. Some studies have shown that bank vegetation can be improved and bank erosion reduced by riparian intensive rotational grazing, although results vary from study to study.

Marie Peppler, August 12, 2004

Cattle cross the stream and cause bank erosion by trodding. In addition, the cattle often use the raw banks for scratching which causes more loss of vegetation.

OBJECTIVE

The goals of this study are to: (1) establish a long-term monitoring program to measure bank erosion, channel morphology and position, and stream substrate along the Galena River through the seven pastures, and (2) determine if there are changes in the amount of bank erosion over time. An additional goal is to evaluate the usefulness of photo-electronic erosion pins (PEEPs) for measuring bank erosion in this type of geomorphic setting. Changes in bank conditions will be put in context with historical and current hydrologic conditions and cattle grazing schedules.

APPROACH

Approximately 30 cross sections will be surveyed with a total station and approximately 150 erosion pins will be placed in the eroding banks in different geomorphic settings. Three photo-electronic erosion pins (PEEPs) will be installed in banks near the two existing gaging stations. Approximately 60 photo points will be established. One time-lapse digital camera will be installed to overlook the stream and the pastures, set to take a photograph every day. The area of exposed, non-vegetated, banks along the reach will be measured. Substrate will be characterized by use of Wolman pebble counts near a subset of cross sections. The cross sections will be resurveyed after major floods.

PROGRESS (JULY 2003–JUNE 2004)

Eroding banks have been described and located, cross sections have been surveyed, and some erosion pins have been installed.

PLANS (JULY 2004–SEPTEMBER 2005)

Finish installation of erosion pins. Install camera and locate photo points. Install PEEPS. Conduct approximately six surveying trips to resurvey each cross section. Recover digital photos and select a subset for use in data summary. Repeat pebble counts and write a USGS fact sheet to summarize results of the study.

REPORTS

A USGS Fact Sheet will be published in 2005.

Neopit Mill Pond Sedimentation and Sediment Chemistry Study

Cooperator: Menominee Indian Tribe of Wisconsin

Project Chief: Faith A. Fitzpatrick

Location: Neopit, Menominee Indian Reservation

Project Number: 9K039

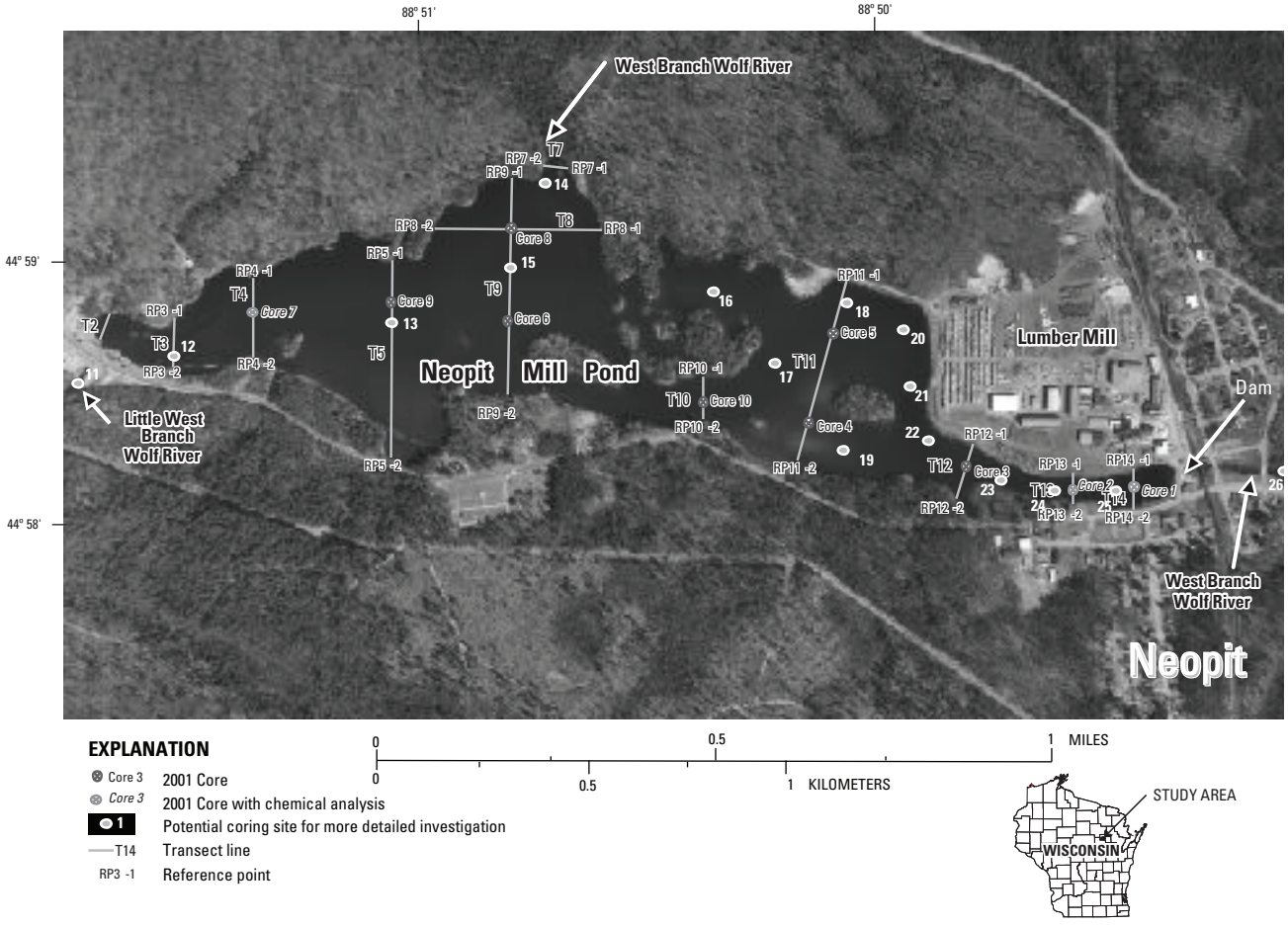
Period of Project: February 2001–September 2005

PROBLEM

A dam at the Neopit Mill Pond, Neopit, Wisconsin, Menominee Reservation, may be removed and the Menominee Indian Tribe needs information on the volume, texture, and chemistry of sediment stored in the mill pond behind the dam. A preliminary study was completed in 2003 and elevated concentrations of semi-volatile organic compounds (SVOCs) were detected in sediment from the mill pond. Additional sampling for SVOCs in the mill pond sediment is needed to determine spatial extent of possible contamination.

OBJECTIVE

The project objective is to determine the spatial distribution of SVOCs in the Neopit mill pond sediment.



APPROACH

Approximately 15 sediment cores will be collected from the Neopit mill pond in the summer of 2004. Samples from the cores will analyzed for SVOCs, dioxin/furans, organic carbon, and particle size. Approximately 10 percent of the samples will be submitted for quality assurance.

PROGRESS (JULY 2003–JUNE 2004)

The project for additional sampling began in October 2004. A QAPP was written. Labs were selected for SVOC and dioxin/furan analyses.

PLANS (JULY 2004–JUNE 2005)

Cores will be collected in August and submitted and for analyses. Data will be analyzed.

Nonpoint Evaluation Monitoring Team

OFFICE OF THE ASSISTANT DISTRICT CHIEF FOR ENVIRONMENTAL STUDIES

MISSION

Evaluation monitoring provides critical information to cooperators to help formulate watershed management plans and evaluate the effectiveness of these plans. This information is also used by cooperators to make informed water resource decisions. The monitoring also provides a unique, comprehensive data set of interest to the nonpoint research community at large. It is our intent to continuously evolve data collection and analysis techniques, plan for future projects, enhance the skills and evolve data collection and analysis techniques, enhance the skills and growth of individual team members, and maintain a positive relationship with cooperators.

TEAM MEMBERS

David J. Graczyk, Hydrologist (Team Leader)
Steve R. Corsi, Research Hydrologist (Chemistry)
David W. Hall, Hydrologist
David W. Owens, Hydraulic Engineer
William R. Selbig, Hydrologist
Todd D. Stuntebeck, Physical Scientist
Judy A. Horwatich, Hydraulic Engineer
Troy D. Rutter, Hydrologic Technician
Mari E. Danz, Hydrologist
Matthew J. Komiskey, Physical Scientist
Eric G. Booth, Student Trainee (Hydrology)
Justin M. Haasch, Hydrologic Technician
Laura E. Wagner, Student Trainee (Hydrology)
Ana R. Considine, Hydrologic Aid (Student)

PROJECTS

STATEWIDE PROJECTS

BQY14 Influences of Riparian Corridors on the In-Stream Habitat, Fish, and Macroinvertebrate Communities for Small Streams in Wisconsin

BQY17 The Effect of Near-Shore Development on Constituent Loading to Lakes in Northern Wisconsin

BQY23 Thresholds of Toxicity in Urban Streams

BQY24 Calibration of the Source Loading and Management Model (SLAMM)

PROJECTS OUTSIDE OF WISCONSIN

Dallas, Texas

9VN00 Monitoring and Evaluation of the Impacts of Aircraft Deicers in Runoff from the Dallas/Fort Worth Airport

LOCATION-SPECIFIC PROJECTS

REGIONAL

Southeast Wisconsin

9KP19 Sources of Cryptosporidium in the Milwaukee River Watershed

Milwaukee and Lake Superior Areas

9KP31 Occurrence and Variability of Pathogens in Wisconsin's Urban Streams

COUNTY

Buffalo

BQY11 Evaluation Monitoring in Wisconsin Priority Watersheds

BQY12 Discovery Farms

Dane

BQY15 Fertilization and Runoff from Urban Lawns

BQY19 Evaluation of Street Sweeping as a Water-Quality Management Tool in Residential Basins in Madison

Iowa

BQY12 Discovery Farms

Kewaunee

BQY12 Discovery Farms

La Crosse

BQY10 Halfway Creek Constructed Wetland Evaluation

Lafayette

BQY12 Discovery Farms

Sauk

BQY16 Hydrology and Water-Quality Impacts of Different Pasture Management Practices in Southwestern Wisconsin

Sheboygan

BQY11 Evaluation Monitoring in Wisconsin Priority Watersheds

MUNICIPAL

Cross Plains

BQY25 Evaluation of the Effectiveness of Low-Impact Development Practices

Green Bay

BQY22 Verification of a Pressurized Stormwater Filtration System at St. Mary's Hospital

Madison

BQY21 Long-Term Water Budget of Two Rain Gardens in Madison

BQY26 Department of Transportation Street Sweeping, Phase II

Milwaukee

BQY18 Verification of Treatment Performance of the Vortechnics and Stormwater Management Filter

BQY20 Monitoring and Evaluation of the Impacts of Aircraft Deicers in Runoff from General Mitchell International Airport

Platteville

BQY13 Quantification of Constituent Loads from Farm Fields at the Pioneer Farms in Wisconsin

Sources of *Cryptosporidium* in the Milwaukee River Watershed

Cooperator: Wisconsin State Laboratory of Hygiene

Project Chief: Steven R. Corsi; Robert J. Waschbusch

Location: Southeast Wisconsin

Project Number: 9KP19

Period of Project: October 1999–April 2002

PROBLEM

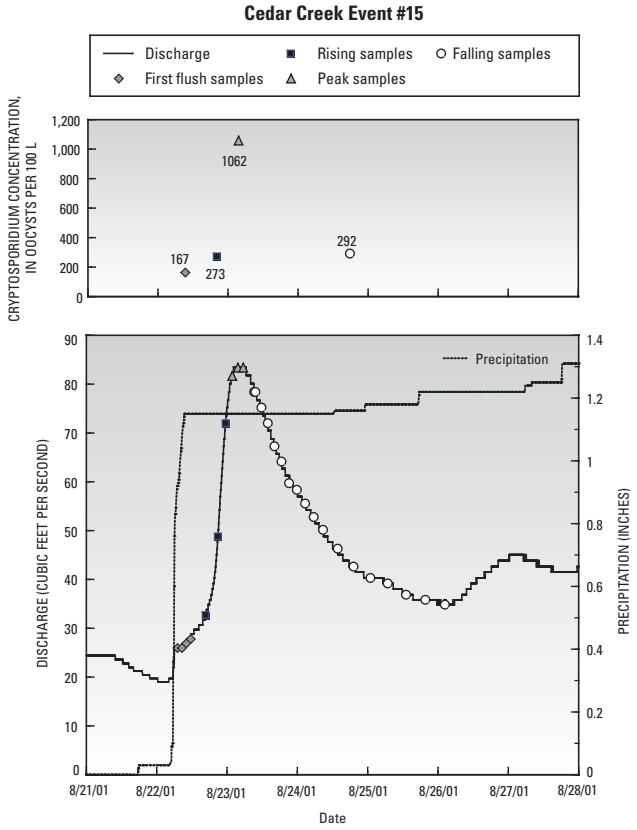
For the past 75 years, the water-supply industry has enjoyed an excellent track record of providing safe, potable water to the public. This success has been possible through an emphasis on continuous improvement in both water-treatment technology and source-water protection. Despite this effort, recent well-publicized waterborne disease outbreaks of cryptosporidiosis involving large numbers of ill people and some deaths have been attributed to possible treatment deficiencies linked with source-water contamination. Recent studies have suggested that the Milwaukee outbreak of 1993 was caused by a "human only" genotype which would point to poorly treated human waste as a possible source of the outbreak. Understanding the occurrence and variability of *Cryptosporidium* in source water is critical to the production of a safe drinking water supply.

OBJECTIVE

The goals of this research study were to define the relative magnitude and contributions of *Cryptosporidium* from major sources defined by land use and wastewater discharges on an annual basis, to characterize contributions of each source by factors such as hydrograph timing, climatic effects, and seasonal variations, and to compare and integrate the resulting data with existing data on *Cryptosporidium*.

APPROACH

Two subwatersheds were selected for monitoring for the entire project duration. One of these basins was primarily agricultural land use and the other was primarily urban land use. In addition, three wastewater treatment plant discharges representing different treatment technologies and/or flow levels and one combined sewer overflow (CSO) were monitored for approximately six months each. Both fixed interval and runoff event samples were collected from all sites. The sample results were used to determine *Cryptosporidium* magnitude and variability. These data were used along with flow data to calculate event and annual loads at the sites. Other data were also collected including precipitation, water temperature, dissolved oxygen, turbidity, conductance and also land-use data in a GIS system. The data and tools resulting from this project enable managers to better understand and deal with the sources of *Cryptosporidium* in their watersheds.



PROGRESS (JULY 2003–JUNE 2004)

The report was published in June of 2003. Some of the significant findings are:

- Samples from the urban stream consistently had higher *Cryptosporidium* concentrations than those from a rural/agricultural stream and publicly owned sewage treatment facility (POTW) effluents.
- Runoff events play a significant role in the introduction of oocysts to a watershed.
- Automated sampling methods were shown to be both practical and reliable for the evaluation of *Cryptosporidium* concentrations in a watershed.
- Statistical models were constructed that can be used to estimate the probability of high *Cryptosporidium* levels from a given combination of conditions and may be useful for maximizing sampling strategies for watershed managers charged with understanding *Cryptosporidium* occurrence in a watershed.

PLANS (JULY 2004–JUNE 2005)

None—this project is completed.

REPORTS

Corsi, S.R., Walker, J.F. , Waschbusch, R.J., and Standridge, J., 2003, Sources and variability of *Cryptosporidium* in the Milwaukee River watershed, Water Environment Research Foundation Report 99–HHE–2, 114 p.

Occurrence and Variability of Pathogens in Wisconsin's Urban Streams

Cooperator: Wisconsin Department of Natural Resources

Project Chiefs: Robert J. Waschbusch; Steven R. Corsi

Location: Milwaukee area and Superior area

Project Number: 9KP31

Period of Project: March 2001–September 2003

PROBLEM

Water-borne pathogens are of great concern to water-quality managers because of the potential impact on human health, aquatic life, and recreational use. Nowhere have pathogens been more in the public eye than Milwaukee, Wisconsin, where a 1993 *Cryptosporidium* outbreak was blamed for the death of over 100 people. In addition, recent Milwaukee beach closures have brought renewed concerns before an anxious public over area-wide sanitary and stormwater management. The origins of pathogenic organisms can be many and difficult to delineate. Obviously, sanitary sewer and combined sewer overflows can be a major source of pathogens originating from human fecal material. In 1999 alone, 120 bypasses were reported by municipalities in Wisconsin (WDNR report) and 87 of these were associated with storm events. They are not confined to just the large metropolitan areas. They occur in cities and villages of all sizes and in all geographic regions of the State. Another important source of pathogens is runoff water from storm sewers and diffuse inputs. Past research has shown microbial densities in stormwater runoff to be similar to those found in diluted raw sewage. The documented presence of pathogenic organisms, such as *Giardia*, *Cryptosporidium*, *Salmonellae*, and *Pseudomonas aeruginosa* in storm sewers with no sanitary sewer connections suggests that diffuse or nonpoint sources of these microorganisms may be an overlooked water-quality issue.

OBJECTIVE

The overall goal of this project is to provide a greater understanding of the occurrence of pathogenic organisms in urban streams. Specific objectives include: (1) determine concentrations of pathogenic indicators and specific pathogens in urban streams of different sizes, land uses, and point source inputs, (2) determine ambient concentrations of total suspended solids, BOD, total phosphorus, and chloride, (3) explore the data in an attempt to develop relations between watershed size, major land use, hydrologic and meteorological conditions, and water-quality parameters identified above, and (4) determine sources and relative contributions of *E. coli* bacteria to urban streams by use of strain identification and typing.

APPROACH

The focus of this study was a synoptic survey of 12 stream sites in the Milwaukee metropolitan area and 2 in the Superior area. Milwaukee sites were selected to spatially cover the watershed draining to the Milwaukee Harbor. All sites were selected to represent a range of water-course size, land use (residential, industrial, open space), and point source input locations (CSO, SSO, and stormwater discharges). Some streams had more than one site to examine downstream longitudinal changes. The sampling goal was to collect 9 samples during periods of high flow, and 4 during base-flow conditions. Sampling was spaced to address seasonal differences, and occurred over a period of 2-1/2 years. Genetic strain identification was used to identify the sources of *E. coli*.

PROGRESS (JULY 2003–JUNE 2004)

The two USGS sites in the Milwaukee River basin were operated from spring 2001 to September 2003. The USGS collected event samples at the sites whenever WDNR indicated, discharge was continuously monitored, and mean daily flows were computed and published for the two sites.

PLANS (JULY 2004–JUNE 2005)

The project is complete from the USGS side unless WDNR requests further assistance or data for the analysis or report preparation.

Monitoring and Evaluation of the Impacts of Aircraft Deicers in Runoff from the Dallas/Fort Worth Airport

Cooperator: Dallas/Fort Worth airport

Project Chief: Steven R. Corsi

Location: Dallas, Texas

Project Number: 9VN00

Period of Project: April 2002–Continuing

PROBLEM

The Dallas/Fort Worth Airport (DFW) is involved in an effort to reduce runoff of deicing chemicals to Big Bear Creek. Ethylene and propylene glycol-based deicers are used during cold weather periods for aircraft deicing and anti-icing activities. Glycol concentrations in stream samples collected during deicing events throughout the winters between 2002 and 2004 ranged from less than detection limits to 20,000 mg/L in DFW outfalls.

OBJECTIVE

The overall goals of the project are to evaluate water quality in Big Bear Creek and tributaries originating inside the DFW airport drainage area, how this water quality is affected by deicer runoff, and to investigate chemicals causing toxicity to aquatic organisms. Specific objectives are as follows: (1) Monitor surface water at five sites in the Big Bear Creek watershed for water quality and flow during dry weather and runoff conditions, (2) determine critical periods and provide relevant data for appropriate deicer management decisions, and (3) conduct investigations to identify additives in deicer and anti-icer formulations that are responsible for toxicity to aquatic organisms in the receiving stream. This monitoring should quantify a suite of water-quality parameters that help define potential effects on dissolved oxygen in receiving waters as well as those additives that are shown to contribute aquatic toxicity.

APPROACH

Flow is measured and samples are collected at one site upstream from airport runoff and four sites downstream. Dissolved oxygen and water temperature are monitored continuously during the deicing season at these five sites and also at three sites within Trigg Lake (which receives runoff from DFW) and one urban reference site. Assessments of water quality will be made on a yearly basis. Toxicity identification evaluation tests are conducted using several aquatic organisms to identify toxic additives in deicer formulations, and sampling is conducted at the five monitoring sites to determine the level of additives in the receiving stream.

PROGRESS (JULY 2001–JUNE 2004)

An extensive runoff monitoring program has been in place since October 2002. Flow, dissolved oxygen, water temperature, and rainfall are being monitored continuously. Water-quality constituents are sampled selectively during deicer application events, base flow, and one summer rainfall event per year. Glycol, biochemical oxygen demand, chemical oxygen demand, nonylphenol ethoxylates, and tolyltriazole analyses are being conducted. Microtox and bioassay analyses are being conducted for toxicity assessment.

PLANS (JULY 2002–JUNE 2003)

At least one more year of monitoring is planned. After monitoring for one more year, a report will be written defining water-quality conditions.

Halfway Creek Constructed Wetland Evaluation

Cooperator: U.S. Environmental Protection Agency, Cincinnati, Ohio

Location: La Crosse County

Project Chief: Peter E. Hughes

Project Number: BQY10

Period of Project: August 2003–December 2008

PROBLEM

Constructed wetlands are commonly used as a BMP to mitigate the pollution from sediments and nutrients often found in nonpoint-source runoff resulting from a number of different land uses. Evaluation of the effectiveness of constructed wetlands as a BMP is needed to determine the level of control that can be achieved with their use.

OBJECTIVES

The objective of this study is to develop a better understanding of how constructed wetlands function to reduce the amount of suspended sediment, nutrients, and pathogens that are released into receiving streams from upland sources. The effectiveness of the constructed wetland in stressor attenuation and the assimilative capacity of the natural wetland to absorb stressors introduced from upstream will be compared to model predictions.

APPROACH

Gaging stations will be installed on the inlet to the Halfway Creek constructed wetland, on Halfway Creek downstream of the wetland and on Sand Coulee Creek near the wetland. The stations will be equipped to monitor flow, precipitation, *in-situ*

Tim Hanson

Flow into constructed wetland from Halfway Creek during highwater on March 1, 2004.

water quality, and have automated water-quality samplers for collecting discrete event samples. The BRD office in Onalaska will service the water-quality monitors, collect the water-quality samples, and analyze selected samples for suspended sediment and nutrients. USGS will work with EPA researchers to install clay pads in the wetland to quantify the deposition of suspended materials during inflow events. Sediment and nutrient loads will be computed using concentration and flow data for each site and will be used to determine the effectiveness of the wetland in reducing the transport of these constituents from the watershed.

PROGRESS (JULY 2003–JUNE 2004)

Monitoring equipment was installed and sampling initiated in February 2004. Baseflow samples have been collected on a bi-weekly schedule and a total of five runoff events were sampled. Clay pads for deposition monitoring in the wetland were installed in November and sampled the following June.

PLANS (JULY 2004–JUNE 2005)

An additional gaging station will be installed on Halfway Creek at the confluence with the Mississippi River. *In-situ* laser sediment analyzers will be installed at this site and two others to provide continuous sediment concentration data. All the sites will continue to be operated for flow and water quality. Loads of suspended sediment and nutrients will be computed and used to evaluate the effectiveness of the wetland.

Evaluation Monitoring in Wisconsin Priority Watersheds

Cooperator: Wisconsin Department of Natural Resources

Project Chiefs: David J. Graczyk; Steven R. Corsi

Location: Priority Watersheds in Buffalo and Sheboygan Counties

Project Number: BQY11

Period of Project: October 1990–Continuing

PROBLEM

An evaluation strategy is needed to assess the effectiveness of nonpoint-source pollution-control measures in Priority Watersheds. Specifically, research is needed to determine the impact of management practices on stream-water quality and biology. 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 at sites during and after implementation of improved land-management practices in priority watersheds and to use GIS to understand changes in land use/land cover.

APPROACH

Post-practice implementation monitoring will be done for Otter, Eagle, and Joos Valley Creeks, which are in the Sheboygan River, and Waumandee River Priority Watershed Projects, respectively. The pre-practice implementation is complete for all of these sites. Continuous-record streamflow and water-quality 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 2003–JUNE 2004)

Post-practice implementation monitoring for Otter Creek is complete and the final report is being prepared. Post-practice implementation monitoring for Eagle and Joos Valley Creeks has been ongoing since October, 2002. Water-quality loads were calculated for selected parameters and storm periods. All the data were summarized and published in the report "Water-Resources Data–Wisconsin." Land-use inventories were completed for each basin.

PLANS (JULY 2004–JUNE 2005)

A report will be published on post-monitoring of Otter Creek in the Sheboygan River Priority Watershed Project. The report summarizes the results of a study on the effectiveness of watershed-management practices for controlling nonpoint source contamination in the Otter Creek watershed. Eagle and Joos Valley Creeks will be continued to be monitored for streamflow and water quality. Water-quality samples are collected bi-weekly from April through October, and monthly from December through March. Samples will be collected at all sites during runoff periods. Land use will be updated for each basin. 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.

REPORTS

Graczyk, D.J., Walker, J.F., Horwatich, J.A. and Bannerman, R.T., 2003, Effects of Best-Management Practices in the Black Earth Creek Priority Watershed, Wisconsin, 1984–98: U.S. Geological Survey Water-Resources Investigations Report 03-4163, 24 p.

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

Rappold, K.F., Wierl, J.A., and Amerson, F.U., 1997, Watershed characteristics and land management in the nonpoint-source evaluation monitoring watersheds in Wisconsin: U.S. Geological Survey Open-File Report 97–119, 39 p.

Wierl, J.A., Rappold, K.F., and Amerson, F.U., 1996, Summary of the land-use inventory for the nonpoint-source evaluation monitoring watershed in Wisconsin: U.S. Geological Survey Open-File Report 96–123, 23 p.

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

Discovery Farms

Cooperator: University of Wisconsin–Extension, Wisconsin Department of Natural Resources

Project Chief: Todd D. Stuntebeck

Location: Buffalo County, Lafayette County, Iowa County, Kewaunee County

Project Number: BQY12

Period of Project: July 2001–Continuing

PROBLEM

Agricultural nonpoint pollution in the form of nutrients, sediment, and pesticides threatens many of Wisconsin streams and lakes. Understanding how to help reduce these pollutants while allowing farmers to remain economically viable provides a great challenge.

OBJECTIVE

Under the Wisconsin Agriculture Stewardship Initiative, agencies will work together to develop science-based, productive, and profitable approaches to farming. Projects will be conducted on numerous “Discovery Farms” which will represent diverse land characteristics and management styles. Information learned from these projects will then be shared with the agricultural community to allow them the tools to remain competitive in today’s market while taking environmentally sound approaches to farming.

APPROACH

Water-quality-monitoring stations will be installed on selected Discovery Farms throughout Wisconsin which represent different land characteristics and farm management styles. If the farm lends itself to stream monitoring, stations will be installed to measure streamflow and constituent loading within the stream. If a stream does not bisect the farm, field-level monitoring stations will be installed to measure flow and constituent loading within waterways in the cropped fields. The stations will

Gaging station at the Pagel Discovery Farm in Kewaunee County.

Samples from a rainfall-runoff event.

be designed to monitor runoff volume and to collect discrete water samples during storm-runoff periods, including snowmelt. The discrete samples collected will be composited into a single sample such that the sample represents the average concentration over the duration of the storm. These composite samples will be analyzed for total phosphorus, dissolved phosphorus, suspended sediment, suspended solids, total solids, volatile suspended solids, ammonia, nitrate, Kjeldahl nitrogen, chloride, pH, conductivity and alkalinity. Storm loads will be computed for the constituents and comparisons will be made based on constituent loading yields on a unit-area basis.

The primary experimental approach is to conduct multiple paired-watershed analyses on each farm to determine the impacts of the current management practices and to see if modification of these practices significantly reduces constituent yields. The study is expected to last between five and seven years on each farm. During the first few years of the study, constituent yields from each of the three stations on a farm will be compared and a relationship developed. Once this relationship has been established, one or more best-management practices (BMPs) will be implemented in one or two of the watersheds. The third watershed will remain unchanged and will be the control watershed. Data will be collected for the post-BMP periods and comparisons between constituent yields will be made again. If the BMPs have had a significant impact on water quality, the results of the post-BMP comparisons should be different than the results of the pre-BMP comparisons.

In addition to the paired-watershed design, several other investigations will be conducted on various aspects of the farms. These studies may include, but not be limited to: comparing constituent yields from each farm to those in other regions of Wisconsin; comparing constituent yields from one type of management system to that of a different management system; comparisons of measured sediment losses versus loss estimates from various predictive indices; development, calibration, and verification of a phosphorus-loss risk index; and development, calibration, and verification of a hydrologic and chemical model (surface and ground water).

PROGRESS (JULY 2003–JUNE 2004)

Two stream gages at the Bragger Discovery Farm in Buffalo County have been operating since September 2001. Since then, 34 base-flow samples and samples representing over 40 storm-runoff events have been collected at each site. Three field-level waterway monitoring stations have been installed and operated at the Pagel Discovery Farm in Kewaunee County since November 2003. Since then, samples representing over 20 snowmelt and storm-runoff events have been collected at each site. Three field-level waterway monitoring stations have been installed and operated at the Riechers Discovery Farm in Lafayette County since December 2003. Since then, samples representing over 10 snowmelt and storm-runoff events have been collected at each site.

PLANS (JULY 2004–JUNE 2005)

Two additional monitoring stations designed to measure flow and collect water samples from two underground tile lines will be installed at the Pagel Discovery Farm in Kewaunee County. Two stream-monitoring stations and a field-level station will be installed at the Heisner Discovery Farm in Iowa County to evaluate nonpoint inputs from an organic dairy. Three monitoring stations will be installed on farms in Manitowoc County to evaluate sediment and nutrient inputs. Two tile line and one field-level monitoring station will be installed at the Koepke Discovery Farm in Waukesha County.

Quantification of Constituent Loads from Farm Fields at the Pioneer Farms in Wisconsin

Cooperator: State of Wisconsin Pioneer Farm

Project Chief: David W. Owens

Location: University of Wisconsin, Platteville Experimental Farms

Project Number: BQY13

Period of Project: October 2001–October 2008

PROBLEM

Wisconsin has many operating farms throughout the State where best-management practices (BMPs) could be implemented. These BMPs are designed to protect the environment and enhance the farm operations. Many farmers, however, do not want to implement BMPs without knowing the cost and benefits of each BMP. The Pioneer Agricultural Stewardship Farm located at the University of Wisconsin-Platteville Farm has been established to evaluate and promote management practices within the context of the farming systems in order to develop

compatible methods and technologies that will help farmers achieve their economic goals while protecting and enhancing natural resources.

OBJECTIVE

The main objective of this project is to provide field-level water quality and quantity data from rainfall and snowmelt runoff events. These data will be used to: (1) verify the Wisconsin Phosphorus Index, (2) verify the Revised Universal Soil Loss Equation (RUSLE) and Revised Universal Soil Loss Equation II (RUSLE II), (3) establish "base-line" in-stream conditions, and (4) evaluate individual BMPs such as infiltration trenches and/or rotational grazing practices.

APPROACH

Water-quality-monitoring stations will be installed at several sites throughout the experimental farm. These sites include five field-level stations and one in-stream station located downstream of the experimental farm. The stations will monitor runoff volume and will collect water-quality samples throughout the runoff event. These samples will be analyzed for solids, nutrients, bacteria, and selected pesticide concentrations. Stations need to be designed to collect data during snow-melt runoff events.

PROGRESS (JULY 2003–JUNE 2004)

Two new field-level water-quality sampling stations were installed to support the rotational grazing research being conducted at the Pioneer Farm. Snowmelt and rainfall runoff samples were collected at one stream and nine field-level monitoring sites. Soil moisture and temperature-monitoring strings were installed at different soil elevations to measure the effects of aspect and crop type on soil moisture. Stand-alone time-lapse digital cameras were also installed to document field activities such as field cultivation, crop planting, growth, harvesting, and snow depth.

PLANS (JULY 2004–JUNE 2005)

Maintain and operate monitoring stations to support additional research. Two additional research efforts include evaluation of infiltration effectiveness in grass waterways and BMP evaluation of an existing and then reconstructed barnyard filter strip.

Influences of Riparian Corridors on the In-Stream Habitat, Fish, and Macroinvertebrate Communities for Small Streams in Wisconsin

Cooperator: Wisconsin Department of Natural Resources

Project Chief: Judy A. Horwatich

Location: Statewide

Project Number: BQY14

Period of Project: July 1, 2001–Continuing

PROBLEM

Riparian corridor land cover can play an important role in determining stream-water quality by reducing runoff, sediments, and nutrients, and by maintaining more stable flows, water temperature, and channel morphology. Numerous studies have also shown the importance of riparian corridors in determining in-stream habitat and influencing aquatic biota, yet little is known about the influence of riparian corridor width, continuity, or proximity of an undisturbed riparian corridor to a sampling site on these measures. A better understanding of these factors will assist resource managers in developing guidelines for establishing and maintaining riparian corridors for small non-urban streams in Wisconsin.

OBJECTIVE

The objectives of this project are to: (1) examine the influence of riparian corridor width on in-stream habitat, and fish and macroinvertebrate communities, (2) examine the effect of distance to the sampling site from a disturbed versus an undisturbed riparian corridor on in-stream habitat, and fish and macroinvertebrate communities, and (3) quantify the influence of the continuity of an undisturbed riparian corridor on in-stream habitat, and fish and macroinvertebrate communities.

APPROACH

A subset of streams will be selected for this project from 241 wadeable streams that were sampled as part of Nutrient Impacts on Streams, a cooperative project between the USGS and WDNR. The first step will be to categorize all streams into four groups, based on the ecoregion (Omernik, 1987) in which they are located. Sixty of these sites will be selected for this study based on the amount of variability of land cover within the basin, availability of digital orthophotography, similarities in slope and surficial deposits within ecoregions, and preliminary assessments of riparian corridor land cover using the WISCLAND satellite-derived land-cover data. For the selected watersheds, riparian corridor land cover will be interpreted at various buffer widths from digital and orthophotography. Streams within each ecoregion will be categorized into four groups based on the width of an undisturbed riparian corridor (narrow versus wide) and distance upstream, from the sampling site to an undisturbed riparian corridor (near versus far). Multivariate statistics will be used to examine relations between riparian-corridor width, proximity of an undisturbed riparian corridor to the sampling site, and continuity of an undisturbed riparian corridor and in-stream habitat, and fish and macroinvertebrate communities.

PROGRESS (JULY 2003–JUNE 2004)

The 241 sampling sites were selected for the Nutrient Impacts on Streams study and sampled for water quality, habitat, and biology. A preliminary design has been developed for the riparian corridor study based on the objectives and the type and location of the nutrient impact sites. The riparian corridors for 60 streams were analyzed at various buffer widths. It was determined the buffer widths within the wastersheds were similar in land-use characteristics, making relationships between stream characteristics and width of the buffer difficult to ascertain.

PLANS (JULY 2004–JUNE 2005)

An additional 30 streams will be selected based on diverse land-use characteristics within a watershed. Multivariate statistics on all 30 streams will assist in the investigation of the relation between riparian-corridor width, proximity of an undisturbed riparian corridor to the sampling site, and continuity of an undisturbed riparian corridor and in-stream habitat, and fish and macroinvertebrate communities.

Fertilization and Runoff from Urban Lawns

Cooperator: Wisconsin Department of Natural Resources

Project Chief: Judy A. Horwatich

Location: Dane County

Project Number: BQY15

Period of Project: March 1994–Continuing

PROBLEM

Excessive phosphorus entering lakes is known to promote unsightly weed growth, decrease recreational uses, and ultimately speed the eutrophication process. Structural or "end-of-pipe" management practices designed to reduce phosphorus are generally expensive. Reducing phosphorus at the source may be a less-expensive alternative. Restricting fertilizer use in the watershed to phosphorus-free brands would seem to be a potentially inexpensive way to reduce phosphorus loads to Lake Wingra. However, there is little applicable field evidence supporting the hypothesis that runoff from fertilized lawns is greater in phosphorus concentrations than runoff from non-fertilized lawns. A better understanding of how much water runs off a typical urban lawn and under what conditions will help watershed investigators improve their ability to predict the impacts of management decisions.

OBJECTIVE

Objectives are to: (1) determine if the concentrations of total phoshorus, dissolved phosphorus, suspended solids, and total solids in runoff from fertilized lawns are different than concentrations from lawns that are not fertilized, (2) use the concentration data in an existing Source Loading and Management Model (SLAMM) to estimate phosphorus loads entering Lake Wingra from both fertilized and non-fertilized lawns, (3) determine the potential reduction in phosphorus loads to Lake Wingra by restricting fertilizer use in the watershed to phosphorus-free brands, (4) obtain rainfall and runoff data with site characteristic data for lawns from different soil types, (5) use the concentration/runoff information to make improvements to the SLAMM model, and (6) determine the lawn infiltration parameters from natural and simulated rainfall from roof runoff.

APPROACH

Lake Wingra Lawn Fertilization Study (Water-quality samplers only)

Lawn-runoff samples were collected from 30 water-quality samplers between May 1999 and September 2001. Fifteen of the samplers were located in lawns that were fertilized, and the other 15 were in lawns that were not fertilized. Samples were analyzed for total phosphorus, dissolved phosphorus, total solids, and suspended solids. Site characteristic data such as soil type and chemical contents, grass density, lawn slope, soil compaction, and infiltration capacity were measured for each of the 30 lawns. Several small experiments were conducted in order to better understand what happens when the bottles overfill and how much phosphorus is likely to come from grass clippings only.

Lawn Runoff Study (Volume/QW samplers)

Runoff volumes are being measured and water-quality samples are being collected for five specialized samplers in the Lake Wingra watershed. In addition to the runoff data, several explanatory variables will be measured for each lawn, including grass density, lawn slope, soil compaction, and infiltration rate. Using statistical regression techniques, an equation will be developed to help explain much of the variability in lawn runoff volumes. Sites were operated through June 2004.

PROGRESS (JULY 2003–JUNE 2004)

Nearly 1,200 sample concentrations have been obtained for 42 runoff periods since May 1999. The five samplers have recorded runoff data and collected water-quality data for over a dozen snowmelt and rainfall-runoff events. This summer, a study that simulated rainfall from rooftops flowing onto lawns measured volume, infiltration, travel distance, and spread of runoff.

PLANS (JULY 2004–JUNE 2005)

All of the data from the initial lawn-runoff study (water-quality samplers only) will be compiled and analyzed and a Fact Sheet describing the findings will be published. A Fact Sheet will be published explaining the Lake Wingra Fertilization Study. In the fall of 2004, a roof runoff downspout study will begin using natural rainfall. During the summer of 2005, the data from both rooftop studies will be analyzing for infiltration characteristics, and will be used in evaluate several models.

Hydrology and Water-Quality Impacts of Different Pasture Management Practices in Southwestern Wisconsin

Cooperator: Wisconsin Department of Natural Resources

Project Chief: David J. Graczyk

Location: Sauk County

Project Number: BQY16

Period of Project: October 1997–September 2004

PROBLEM

Nonpoint-source pollution is a major concern in Wisconsin. There are approximately 24,000 dairy farms in Wisconsin which may be sources 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. MIRG farmers rely on pastures for their dairy herds' forage needs and move their cows to a new pasture at least once a week. In 1992, roughly 7 percent of Wisconsin dairy farms used MIRG but in 1994, 14 percent of Wisconsin dairy farms used MIRG. 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, rotational grazed pastures evidenced a reduction in average annual runoff and sediment discharges when compared to a continuously grazed basin.

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) outwintering practices. Streamflow and water-quality data will be collected at each pasture outlet. In addition ancillary data will be collected that will include rainfall and other meteorological data. An ISCO automatic water-quality sampler was installed at each site. One composite sample per rainfall or snowmelt event will be sent to the Wisconsin State Laboratory of Hygiene for analysis. 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 (JULY 2003–JUNE 2004)

Three small basins were monitored for continuous streamflow and rainfall. Four runoff samples were collected at site 1, three runoff samples at site 2, and two runoff samples at site 3. Water-quality-constituent loads and subsequent yields were calculated at all three sites. Runoff events include summer thunderstorms and early winter rainfall and snowmelt events. All data were summarized and published in the report "Water Resources Data–Wisconsin, Water Year 2003." Monitoring was discontinued at all three sites on September 30, 2003.

PLANS (JULY 2004–JUNE 2005)

A final report will be prepared summarizing the results of the study. Monitoring is complete at all three sites. Yields will be compared at each site before grazing was started at each basin and after grazing was started. In addition, site 1 (no out-wintering of animals) and sites 2 and 3 (where out-wintering is part of the grazing plan) will be compared with each other to determine if differences can be found.

The Effect of Near-Shore Development on Constituent Loading to Lakes in Northern Wisconsin

Cooperator: Wisconsin Department of Natural Resources

Project Chiefs: David J. Graczyk; Randy J. Hunt

Location: Statewide

Project Number: BQY17

Period of Project: October 1999–September 2004

PROBLEM

Additions of nutrients, pesticides, and sediment from near-shore developments to lakes may seriously degrade lake-water quality. Shoreline-zoning regulations such as required setbacks, cutting restrictions, and buffers between the lake and development have been developed in the hope that these requirements can mitigate the effects of sediment and nutrient runoff.

Previous studies have estimated the amount of these loadings from the lake watershed but few studies have determined the processes and pathways in which these constituents are delivered to the lake at a site-specific scale (for example, a one-acre parcel). The effectiveness of buffers or cutting restrictions on reducing the amount of chemical constituent loads and sediment has yet to be demonstrated.

OBJECTIVE

The objectives of the study are to: (1) estimate the quantity of surface-water runoff and ground water that flows into a lake from developed and undeveloped lands, and (2) determine the quality of surface-water runoff and ground water that flows into a lake from developed and undeveloped lands.

APPROACH

Effects of shoreline development on water and nutrient loading will be assessed using a paired approach. The comparison will focus on developed and undeveloped sites on four lakes in Vilas and Forest Counties in northern Wisconsin. Developed sites may include runoff from lawns, driveways, sidewalks, and roofs; undeveloped sites consist of mostly immature woods having woody and non-woody vegetation and relatively undisturbed ground. Both surface-water runoff and ground-water components will be characterized where appropriate.

Sites were divided into those where the lakes have ground-water inflow and those that do not. Those that had ground-water inflow will be instrumented to characterize the ground- and surface-water components. Sites with ground-water flow away from the lake will be instrumented to characterize surface-water components only. Each site will be surveyed and a detailed map will be prepared to determine the areas that contribute to surface runoff.

A tipping bucket rain gage will be installed at each site. Precipitation will be measured during the non-freezing portion of the year. Precipitation from a nearby National Weather Service gage will be used during freezing periods.

Surface-water runoff will be measured by using two types of monitors depending on the site. An automatic collection monitor will be installed at four sites. A passive collection monitor will be installed at two sites. The quality of surface water will be determined from analyses of the runoff collected by both automated and non-automated systems.

Ground-water flow will be monitored by the installation of piezometer nests. The nests will be distributed along the topographic gradient. The most downgradient nest will be installed adjacent to the lakeshore. The quality of ground water will be determined from a subset of water-table wells and piezometers located at the nest sites. In addition, the quality of ground water that discharges to the lake will be characterized using seepage meters and pore-water diffusion equilibrators. All surface- and ground-water samples will be analyzed for total dissolved phosphorus, total phosphorus, ammonia nitrogen, nitrate and nitrite nitrogen, and total Kjeldahl nitrogen. Approximately 7 surface-water samples per site will be collected, and 5–10 ground-water samples will be collected. The Wisconsin State Laboratory of Hygiene will analyze all samples.

PROGRESS (JULY 2003–JUNE 2004)

A final report was published that summarized all loadings and yields to the lake from different land uses. Median surface-runoff estimates from the wooded catchments were an order of magnitude less than those from the lawn catchments. The increased water volumes from the lawn catchments resulted in greater nutrient loads and subsequent annual nutrient yields from the developed sites. Median nutrient yields in surface runoff from lawns always were greater than those from the wooded catchments. Runoff volumes were the most important factor in determining whether lawns or wooded catchments contribute more nutrients to the lake. The ground-water system had appreciable nutrient concentrations, and is likely an important pathway for nutrient transport to the lake. Soil moisture probes were installed on two sites around Geneva Lake. The soil moisture probes will be used to determine how water moves across a lawn through a buffer and eventually to the lake.

PLANS (JULY 2004–JUNE 2005)

Soil moisture probes will be installed at two more lake sites in northwest Wisconsin. The soil moisture data will be summarized and published in a data report.

REPORTS

Graczyk, D.J., Hunt, R.J., Greb, S.R., Buchwald, C.A., and Krohelski, J.T., 2003, Hydrology, nutrient concentrations, and nutrient yields in nearshore areas of four lakes in northern Wisconsin, 1999–2001: U.S. Geological Survey Water-Resources Investigations Report 03–4144, 64 p.

Verification of Treatment Performance of the Vortechnics and Stormwater Management Filter

Cooperator: Wisconsin Department of Transportation

Project Chiefs: Judy A. Horwatich; David W. Owens

Location: City of Milwaukee

Project Number: BQY18

Period of Project: October 2000–September 2005

PROBLEM

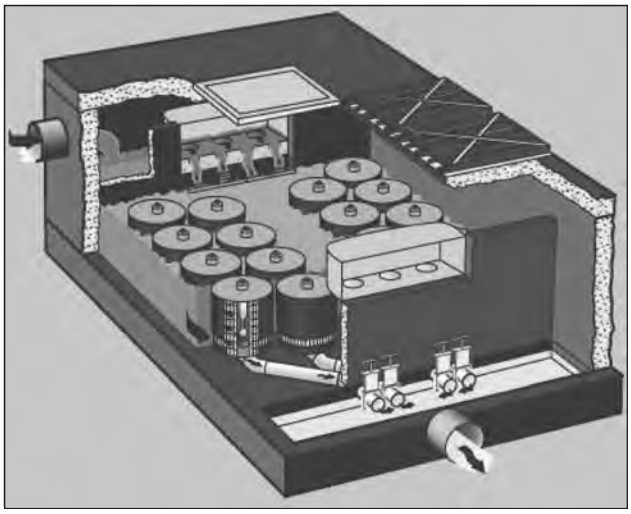
The Wisconsin Department of Transportation (WDOT) is required to improve the quality of runoff from roadways under their control as part of the National Pollution Discharge Elimination System (NPDES) and an agreement with the Wisconsin Department of Natural Resources (WDNR). Installing a vendor practice to reduce pollutant loads is one way to meet the NPDES requirements; however the effectiveness of these devices is uncertain.

OBJECTIVE

The objectives of this project are to: (1) determine the effectiveness of a Vortechnic's Stormwater Treatment System and a Stormwater Management's Storm Filter System in removing pollutants from highway runoff water, (2) compare the measured removal efficiencies with manufacturers' estimates, (3) characterize the variability in freeway runoff quality, (4) characterize pollutant loading in freeway runoff, (5) determine the practical application of the treatment devices (for example, installation, operation, and maintenance costs), and (6) both study results will be reviewed and made available to the public through the U.S. Environmental Protection Agency Environmental Technology Verification (ETV) Program in cooperation with National Sanitation Foundation International (NSF) as the verification partner.

APPROACH

Discharge and event mean concentration (EMC) data will be collected at the BMP inlets and outlets for 15 consecutive large (more than 0.20 inches of precipitation) runoff events. These samples will be analyzed for total phosphorus, suspended and



Stormfilter™ by Stormwater Management Inc.

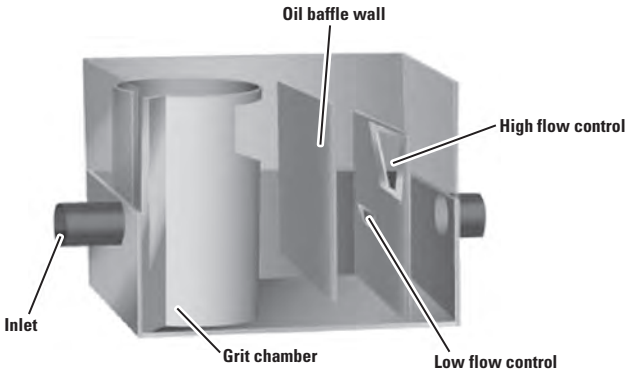
dissolved solids, zinc, copper, and chloride. Other samples from small (less than 0.20 inches of precipitation) events occurring between the larger events will be analyzed only for suspended solids. The data will be used to calculate individual event water-quality loads entering and exiting the BMPs. The calculated loads will be used to determine the removal efficiencies of the two treatment systems for the test period and to determine if there are any efficiency patterns related to event size.

PROGRESS (JULY 2003–JUNE 2004)

Treatment systems water quality monitoring has been completed. Volumes and loads at the inlet and outlet for both sites have been completed and the results have been forwarded to NSF for verification.

PLANS (JULY 2004–JUNE 2005)

USGS interpretive reports will be written describing the effectiveness of each of device.



Vortechs™ System by Vortechnics

Evaluation of Street Sweeping as a Water-Quality Management Tool in Residential Basins in Madison

Cooperator: Wisconsin Department of Natural Resources

Project Chief: William R. Selbig

Location: Dane County

Project Number: BQY19

Period of Project: May 2001–September 2005

PROBLEM

The City of Madison is required to control the quality of stormwater runoff as part of the National Pollution Discharge Elimination System (NPDES). Previous studies have indicated that runoff from street surfaces is a major contributor of pollution in the city (Waschbusch and others, 1999). One way to control roadway runoff is to use street sweeping to remove pollutants before they are entrained in runoff. This option may be preferable to structural Best Management Practices (BMPs) since structural BMPs can be expensive and often require land. In addition, the City already conducts street sweeping and may only need to modify their sweeping practices.

OBJECTIVE

The primary objective of this project is to determine if the dirt load on residential streets is reduced by various street-sweeping scenarios and if so, to what degree. Water-quality samples will be collected from three basins to determine if water-quality benefits are realized by the street-sweeping program, and to what extent. The water-quality sampling results from these basins and the street dirt load data will be used to estimate the benefits that may be achieved using other street-sweeping programs.

APPROACH

This study will use a paired basins approach, meaning that data will be collected from four basins and then compared to each other. One basin will be the “control” basin and will have minimal sweeping. The other three basins (the “test” basins) will have different sweeping regimens implemented. Two basins will utilize two different street sweepers provided by Elgin Inc. and will be swept once per week. The remaining basins will be swept on the same schedule as other areas of Madison, approximately one time per month, and will be completed using existing equipment. Data from the test basins will be compared to data from the control basin.

The USGS will collect vacuum samples once a week from four study basins for the duration of the study. During sweeping periods, samples will be collected immediately before street sweeping occurs and immediately after. The USGS will dry,

sieve, and weigh the vacuum samples. The samples will be sieved into particle-size fractions ranging from <63 µm to >2,000 µm in an effort to further characterize street dirt.

In addition to the street-dirt sampling, the control basin and the basins utilizing Elgin street sweepers will have water-quality samples collected and compared. These basins will be equipped with monitoring stations to collect discharge and water-quality data.

PROGRESS (JULY 2003–JUNE 2004)

Continued to monitor water quantity and quality at the control and test basins. Vacuum samples were collected weekly in each basin from April to October 2003 and April to June 2004 in order to characterize street-dirt load. A new street sweeper using vacuum technology replaced the existing sweeper in one of the test basins. This new sweeper will be evaluated for the duration of the study.

PLANS (JULY 2004–JUNE 2005)

Continue to monitor water quantity and quality at the control and test basins. Vacuum samples will be collected weekly at each basin from June to October 2004. Vacuum samples will resume in April 2005 and conclude in May 2005.

REPORTS

Scientific Investigations Report, September 2005.

A street sweeper using mechanical broom and vacuum technology passes through a residential street in Madison, Wis.

Monitoring and Evaluation of the Impacts of Aircraft Deicers in Runoff from General Mitchell International Airport

Cooperator: Milwaukee County

Project Chief: Steven R. Corsi

Location: Milwaukee, Wisconsin

Project Number: BQY20

Period of Project: October, 1996–Continuing

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 for purposes of deicing and antiicing aircraft. Glycol concentrations in stream samples collected during deicing events throughout the winters between 1996 and 2003 ranged from less than detection limits to 39,000 mg/L in GMIA outfalls (well above toxic levels).

OBJECTIVE

The overall goals of the project are to evaluate changes in water quality in Wilson Park Creek due to implementation of deicer management at GMIA, to investigate chemicals causing toxicity to aquatic organisms, and to 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 deicer management, (2) determine changes in water quality and toxicity levels in Wilson Park Creek due to implementation of deicer management, and (3) conduct investigations to identify additives in deicer and antiicer formulations that are responsible for toxicity to aquatic organisms in the receiving stream.

APPROACH

Flow is measured and samples are collected at one site upstream from airport runoff and three sites downstream. Assessments of water quality are made on a yearly basis. After two years of post-management monitoring, comparisons between pre- and post-management data will be made to determine if changes in water quality have occurred. Toxicity identification evaluation tests are conducted using several aquatic organisms to identify toxic additives, and sampling is conducted at the four monitoring sites to determine the level of these additives in the receiving stream.

PROGRESS (OCTOBER 1996–SEPTEMBER 2004)

An extensive runoff monitoring program has been in place since November 1996. The first two winters represent conditions before deicer management was implemented. The 1998–2001 winters represent data with partial deicer management. The 2002–2004 winters represent fully implemented deicer management conditions. 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 deicer application events, baseflow, and one summer rainfall event per year. Glycol, biochemical oxygen demand, selected nutrients, and selected metals analyses are being conducted. Microtox and bioassay analyses are being conducted for toxicity assessment. *In situ* fathead minnow assays were conducted upstream and downstream from airport runoff. Snow banks within the airport have been monitored for four years to determine the quantity of deicer stored within the snow banks.

PLANS (OCTOBER 2004–SEPTEMBER 2005)

Several more years of monitoring are planned during post-implementation conditions. After monitoring of post-implementation runoff, statistical analyses will be conducted to determine the effectiveness of the deicer management practices. A direct comparison of pre- to post-implementation data will be done. One report is currently being written that will discuss the results of snowbank monitoring. Another report will be written in the next year that will focus on the effectiveness of deicer management practices at GMIA.

REPORTS

Corsi, S.R., Booth, N.L., Hall, D.W., 2001, Aircraft and runway deicers at General Mitchell International Airport, Milwaukee, Wisconsin, USA, 1—Biochemical oxygen demand and dissolved oxygen in receiving streams: Environmental Toxicology and Chemistry, v. 20, no. 7, p. 1474–1482.

Surveying snowbanks at General Mitchell International Airport for studying aircraft deicers in snow.

Corsi, S.R., Hall, D.W., Geis, S.W., 2001, Aircraft and runway deicers at General Mitchell International Airport, Milwaukee, Wisconsin, USA—1. Toxicity of aircraft and runway deicers: Environmental Toxicology and Chemistry, v. 20, no. 7, p. 1483–1490.

Cancilla, D.A., Baird, J.C., Geis, S.W., Corsi, S.R., 2003, Studies of the environmental fate and effect of aircraft deicing fluids: Detection of 5-methyl-1H-benzotriazole in the fathead minnow (*Pimephales promelas*): Environmental Toxicology and Chemistry, v. 22, no. 1, p. 134–140.

Corsi, S.R., Zitomer, D.H., Field, J.A., Cancilla, D.A., 2003, Nonylphenol ethoxylates and other additives in aircraft deicers, antiicers, and waters receiving airport runoff: Environmental Science and Technology, v. 37, p. 4031–4037.

Long-Term Water Budget of Two Rain Gardens in Madison

Cooperator: City of Madison

Project Chief: William R. Selbig

Location: Madison

Project Number: BQY21

Period of Project: May 2003–September 2008

PROBLEM

Guidelines on the construction of a rain garden are still in their infancy. Criteria for locating and constructing these infiltration devices keep the homeowner in mind and therefore do not require a lot of time or money. However, in order to increase the efficiency of a rain garden, soils are often engineered to maximize infiltration of runoff. Additionally, rain gardens are often planted with native prairie species with deep root growth to promote infiltration. This can, in some cases, be cost-prohibitive for individual landowners. The benefits of native prairie species over more commonly used turf grass at infiltrating storm runoff are not well understood. Furthermore, few studies have evaluated the performance of rain gardens located in varying soils (sand versus clay). Understanding how vegetation and soil type affect infiltration in a rain garden could help direct future management decisions.

OBJECTIVE

The primary objective is to evaluate the effectiveness of two rain gardens with varying soils at infiltrating stormwater. Secondary objectives include, but are not limited to:

(1) Measuring the vertical flux of infiltrated water beyond the root zone as well as soil moisture available for evapotranspiration, and

(2) Measuring atmospheric parameters necessary to calculate potential evapotranspiration at each location.

APPROACH

This study will focus on two locations within the City of Madison where rooftop runoff can be equally divided and directed into adjacent rain gardens. One rain garden will be constructed using existing guidelines for the typical homeowner and include turf grass typically grown in area lawns. The other will utilize native plant species with deep root zones to optimize infiltrative capacities.

Equipment will be installed at each location in an effort to calculate a volumetric mass balance per each rain garden based on the following equation:

$$V_{ground} = V_{in} + P - V_{out} - PET$$

where

V_{ground} is the volume of water moving vertically through the soil column,

V_{in} is the volume of water entering the rain garden from the rooftop,

P is direct precipitation on the rain garden, and

V_{out} is the volume of water escaping the confines of the rain garden during larger storm events.

Additionally, various atmospheric conditions will be monitored to determine potential evapotranspiration (PET) rates at each test site.

PROGRESS (JULY 2003–JUNE 2004)

Two locations of differing soil types were chosen to construct rain gardens side-by-side in order to quantify their ability to infiltrate runoff. One site represents silt/clay type soils and the other represents sandy soils.

Monitoring stations were installed to measure a variety of parameters in each rain garden including discharge into and out of each rain garden, soil moisture at incremental depths below each rain garden, depth of standing water in each rain garden, and meteorological variables to calculate potential evapotranspiration.

Soil cores were taken and preserved to not only characterize the underlying soil structure but also to determine the bulk density, wilting point, organic content, and field capacity. This information will be useful in determining the volume of water moving up or down through the soil horizon before, during, and after runoff events.

Several storm runoff events were monitored during fall 2003 and spring 2004. A digital camera was installed at one study area to document the rain gardens.

Standing water in two rain gardens after a recent storm event in Madison, Wis.

PLANS (JULY 2004–JUNE 2005)

Plans for the upcoming year include continuing to monitor runoff events to determine the amount of water entering, leaving, and infiltrating into each rain garden. Meteorological parameters will be measured to calculate potential evapotranspiration at each site. This information will facilitate the calculation of a volumetric mass balance in each rain garden and help evaluate the overall effectiveness of infiltrating stormwater.

A secondary soil-moisture sensing device will be utilized to periodically calibrate continuous soil-moisture sensors. Additional calibration tests will be performed on all equipment measuring runoff into and out of the rain gardens.

REPORTS

Scientific Investigations Report, September 2008.

Verification of a Pressurized Stormwater Filtration System at St. Mary's Hospital

Cooperators: Wisconsin Department of Natural Resources; National Science Foundation

Project Chief: Judy A. Horwatich; Steven R. Corsi

Location: Green Bay

Project Number: BQY22

Period of Project: September 2000–Continuing

PROBLEM

Urban stormwater is degrading Wisconsin waters. Cost-effective treatment technologies are needed to reduce adverse impacts that urban stormwater runoff can have on surface-water quality. A

variety of advanced technologies have emerged in recent years that can help communities achieve compliance with new regulations. The EPA's Environmental Technology Verification (ETV) Program established a cooperative agreement with the National Standards Foundation (NSF) International to verify the treatment capabilities of the proprietary treatment devices.

The Wisconsin Department of Natural Resources and the USGS will conduct a study of a pressurized stormwater filtration system as an ETV program. The system has been installed at St. Mary's Hospital in Green Bay and is being used to treat runoff from its parking lot and rooftops. Stormwater is captured and pumped through a two-phase filter system and discharged into a city storm sewer. Backflush water is discharged into a sanitary sewer.

OBJECTIVE

The project objective is to determine the efficiency of the pressurized filtration system in extracting sediment, nutrients, and zinc from stormwater runoff.

APPROACH

To accomplish the above objective, the following approach will be used: (1) install flow-monitoring and water-quality sampling equipment at the inflow, outflow, and bypass of the system, (2) continuously monitor rainfall and flow, and collect water-quality samples for 15 runoff events, (3) analyze samples for sediment, total and dissolved phosphorus, Kjeldahl N, NO_2-NO_3 N, and zinc, (4) compute loads for inflow, filtered outflow, and bypass for the above constituents, (5) compute a mass balance on flow and water-quality loads for all events, and (6) publish a technical report on the results of the study.

PROGRESS (JULY 2003–JUNE 2004)

Monitoring has been completed and records have been worked up. The final report is in draft form. Data have been sent to NSF for verification of the device.

PLANS (JULY 2004–JUNE 2005)

Plans are to: (1) publish a monitoring report on the efficiency of the pressurized stormwater filter, and (2) compute and publish the discharge record and water-quality loads for the three monitoring locations and publish in the 2004 report "Water Resources Data –Wisconsin."

REPORTS

Horwatich, J.A., Corsi, S.R., and Bannerman R.T., 2004, Effectiveness of a pressurized stormwater filtration system in Green Bay, Wisconsin: a study for the Environmental Technology Verification Program of the U.S. Environmental Protection Agency: U.S. Geological Survey Scientific Investigations Report 2004-5222.

Thresholds of Toxicity in Urban Streams

Cooperator: Wisconsin Department of Natural Resources

Project Chief: Steven R. Corsi

Location: Statewide

Project Number: BQY23

Period of Project: July 2001–September 2006

PROBLEM

The State of Wisconsin has recently implemented a federally mandated program that requires cities with populations greater than 10,000 to develop stormwater management plans. The intent is to eventually regulate stormwater as a point source of pollution by setting limits on the quantity and quality of runoff entering receiving waters. The critical problem that needs to be addressed is the degree to which toxicants found in urban runoff need to be regulated in order to protect the biological integrity of receiving streams. One question that needs to be addressed: is there a threshold level of watershed imperviousness below which regulation of toxicants in stormwater runoff is not needed? Another question that needs to be answered is: at what field concentration of potential toxicants do we see adverse effects in stream-dwelling organisms? This will permit regulatory effort to be more effectively focused on problem areas and problem chemicals.

The Wisconsin Department of Natural Resources would use this information to identify areas where regulation of toxicants in runoff is necessary to protect, enhance, or restore aquatic communities. Municipalities will need this information to most economically and effectively comply with these impending regulations.

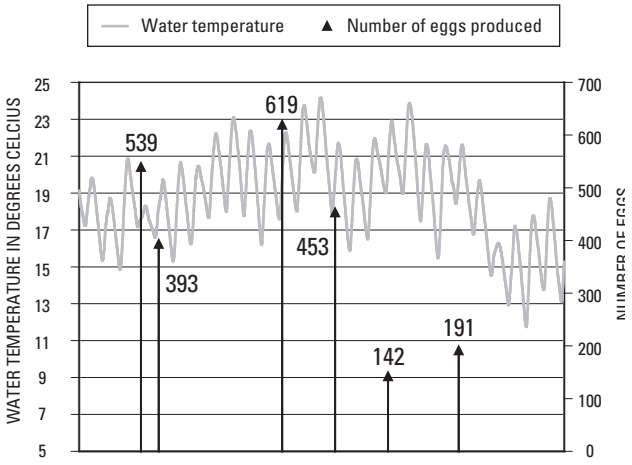
OBJECTIVE

The purpose of this study is to examine the relation of watershed imperviousness in urban river systems to measures of toxicity in aquatic organisms. More specifically, the objective is to determine the toxicity of urban river systems to *P. promelas* as measured in 21-day spawning tests using *in-situ* caged fish.

APPROACH

In-stream fish exposures will involve the following details: (1) in-stream fathead minnow exposures will consist of tests at 3–6 streams per time period with 1 test chamber per stream and 1 control chamber placed in a relatively undeveloped stream, (2) chambers consist of 6 cartridges with a pair of adult fathead minnows (one female and one male) per cartridge, (3) each stream tested will fit into a matrix of different urban influences. Placement of chambers will coincide with the NAWQA ULUG topical study, and (4) Site visits will be made each day to check on the condition of the minnows, and collect data.

Egg counts from 6 fathead minnow pairs and water temperature during spawning test at Sugar R. at Hwy. PD



The overall goal is to conduct this test for 21 days at each of 30 different sites with varying degrees of urbanization. Toxic response as measured by spawning success will be compared to the degree of urbanization.

PROGRESS (JULY 2003–SEPTEMBER 2004)

A pilot study was conducted at two sites on the Sugar River near Verona, Wis., and three rivers in the Milwaukee area during summer 2003 and 2004. This pilot study did verify that the fish can spawn with reasonable success in the test cages when deployed in a stream.

PLANS (OCTOBER 2004–JUNE 2006)

Approximately 15 sites will be monitored during summer 2005, and 12 sites during summer 2006.

REPORTS

A final report will be written after the 2006 summer and submitted to an appropriate journal.

Calibration of the Source Loading and Management Model (SLAMM)

Cooperator: Wisconsin Department of Natural Resources

Project Chief: Judy A. Horwatich

Location: Statewide

Project Number: BQY24

Period of Project: July 2001–Continuing

PROBLEM

Wisconsin municipalities are using urban runoff models to help them prepare stormwater management plans. Planners and engineers use the models to identify the most important sources of pollutants and quantify the benefits of different management alternatives. The Source Loading and Management Model (SLAMM) is one of the models recommended for stormwater planning by the WDNR.

All watershed models should be calibrated before they are applied. Large errors in flow and pollutant concentrations can result if the model is not adjusted as much as possible to the places it will be used. In most cases the municipalities will not have the resources to collect the necessary flow and pollutant concentration data. Fortunately, enough stormwater data have been collected to adjust SLAMM for use by municipalities in Wisconsin.

OBJECTIVE

The objective of the project is to calibrate and verify the SLAMM model with the stormwater flow and pollutant concentration data available from urban studies conducted in Wisconsin.

APPROACH

The USGS in Wisconsin has collected flow and pollutant concentrations from source-area and at the end of the pipe for several projects. Land use and development characteristics, such as percent connected imperviousness, were determined for each study area. All the above information is needed to calibrate and verify SLAMM.

There are three steps to calibrate SLAMM. First, the predicted runoff volumes should be adjusted to match the values observed at the end of the pipe. Second, the predicted particle solids loads should be adjusted to match, as much as possible, the observed particle solids loads at each sites. The last step is to calibrate pollutant loads, such as total and dissolved sediment, nutrients, metals and organics.

All the files created by the calibration will be placed on the USGS web page. There is a link from the WDNR web page to the USGS web page.

PROGRESS (JULY 2003–JUNE 2004)

Flow, pollutant concentration, and land-use data have been compiled. Calibration of the runoff volume has been completed resulting in a slight reduction in the runoff curves for parking lots and lawns. The average concentration of particulate solids loads and the geometric mean concentration of pollutant were used to calibrate the model loadings. A street delivery file was created to better interpret the end of pipe sediment loads. Files are available on the USGS web page *http://wi.water.usgs.gov/slamm/index.html*

PLANS (JULY 2004–JUNE 2005)

At the end of this year, data will be compiled for three additional stormwater studies to verify SLAMM. These studies areas were lawns, freeways and a flat roof. An Open-File Report will be published explaining calibration and uses of the model.

Evaluation of the Effectiveness of Low-Impact Development Practices

Cooperator: Wisconsin Department of Natural Resources

Project Chief: William R. Selbig

Location: Cross Plains

Project Number: BQY25

Period of Project: July 1998–September 2007

PROBLEM

Farmland in Wisconsin is rapidly being converted to urban land uses. This urban development, with the associated increase in impervious area, generally impacts the water quality and increases the runoff volume that is delivered to the receiving water-body. When new site plans are proposed, many of the plans use "end-of-pipe" structural Best Management Practices (BMPs) such as wet and dry detention ponds. However, these structural BMPs are primarily designed to reduce the flood peak of a runoff event. They have limited water quality and quantity benefits.

Low-impact development is designed to reduce the volume and improve the quality of runoff while attempting to preserve the natural hydrology of the site. Low impact practices include the reduction of impervious surfaces and installation of infiltration devices, such as rain gardens.

OBJECTIVE

To evaluate the effectiveness of low-impact practices for reducing runoff quantity and improving runoff water quality.

APPROACH

Test and control sites have been selected in Cross Plains, Wisconsin. The control site, which was developed from 1988 to 1991, used traditional urban design practices such as storm sewers, curbs and gutters, and a wet detention basin. The second site began development in May 1999 and is implementing low-impact development practices. Both sites are finger valleys that are approximately a quarter mile apart.

Equipment at both sites is maintained to continuously monitor water level, precipitation, and water temperature and is housed in a monitoring station that has phone telemetry and electrical power. An automated water-quality sampler at each site is programmed to take flow-proportional samples from runoff producing storm events.

A detention pond (foreground) serves as one stormwater runoff control device during construction of a residential subdivision using low impact development practices in Dane County, Wis.

Comparisons in the performance of BMPs in the control and study area will be made based on unit-area runoff and unit-area loads. Trends in water quality and quantity will also be analyzed to further characterize the construction cycle (from platting to site closeout).

PROGRESS (JULY 2003–JUNE 2004)

Continuous discharge, precipitation, and temperature continue to be measured at both the control and test sites. Additional discharge monitoring equipment was installed in the outfall of a detention pond downstream of the control site. Runoff volumes leaving the detention pond will be compared to runoff volumes from the control site as a means to more accurately calculate total stormwater runoff. Monitoring equipment was also installed at a third residential subdivision to complement data collected at the control site. This subdivision will essentially act as a second control site as it also was built using traditional urban design practices such as storm sewers, curbs and gutters, and a large grassy area intended for recreational activities.

Water-quality samplers were suspended from October 2002 until March 2004 then reactivated for the remainder of the project. Water-quality samples for the majority of runoff events will be analyzed for total and suspended solids, and total phosphorus.

A number of infiltration tests were conducted inside the infiltration basin of the test area. The results will be compared to previous tests to determine trends in infiltraton rates over time.

PLANS (JULY 2004–JUNE 2005)

Continue to monitor discharge, precipitation, temperature, and water quality at both the control and test sites. Additional infiltration tests will be performed in the infiltration basin to comprehensively understand expected infiltration rates and track any increases or decreases over time.

REPORTS

Scientific Investigations Report is planned for September 2007.

DOT Street Sweeping Phase II

Cooperator: Wisconsin Department of Transportation and Wisconsin Department of Natural Resources

Location: City of Madison

Project Chief: Judy Horwatich

Project Number: BQY26

Period of Project: October 2004–September 2006

PROBLEM

The Wisconsin Department of Transportation (WDOT) is required to improve the quality of runoff from roadways under their control as part of the National Pollution Discharge Elimination System (NPDES) and an agreement with the Wisconsin Department of Natural Resources (WDNR). A possible cost-effective method to control stormwater-runoff pollutants on urban freeways is the use of highly efficient street sweepers.

OBJECTIVES

The objectives of this project are to: (1) determine the effectiveness of street sweeping in removing pollutants from highways by alternating the technique and frequency throughout the project, (2) compare the measured removal efficiencies with manufacturers' estimates, (3) characterize the variability in freeway runoff quality, and (4) characterize pollutant loading in freeway runoff.

APPROACH

The control site will be swept once per week with a broom sweeper. Storm discharge and water quality samples will be collected for at least 15 storms. Event Mean Concentrations (EMC) will be calculated at one water quality monitoring site. The test-site evaluation will compare changes in the dirt load on the roadway to predict the benefits of three sweeping formats. The sweeping formats will include: (1) sweeping at different speeds, (2) using tandem sweepers, and (3) sweeping twice per week instead of once. Roadway vacuuming at both the test and control sites will be done to determine particulate matter accumulation rates on the highway and street-sweeping efficiency. Vacuuming will initially need to occur immediately before and after a sweeper makes a pass.

Results from the water-quality sampling will be used to develop plots describing the amount of pollutants removed from the road surface for different rainfall amounts and intensities. A relation will be developed between the efficiency of each format and the amount of pollutants washed off the road surface. This relation will quantify the water-quality benefits of each street-sweeping format.

PROGRESS (JULY 2003–JUNE 2004)

The WDOT, Dane County, City of Madison, WDNR, and USGS have cooperatively selected a monitoring site.

PLANS (JULY 2004–JUNE 2005)

Install monitoring equipment and begin data collection. Initially, vacuuming of the highway will be done after a street sweeper makes a pass over the highway.

Database Applications Team

OFFICE OF THE ASSISTANT DISTRICT CHIEF FOR ENVIRONMENTAL STUDIES

MISSION

Provide data organization and distribution services for water resources-related information at local, state, national, and international levels. Targeted organizations include local planning commissions, municipalities, the Wisconsin Department of Natural Resources, USGS, EPA, and others. An emphasis will be placed on using the Oracle RDBMS system and other Oracle tools for this purpose. Efforts will be made to acquire and develop solutions with the best state-of-the-art technologies available, including high-end data query tools, case tools, WWW-oriented distribution strategies, map serving software, and sophisticated relational database and multi-dimensional OLAP systems.

TEAM MEMBERS

Harry R. House, IT Specialist (Team Leader)
John F. Walker, Research Hydrologist (Engineering)
Daniel J. Sullivan, Hydrologist
Nathaniel L. Booth, IT Specialist (Systems Analysis)
Morgan A. Schneider, Hydrologist
Carolyn J. McCullough, Physical Scientist
James R. Statz, IT Specialist
Jessica L. Thompson, Hydrologist
Eric J. Everman, IT Specialist
Kathryn M. Schoephoester, IT Specialist

PROJECTS

STATEWIDE PROJECTS

9KN10 Database Applications
9KN12 WDNR Beachhealth Database

NATIONWIDE PROJECTS

9BI75 NAWQA Data Warehouse
9KN14 WDNR Biology Database
9KN15 USGS Mobile Computing
9KN17 Mercury Vulnerability Identification Maps
9KN20 USGS National Map Hosting
9KN21 USGS Publications Warehouse

NAWQA Data Warehouse

Cooperator: USGS

Project Chief: Nathaniel L. Booth

Location: National

Project Number: 9BI75

Period of Project: November 1998–Continuing

PROBLEM

The USGS has need for a national system for storing, managing, and distributing data for the National Water-Quality Assessment program.

OBJECTIVE

The purpose of the project is to organize, store, and present information for the National NAWQA program in a data warehouse-style system in the Wisconsin District. This system is to be a central resource for all data related to NAWQA that are relevant for analysis to NAWQA scientists, USGS scientists, and to the public at large. Data will be deployed via World Wide Web technology.

APPROACH

A database will be developed to store and organize the various data components for this project. Web-enabled interfaces will be developed to access that information by end users.

PROGRESS (JULY 2003–JUNE 2004)

Main priorities for this time period include transforming data loading procedures to using Informatica "Extract Transform Load" (ETL) software to directly access USGS databases. Once load programs were converted, extensive acceptance testing was done. Automation efforts were made to allow databases to be aggregated on a monthly time interval. Many data-checking routines were ported from previous technologies and improved.

Several training courses were conducted around the country. User support continued to be a major emphasis both involving USGS scientists and the public.

Also in this period, a major overhaul of security procedures was made to the overall computing architecture that supports the data warehouse. Continued server maintenance and upgrades better supported the program.

PLANS (JULY 2004–JUNE 2005)

Plans for this period include finalizing the design, testing and documentation of data loading procedures for remaining national NAWQA related datasets. Algae and habitat are among the new datasets to be included into the data warehouse this period. New data checking routines and a data owner-to-data warehouse feedback mechanism will be designed to accommodate NAWQA study units and national synthesis scientists.

Value-added features to the data warehouse and/or the public interface planned for this period include: GIS front end to pick sites/networks; mechanism to output results on maps; online summary report graphs; and linked Pesticide Toxicity Index. A public data warehouse user group is to be formed this period.

Database Applications

Cooperators: City of Milwaukee; U.S. Environmental Protection Agency (USEPA); U.S. Geological Survey, (CAPP, WRD, GD), Wisconsin Department of Natural Resources (WDNR)

Project Chief: Harry House

Location: United States

Project Number: 9KN10

Period of Project: June 1998–Continuing

PROBLEM

Some natural resources agencies have difficulty organizing, storing, and distributing their information products using their existing resources (staff, hardware, and software). This can result in less than optimal use of acquired data and loss of value to customers.

OBJECTIVE

The purpose of this project is to provide our customers with the best possible data management systems for their given budget and resources.

APPROACH

The Database Applications Team employs skilled developers from a wide variety of natural science backgrounds. Each developer is supported by a robust set of software development tools and servers. Our strategy is to ensure we understand the customer's data and scientific goals first. We then select the best technologies to meet their needs.

PROGRESS (JULY 2003–JUNE 2004)

Many new servers were purchased to support the increasing resource demands of the team. Support licensing was renewed for all software, and additional purchases of software for web-enabled graphing were purchased from Visual Mining Corporation, as well as software to collect and store requirements information for projects. Additional copies of Redhat Linux were made to support all projection and some supporting database servers. A large number of publicity articles and bulletins came out describing the team's activities with various IT products.

PLANS (JULY 2004–JUNE 2005)

It is expected that there will be additional purchases of servers to further enhance our hardware infrastructure. We also expect to investigate the possibility of using some kind of SAN device to support multiple servers to simplify disk management issues that are becoming an issue. This may also have implications in regard to what backup system we use going forward.

We are working diligently to satisfy DOI security guidelines within our data center, and anticipate being accredited by the end of July 2004. This includes tightening firewalls, strengthening passwords and other measures.

WDNR Beach Health Database and Website

Cooperators: Wisconsin Department of Natural Resources

Co-Project Chiefs: Carolyn J. McCullough and Morgan A. Schneider

Location: Wisconsin

Project Number: 9KN12

Period of Project: November 1999–Continuing

PROBLEM

WDNR is managing a statewide program to monitor Wisconsin Great Lakes public beaches with funding from the USEPA BEACH (Beaches Environmental Assessment and Coastal Health) Act of 2000. WDNR needed a statewide system for storing, managing, and distributing data for public beach data-collection activities.

OBJECTIVE

The objectives of this project are to maintain a website with timely beach water-quality information for Wisconsin Great Lakes public swimming beaches (approximately 110), store information associated with beach water-quality advisories and monitoring data, and provide annual updates to the national dataset maintained by the USEPA. The Beach Health website (*http://infotrek.er.usgs.gov/servlet/page?_pageid=1993,2002&_dad=portal30&_schema=PORTAL30*) allows users to find advisory and monitoring data via a map interface or tabular reporting format. Health departments and other individuals responsible for collecting beach water-quality information enter information directly into the database with online forms. At the end of the beach season, data will be sent to the USEPA where it will be compiled with data from other coastal states.

Memorial Drive Wayside Beach South, Manitowoc County, Wisconsin (left) and Atwater Park Beach, Milwaukee County, Wisconsin (right).

APPROACH

A database has been developed to store advisory and monitoring data. Web-enabled data-entry forms have been created to allow forms-based input for beach monitoring personnel. Web-based reporting applications provide access to information. Scripts have been written to extract data from the database in a format required by USEPA for submittal to the national dataset.

PROGRESS (JULY 2003–JUNE 2004)

Updates to the forms, reports, website, and database were completed to account for minor changes in the program from the 2003 to the 2004 swimming season. Data from the 2003 swimming season were prepared and submitted to the USEPA for incorporation into a national dataset.

PLANS (JULY 2004–JUNE 2005)

Support of the data collection effort and the public website will continue through the end of the 2004 swimming season. At the end of the season the advisory and monitoring data will be sent to the USEPA for incorporation into the national dataset.

It is anticipated that the project will continue into the 2005 swimming season but the need for additional work will be determined by WDNR and is dependent on available funding.

WDNR Biology Database

Cooperators: Wisconsin Department of Natural Resources

Project Chief: Morgan A. Schneider

Location: Wisconsin

Project Number: 9KN14

Period of Project: June 1998–Continuing

PROBLEM

The WDNR Bureau of Fisheries Management and Habitat Protection collect and manage a wide variety of biological data. Data from biological programs were previously managed and stored in multiple databases in a wide variety of formats, making

Wisconsin Department of Natural Resources personnel electrofishing in Plum Creek, Wisconsin.

retrieval and analysis of data from the different programs difficult and time consuming. One central database was needed to manage data from the statewide fish propagation and habitat assessment programs.

OBJECTIVE

A database was created to house data collected by the Bureau of Fish Management and Habitat Protection. Statewide WDNR personnel manage data using on-line forms and reports.

APPROACH

Initial development of the project was directed toward providing data entry and data reporting capability on the Internet for data from all major field activities. The database was deployed over the Internet so that geographically dispersed users across the State could input and access data using electronic forms and reports.

PROGRESS (JULY 2003–JUNE 2004)

Creation and modification of existing forms and reports was ongoing. Selected legacy datasets were loaded into the database. Stocking data from 1972–2002 were made available on the public website. A data warehouse storing the WDNR Master Fish File (MFF) data was designed and loaded.

PLANS (JULY 2004–JUNE 2005)

Support of data-entry forms and reports will continue. A major rearchitecturing of the system is planned which will move a majority of the historic data to a separate system. This will require a rework of most reports and forms.

USGS Mobile Computing

Cooperators: USGS

Project Chief: John F. Walker

Location: National

Project Number: 9KN15

Period of Project: October 2001–Continuing

PROBLEM

USGS has a need for a nation-wide system for storing, managing, and distributing data collected on hand-held PDAs in the field. The development and implementation of this technology could dramatically reduce errors in data acquisition and transmission to central servers.

OBJECTIVE

The purpose of the project is to develop an application capable of interfacing with a standard current meter (Price AA or Pygmy) and collecting and computing a discharge measurement. The application will run on either a Palm or WinCE handheld device, and will synchronize with a central Oracle database. The Oracle database will be designed such that the resulting data can be uploaded to NWIS via an XML parser/loader application being developed by the NWIS team.

APPROACH

A database will be developed to store and organize the various data components for this project on PDAs. Web-enabled front ends will be developed to access that information by end users. An application for presenting the online forms required for a standard USGS discharge and field site measurement will be created in C code to run on Palm OS and Pocket PC systems against Oracle Lite databases.

PROGRESS (JULY 2003–JUNE 2004)

Consultants developed code for PalmOS version, and Alpha testing is nearly complete. Developed web-based forms for entry of user-specific information to be synched to PDA.

PLANS (JULY 2004–JUNE 2005)

Beta testing of the Palm OS system is scheduled for Fall 2004, with an initial release to a small subset of users to follow. Conversion of the Palm OS version of the application to PocketPC platform will begin in August, and is expected to be completed by Spring 2005.

It is anticipated that additional funds will be provided by USGS to support continued development of the application, through deployment in production environment during this period. Future resources dedicated to this effort would be expected to come in proportion to the degree of national acceptance of the system.

Mercury Vulnerability Identification Maps

Cooperators: USGS

Project Chief: Nathaniel L. Booth

Location: National

Project Number: 9KN17

Period of Project: March 2004–Continuing

PROBLEM

Mercury contamination in aquatic ecosystems poses a serious risk to both humans and aquatic life. Literature reflects methylated mercury contributes the majority of the toxicological response. Methylation of inorganic mercury occurs through various geochemical processes. While mercury deposition patterns are somewhat understood, to more precisely understand where problem areas might arise, landscape and water-quality data need to be linked to aerial mercury deposition patterns. In order for policy makers to estimate the response from various mercury emission rule scenarios, regions of the United States that have chemical, biological, and physical environmental characteristics that foster the methylation process need to be identified.

OBJECTIVE

The intention of this project is to produce a series of map snapshots of mercury sensitivity based on several chemical, biological, and physical characteristics. The scale of the project is the 48 contiguous United States. As such, sensitivity characteristics will be investigated at a regional scale.

APPROACH

A web-based mapping interface will be built that will display various individual physical, chemical, and biological characteristics. The interface and the supporting datasets will be supported (hosted) under Phase I funds (below) until Phase I is complete. Report-quality map snapshots will be produced for various scenarios. Reference layers for the map will be limited to broad non-detailed physical, political, and infrastructure boundaries (i.e. U.S. highways, major rivers, state boundaries).

PROGRESS (JULY 2003–JUNE 2004)

Initial planning was undertaken to clarify the user and system requirements. A project plan was created and approved by the customer. Initial work was begun to bring together the required datasets and begin development of the mapping applications.

PLANS (JULY 2004–JUNE 2005)

Identification of physical, chemical, and biological characteristics that lead to mercury sensitivity (i.e., methylation and bioaccumulation) will be conducted. Datasets that will provide coverage of these characteristics will be gathered. A database will be designed and populated from these disparate data sources.

Algorithms to deal with temporal and spatial variability of the characteristics will be defined and resultants will be displayed through a web-based mapping interface. Methylmercury surface-water concentration data will be incorporated into the database. The mapping interface will allow researchers to identify areas where defined characteristics overlap which may indicate a susceptibility of that area to methylmercury occurrence in surface waters.

USGS National Map Hosting

Cooperators: USGS

Project Chief: Nathaniel L. Booth

Location: National

Project Number: 9KN20

Period of Project: January 2004–Continuing

PROBLEM

USGS has a need for a second node for the National Map Catalog application.

OBJECTIVE

The purpose of the project is to site a second node developed by USGS-GD at a location separate from the central system in Rolla, MO.

APPROACH

A system will be configured in the Middleton, Wisconsin data center for housing the National Map Catalog.

PROGRESS (JULY 2003–JUNE 2004)

An agreement was entered into between GD and WRD to support this objective. Appropriate hardware and software were purchased. The application was successfully installed, and is currently in production as a secondary (or primary) node for the National Map.

PLANS (JULY 2004–JUNE 2005)

It is anticipated that GD will continue with the program as is for the remainder of the coming fiscal year. The Middleton Data Center is merely acting as a cohost location for this application, and is not directly involved in the development or other considerations related to the status of this system.

USGS Publications Warehouse

Cooperators: USGS

Project Chief: Carolyn McCullough

Location: National

Project Number: 9KN21

Period of Project: June 1998–Continuing

PROBLEM

The USGS does not support a unified, up-to-date database to store and retrieve publications-related information, such as bibliographic elements and/or the content of the publications themselves. The lack of such a system has resulted in increased difficulties for USGS personnel and customers to locate and obtain information about or including publications they may be interested in for their varying needs. It is expected that the development and maintenance of such a system would significantly enhance the ability of the USGS to meet the needs of the users for which the publications were developed for in the first place.

OBJECTIVE

The purpose of the project is to create a database to organize and store information on products produced by the USGS (as well as the products themselves when available) and create a web-based query interface that displays these data.

APPROACH

A database will be built to store bibliographic information and electronic versions of USGS publications. Data will be accessible through a web-based search interface.

PROGRESS (JULY 2003–JUNE 2004)

Public version of website (*http://pubs.usgs.gov*) was released January 15, 2004 in conjunction with the new USGS home page and the USGS Store. The public version included application of the new USGS template for web pages, links between the Pubs Warehouse and the USGS Store for ordering of publications, and links to scanned reports. Added features to the search interface including next and previous buttons, better layout, and better search capabilities.

A server was installed for storage and serving of scanned reports, and the first 9,000 reports where made available, tripling the number of online USGS reports. Development staff attended the Pubs 2003 meeting in Denver and presented an interactive poster presentation about the Publications Warehouse which was well received. A total of 61,000 records have been loaded into the database to date including some of the older BRD publications.

PLANS (JULY 2004–JUNE 2005)

Plans include continuing to improve the current dataset by trying to fill in the remaining gaps, loading new publications and scanned reports as they become available, spatially tagging the citations for use in a map-based search interface, and the addition of keywords from the USGS thesaurus for a browse-based search interface. Development staff will begin loading publications lists from the BRD science centers.

Verification of the unnumbered series data from the USGS Library will be started. Development staff will continue to improve the web interface and incorporate user feedback. This includes improved searching; printable, citation, and downloadable versions of results lists; and result lists by program or cost center.

Ground-Water Systems Team

OFFICE OF THE ASSISTANT DISTRICT CHIEF FOR GROUND-WATER AND NATIONAL INVESTIGATIONS

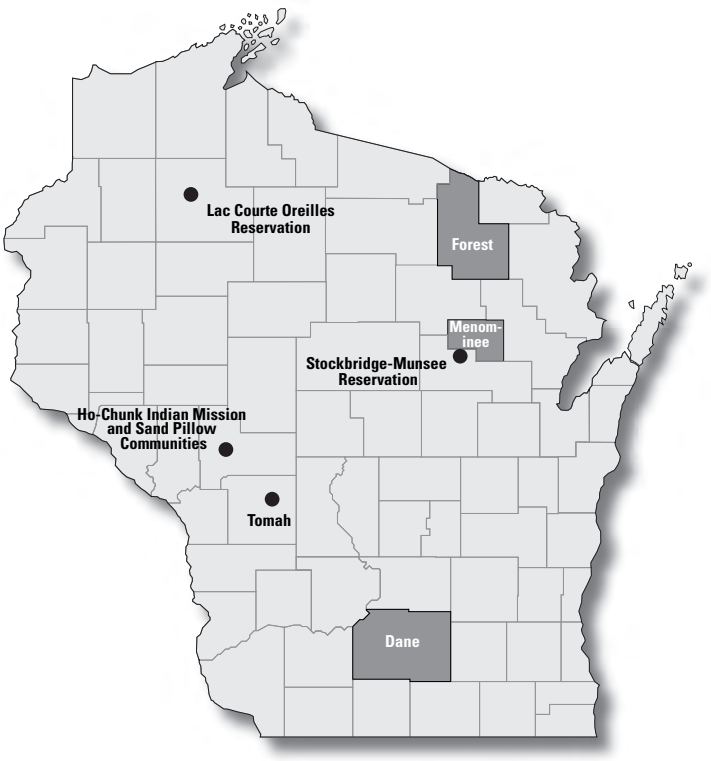
MISSION

The mission of the Ground-Water Systems Team is to provide a pool of expertise in a variety of disciplines from which flexible and dynamic sub-teams are formed to conduct District projects. The team serves as a forum in which participating members are kept abreast of new techniques and approaches in ground-water research and investigations. The team provides technical review for existing ground-water projects and designs and presents proposals to cooperators. Team membership fosters a close working relationship with cooperators and the University community. The team provides cooperators with state-of-the-art techniques and expertise to provide an understanding of the relation of ground-water systems to other natural resources and humans.

TEAM MEMBERS

Charles P. Dunning, Assistant District Chief (Team Leader)
Randy J. Hunt, Research Hydrologist (Geology)
David A. Saad, Hydrologist
Daniel T. Feinstein, Hydrologist
Paul F. Juckem, Hydrologist
James M. Rauman, Hydrologic Technician
Cheryl A. Buchwald, Hydrologic Technician
Gregory D. Mueller, Student Trainee (Hydrology)
James T. Krohelski, Hydrologist (Scientist Emeritus)

PROJECTS



STATEWIDE PROJECTS

9KH50 Collection of Basic Records – Ground Water

9KH51 Wisconsin Water-Use Data File

9KH38 Recharge

NATIONWIDE PROJECTS

9KH44 Drilling Operations Group

LOCATION-SPECIFIC PROJECTS

TRIBAL

Ho-Chunk Communities of Indian Mission and Sand Pillow

9KH36 Simulation of Shallow Ground-Water Flow for the Ho-Chunk Nation area of Indian Mission and Sand Pillow with the Use of an Analytic Element Model

Lac Courte Oreilles Indian Reservation

9KH35 Grindstone Springs

Stockbridge-Munsee Indian Reservation

9KH11 Simulation of Shallow Ground-Water Flow on the Stockbridge-Munsee Indian Reservation with the Use of an Analytic Element Model

REGIONAL

North-central Wisconsin

9KH52 Hydrologic and Biogeochemical Budgets in Temperate Lakes and their Watersheds, Northern Wisconsin

Northwest Wisconsin and Northwest Minnesota

9KH41 NPS St. Croix Ground Water

Southeast Wisconsin

9KH26 Great Lakes Protection Fund Web site

9KH37 Chiwaukee Prairie Ground Water

COUNTY

Dane County

9KC31 Black Earth Creek Ground-Water/Surface-Water Model

9KH32 Monitoring Contaminant Flux from a Stormwater Infiltration Facility to Ground Water

Forest County

9KH47 Crandon Ground Water

Menominee County

9KH12 Characterization of the Regional Aquifer Flow-System on the Menominee Indian Reservation

MUNICIPAL

Tomah, Monroe County

9KH40 Department of Justice Assistance

USGS Black Earth Creek GW/SW Model

Cooperator: Village of Cross Plains, Wisconsin Department of Natural Resources

Project Chief: Randy Hunt, Dave Graczyk

Location: Western Dane County

Project Number: 9KC31

Period of Project: July 2003–June 2004

PROBLEM

Six miles of Black Earth Creek are classified as Class I trout water with an additional six miles of stream classified as Class II trout water. Urbanization within Dane County may affect the water resources that are critical to maintain the coldwater fishery. A DNR report on the 2001 fish kill on Black Earth Creek notes, "Increased development which brings with it an increase in impervious surfaces poses a long-term threat to the stream ecosystem."

OBJECTIVE

The objective of the study is to compile existing data from the watershed and construct a ground-water and surface-water model suitable for future work on: (1) quantitatively characterizing the hydrologic system, (2) assessing gaps in the existing data, and (3) providing an initial tool suitable for urbanization and associated mitigation scenario simulations.

APPROACH

The hydrologic system will be simulated using a ground-water/surface-water numerical model. The ground-water-flow model is extracted from a regional Dane County model with subsequent vertical and horizontal detail and refinement of surface-water features. The surface-water model was developed using the high-resolution digital elevation model and data sets available for the basin.

PROGRESS (JULY 2003–JUNE 2004)

Historical data and reports were compiled and evaluated. The models were constructed and calibrated using historic data. A draft report describing model approach, construction, and calibration was prepared.

PLANS (JULY 2004–JUNE 2005)

The project report will be finalized.

Simulation of Shallow Ground-Water Flow on the Stockbridge-Munsee Indian Reservation with the Use of an Analytic Element Model

Cooperator: Stockbridge-Munsee Band of Mohican Indians

Project Chief: Charles P. Dunning

Location: Stockbridge-Munsee Reservation

Project Number: 9KH11

Period of Project: January 2002–September 2004

PROBLEM

The Stockbridge-Munsee Indian Tribe of northeastern Wisconsin is interested in increasing their understanding of regional ground-water flow across the reservation. This understanding can be applied to a variety of water-management needs, and will enable the Tribe to make informed decisions about water quantity and quality issues.

OBJECTIVE

The objective of this study is to develop an understanding of the regional ground-water flow system across the Stockbridge-Munsee Indian Reservation, and to provide the Tribe a tool to investigate a wide range of water-resource problems.

APPROACH

Water supply for the Stockbridge-Munsee Indian Reservation is provided primarily by shallow wells completed in unconsolidated glacial sediments. Because of the relatively uncomplicated nature of the glacial sediment aquifer on the reservation, the analytic element model code GFLOW has been used to simulate the ground-water/surface-water system across the Stockbridge-Munsee Reservation. Once calibrated, the model can be used to simulate and plot the direction of ground-water flow and ground-water travel time. The results of this study will provide the Tribe with a water-resources-management tool that will help assess the fate and transport of contaminants and provide the necessary information to plan well-head protection strategies for the community well systems. Tribal staff will benefit from this study by learning appropriate techniques to determine contributing areas and time of travel. The study will help determine areas where future data collection may be needed to understand the complexities of the ground-water-flow system.

PROGRESS (OCTOBER 2003–SEPTEMBER 2004)

Hydraulic detail has been added to the regional GFLOW model around the Stockbridge-Munsee reservation area. Additional hydraulic head and streamflow targets have been compiled and added to the model. Additional streamflow measurements were taken at several locations across the reservation.

Model calibration has been completed, and the model is being used to address a number of water-management issues including evaluating new municipal locations. The results of this investigation are being summarized in a Scientific Investigations Report.

PLANS (OCTOBER 2004–SEPTEMBER 2005)

The Scientific Investigations Report will be printed and distributed.

Characterization of the Regional Aquifer Flow System on the Menominee Indian Reservation

Cooperator: Menominee Indian Tribe of Wisconsin

Project Chief: Charles P. Dunning

Location: Menominee County

Project Number: 9KH12

Period of Project: October 1998–September 2005

PROBLEM

The Menominee Indian Tribe is interested in increasing their understanding of regional ground-water flow across the reservation. Of specific interest is determining contributing areas and time of travel for water captured by wells for a number of community water systems. The Tribe's interest in well-head protection is heightened over concern about the presence of elevated nitrate levels in several wells.

OBJECTIVE

The objective of the study is to increase understanding of regional ground-water flow, and to determine the contributing areas and time of travel for water captured by community wells. This information will be used by the Menominee Indian Tribe for water resource and well-head protection planning in community areas.

APPROACH

The USGS will construct a simple one-layer, analytic element model to simulate regional ground-water flow across the reservation, and specificaly the hydrologic conditions in an appropriate area around community wells. The ground-water flow model will be used to delineate the zone of ground-water contribution to the wells for 5-, 10- and 100-year times of travel, and define the associated area of contribution. The results of these investigations will provide the Tribe with the necessary information to plan a well-head protection strategy for each community system.

PROGRESS (OCTOBER 2003–SEPTEMBER 2004)

Calibration of the reservation-wide analytic element model has been completed. Model simulations and insight gained through the study have been instrumental in:

- identifying locations around Zoar that will avoid the elevated nitrate found in the current municipal wells.
- identifying locations around Keshena for new municipal wells whose contributing areas are undeveloped, do not include the Wolf River, and are on land controlled by the Tribe.
- evaluating the hydrologic setting of the community wells and the sewage treatment lagoons in Neopit.
- completing specific ground-water-flow modeling at five other communities on the Reservation—Zoar, Neopit, Middle Village, Onekewat, and Redwing.

Results of these investigations are being summarized in a Scientific Investigations Report.

PLANS (OCTOBER 2004–SEPTEMBER 2005)

The Scientific Investigations Report will be printed and distributed.

Great Lakes Protection Fund Web Site

Cooperator: Great Lakes Protection Fund

Project Chief: Daniel T. Feinstein

Location: Southeastern Wisconsin

Project Number: 9KH26

Period of Project: September 2002–September 2004

PROBLEM

Much 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, Menomonee 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. At a more regional scale, the issue of protecting the waters of the Great Lakes has become central and led to efforts to revise the Great Lakes Charter to strictly regulate diversions from the Great Lakes Basin. An example of the kind of question raised by the proposed Annex to the Charter is the location of ground-water divides relative to the surface-water divide that separates the Great Lakes from the Mississippi River Basins and the implications of its location for regulating diversions.

OBJECTIVE

The three-dimensional ground-water model for southeastern Wisconsin, completed in 2003, provides a good tool to study the effects of pumping on ground-water flow to Lake Michigan and ground-water flow between the Mississippi River and Great Lakes Basins. The Great Lakes Protection Fund asked the USGS to construct a web site that would serve to educate the public about ground-water flow and present the model findings in the context of resource issues involving the Great Lakes. The web site is also meant to provide policy makers such as members of the Great Lakes Council of Governors with information helpful in revising the Great Lakes Charter. The model of Southeastern Wisconsin provides a case study for how ground water interacts with the Great Lakes and how pumping has influenced these interactions.

APPROACH

The web site contains two main parts. The first provides concepts important in understanding the flow and availability of ground water. The second applies these concepts to the case study of southeastern Wisconsin. A final page summarizes the findings of the model in terms of the location of ground-water divides, their response to pumping, and the effect of pumping on ground-water movement toward Lake Michigan.

PROGRESS (JULY 2003–SEPTEMBER 2004)

A full version of the web site was completed during this period and the site is available to the public at: *http://wi.water.usgs.gov/glpf/*.

PLANS (OCTOBER 2004–SEPTEMBER 2005)

Future updates to the web site are aimed at improving its appearance and ease of use.

Monitoring Contaminant Flux from a Stormwater Infiltration Facility to Ground Water

Cooperator: Wisconsin Department of Natural Resources

Project Chief: Charles P. Dunning

Location: Dane County

Project Number: 9KH32

Period of Project: July 2001–October 2005

PROBLEM

Wisconsin State administrative code NR 151 defines performance standards for infiltration of stormwater from new developments. The stormwater infiltration standards are intended to preserve ground-water recharge and stream baseflow. However, depending on the land-use characteristics of a drainage area, stormwater may contain significant amounts of contaminants including hydrocarbons, metals, and chloride. In such cases, enforcement of infiltration performance standards has the potential to adversely affect ground-water quality.

OBJECTIVE

The objective of this study is to quantify the relation between the quality of stormwater from the Stonefield neighborhood in Middleton, Wisconsin, the hydrologic character of the infiltration basin, and transport of contaminants to the ground-water system.

APPROACH

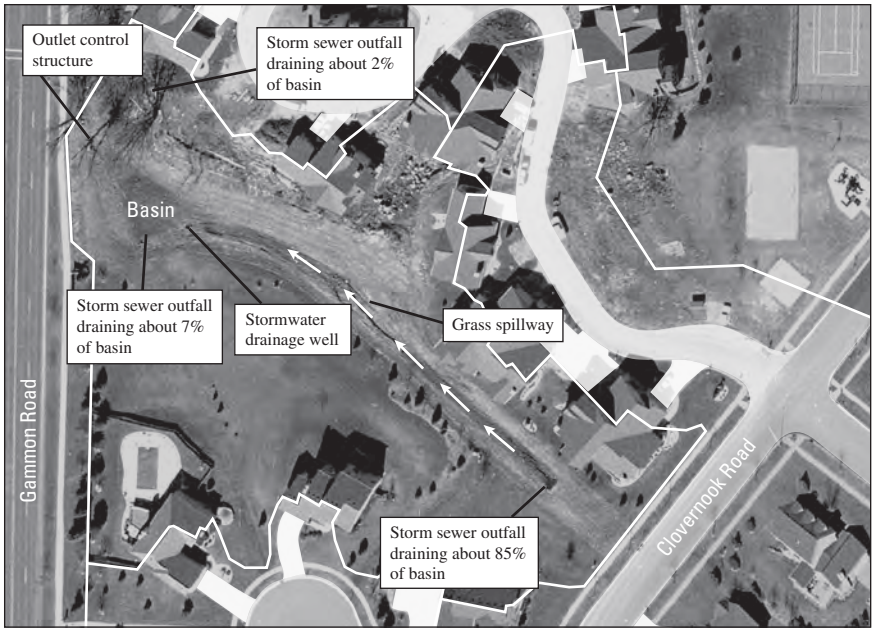
The hydrology of the Stonefield infiltration site was characterized by defining the contributing watershed, coring and describing the sediments from the ground surface in the basin to the ground-water table, monitoring pond stage during stormwater runoff events, monitoring water-table elevation, and monitoring flow into the injection well. Water was sampled for chemical analysis from ponded stormwater, from the water table, and from the vadose zone above the water table. Water-quality sampling was done on a routine schedule as well as in response to events. The period of study was from July 2001 to June 2004, with data collection for different study aspects beginning at different times.

PROGRESS (OCTOBER 2003–OCTOBER 2004)

The Stonefield basin appears to be working as an infiltration site largely because the stormwater discharge well routes ponded stormwater to porous, unsaturated sediments below. Infiltration is generally slow through the basin bottom, but could probably be improved with conditioning of the shallow soils, establishment of appropriate vegetation, and strict control of sediment and debris in the watershed. Water-quality analyses to date suggest that the concentration of many constituents is lower in the site stormwater than in vadose or ground water; this is particularly true of the concentration of solids and most metals. While much work is yet to be done in interpreting these data, it appears that for such constituents, infiltration of stormwater from this watershed may benefit rather than degrade ground-water quality. Hydrologic and water-quality data collected during stormwater events may yet reveal some interesting relations between stormwater quality and transport of contaminants at the Stonefield site. Data continue to be collected and interpretation is ongoing.

PLANS (OCTOBER 2004–SEPTEMBER 2005)

No additional sampling or analyses are planned. Data reduction and interpretation will continue. The project will be summarized in a USGS Scientific Investigations Report.



Aerial photo of a portion of Stonefield neighborhood including the infiltration basin, stormwater drainage well, storm sewer outfalls, and grass spillway.

Grindstone Springs

Cooperator: Lac Courte Oreilles Indian Tribe of Wisconsin

Project Chief: Randy Hunt

Location: Lac Courte Oreilles Indian Reservation

Project Number: 9KH35

Period of Project: July 2002–December 2003

PROBLEM

The Lac Courte Oreilles Tribe has concerns regarding possible reductions in springflow along Grindstone Creek due to development in the area. An understanding of the ground-water-flow system in the vicinity of the springs is needed to evaluate potential effects such as pumping on discharge from the springs and base flow in the creek.

OBJECTIVE

The project objectives are to: (1) monitor streamflow in Grindstone Creek, (2) simulate the regional and local ground-water/surface-water system and the effects of hypothetical pumping on springflow and flow in Grindstone Creek.

APPROACH

The ground-water-flow system in the vicinity of Grindstone Creek was simulated with GFLOW, an analytic element ground-water-flow model. The parameter estimation model, UCODE, was used to optimize the GFLOW model calibration to measured streamflows and ground-water levels, including existing data and measurements made during this project.

PROGRESS (JULY 2003–JUNE 2004)

The ground-water-flow model was calibrated, and scenarios based on hypothetical annual pumping and maximum seasonal pumping were simulated. The parameter estimation code, UCODE, was used to estimate 95 percent confidence intervals around simulated reductions in base flow in Grindstone Creek for the pumping scenarios.

PLANS (JULY 2004–SEPTEMBER 2005)

The project has been completed.

REPORTS

None.

Simulation of Shallow Ground-Water Flow for the Ho-Chunk Nation Area of Indian Mission and Sand Pillow with the Use of an Analytic Element Model

Cooperator: The Ho-Chunk Nation

Project Chief: Charles P. Dunning

Location: The Ho-Chunk Nation communities of Indian Mission and Sand Pillow

Project Number: 9KH36

Period of Project: January 2003–September 2004

PROBLEM

The Ho-Chunk Nation of Wisconsin is seeking assistance in identifying sources of ground water to satisfy future water needs of the Indian Mission and Sand Pillow communities in Jackson County, Wisconsin. Projected demand in five years is 114,000 gpd (gallons per day); projected demand in twenty years is 216,000 gpd. In order to provide for the anticipated water demand in the most efficient and sustainable way, an understanding of the geology and hydrology of the aquifer is necessary.

OBJECTIVE

The objective of this USGS project is to assist the Ho-Chunk Nation in understanding ground-water flow in the vicinity of the Mission and Sand Pillow communities, and identify water resources to support planned growth in the area. In doing so this work will help characterize the regional ground-water flow system across the Stockbridge-Munsee Indian Reservation, and provide the Tribe a tool to investigate a wide range of water-resource problems. This understanding can be applied to a variety of water-management needs, and will enable the Tribe to make informed decisions about water-quantity and -quality issues.

APPROACH

This hydrologic investigation was undertaken using a single-layer model calibrated to existing data. Additional field data may be collected to assist in characterizing the aquifer and refine the hydrologic model. Zones of contribution to existing municipal wells will be delineated and hydrogeologically favorable locations for new municipal wells will be identified.

PROGRESS (JANUARY 2003–OCTOBER 2004)

The single-layer analytic element model has been constructed and calibrated to existing data and additional data that resulted from a USGS augering program in the Sand Pillow and Indian Mission areas. Based on model simulations and hydrogeologic information gained through the auger investigation, three loca-

tions were identified as most favorable for future water supplies. Two of the three test wells returned very good water-quality analyses; the third well tested high in iron, the principle water-quality problem in the area. Using the analytic element model, zones of contribution were determined for the existing municipal wells, as well as for combinations of location and pumping rates for the new well locations. A USGS Scientific Investigations Report is in preparation.

PLANS (OCTOBER 2004–SEPTEMBER 2005)

Print and distribute Scientific Investigations Report.

Chiwaukee Prairie Ground Water

Cooperator: Southeastern Wisconsin Regional Planning Commission (SEWRPC)

Project Chief: Daniel Feinstein

Location: Southeastern corner of Wisconsin

Project Number: 9KH37

Period of Project: June 2003–June 2004

PROBLEM

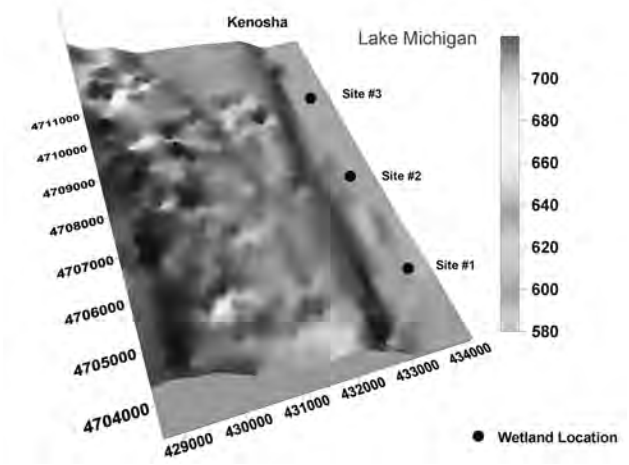
Wetland loss has been an important issue in Wisconsin and across the United States. Seasonal wetlands, which may be dry during much of the growing season, have been most significantly affected due to the difficulties associated with their identification and their easy conversion to other uses. In southeastern Wisconsin seasonal wetlands occupy the coastal zone near the border with Illinois, and are threatened by development in the area.

OBJECTIVE

The objectives of this data-collection and ground-water-modeling study are to better understand the shallow ground-water conditions in the vicinity of these seasonal wetlands and to develop a planning tool that can be used to help protect them. The modeling puts great emphasis on the relation between ground water and ground-water-fed surface-water bodies that include perennial creeks and Lake Michigan as well as wetlands. The model identifies expected recharge areas that act as sources of waters to the wetlands, and simulates effects of land-use changes associated with potential development on seasonal wetland ground-water levels.

APPROACH

The approach combined field activities and ground-water-flow modeling to produce a better understanding of the sources, circulation, and discharge behavior of the ground water in the vicinity of the wetlands. By accounting for all ground-water



sinks in the area, the flow model is capable of delineating the recharge areas that contribute water that sustains the seasonal coastal wetlands. By calibrating the model to observed field data, the model provides a reliable tool for studying the effects of development and other land-use or climatic changes on water level conditions around and under the wetlands.

PROGRESS (JULY 2003–JUNE 2004)

Field activities included installation of six water-table wells and three piezometers in the sedge meadow and wet prairie parts of three seasonal coastal wetlands. Continuous water levels were collected from some of the wells. The data showed that the Carol Beach/Chiwaukee Prairie wetlands are dry during much of the growing season, but at other times they interact with ground water when the water table rises into the root zone of the vegetation. Water-level data from wells installed in these wetlands demonstrates that this ground-water-fed condition occurs over much of the year. Other field-related activities involved GPS surveys to determine precise stages of water bodies and stream gaging to provide measurements of baseflow in streams.

Because of the importance of shallow ground-water/surface-water interactions in understanding the hydrology of the Chiwaukee Prairie area, we applied a modeling code called GFLOW that is particularly adapted to modeling ground-water flow in the presence of many small water bodies. After construction of the model and calibration to water-table depths and stream baseflow, particle tracking was used to delineate contributing areas to three wetlands. A set of simulations was devoted to what-if scenarios involving changing levels of Lake Michigan, installation of dewatering drains near the coast, and development near the coast. The model predicted the effect of such changes on water levels around the seasonal wetlands.

In the spring of 2004, a technical memorandum was prepared to describe the field and modeling activities. This memorandum is part of a larger report on the wetland ecology prepared by SEWRPC.

PLANS (JULY 2004–SEPTEMBER 2004)

An account of the fieldwork and modeling activities will contribute to future journal article(s) on the seasonal wetlands in southeastern Wisconsin.

REPORTS

None.

USGS Recharge Project

Cooperator: USGS Office of Ground Water

Project Chief: Randy Hunt

Location: Statewide

Project Number: 9KH38

Period of Project: March 2003–September 2006

PROBLEM

Knowledge of recharge rates is paramount for understanding ground-water systems and determining water-resource vulnerability. Moreover, the travel time of contaminants in the subsurface, and the time lag before contamination may affect important water resources, depends in part on recharge rates. More accurate estimates of ground-water recharge rates by the USGS will greatly enhance our ability to simulate ground-water systems, and provide a higher level of understanding for informed water-resource-management decisions.

OBJECTIVES

The objective of the study is to improve the understanding of the spatial and temporal characteristics of ground-water recharge in humid climates. Work elements include both interpretation of existing data sets and new data collection as needed.

APPROACH

The approaches used include regression modeling of base flow, coupled ground-water/surface-water modeling, and investigation into the temporal and spatial distribution of recharge in Wisconsin. A second area of work will involve analysis of the long-term Ground Water Observation Well database for climate trends and effects of oceanic climate signals.

PROGRESS (JULY 2003–SEPTEMBER 2004)

A preliminary time series analysis of 23 water-table wells in Wisconsin's ground-water observation well network was completed; the time series show Monsoonal decadal climate influences. Increasing water level trends from the 1970s through 1999 were noted, with an indication of decline in water levels since 1999. Stream baseflow measurements throughout the state were compiled and analyzed to assess ground-water recharge rates. The results show both regional coherence and appreciable basin variability. A climate/recharge journal article was completed and included in the Wisconsin Academy of Sciences, Arts, and Letters "Waters of Wisconsin" *Transactions* volume.

PLANS (OCTOBER 2004–SEPTEMBER 2005)

Future work will investigate recharge zonation in a highland forest, a glaciated rural area, and an unglaciated rural area of the state. Zonation will be evaluated using hydrologic models and measured data. Time series analysis will be performed on all the Observation Well Network data and selected streamflow data for climate effects and representativeness for the statewide conditions.

USGS DOJ Assistance

Cooperator: U.S. Department of Justice

Project Chief: Randy Hunt

Location: Tomah

Project Number: 9KH40

Period of Project: March 2003–May 2004

PROBLEM

As part of a Clean Water Act enforcement on an alleged wetland fill, questions regarding the presence of wetland hydrology became an issue. The definition of a "wetland" requires that soil, vegetation, and hydrology criteria be met.

OBJECTIVE

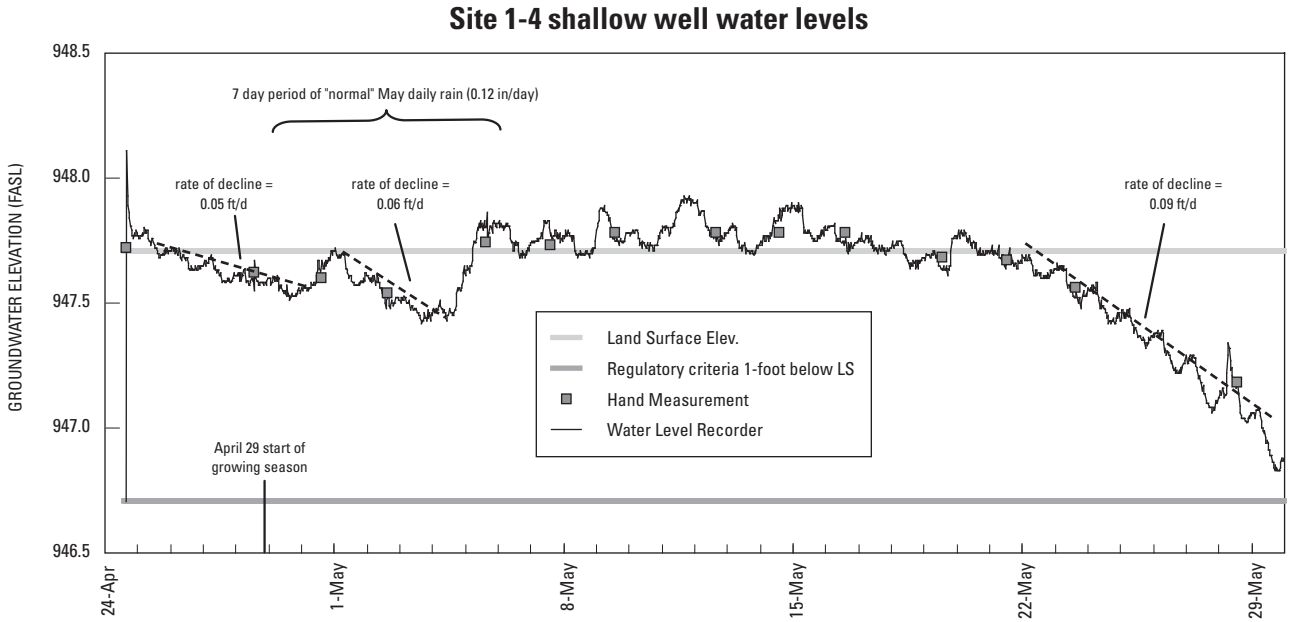
The objective of the study was to characterize the hydrology of the site to determine if wetland hydrology criteria were met.

APPROACH

The approach included installation of 6 shallow wells, 1 deeper piezometer, and 2 staff gages in a stream and ditch adjacent to the site area. Shallow wells were instrumented with pressure transducers and dataloggers. Periodic hand measurements were taken from all wells and the staff gages. Meteorological data from a nearby weather station were used to evaluate climate effects on the site hydrology.

PROGRESS (JULY 2003–JUNE 2004)

Data were collected and evaluated for the 2003 growing season. Wetland hydrology criteria were met at all locations on the site. A summary judgment was handed down before trial that ruled the site was a wetland, but left some questions regarding liability unresolved. The litigation with the landowner was then settled



before trial, and the contractor performing the fill was found at fault at the conclusion of the trial. Civil penalties totaling $160,000 were assessed to the landowner and contractor.

PLANS (JULY 2004–SEPTEMBER 2005)

The project is complete.

NPS St. Croix Ground Water

Cooperator: National Park Service (NPS)

Project Chief: Daniel Feinstein

Location: Northwestern Wisconsin and Northeastern Minnesota

Project Number: 9KH41

Period of Project: October 2002–September 2004

PROBLEM

Streams tributary to the St. Croix River flow through 19 counties in northwestern Wisconsin and northeastern Minnesota. A number of water-quality studies have been done in the St. Croix Basin to determine loadings and source areas of contamination, but none of these studies have attempted to explain water-quality results based on how the hydrologic system works. To do this, a process-based framework synthesizing what is known about the hydrology (both ground and surface water) is needed. The framework required would describe sources and sinks of water and general directions of ground-water flow and estimates of travel times. This framework should also highlight areas where more and what types of data are needed to contribute to the understanding of the system.

OBJECTIVE

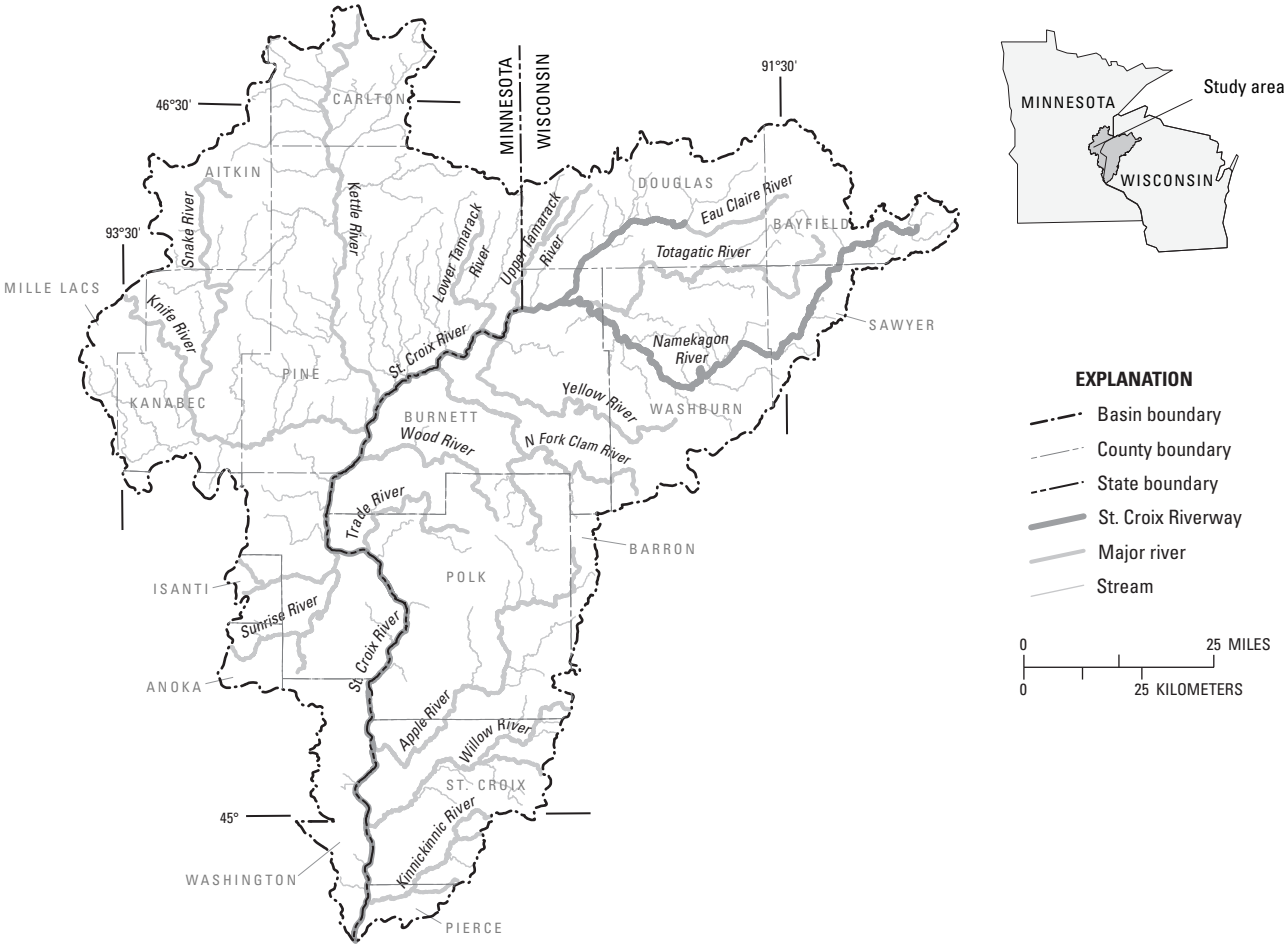
The overall study objective is to improve understanding of the St. Croix River Basin by testing alternative conceptual models of the system in a quantitative framework, a process that highlights areas where more data are needed. Other objectives include: evaluating surface-water/ground-water interactions and base-flow contributions to streams; describing general directions of ground-water flow and estimating rates of flow and travel times; and providing information that can be used to characterize contaminant movement in the Basin.

APPROACH

A stepwise modeling approach has been adopted that uses a simple screening model to test conceptual models and to guide future field data collection. This approach is preferable to more traditional approaches (where all data collection takes place before the modeling is initiated) because gaps in our understanding are identified at the beginning of the project. The analytic-element code GFLOW will be used in this study because the regional system is largely two-dimensional and seasonal precipitation can be approximated by steady-state conditions. Moreover, conceptual model testing that evaluates the importance of surface-water features as sinks and sources of water are easily accommodated in GFLOW.

PROGRESS (JULY 2003–JUNE 2004)

The main tasks fulfilled in 2003 and 2004 include completion of databases, construction of a regional screening model, and calibration of the model. Numerous GIS-based geologic maps from science agencies in both Wisconsin and Minnesota have been trimmed and projected into a unified project coordinate



Location of study area, St. Croix River Basin, Minnesota and Wisconsin.

system. Additional GIS-based maps with land use, hydrography, and infrastructure data have been incorporated as well. Well data from over 27,000 geologic logs and well construction records were selected in the 19-county watershed, and evaluated for use in the development of the flow model. Currently, there are six databases: well location and unifying identifier database, geology database, lithology database, surface-water discharge database, water-use database, and the ground-water-level observation database.

Construction of the flow model has involved delineation of hydraulic conductivity zones based on information in the geology and lithology databases. Point estimates of hydraulic conductivity across glacial and bedrock deposits are contoured, and the resulting map is zoned to provide model input. Stage data for hundreds of streams and lakes has been carefully compiled from topographic maps.

Calibration of the flow model depends on the match of observed head and base-flow values to simulated results. The head values reflect water-table conditions and are derived from measurement on shallow wells. The base flow estimates reflect the average ground-water contribution to streams and are derived from the streamflow database maintained by the USGS. Both trial-and-error and a parameter-estimation tool (UCODE) were used to calibrate the model. Sensitivity runs have also been performed to evaluate the effect of changing the input zonation and introducing pumping wells. Finally, the model was used to simulate ground-water contributing areas to streams in sensitive areas identified by the NPS.

PLANS (JULY 2004–SEPTEMBER 2004)

Maps detailing model input along with the simulated regional water table and capture zones around streams will be prepared. Also under preparation are explanations of methodology (for example, the application of parameter estimation) and discussions of uncertainty related to data gaps made evident in the modeling process. Tables will be constructed to present the series of databases devoted to geology, lithology, well information, water levels, and streamflow.

REPORTS

A USGS Scientific Investigations Report detailing data collection, construction and calibration of the screening model, and analysis of results for the St. Croix Basin will be prepared for the NPS in the summer and fall of 2004.

Drilling Operations Group

Cooperators: Numerous

Project Chief: James M. Rauman

Location: Nationwide

Project Number: 9KH44

Period of Project: Ongoing

PROBLEM

Ground-water investigations often required installation of monitoring wells or piezometers, collection of rock core or unconsolidated samples, or sampling for water-quality analysis.

OBJECTIVE

The objective of the Wisconsin District Drilling Operations Group is to provide equipment and expertise for a wide range of field drilling, instrumentation, and testing in support of hydrogeologic investigations. Equipment and staff are available to assist state, local, and tribal agencies with needed field support.

APPROACH

Equipment includes a drill rig, a packer rig, and a geoprobe mounted on an all-terrain vehicle. Drilling and testing activities are tailored to project requirements, and since the staff and equipment are housed at the Wisconsin District, field logistics are efficient. The following figure summarizes recent activities of the Drilling Operations Group.

Crandon Ground Water

Cooperator: Wisconsin Department of Natural Resources

Project Chief: Daniel Feinstein

Location: Forest County

Project Number: 9KH47

Period of Project: October 1994–June 2004

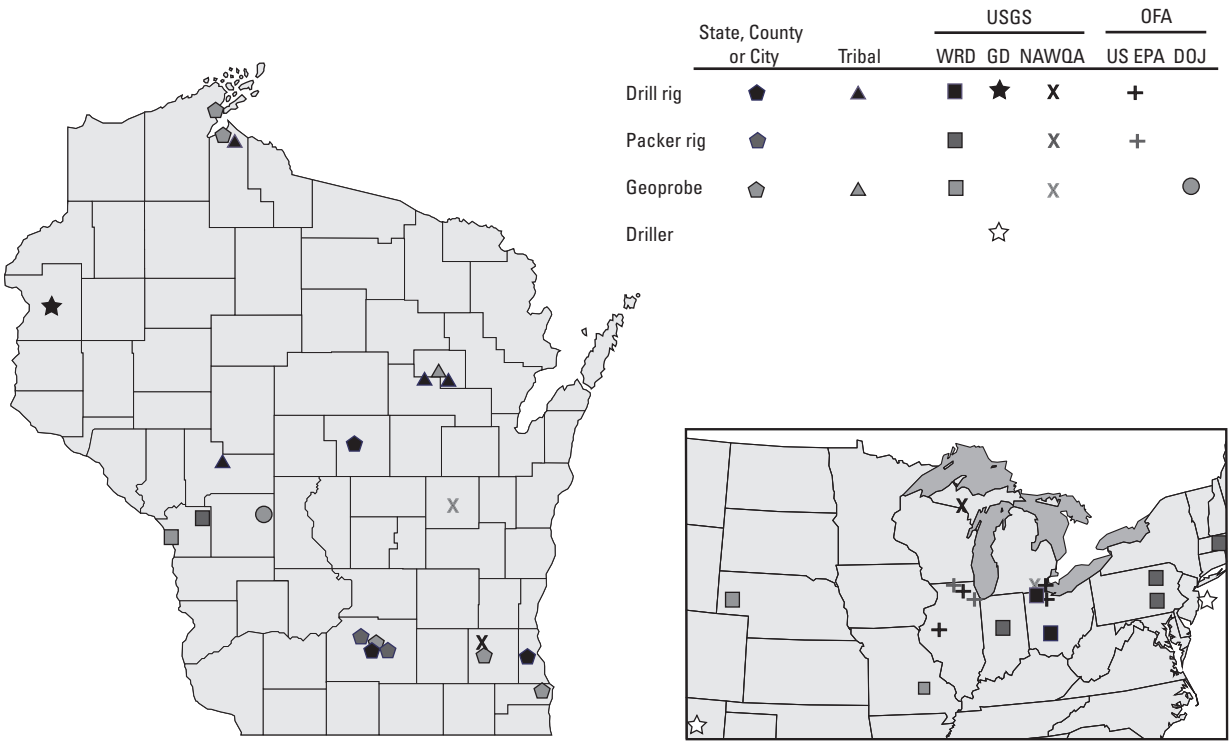
PROBLEM

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. After a very long technical process but before a final permit hearing, the mining rights were purchased by two local Native American tribes who have withdrawn the permit.

OBJECTIVE

The objective is to archive a decade of work involving mostly interpretation of hydrogeologic data, and submit part of the archive to the WDNR.

Activities of the Wisconsin District Drilling Operations Group



APPROACH

Hard copies of data sheets, analyses and memo drafts will be stored in boxes according to USGS protocol. All computer material is to be submitted to the WDNR on DVD disks.

PROGRESS (JULY 2003–JUNE 2004)

During this last period of work, several technical memoranda were completed including studies of effects of heterogeneity on ground-water/lake interactions. A new draft of the Technical Working Group's report for the ground-water-flow model was completed and reviewed. It includes new sections such as an analysis of the effect of drought on mine impacts. A review of two contaminant transport models, one devoted to the Tailings Management Area and the other to issues arising from mine reflooding, was completed. Beginning in later 2003, activities shifted to archiving hardcopy and computer material. The base, sensitivity, and scenario runs with the MODFLOW flow model have been entirely archived.

PLANS (JULY 2004–SEPTEMBER 2004)

The archiving will be completed in 2004, completing the project.

REPORTS

None.

Collection of Basic Records–Ground Water

Cooperator: Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension

Project Chief: Charles P. Dunning

Location: Statewide

Project Number: 9KH50

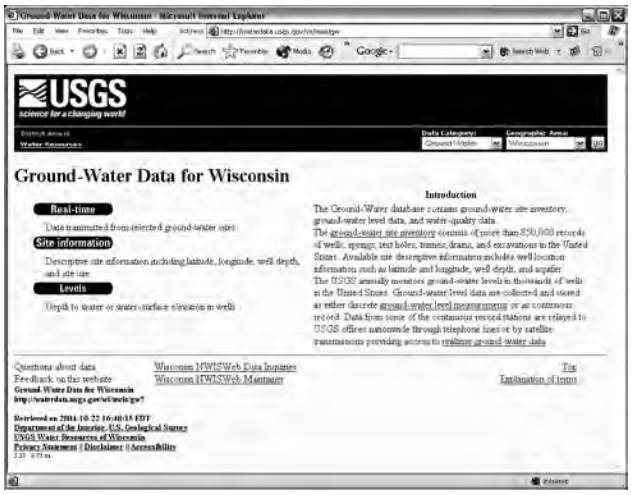
Period of Project: July 1946–Continuing

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 human-induced and how these changes are affecting storage in the ground-water reservoirs.

OBJECTIVE

Maintain records of ground-water level fluctuations from a network of observation wells representative of Wisconsin's principal aquifers.



http://waterdata.usgs.gov/wi/nwis/gw

APPROACH

A basic network of 106 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 (OCTOBER 2003–SEPTEMBER 2004)

Routine data collection and data being collected by observers is evaluated and entered into USGS databases. Water-level data for the annual report, "Water Resources Data–Wisconsin, Water Year 2003" was completed. Water-level data for all observation wells was made available on the Internet at *http://wi.water.usgs.gov*.

PLANS (OCTOBER 2004–SEPTEMBER 2005)

Plans include: (1) continue measurements on the observation-well network, (2) replace and hire new observers as needed, and make quality-assurance visits when possible, and (3) evaluate and prepare data for the annual report. A thorough re-evaluation of the network and its objectives is planned, as is an aggressive program for converting to real-time reporting of water levels where possible and identifying new sources of funding.

REPORTS

Patterson, G.L., and Zaporozec, A., 1988, Analysis of water-level fluctuations in Wisconsin wells: Wisconsin Geological and Natural History Survey Information Circular 63, 38 p.

Erickson, R.M., and Cotter, R.D., 1983, Trends in ground-water levels in Wisconsin through 1981: Wisconsin Geological and Natural History Survey Information Circular No. 43, 139 p.

Erickson, R.M., 1972, Trends in ground-water levels in Wisconsin, 1967–71: Wisconsin Geological and Natural History Survey Information Circular No. 21, 40 p.

Devaul, R.W., 1967, Trends in ground-water levels in Wisconsin through 1966: Wisconsin Geological and Natural History Survey Information Circular No. 9, 109 p.

Wisconsin Water-Use Data File

Cooperator: Wisconsin Department of Natural Resources

Project Chief: Charles P. Dunning

Location: Statewide

Project Number: 9KH51

Period of Project: March 1978–Continuing

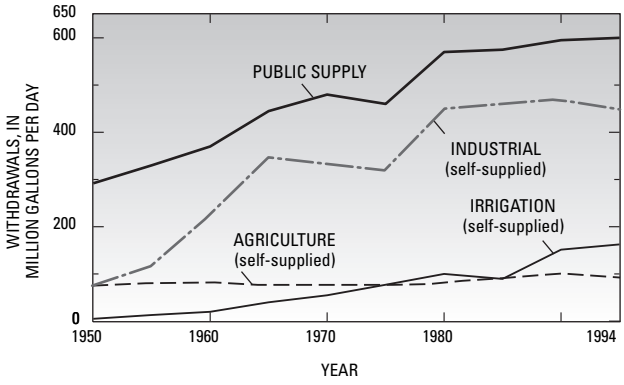
PROBLEM

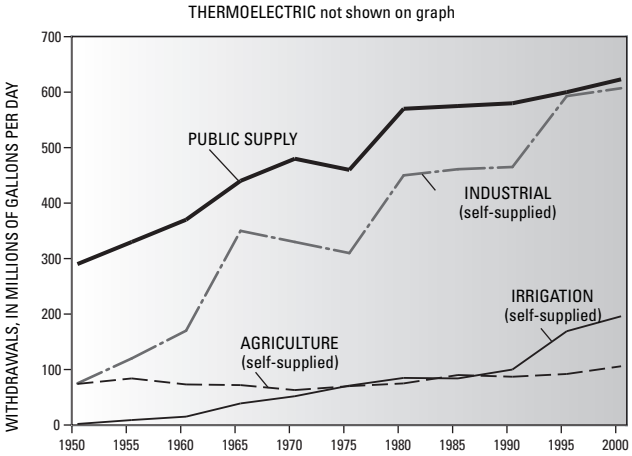
The need for reliable water-use data by State and Federal planning agencies is increasing as the competition for water resources grows. Water-use data in a standardized format needs to be available to assist in making decisions on future water use. Since about 1950 the federal government has had a program for estimating national water use. Since 1995, USGS and WDNR have been involved in a cooperative program to collect and summarize water use in Wisconsin.

OBJECTIVE

The purpose of the National Water-Use Information Program is to:

- analyze the source, use, and disposition of water resources at local, state, and national levels;
- reply to water-use information requests from the public;
- document trends in water use in the United States;
- cooperate with state and local agencies on projects of special interest;
- develop water-use databases; and
- publish local, state, and national water-use data reports





The specific goals of the cooperative USGS/WDNR project is to collect accurate and complete data on Wisconsin's water use, archive the data in useful format, and to prepare periodic reports on water use in the State.

APPROACH

Analyze the source, use, and disposition of water resources at local and state levels. The best available data is compiled, evaluated, and managed in a USGS database. The means of collecting water-use data, and its resulting accuracy, is constantly evaluated.

PROGRESS (OCTOBER 2003–SEPTEMBER 2004)

The database has been updated with current water-use data. These data included high-capacity well data, public-supply information, and data used to estimate irrigation water use.

PLANS (SEPTEMBER 2004–OCTOBER 2005)

Plans include: (1) continue to update and maintain the database with current water-use data, (2) supply water-use data for water-resources studies currently being conducted in the State, and (3) prepare for the next water-use report, "Water Use in Wisconsin, 2005." A thorough re-evaluation of the water-use project is planned, as is an aggressive program for identifying new ways of identifying and compiling data. We will work with the State of Wisconsin to maximize the effectiveness of those aspects of the new water quantity legislation intended to provide accurate and complete estimates of water use around the state. At the federal level there is growing interest in quantifying water use by aquifer as well as by the traditional use categories.

REPORTS

Ellefson, B.R., Mueller, G.D., and Buchwald, C.A., 2002, Water use in Wisconsin, 2000: U.S. Geological Survey Open-File Report 02–356, 1 sheet, scale 1:5,000,000.

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

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

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

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

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

Lawrence, C.L., and Ellefson, B.R., 1982, Water use in Wisconsin, 1979: U.S. Geological Survey Open-File Report 82–444, 98 p.

Hydrologic and Biogeochemical Budgets in Temperate Lakes and their Watersheds, Northern Wisconsin

Cooperator: Global Change Hydrology Program, U.S. Geological Survey

Project Chiefs: John F. Walker; David P. Krabbenhoft; Randy J. Hunt

Location: North-Central Wisconsin

Project Number: 9KH52

Period of Project: October 1990–Continuing

PROBLEM

There has been expanding evidence that rates of global change 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 change. Promotion of such research is the function of the Water Resources Discipline'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 (^{13}C, ^{18}O, ^{87}Sr, and ^{2}H) 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 2003–SEPTEMBER 2004)

Ongoing data collection efforts have continued, which include collecting samples at the streams tributary to Trout Lake, operating 5 continuous-record stream gages monitoring water levels

in a network of 22 wells, and operating four detailed monitoring sites at existing benthic invertebrate sampling sites. A new initiative in collaboration with the University of Wisconsin included installation and monthly sampling of piezometers located along three flowpaths within the Allequash Creek basin. Work continued on five new research efforts, including a comparison of solute budgets across the five WEBB sites, a unified approach to watershed modeling applied to the five WEBB sites, comparison of land-use history and sediment and carbon budgets across the five sites, investigation of mercury cycling across the five sites, and an investigation of macroinvertebrate populations and energy dynamics in the Allequash Creek system.

PLANS (OCTOBER 2004–SEPTEMBER 2005)

Basic data collection efforts will continue, as well as data-collection efforts related to flow-path studies, carbon dynamics in the hyporheic zone, unsaturated zone processes, mercury cycling and macroinvertebrate dynamics. Collaborative work with the Geology Department at the University of Wisconsin will continue. Several papers currently in preparation will be completed and submitted to appropriate journals.

REPORTS

Dripps, W.R., Hunt, R.J. and Anderson, M.P., in review, Estimating Recharge Rates With Analytic Element Models and Parameter Estimation: submitted to Ground Water.

Hunt, R.J., in review, Evaluating the importance of data type and location using parameter estimation and groundwater flow models: submitted to Ground Water.

Hunt, R.J., Strand, R.M., and Walker, J.F., in review, Measuring groundwater-surface water interaction and its effect on wetland stream benthic productivity, Trout Lake watershed, northern Wisconsin, USA: submitted to Journal of Hydrology.

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Hunt, R.J., 2002, Evaluating the importance of future data collection sites using parameter estimation and analytic element groundwater flow models in Proceedings of the XIV International Conference on Computational Methods in Water Resource: Delft, Netherlands, Delft University.

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Mercury Team

OFFICE OF THE ASSISTANT DISTRICT CHIEF FOR GROUND-WATER AND NATIONAL INVESTIGATIONS

MISSION

The mission of the Wisconsin District Mercury Research Laboratory (WDMRL) is to provide a better understanding of the causes of aquatic mercury contamination through the execution of scientific studies, and to provide expert assistance to the USGS and other state and Federal agencies. Assistance is provided through consultation, drafting and reviewing proposals, field sampling, sample analysis, interpreting data, and drafting reports. We strive to provide the best possible data and service by remaining on the cutting edge of mercury research, and maintaining a state-of-the-art mercury analysis laboratory. Our team objectives are:

- Continually seek high-quality projects that contribute to providing a better understanding of factors controlling mercury toxicity in the environment;
- Enhance the scientific level and facilitate the execution of mercury studies conducted by the USGS, and provide a better awareness of the nature of the mercury problem nationwide;
- Maintain a reliable level of challenging work that will sustain the professional and financial needs of the team; and
- Achieve a significant level of outreach to the USGS, other agencies, and the public.

An online description of the Mercury Studies Team mission, project descriptions, publications, laboratory operations, and other general information on mercury is at our Team home page: *http://infotrek.er.usgs.gov/mercury*.

TEAM MEMBERS

David P. Krabbenhoft, Research Hydrologist (Co-Team Leader, Geochemistry)
Mark L. Olson, Biologist (Co-Team Leader)
John F. DeWild, Hydrologic Technician
Shane D. Olund, Chemist
Michael T. Tate, Chemist
Tom Sabin, Hydrologic Technician
Michael O'Keefe, Student Trainee (Hydrology)
Carl Johnson, Hydrologic Technician (Student)
Angie Marik, Hydrologic Technician (Student)

PROJECTS

NATIONWIDE PROJECTS

9BI81 NAWQA Mercury Topical Study
AK710 National Mercury Project

PROJECTS OUTSIDE OF WISCONSIN

Florida Everglades
0H712 Florida Everglades Mercury Cycling

Lake Pontchartrain Basin, Southern Louisiana
9KL16 Mercury Cycling in the Lake Pontchartrain Basin, Louisiana Project

Lostwood National Wildlife Refuge, Northwestern North Dakota
ARN00 Mercury Contamination at the Lostwood National Wildlife Refuge, Northwestern North Dakota

Florida Everglades Mercury Cycling

Cooperator: Critical Ecosystems Program, U.S. Geological Survey, Reston, Virginia

Project Chief: David P. Krabbenhoft

Location: Florida Everglades

Project Number: OH712

Period of Project: January 1995–Continuing

PROBLEM

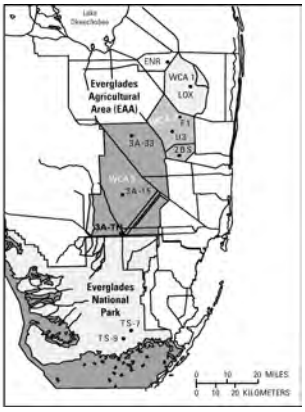
Mercury contamination is one of the largest potential health risks to aquatic organisms, predatory animals, and humans. This great concern is the result of two observations: (1) mercury biomagnifies in the food chain to toxic concentrations even though it is found at very low aqueous concentrations, 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 and applied, in-field experiments are used to determine the most important processes regulating the transport, fate, and toxicity of mercury in the Everglades, including methylation, volatilization, biological uptake, and interactions with dissolved organic carbon.

APPROACH

Mercury contamination of the Florida Everglades has been recognized as a serious problem for over a decade, yet solutions to the problem have remained elusive. Research conducted by the Wisconsin District Mercury Research Laboratory from 1995 to 2000 on the factors leading to high levels of mercury bioaccumulation revealed that in addition to mercury inputs, sulfate, phosphate, and organic carbon loading from upstream point sources, as well as water-level management, all likely contribute to the problem. To aid in the decision-making process for the Consolidated Everglades Restoration Program (CERP), which is an interagency program charged with developing the restoration plan for the Everglades, we have taken a new direction in our research to directly evaluate the relative importance of each of the co-factors. We have installed 75 wetland enclosures at five sites in the Everglades, and within them we are performing chemical addition studies using stable isotopes of mercury, sulfate, phosphate, and organic carbon to quantify the dose response of each to the formation of methylmercury and bioaccumulation in the food web. Following each amendment, sediment, surface water, pore water, plant, and fish samples are collected at several time intervals for periods up to six months. With this type of information, we will be able to provide a much clearer quantitative context of the relative importance of each of the contributing factors to the mercury problem, and agencies responsible for direction.



PROGRESS (JULY 2003–JUNE 2004)

During this time period, we executed our last planned mesocosm dosing experiment. Experimental variables included dosing at different rates with mercury (^{202}Hg and ^{200}Hg), sulfate and dissolved organic carbon (hydrophobic acid extracted from water taken from the northern Everglades). In addition, in November 2003, we initiated a sulfur toxicity experiment to determine whether sulfur loading derived from agricultural fields may be at least partially responsible for the die-off of sawgrass and replacement by cattails (sulfur tolerant) and net habitat degradation. Results to date show substantial methylmercury production response to mercury, sulfate, and dissolved organic carbon additions, the last being somewhat unexpected. Given that there are external sources of all three of these controlling factors on methylmercury production, and all of which are potentially influenced by existing Everglades Restoration plans, a robust plan is necessary. Presently, sulfur abatement is not part of Everglades Restoration planning, and if our toxicity experiments show a definitive and substantial response, new considerations may be necessary for Restoration Planners.

PLANS (JULY 2004–JUNE 2005)

Plans for this time period call for planning and beginning a new phase of mercury cycling research in south Florida that would include evaluations of methylmercury production and biological uptake in near coastal zones and embayments (for example, Florida Bay). Presently, most human exposure to methylmercury is through the consumption of marine fish, yet very little is known about how marine fish derive their methylmercury. This effort would begin to evaluate where this important exposure pathway originates.

REPORTS

The Aquatic Cycling of Mercury in the Everglades (ACME) project: A Synthesis of Scientific Findings (complete first draft by September 30, 2004).

NAWQA Mercury Topical Study

Cooperators: USGS: National Water Quality Assessment (NAWQA) Program, USGS Toxic Substances Hydrology Program, USGS National Research Program, Wisconsin Department of Natural Resources, Menominee Indian Tribe of Wisconsin

Project Chief: Barbara C. Scudder

Location: Nationwide, including 3 sites in Wisconsin: Oak Creek in Milwaukee, Evergreen River in the Menominee Indian Reservation, and Pike River near Amberg

Project Number: 9BI81

Period of Project: October 2001–September 2006

PROBLEM

Mercury is a widespread contaminant affecting aquatic ecosystems. Methylmercury is the most toxic form and it is readily accumulated in aquatic life. It magnifies in concentration in aquatic food chains. Most mercury studies have focused on lakes, reservoirs, and wetlands. Much less is known about mercury in water, sediment, and biota of streams and rivers.

OBJECTIVE

The objectives of the study are to determine the effects of source strength, cycling, and food-web interactions on bioaccumulation of mercury in fish. The study also aims to quantify the source and seasonality of mercury and methylmercury as well as biogeochemical species and transformation rates related to the aquatic mercury cycle.

APPROACH

Stream sampling sites were selected based on the availability of target predator fish and mercury-source landscapes including urban and reference or non-cultivated. Three streams in the Western Lake Michigan Drainages (WMIC) NAWQA unit are being sampled as part of this study and data collection for this unit will be complete by September 2004. Total and methylmercury in water are sampled monthly plus during selected storm events over two years. Potential net methylation rates in sediment and mercury in porewater and sediment are measured seasonally. Total mercury and stable carbon and nitrogen isotopes are being determined in predator fish; total and methylmercury and stable isotopes will be determined in food chain organisms (forage fish and invertebrates). Data from the Mercury Deposition Network will be used to determine loading rates so that the amount of mercury entering the stream ecosystems can be assessed in relation to the amount of mercury accumulating in the water, sediment, and fish. The Wisconsin District Mercury Laboratory will analyze surface water, porewater, streambed sediment, and invertebrates for mercury and methylmercury.

PROGRESS (JULY 2003–JUNE 2004)

Surface water was sampled monthly plus several storm events. Sediment and porewater were collected in June, August, December 2003, and March 2004. Collections of biota were completed in June and August 2003. We provided input and assistance to the Wisconsin Department of Natural Resources (WDNR) toward a new atmospheric MDN site in Milwaukee. The WDNR supplied and installed MDN equipment in fall 2002 and collected samples; the USGS is funding laboratory analyses of the samples through September 2004. The Menominee Indian Tribe provided field assistance at the Evergreen River site in the Menominee Reservation.

PLANS (JULY 2004–JUNE 2005)

Water sampling and analysis of atmospheric deposition samples will continue through September 2004 for the WMIC unit. An intensive streambed sediment sampling is planned at all Wisconsin sites in July 2004 for total and methylmercury, sulfide, and microbial methylation; porewater will be collected concurrently from one site. We will continue to review and process results for a USGS Fact Sheet and national scope journal articles. Additional NAWQA study units across the nation are scheduled to begin mercury sampling in 2005.

Mercury Cycling in the Lake Pontchartrain Basin, Louisiana Project

Cooperator: USGS Headquarters (Toxic Substances Hydrology and National Research Programs) Reston, VA

Project Chief: David P. Krabbenhoft

Location: Lake Pontchartrain Basin, southern Louisiana

Project Number: 9KL16

Period of Project: July 2003–September 30, 2004

PROBLEM

Mercury contamination of aquatic ecosystems is a widely recognized global problem. Exposure to food webs is generally known to be most pronounced in areas where abundant wetlands exist, due to the effective transformation of inorganic mercury (from atmospheric deposition) to methylmercury (the most toxic and bioaccumulative form of mercury), which is optimized in anaerobic wetland sediments. In addition, the scientific literature has recently shown that coastal settings appear to be areas where elevated mercury deposition occurs. Therefore, ecological settings like the Lake Pontchartrain Basin that are dominated by wetlands and near the coast are especially prone to problems related to mercury contamination. The entire Lake Pontchartrain Basin is currently under an advisory for high levels of mercury in fish. However, very little was known regarding which areas of the Basin were most prone to yield methylmercury and the linkages that may exist between the freshwater streams, Lake Pontchartrain and other estuaries, and the saltwater systems along the coast. As a result, the USGS received a Congressional allocation to conduct assessment studies that will address water-quality issues in the Lake Pontchartrain Basin, and mercury was one of those issues.

OBJECTIVE

The objectives of the project are: (1) to provide data and scientific insight that may be used to improve water-quality management of Lake Pontchartrain, and (2) to gain scientific understanding and to develop methods, models, and theories that will have transfer value to other impacted areas of the Nation. Mercury contamination is widespread, although areas of the southeastern U.S. seem particularly prone to yield very high levels of methylmercury in food webs, but the reasons for this are still not resolved. Research efforts on this project will help to resolve what factors and what sub-ecosystem types lead to exacerbated methylmercury contamination. The distribution, speciation (especially methylmercury), and transport of mercury will be investigated throughout the Lake Pontchartrain basin, focusing particularly on the Tchefuncte or Tangipahoa sub-basins and on the wetlands near the Lake. In addition, some key processes regulating the exposure of mercury to local food webs, such as microbial mercury methylation, will be evaluated. Field sampling is supported by measurements of important process rate measurements (methylation, demethylation, and reactive mercury measurements) that can help in the interpretation and aid in understanding of the factors controlling mercury cycling, fate, and toxicity in the Lake Pontchartrain Basin.

APPROACH

The USGS already has some data on mercury in the basin, but many results to date have proved counter-intuitive given the current knowledge of factors regulating mercury cycling. Further analysis and fieldwork will be conducted to try to resolve some of the important research questions regarding the sources, transport and transformations of mercury and methylmercury. One hypothesis suggested that eutrophication caused by excessive nutrient loadings provides a highly reactive source of organic carbon that can facilitate the methylmercury formation process. Other redox and microbially mediated reactions, such as those involving sulfur, can also affect mercury methylation and will be measured. To achieve these goals, the Wisconsin District Mercury Research Team, in collaboration with researchers from the National Research Program and the Louisiana District Office, is conducting a series of field-oriented studies to examine spatial and temporal variations in mercury and methylmercury distributions in the Lake Pontchartrain Basin. The research team has established a network of four sub-ecosystem locations where detailed sampling is performed to assess the mechanisms and rates of methylmercury production and transfer to streams. The four locations include two freshwater settings (Tchefuncte and Blind Rivers), one estuarian site (the mouth Bayou Lacombe at Lake Pontchartrain), and a coastal saltwater marsh site downstream of Lake Pontchartrain. At each site, detailed sampling of the sediments, porewater, and surface water is conducted for a variety of constituents that are known to affect mercury methylation and speciation.

PROGRESS (JULY 2003–JUNE 2004)

During this time period, two field trips were conducted to provide an initial examination of the overall levels of methylmercury in the Basin, and to reveal any temporal and spatial patterns. Each study site has a transect of six sampling locations that are aligned with the direction of surface-water flow from the wetland to the adjoining stream. Sampling efforts were focused on assessing the wetland-to-stream transfer of methylmercury at four study sites.

PLANS (JULY 2004–JUNE 2005)

Plans for this time period call for continued sampling, and to expand the network of sampling sites into the coastal environment, where tidal actions and dramatic changes to water quality are expected to have pronounced effects on mercury and methylmercury abundance and distributions. We plan to execute several novel measurements of mercury reactivity in sediments, pore-

water and surface water to help explain the patterns observed among the field data. Particular emphasis will be placed on understanding the connections between the freshwater-estuarine-saltwater environments.

National Mercury Project

Cooperator: Toxic Substances Hydrology Program, U.S. Geological Survey, Reston, VA

Project Chief: David P. Krabbenhoft

Location: Nationwide

Project Number: AK710

Period of Project: July 2001–June 2010

PROBLEM

Concerns about environmental mercury pollution and contamination of aquatic food webs stem largely from the human and wildlife health risks of dietary exposure to methylmercury, the dominant form of mercury in the edible flesh of fish and aquatic mammals. The widespread nature and adverse consequences of mercury pollution continue to prompt considerable scientific investigation, and the environmental sources, biogeochemistry, transformations, transport, fate, and effects of mercury in the environment are subjects of frequent symposia, workshops, and a large steadily expanding body of scientific literature.

OBJECTIVE

The Mercury in Aquatic Ecosystems project, coordinated by the Wisconsin District Mercury Research Laboratory (WDMRL) has several overall objectives that seek to provide critical information to aid in the definition of the mercury problem and seek possible solutions or mitigation strategies. These goals are: (1) to clarify the broader mercury problem from a scientific perspective, (2) conduct research that will provide critical (but previously unavailable) information for resource managers and decision makers on what should be done to improve environmental mercury conditions, (3) continue to provide scientific leadership (within the USGS and nationally and internationally) for the planning and execution of investigations of mercury biogeochemistry, transformations, transport, and fate in the environment, and (4) serve as an intra-agency and inter-agency communication and coordination point for mercury research.

APPROACH

To achieve these goals, the Wisconsin District Mercury Research Team is conducting a variety of field-oriented studies. First, in the summer of 2002 we are continuing our collaboration with the NAWQA program to collect fish, water, and sediment samples from across the United States in a variety of water-

shed types. This synoptic type sampling will be followed by more intense sampling efforts in a few of the watersheds where the goal will be to provide a detailed understanding of the processes that control mercury bioaccumulation in food webs. In addition, the Mercury Research Team is involved in two "mercury-loading" studies in the Everglades of Florida and the Experimental Lakes Area (ELA) of Ontario, Canada, whereby the overall goal is to establish what the mercury dose to bioaccumulation response is for natural systems using traceable amounts of mercury stable isotopes. Previously, research of this kind has been conducted in laboratories or controlled environments where the natural response was not adequately represented. For the study site in Canada, we are dosing an entire watershed with three different stable isotopes of mercury (^{198}Hg, ^{200}Hg, and ^{202}Hg), which are being added to the wetland, upland forests, and lake, respectively. By applying different stable isotopes to the three major components of the watershed, we will be able to track where the mercury comes from, and at what time scales, that accumulates in fish.

PROGRESS (JULY 2003–JUNE 2004)

During this time period, the Mercury Cycling in Aquatic Ecosystems project was active in a wide variety of settings across North America, evaluating the factors controlling mercury cycling and toxicity. These activities include studies at the following locations:

- The Yukon River Baseline project (Alaska)
- The Marcell Experimental Forest Sulfate Addition study (Minnesota)
- The New England Coastal Basins project (New England)
- Yellowstone National Park Mercury Emissions project (Wyoming)
- Lostwood National Wild Life Refuge Mercury Assessment project (North Dakota)
- Four Corners Source-Receptor Project (Colorado)

In addition, this project continues to focus a great deal of effort on the The Mercury Experiment to Assess Atmospheric Loadings in Canada and the U.S. (METAALICUS) project.

The METAALICUS project is an internationally recognized whole-ecosystem loading experiment to assess environmental responses to changes in atmospheric loading of mercury. The USGS Mercury Research Lab is one of the principal participating investigators involved with the project, and serves as the lead group for conducting studies in the terrestrial and wetland sub-ecosystems, as well as watershed mass balances. This project is in the fourth of a five-year loading effort, in which three different stable isotopes of mercury are applied annually to the three major sub-ecosystems of the watershed (^{202}Hg on the lake, ^{200}Hg on the forest, and ^{198}Hg on the wetland). Each year, the isotopic mercury additions are about 3–5 times the current ambient loading. The overall goal of the study is to assess the major processes regulating the fate and transport of newly deposited mercury to a watershed, and to determine the net effect on the food web. At the conclusion of the 5-year addition effort, the METAALICUS project will become a whole-ecosystem "mercury-reduction" study, which will probably have even more relevance to proposed mercury reduction regulations that are being considered throughout the U.S. and worldwide. As such, the METAALICUS project will serve a sentinel study for expected benefits to such regulations.

PLANS (JULY 2004–JUNE 2005)

Plans for this time period call for continued widespread efforts across a wide variety of ecosystem settings that will allow for a robust scientific assessment of the controlling factors of mercury cycling in aquatic ecosystems. In addition to the studies mentioned above, this project will include new study sites during this time period including a synoptic sampling effort of about 200 sensitive, high-elevation lakes in the eastern U.S. (from northern Maine to Pennsylvania), controls of mercury methylation in the Lake Pontchartrain Basin (Louisiana) and an assessment of the "mercury-halo effect" around known mercury emitters in the Milwaukee metropolitan area.

Mercury Contamination at the Lostwood National Wildlife Refuge, Northwestern North Dakota

Cooperator: North Dakota State Department of Health, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency

Project Chief: David P. Krabbenhoft

Location: Lostwood National Wildlife Refuge, Northwestern North Dakota

Project Number: ARN00

Period of Project: July 2003–September 30, 2004

PROBLEM

The Lostwood National Wildlife Refuge (LNWR) is a 26,904-acre rolling prairie/wetland ecosystem in northwestern North Dakota, and is a critically important aquatic ecosystem for resident migratory wildlife. Recently, however, the U.S. Fish and Wildlife Service and the State of North Dakota have become concerned that the proximal location of a large coal combustion facility immediately upwind of the LNWR may be impacting the ecosystem through the deposition of atmospherically transported mercury. In the past 15 years, scientists have revealed that wetlands and their landscapes have a pronounced ability to expose resident wildlife to mercury loads; however, no known mercury assessments have ever been conducted on pothole wetlands in this region or anywhere else. Recent surveys have revealed that certain ecosystem types (for example, wetland ecosystems, newly flooded reservoirs, or seasonal impoundments) are particularly sensitive to mercury inputs and can result in high concentrations of mercury in fish or other aquatic biota. The pothole wetlands at the LNWR have most or all of these environmental characteristics, and in addition, the annual or semiannual wetting and drying cycles that are characteristic of the pothole wetlands likely exacerbate the methylmercury production cycle. However, previous to this study, there were no available data to test whether high mercury exposure levels to the food web occurred in pothole wetlands like the LNWR.

OBJECTIVE

The overall goal of this project is to assess the mercury contamination level of pothole wetland environments, and to determine whether these ecosystems are "naturally prone" to be high in mercury exposure to indigenous wildlife. The goal of decreasing wildlife and human exposure to mercury presents major challenges to environmental managers and scientists alike. However, the first steps are to provide a better definition of the environments that are most prone to producing methylmercury, and then to establish what the limiting factors are for mercury exposure for each ecosystem type such that the most effective decision can be made. Currently, there is no known information on mercury cycling, fate, and biological exposure in prairie pothole wetlands. Many tens of thousands of these wetlands exist across the northern high plains, and they serve as a critical aquatic ecosystem for native and migratory wildlife in North America. This assessment study would provide sorely needed information on the level of methylmercury exposure in pothole wetlands, the controls on the levels of methylmercury produced across a range of physical, hydrological, and chemical characteristics represented at the LNWR, and whether or not local mercury source contributions play a role in potentially elevated levels of exposure.

APPROACH

This assessment project will have three integrated work elements, including: (1) a widespread synoptic sampling effort, (2) an atmospheric mercury monitoring effort to assess whether any nearby emissions sources can be "sensed" at LNWR, and (3) a historical determination of mercury deposition using dated sediment cores. The first element will be accomplished by sampling approximately 30 prairie pothole wetlands on the LNWR that span a wide range of geomorphic, hydrologic, and chemical conditions. The primary land-management method currently used by the Fish and Wildlife Service at LNWR is planned prairie burns. Recent studies have revealed that burning generally serves to stimulate mercury methylation by oxidizing sulfur to sulfate, and produces more reactive carbon substrate for bacteria to utilize when the soils are re-flooded. We will include sites that have been recently burned in the synoptic sampling to test whether this practice is possibly exacerbating methyl-mercury exposure at LNWR. Atmospheric mercury monitoring can be used to ascribe source-receptor relationships for areas of concern. Recently, the USGS has constructed a mobile mercury lab that has the capability of providing real-time atmospheric mercury measurements, that when coupled with supporting information, can help ascertain the relative importance of local versus global mercury pools. Lastly, a carefully collected set of sediment cores will be used to determine whether the establishment of several nearby coal combustion facilities in northwestern North Dakota and southern Saskatchewan, Canada has any local impacts on mercury deposition rates to the LNWR. The cores will be dated with radio-isotope markers (^{210}Pb and ^{137}Cs) and combined with mercury profiles to determine if local mercury deposition conditions were altered in response to startup operations of these facilities.

PROGRESS (JULY 2003–JUNE 2004)

During this time period, two field trips were conducted to sample about 30 pothole wetlands on the LNWR. Sediment and water samples were collected and shipped to the Wisconsin District Mercury Research Laboratory for analysis. In addition, the mobile mercury lab was deployed to LNWR for five weeks in the spring of 2004. Presently, sample analyses of the dated cores are underway, and are expected to be completed by October 2004.

PLANS (JULY 2004–JUNE 2005)

Future plans on this project call for synthesis of all the data collected at LNWR, and the formulation of a USGS report. If data gaps are identified during the reporting process, a proposal will be developed to follow up the present studies.

Regional and National Assessment Team

OFFICE OF THE ASSISTANT DISTRICT CHIEF FOR GROUND-WATER AND NATIONAL INVESTIGATIONS

MISSION

The Regional and National Assessment Team consists of projects and personnel involved in studies at the multi-state to national level. Personnel are engaged in studies at many levels, from serving on national-level workgroups and advisory panels to collection, synthesis, and interpretation of data. Investigations focus on water-quality issues, utilize new technologies and techniques, and are conducted over a wide range of spatial and temporal scales. The goal of the team is to understand the interactions among components of hydrologic systems and their relations to water quality in order to enhance the management of water resources on a broad scale.

TEAM MEMBERS

Jeff Steuer, Hydrologist (Team Leader)
Dale M. Robertson, Research Hydrologist
Faith A. Fitzpatrick, Research Hydrologist (Geology)
Kevin D. Richards, Physical Scientist
Barbara C. Scudder, Hydrologist
Jana S. Stewart, Geographer
Daniel J. Sullivan, Hydrologist
Brett M. Esser, Hydrologic Technician
Judith C. Thomas, Hydrologist
Michelle A. Lutz, Physical Scientist
David A. Saad, Hydrologist
Rebecca H. Woll, Hydrologist
Krista A. Stensvold, Student Trainee (Hydrology)
Amanda A. Bell, Student Trainee (Hydrology)
Marie C. Peppler, Student Trainee (Geography)
David O. Bratz, Hydrologic Technician (Student)
Laura L. Rozumalski, Hydrologic Technician (Student)

PROJECTS

NATIONWIDE PROJECTS

9KM16 National Water-Quality Assessment (NAWQA) Special

9KM42 National Environmental Methods Index

9KM43 Interagency Methods and Data Comparability Board (MDCB)

LOCATION-SPECIFIC PROJECTS

REGIONAL

Great Lakes States

9KM47 Great Lakes Aquatic Gap

Upper Illinois River Basin in Illinois, Indiana, and Wisconsin

9BI57 Upper Illinois River Basin National Water-Quality Assessment (NAWQA)

Upper Midwest

9KM30 Technical Assistance in the Development of Regionalization Schemes for Suspended Sediments and Nutrients in Streams in the Midwest

Upper Mississippi, Ohio, and Great Lakes River Basins

9BI92 Upper Mississippi, Ohio, and Great Lakes River Basins Regional Synthesis: National Water-Quality Assessment Program

Western Lake Michigan Basin (WMIC), Georgia-Florida Costal Plains Basin (GAFL), Willamette River Basin (WILL)

B2100 Periphyton-Mercury: The Role of Periphyton in Mercury Bioaccumulation in Stream Ecosystems

LOCAL

Upper peninsula of Michigan, eastern Wisconsin basins discharging to Green Bay, and western Wisconsin basins that directly drain into Lake Michigan

9BI31 Western Lake Michigan Drainages National Water-Quality Assessment (NAWQA)

Western Lake Michigan Drainages National Water-Quality Assessment (NAWQA)

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

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

Project Number: 9BI31

Project Chief: Jeffrey J. Steuer

Period of Project: December 1990–Continuing

PROBLEM

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

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.

APPROACH

Western Lake Michigan Drainages study unit investigations will be conducted in 10-year cycles. Cycle 1 took place between 1991 and 2000 and consisted of a retrospective analysis of existing water quality (1991–1993), high intensity phase data collection (1993–1995), data analyses and report writing (1995–1997), and low-intensity phase data collection (1996–2000). Cycle 2 began with a planning and retrospective data analyses phase (2000–2001) and is followed by high-intensity phase data collection (2002–2004), topical study data collection (2002–2004), data analyses and report writing (2004–2007), and low-intensity phase data collection (2005–2010).

These types of studies will be conducted as part of the Western Lake Michigan Drainages study unit investigation: (1) occurrence and distribution assessments, (2) trends assessments, and (3) topical studies.

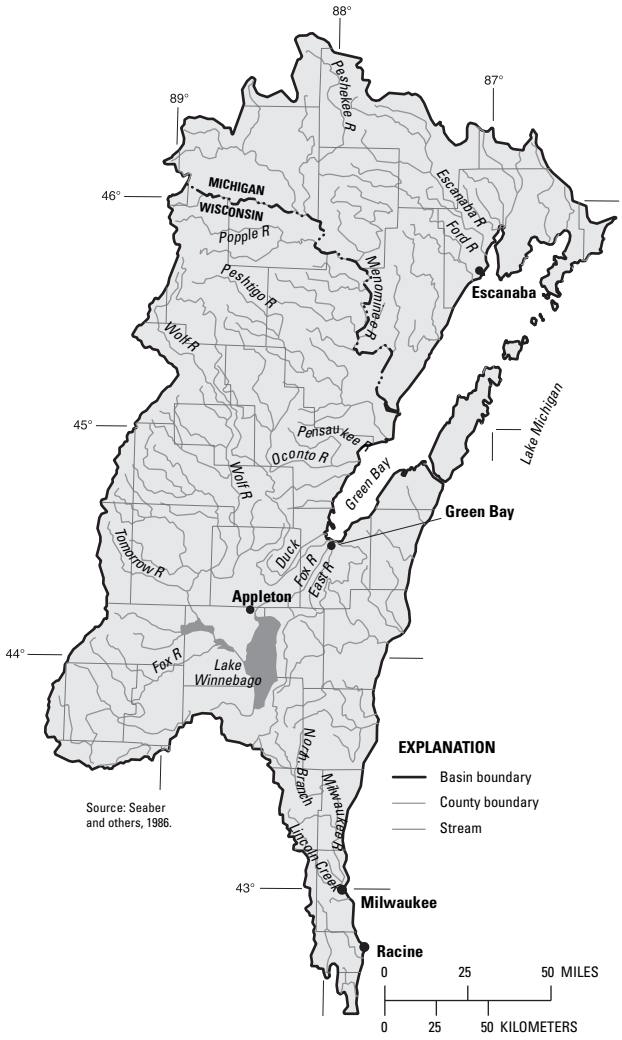
The surface water occurrence and distribution and trends assessment networks were developed by identifying relatively homogeneous areas of specific land use and environmental characteristics. Sampling sites were chosen to assess watersheds representing a single relatively homogeneous unit (RHU) or watersheds defined by several RHUs. Sites sampling a single RHU were called indicator sites and those sampling several RHUs were termed integrator sites.

The ground-water sampling networks were designed to assess the primarily used aquifers in the study unit (the Cambrian-Ordivician Sandstone and the glacial outwash aquifer systems) and also to assess the effect of various land uses on shallow ground water.

PROGRESS (JULY 2003–JUNE 2004)

Cycle 1 (1991–2000)

Eleven basic-fixed sites (BFS) were sampled during the cycle 1 high-intensity sampling phase (HIP), including 8 indicator sites and 3 integrator sites. The sites were sampled monthly and augmented with seasonal storm sampling for major ions, nutrients, organic contaminants, trace elements, suspended sedi-



ments, and pesticides during the HIP. Several agricultural and urban land use indicator sites were also sampled more intensively for pesticides during the growing season. The 11 BFS were also assessed for habitat and sampled for fish, macroinvertebrates, and algae annually during the HIP.

The ground-water occurrence and distribution assessment networks were developed around major aquifers in the study unit. During cycle 1, 29 wells in the Cambrian-Ordivician aquifer system were sampled for major ions, nutrients, VOCs, trace elements, radon, tritium, DOC, and pesticides. The shallow ground water land-use networks studied the effect of surficial deposits (clayey or sandy) in agricultural areas on water quality.

Streambed sediments and tissue from aquatic biota were sampled at each of the fixed sites and about 25 additional sites throughout the basin during cycle 1. These samples were analyzed for trace metals, pesticides, and organic compounds.

Special studies during cycle 1 included: a comparison of shallow ground-water chemistry in agricultural areas with varying permeability; ground-water flow-path investigation of agricultural chemical transport; an assessment of biological communities in benchmark streams in agricultural areas; assessments of high- and low-flow chemical conditions; a study to determine the representativeness of the BFS; an investigation of ground-water/surface-water interactions at the end of a flow path; and two studies comparing results obtained using a variety of chemical and biological sampling methods.

Low-intensity phase samples were collected monthly at 3 of the BFS for major ions, nutrients, organic contaminants, trace elements, suspended sediments, and pesticides.

Forty-seven reports were prepared to describe the results of the cycle 1 investigations.

Cycle 2 (2001–2010)

During cycle 2, trends sampling has been conducted at 4 of the BFS, now termed trends sites, for the same list of constituents and at a similar frequency as analyzed for during cycle 1. Approximately 30 Cambrian-Ordivician aquifer wells and the highly permeable shallow ground-water wells in agricultural areas have been sampled for the same set of constituents as sampled during cycle 1. In addition, the entire study unit extent of the glacial aquifer was sampled during 2003 for the same list of constituents as sampled at ground-water sites during cycle 1. Cores will be collected from two or three lakes to determine deposition history of trace elements and organic compounds using age-dating techniques. Occurrence and distribution samples were collected for total mercury in sediment, tissue, and the water column at eight surface-water sites during 2002.

Two topical studies have been in progress since 2003:

(1) The urban land use gradient study assesses the impacts of urbanization on the health of aquatic biota in the Milwaukee and Lower Fox River urbanized area. The study focuses on assessing the health of watersheds with urbanized land use in the 0–100 percent range. Stream chemical, biological, and physical parameters are being measured and will be assessed against a calculated urban index.

(2) The mercury topical study assesses the bioaccumulation of mercury in game-fish species. Total mercury will be determined in axial muscle tissue, composited from 6–10 individuals taken at the same site. Axial muscle is the most relevant component for human health, and can be related to whole-body burdens for toxicity relevance regarding piscivorous wildlife. Sampling of methylmercury and total mercury in water, porewater, and un-sieved streambed sediment at the fish sampling sites will yield useful data regarding exposure of the fish to mercury. Instantaneous methylmercury data from the water and sediment samples will help indicate the relative potential of a watershed to convert inorganic mercury to methylmercury, a critical step in mercury bioaccumulation. Methylmercury is more effectively biomagnified in food chains, is the predominant species of mercury in fish, and is more toxic than inorganic mercury.

PLANS (JULY 2004–2005)

Sampling will continue at the ground-water and surface-water trend sites. It is anticipated that the number of surface-water trend sites will be reduced from four to two after October 1, 2004. Sampling will be completed for the two topical studies (urban and mercury) in September 2004 with data analysis and report writing efforts to commence shortly thereafter.

REPORTS (JULY 2002–JULY 2004)

Robertson, D.M., 2003, Influence of different temporal sampling strategies on estimating total phosphorus an suspended sediment concentration and transport in small streams: Journal of the American Water Resources Association, v. 39, no. 5, p. 1281–1308.

Robertson, D.M., and Saad, D.A., October 2003, Environmental water-quality zones for streams: Environmental Management, v. 31, no. 5, p. 581–602.

Fitzpatrick, F.A., Harris, H.A., Arnold, T.L., and Richards, K.D., 2004, Urbanization influences on aquatic communities in northeastern Illinois streams: Journal of the American Water Resources Association, v. 40, no. 2, p. 461–475.

Upper Illinois River Basin National Water-Quality Assessment (NAWQA)

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

Project Chief: Kevin D. Richards

Locations: Upper Illinois River Basin in Illinois, Indiana, and Wisconsin

Project Number: 9BI57

Period of Project: October 1996–September 2004

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 Upper Illinois River Basin (UIRB), determine the presence or absence of any trends in water quality, and provide an understanding of the link between natural and anthropogenic factors and observed water quality. Specific goals are to: (1) determine the occurrence and spatial distribution of a broad array of water-quality constituents in ground and surface water and streambed 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 effects of urbanization on surface-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 geographic information system (GIS). 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 (1997–1999), followed by a high (1999–2001) and then a low-phase (2002–2006) 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 will be sampled monthly and augmented with event-related samples. A subset of these sites will be extensively sampled for pesticides and volatile organic compounds. Pesticide samples will be collected approximately biweekly during the early to mid-summer period and less frequently during the rest of the year. Volatile organic compound samples will be collected weekly during the winter and less frequently during the rest of the year. Other program components include an urban gradient study to evaluate the relation between community (fish, algae, and invertebrates), habitat structure, land-use practices, and environmental factors. Ground-water studies include a study-unit survey and two land-use studies.

The land-use survey studies the effects of land use on ground-water quality through sampling in specific relatively homogeneous areas (1999 and 2000). A study unit survey provides an indication of water-quality conditions of the major aquifer (Silurian-Devonian) in the study unit.

PROGRESS (JULY 2003–JUNE 2004)

The GIS coverages will continue to be compiled and archived including: labeling the clustered Landsat data, wetlands data from the WISCland inventory, Natural Resource Inventory, Toxic Release Inventory, and others. Data archiving for data collected during the HIP (1999–2001) continues.

Land-use gradient special study—Open-File Data report was published. The retrospective journal article “Urbanization influences on aquatic communities in northeastern Illinois streams” was prepared, underwent colleague review and the comments were incorporated. Data analysis and interpretation are ongoing for the proposed journal article “Ecological responses to physical and chemical changes related to urbanization in the Upper Illinois River Basin.”

PLANS (JULY 2004–JUNE 2005)

Two surface-water trend sites will be monitored for continuous flow and sampled 10 times a year for field parameters, pesticides, nutrients, selected ions, and suspended sediment. This will be reduced to one site starting in October 2004.

Data from the high-intensity phase will continue to be analyzed and the results of analyses compiled in reports.

Ecological sampling will be conducted at the surface-water trend sites in August 2004.

A number of publications are planned related to the ecological data collected and the land use gradient study.

Upper Mississippi, Ohio, and Great Lakes River Basins Regional Synthesis: National Water-Quality Assessment Program

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

Project Chief: Daniel J. Sullivan

Location: Upper Mississippi, Ohio, and Great Lakes River Basins

Project Number: 9BI92

Period of Project: September 2003– September 2006

PROBLEM

A large amount of water-quality data have been collected in National Water-Quality Assessment Study Units across the U.S. since 2001. In some cases these data have been analyzed at the local (Study Unit) and national level, but there has been little or no synthesis at the regional level, where great value may be realized due to similarity of landscapes and water-quality issues. In addition, there are sufficient time-series data to allow trend analysis for the first time at many of the sites that have been monitored.

OBJECTIVE

To synthesize, analyze, and produce a series of reports on important regional water-quality issues using NAWQA and other compatible data. Issues examined will include analysis for the presence or absence of trends, new understanding of factors affecting water quality, and to determine if there are links between natural and anthropogenic factors and observed water quality.

APPROACH

Surface-water chemistry and biological data for the NAWQA Program in the Upper Mississippi River basin, Great Lakes drainages, and Ohio River basin will be synthesized and analyzed for trends and understanding of factors that affect water quality. Significant water-quality issues pertinent to key stakeholders within the region will be analyzed for new regional findings.

PROGRESS (JULY 2003–JUNE 2004) AND PLANS (JULY 2004–JUNE 2005)

Lead scientists were selected for each of eight major river basins across the U.S., report proposals were written, report teams formed, and report plans and budgets finalized. Beginning October 1, 2004, report teams will finalize site selection and begin data compilation, analysis and report writing on the following topics:

- Effects of multi-scale environmental characteristics on agricultural stream biota in the Midwestern United States
- Responses of aquatic communities to land use and hydrologic characteristics in agricultural and urban areas in the north-temperate United States
- Trends in nutrient and suspended-sediment concentrations and loads in the Upper Mississippi, Ohio, and Great Lakes River Basins
- Spatial and temporal trends of pesticides and pesticide degradates in agricultural areas of the upper Midwestern United States

National Water-Quality Assessment (NAWQA) Scientific Records Management and Data Synthesis

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

Project Chief: Jana Stewart

Locations: Support of NAWQA National Leadership and Synthesis Teams

Project Number: 9KM16

Period of Project: October 1996–Continuing

PROBLEM

Since 1991, USGS scientists with the NAWQA program have been collecting and analyzing data and information in more than 50 major river basins and aquifers across the Nation. The goal is to develop long-term consistent and comparable information on streams, ground water, and aquatic ecosystems to support sound management and policy decisions. These data are collected to define baseline conditions, recognize long-term hydrologic and water-quality trends and gain an understanding of natural and anthropogenic factors influencing hydrologic processes and conditions. These records are critical to the mission of the

USGS, and represent a unique National data set that must be managed and preserved to ensure its availability to present and future generations of natural scientists and resource managers.

OBJECTIVE

The objectives of this project are to (1) provide technical support to the NAWQA program for managing and preserving scientific records, and (2) represent the study unit level to help identify, manage and resolve data issues for the NAWQA program.

APPROACH

During the first cycle of NAWQA (1991–2003), data collection was conducted at the study unit level, within major river basins around the country. A comprehensive data archival checklist was developed and used by study units to document and track information related to the archival of study unit hydrologic records and supporting information. A final archival review is conducted at the completion of each of the Cycle I studies. During the second cycle of NAWQA, beginning in 2001, data collection was based around program level topical studies, designed to gain an understanding of hydrologic processes and the natural and anthropogenic factors influencing these processes. Data continue to be collected within study units, however, are aggregated up to a topical study level for regional and national analysis. As a result, data archival needs to be accomplished at both the study unit and topical study level. Other data issues are identified, managed and resolved by the NAWQA Data Synthesis Team, that include scientists and data managers at all levels of NAWQA, during monthly conference calls and frequent email correspondence.

PROGRESS (JULY 2003–JUNE 2004)

Archive reviews were conducted for a number of the remaining Cycle I study units and draft plans were developed to manage and archive scientific records in Cycle II. A committee was developed to assess Scientific Records Management in USGS WRD and to update the guidance for managing and archiving USGS WRD mission-critical scientific records. Monthly conference calls were conducted to identify and resolve NAWQA data issues at the National, Regional, and local study unit levels.

PLANS (JULY 2004–JUNE 2005)

Work is underway to develop customized plans to manage and archive scientific records for NAWQA topical studies that center around the effects of urbanization, nutrient enrichment, and mercury contamination in streams; understanding the transport of natural and anthropogenic contaminants to public supply wells; and understanding the transport of agricultural chemicals in ground water. Additional work is being conducted to identify and address data problems related to these topical studies.

Technical Assistance in the Development of Regionalization Schemes for Suspended Sediments and Nutrients in Streams in the Midwest

Cooperator: U.S. Environmental Protection Agency

Project Chief: Dale M. Robertson

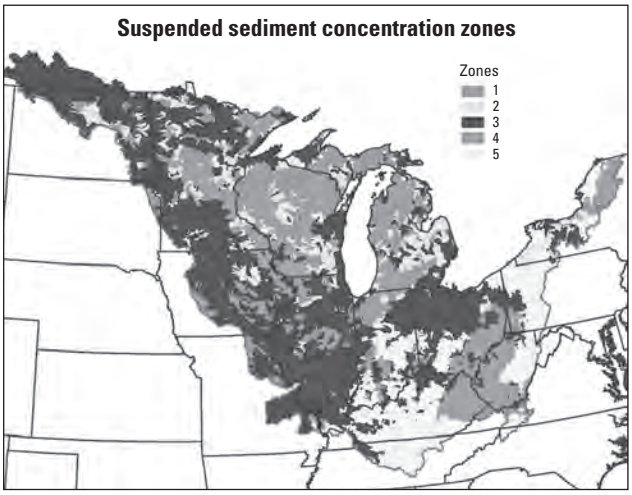
Location: Upper Midwest

Project Number: 9KM30

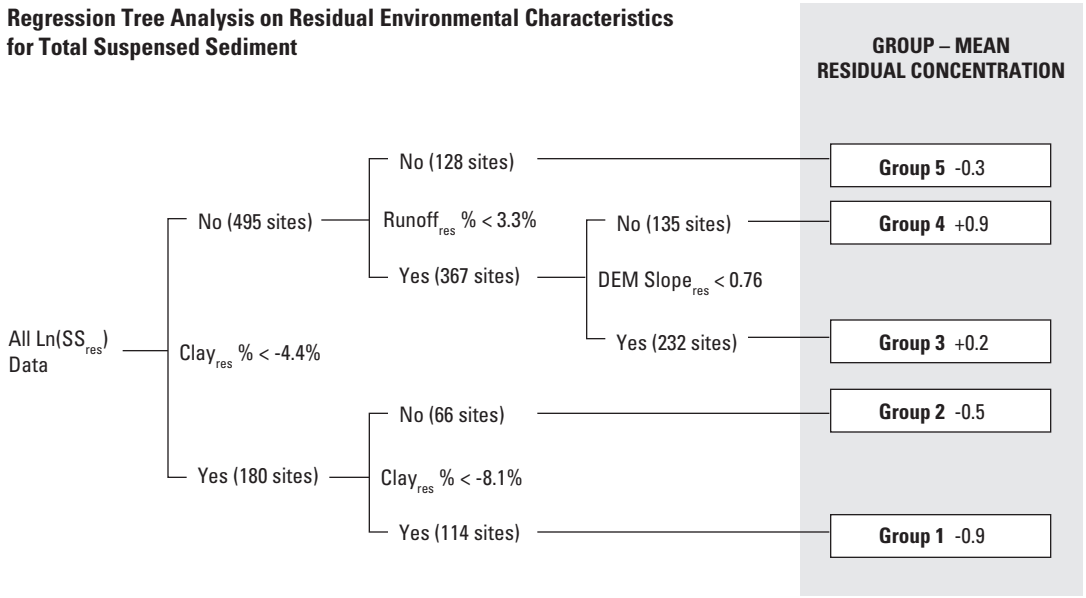
Period of Project: October 2002–September 2004

PROBLEM

According to the USEPA National Water Quality Inventories, reports to Congress, states, tribes, and other jurisdictions consider siltation and the over-enrichment of nutrients to be two of the three most significant causes of impairment in many of the streams throughout the Nation. Much of the sediment and nutrients in streams can be associated with poor land-management practices; however, studies have shown high concentrations and loads can also be directly related to natural environmental factors, such as the type of soil and the slope of the terrain in the basin (Robertson, 1997). To try to reduce nutrient concentrations in streams around Lake Michigan and the Nation, the USEPA in collaboration with states and tribes are developing regional nutrient criteria from which standards will be produced. Once established, Total Maximum Daily Loads (TMDLs) will be needed for tributaries that have been shown to exceed these standards and are considered to be impaired. Therefore, there is a need to develop regional criteria for concentrations and loads of sediment and specific nutrients that reflect the natural variability in water quality that occurs throughout the area (potential water quality).



Regression Tree Analysis on Residual Environmental Characteristics for Total Suspensed Sediment



OBJECTIVES

The project objectives are to: (1) describe the distribution of suspended sediment and nutrient concentrations and loads throughout streams in the Upper Midwest, (2) use regression-tree analysis to determine which environmental factors influence their respective distributions, (3) determine similar potential water-quality zones by regionalizing results of the regression tree analysis (that is, classifying individual watersheds based on their respective natural environmental characteristics), (4) determine background concentrations and yields from each zone, and (5) compare the new potential water-quality zones with those developed by past studies.

PROGRESS (JULY 2003–JUNE 2004)

All water-quality data and corresponding flow data were obtained from the USGS and the major sampling agency in each state. Water-quality data were statistically summarized and loads were computed for all sites with sufficient water-quality data and flow data. Drainage basins of all of the sites with water-quality data were delineated and their environmental characteristics were computed. The distribution of water-quality concentrations and loads have been described.

PLANS (JULY 2004–JUNE 2005)

Use a stepwise residual approach to remove the effects of land use from the water-quality data and each natural environmental factor prior to performing SPARTA (Spatial regression-tree analyses) and determining which environmental factors influence the distributions of suspended sediment and nutrient concentrations and loads. Determine similar potential water-quality zones and background concentrations and yields from each zone. Compare results of this study with those of past studies. Publish final report.

REPORTS

Robertson, D.M., and Saad, D.A., 2003, Environmental water-quality zones for streams, a regional classification scheme: Environmental Management, v. 31, no. 5, p. 581–602.

National Environmental Methods Index

Cooperator: U.S. Environmental Protection Agency

Project Chief: Daniel J. Sullivan

Location: United States

Project Numbers: 9KM42, 9KM39, and 9KM19

Period of Project: October 1999–Continuing

PROBLEM

Many regulatory and non-regulatory water-quality monitoring programs specify the methodology to be used in analyzing water samples. Although this provides each monitoring program with a measure of comparability, there has been virtually no consistency of methods between programs. This program-specific approach to water-quality monitoring inappropriately and inefficiently increases the demands on limited resources while reducing the utility of water-quality information available.

OBJECTIVE

The selection of analytical methods is a critical component of the planning process for environmental monitoring programs. NEMI allows rapid communication and comparison of methods, thus ensuring that the consideration of analytical methods is a more active part of the planning and implementation of

programs. NEMI also allows the use and sharing of monitoring data among different agencies, using different methods at different times.

APPROACH

NEMI is a clearinghouse of environmental monitoring methods. The NEMI database contains method summaries of field and lab protocols for regulatory and non-regulatory water-quality analyses. It is searchable over the World Wide Web (*http://www.nemi.gov/*), and provides up-to-date methods information through a standard Internet connection and browser.

PROGRESS

To date, NEMI contains more than 650 chemical, immunoassay, physical, microbiological, and radiochemical methods. Data fields in NEMI include detection levels, bias, precision, and Quality Assurance/Quality Control requirements that will enable users to document and report on data quality.

PLANS

Conventional analytical methods are continually being added to NEMI. In addition, increased focus is being placed on adding field-collection protocols and analytical methods that use new technologies.

Interagency Methods and Data Comparability Board

Cooperator: U.S. Geological Survey

Project Chief: Daniel J. Sullivan

Location: Comprised of individuals from throughout the United States

Project Number: 9KM43

Period of Project: April 1998–Continuing

PROBLEM

Significant resources are spent to monitor water quality in the United States. The methods used to collect water samples and to analyze the samples collected vary between the collecting authority. The data obtained using the various methods may not be comparable and therefore monitoring entities may collect duplicate data.

OBJECTIVE

The Methods and Data Comparability Board (Board) is a nationwide partnership of water-monitoring authorities from Federal and State agencies, tribes, municipalities, business and industry, academia, and others with expertise in environmental monitoring. The Board has been assembled to coordinate and provide recommendations for the implementation of a voluntary, integrated, nationwide water-quality monitoring strategy.

APPROACH

The Board holds quarterly meetings to discuss the progress and plans of work groups formed to develop consensus positions regarding issues related to sampling and analytical approaches. The eight work groups (Performance Based Systems, National Environmental Methods Index, Laboratory Accreditation and Field Certification, Biological Methods, Nutrient Methods, Water Quality Data Elements, New Technologies, and Publicity and Outreach) establish work plans and meet via conference calls and at the quarterly MDCB meetings to accomplish work plan objectives.

PROGRESS (JULY 2003–JUNE 2004)

The USGS Board co-chair and executive secretary develop and maintain the Board Web site (*http://wi.water.usgs.gov/methods/*), develop work plans, organize meetings and conference calls, prepare meeting minutes, assist with the preparation of position papers and pilot studies, prepare outreach products, and provide guidance for and participate in other Board activities. The co-chair also participates as a steering committee member of the National Water Quality Monitoring Council (NWQMC), and as a co-chair for the biannual National Monitoring Conference, held in Chattanooga, Tennessee in 2004.

PLANS (JULY 2004–APRIL 2005)

Beginning October 1, 2004, the Board co-chair position will rotate to a new person in another District. The Executive Secretary position remains in Wisconsin.

REPORTS

MDCB, 2003, The Value of Data Comparability (Fact sheet).

MDCB, 2003, National Environmental Methods Index (Fact sheet).

MDCB, 2003, Accreditation of Laboratory and Field Activities for Water Quality Monitoring (Fact sheet).

Ward, R.C., and Peters, C.A., 2003, Seeking a Common Framework for Water Quality Monitoring: Water Resources IMPACT, American Water Resources Association, v. 5, no. 5, Sept. 2003.

MDCB, 2002, National Methods and Data Comparability Board: Collaboration and Comparability (Fact sheet).

Diamond, J., Eaton, A., Annis, C., Brass, H., Keith, L., Strong, A., McChesney, D., and Shockey, M., 2001, Towards a Definition of Performance- Based Laboratory Methods - National Water Quality Monitoring Council Technical Report 01–02

Keith, L., Sullivan, D., Boiani, J., Brass, H., and Peters, C., 2001, The National Environmental Methods Index as a Tool to Achieve Methods Comparability: American Water Works Association—Water Quality Technology Conference, Nashville, TN, Nov. 2001

Peters, C.A., Brass, H., and Diamond, J., 2000, United States Water Quality Methods and Data Comparability Board: Creating a framework for collaboration and comparability, in proceedings of Monitoring Tailor-made III, September 25–28, 2000, Nunspeet, the Netherlands.

Parr, J., 2000, Determining and Documenting the Suitability of Analytical Procedures Used for Analysis of Environmental Samples: NWQMC National Monitoring Conference 2000, Austin, TX.

MDCB, 2000, Why is a National Environmental Methods Index needed?, Fact Sheet.

Brass, H.J., Ardourel, H., Diamond, J., Eaton, A., Keith, L., Peters, C., 2000, Activities of the Interagency Methods and Data Comparability Board: Proceedings of the American Water Works Association, Water Quality Technology Conference, Salt Lake City, Utah.

Eaton, A. and Diamond, J., 1999, Reservoir dogs and performance-based systems: J. Environ. Testing and Analysis, 8:18-19.

Brass, H., Spooner, C., Klein, J.M., and Shockey, M., 1999, Objectives and Activities of the National Water Monitoring Council: International Conference of the Israel Society for Ecology and Environmental Quality Sciences, Jerusalem, Israel.

Diamond, J.M., J.B. Stribling, and Yoder, C., 1998, Determining the Comparability of Bio-assessment methods and their results: NWQMC National Monitoring Conference 1998, Reno, NV.

Diamond, J.M., J.B. Stribling, and M.T. Barbour, 1996, Characterizing and comparing bioassessment approaches and their results: A perspective: J. North American Benthological Society 15:713-727.

Strong, A., 1998, Performance Based Methods Systems, NWQMC National Monitoring Conference 1998, Reno, NV.

Eaton, A., 1999, Performance Based Systems (PBMS) - The Methods and Data Comparability Board Approach: 15th Annual WTQA Conference, Washington, DC, July, 1999.

Brass, H., 1999, The Methods and Data Comparability Board: Collaboration and Comparability: American Water Works Association - Water Quality Technology Conference, Tampa, FL, Nov 1999.

Great Lakes Aquatic Gap

Cooperator: U.S. Geological Survey, Biological Resources Discipline

Project Chief: Jana S. Stewart

Location: Great Lakes States

Project Number: 9KM47

Period of Project: September 2001–September 2006

PROBLEM

An Aquatic Gap program is underway for the riverine systems of the Great Lakes Region to identify those aquatic species and communities that are not adequately represented in existing conservation areas. A pilot study to develop a coastal component for Aquatic Gap is also underway for the Great Lakes Region. The Great Lakes are the largest system of freshwater on earth and provide habitat for a wide variety of aquatic organisms unique to these systems. The aquatic biodiversity of the region is being threatened due to increased population growth from urban expansion, more intensive agricultural practices, continued logging and coastal zone shoreline destruction. The Aquatic Gap project seeks to identify the gaps in the conservation of aquatic biodiversity in the Great Lakes region.

OBJECTIVE

The objectives of this project are to: (1) build and maintain partnerships with interested stakeholders, (2) classify aquatic habitats in rivers, streams, and in selected coastal margins using regionally consistent methods, (3) develop aquatic biological databases at state and regional scales, (4) map the actual and predicted occurrence and distribution of fish and other aquatic species in streams and selected coastal habitats, (6) complete a Gap analysis of fish and selected aquatic invertebrate species, (7) serve these data and products on the Internet and on CD-ROM, and (8) analyze, synthesize, interpret, and publish results at statewide, lakewide, and basinwide scales.

APPROACH

Habitat characteristics and species occurrences are being compiled and modeled for riverine and near-shore coastal systems as part of the Great Lakes Aquatic Gap Project. Habitat data from both riverine and coastal studies are being used in conjunction with fish occurrence data to characterize the habitat, identify species-habitat relationships, and model expected

species distributions. For riverine systems, habitat characteristics have been derived for 1:100,000 National Hydrography Data stream segments in MI, NY, OH, and WI using a Geographic Information System and are based on physical characteristics that describe stream geology, geomorphology, temperature, and flow. A spatially nested hierarchical framework has been developed to classify coastal habitat types and has been applied to near-shore coastal systems in two pilot areas, western Lake Erie and eastern Lake Ontario. Characteristics such as circulation, geology, wind and wave exposure, geomorphology, and temperature regime were combined to form coastal habitat units. All habitat characteristics and fish observations are geo-referenced and stored in a central relational database where information is linked to stream segments and coastal units. Results of analyses will be overlaid with land stewardship and other maps to identify gaps in the protection of these species and their habitats.

PROGRESS (JULY 2003–JUNE 2004)

A central database has been developed to accommodate stream habitat characteristics, aquatic biota sample collections, and habitat affinity information for all Great Lakes GAP projects and is housed at the USGS Great Lakes Science Center. For riverine projects, streams have been attributed with habitat characteristics and regression models have been developed to predict stream temperature. Fish data have been acquired and loaded into the central database and sample locations have been linked to the hydrologic network. Initial exploration of modeling methods for fish-environment relations has begun. For near-shore coastal systems, a conceptual framework for identification and classification of coastal habitat types has been developed and applied to a pilot study area in western Lake Erie.

PLANS (JULY 2004–JUNE 2005)

Ecological stream classifications will be finalized and a draft geospatial dataset of physical habitat attributes will be prepared for future publication. Presence/absence modeling will begin for all native and non-native established fish species in WI, MI, and NY streams, and abundance modeling will be undertaken for selected fish species.

Periphyton-Mercury: The Role of Periphyton in Mercury Bioaccumulation in Stream Ecosystems

Cooperators: US Environmental Protection Agency, NAWQA Mercury Topical Study Toxics Program

Project Chief: Barbara C. Scudder; Amanda H. Roehrborn

Location: Western Lake Michigan Basin (WMIC), Georgia-Florida Costal Plains Basin (GAFL), Willamette River Basin (WILL)

Project Number: B2100

Period of Project: May 2003–December 2004

PROBLEM

In 2003, the USGS NAWQA and Toxics Program began a study to examine total mercury and methylmercury in water, streambed sediments, forage fish, predator fish, and benthic macroinvertebrates. Missing from the NAWQA mercury study was an investigation of the role of periphyton (benthic attached algae)—primary producers in riverine systems—in mercury methylation and mercury cycling in river ecosystems. Our USGS NAWQA and USEPA-funded study proposed to fill the gap from the water column and sediments to the invertebrates and fish by conducting an evaluation of the periphyton at the eight NAWQA mercury study sites.

OBJECTIVE

This study will focus on collection and analysis of periphyton to address three main questions:

(1) Is there a correlation between mercury concentrations in the periphyton and water or sediment?

(2) Is periphyton a significant source of methylmercury to biota at higher trophic levels in riverine systems?

(3) Is there a correlation between the concentration of mercury in the periphyton and the invertebrates that feed on periphyton?

APPROACH

Periphyton samples were collected using current NAWQA protocols (Moulton and others, 2002) and ultra-clean techniques. Two composite periphyton samples were collected from each of the eight NAWQA. Analyses include total mercury, methylmercury, stable carbon and nitrogen isotopes, chlorophyll *a*, ash-free dry mass, and general divisional enumeration. Results will be published as a USGS Open-File Report, Scientific Investigations Report, and journal article.

PROGRESS (MAY 2003–JUNE 2004)

All sampling has been completed and analysis has begun on data returned. Preliminary report writing is in progress.

PLANS (JUNE 2004–DECEMBER 2004)

Finish data analysis and report writing, and prepare for fall conference.

REPORTS (PROPOSED)

Roehrborn, A.H. and Scudder, B.C., The role of periphyton in the bioaccumulation of mercury in riverine ecosystems.

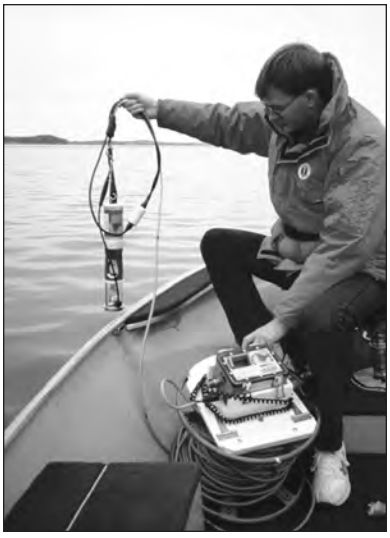
Lake Studies Team

OFFICE OF THE ASSISTANT DISTRICT CHIEF FOR SURFACE-WATER MONITORING

MISSION

The mission of the Lake Studies Team is to provide hydrologic, water-quality, and other scientific information to:

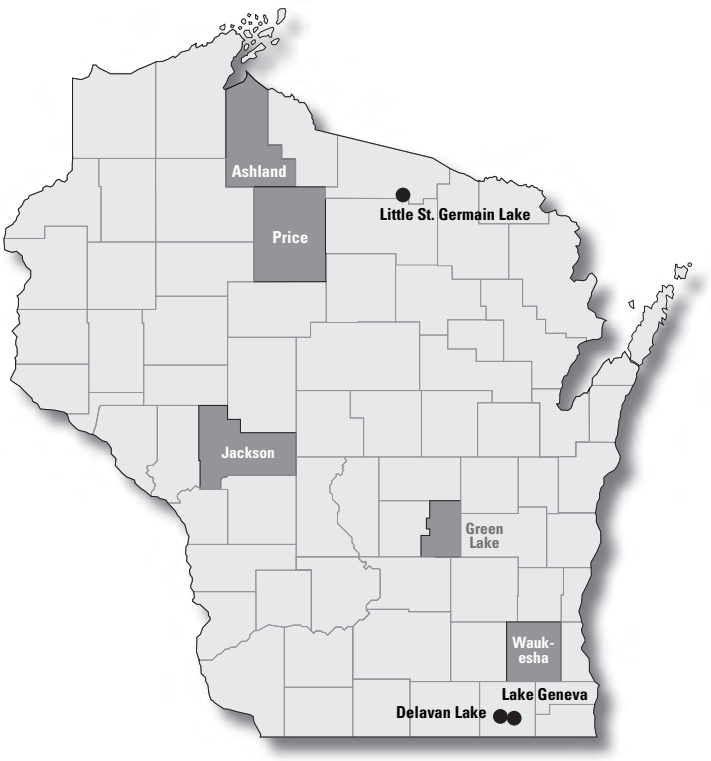
- describe current characteristics and conditions of lakes,
- identify and understand water-quality problems, and
- help determine effective management actions to protect or restore lakes in Wisconsin and the Nation and evaluate their effectiveness.



TEAM MEMBERS

William J. Rose, Hydrologist (Team Leader, Engineering)
Herbert S. Garn, Assistant District Chief
Dale M. Robertson, Research Hydrologist (Limnology)
Gerald L. Goddard, Hydrologic Technician
Daniel L. Olson, Hydrologic Technician
Josef Schuler, Hydrologic Technician
Brent W. Olson, Hydrologic Technician
Stephanie M. Berg, Student Trainee (Hydrology)
Chad J. Bloom, Hydrologic Technician (Student)
S. Bridgett Marsh, Hydrologist
Bernard N. Lenz, Civil Engineer

PROJECTS



STATEWIDE PROJECTS

9KB25 Lake Water-Quality Monitoring, Chemical and Biological Monitoring of Selected Lakes

9KB26 Miscellaneous Monitoring Associated with Lakes

PROJECTS OUTSIDE OF WISCONSIN

Southern California

9KM32 Eutrophication Modeling to Aid in the Development of a TMDL for the Salton Sea

LOCATION-SPECIFIC PROJECTS

COUNTY

Ashland County

9KB34 Assessment of the Hydrology, Water Quality, and Phosphorus Loading of Butternut Lake

Green Lake County

9KB27 Green Lake Monitoring

Jackson County

9KB32 Assessment of the Water Quality of Wazee Lake, Jackson County

Price County

9KB34 Assessment of the Hydrology, Water Quality, and Phosphorus Loading of Butternut Lake

Waukesha County

9KB35 Water Quality of Nagawicka Lake in Response to Hydrologic and Phosphorus Loading

LOCAL

Delavan Lake, Walworth County

9KB33 Assessment of the Hydrology, Water Quality, and Biology of Delavan Lake

Geneva Lake, Walworth County

9KB30 Assessment of the Water Quality, Hydrology, and Biology of Geneva Lake

Little St. Germain Lake, Vilas County

9KB29 Assessment of Phosphorus Loading, Winter Anoxia, and Stage Regulation of Little St. Germain Lake, Vilas County

Lake Water-Quality Monitoring, Chemical and Biological Monitoring of Selected Lakes

Project Chief: William J. Rose

Location: Selected lakes in Wisconsin

Project Number: 9KB25

Period of Project: June 1983–Continuing

COOPERATORS:

IN THE 2003 WATER YEAR:

Big Cedar, Booth, Lac La Belle, Little Cedar, Little Green, Lauderdale, Middle Genesee, Okauchee, Potter, Powers, Waterford Waterways, and Wind Lake Districts; townships of Minocqua (Kawaguesaga and Minocqua Lakes) and Springfield (East and West Twin Lakes); and Village of Oconomowoc Lake (Oconomowoc Lake).

IN THE 2004 WATER YEAR:

Big Cedar, Lauderdale, Little Cedar, Middle Genesee, Okauchee, Potter, Powers, Waterford Waterways, and Wind Lake Districts; townships Auburn (Forest Lake) and Springfield (East and West Twin Lakes); and village of Oconomowoc Lake (Oconomowoc Lake).

PROBLEM

Lakes are a significant and valuable resource in the State of Wisconsin and are experiencing increased pressure from development and use. Many lakes do not have adequate water-quality information available for management of the lake or to assess water-quality trends. 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 database so that any detrimental changes or trends that might occur in the future can be detected quickly and evaluated objectively.

APPROACH

For most lakes in the program water quality 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 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. For some lakes, such as those with multiple basins, more than one site on the lake is monitored.

PROGRESS (JULY 2003–JUNE 2004)

Data were collected, published, and archived for 17 lakes during water year 2003. The locations of lakes included in the monitoring program for water years 2003–2004 are shown on the map above.

PLANS (JULY 2004–JUNE 2005)

Thirteen lakes will be monitored in water year 2004. Data collected during the year will be compiled and transmitted to the respective cooperators. The data will be prepared for publication in the annual report "Water Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2004."

Miscellaneous Monitoring Associated with Lakes

Cooperators: City of Muskego, Little Muskego Lake Management District, Wind Lake Management District, Town of Rice Lake

Project Chief: William J. Rose

Location: Statewide

Project Number: 9KB26

Period of Project: October 1998–Continuing

PROBLEM

Monitoring miscellaneous, single hydrologic aspects of lakes is needed, but does not warrant establishing separate projects or subprojects. This monitoring is typically narrow in scope, such as flow or loading from a single lake tributary or lake stage, and is usually a prelude to, or follow-up from, a more comprehensive lake study.

OBJECTIVE

The objective is to collect lake stage, streamflow, stream-water quality, and constituent load data as needed. These lake-related monitoring efforts will be managed and financially tracked in this project.

APPROACH

Monitoring that fits into this subproject will be done using appropriate standard USGS practices.

PROGRESS (JULY 2003–JUNE 2004)

Monitoring of flow, phosphorus loading, and suspended-sediment loading to Little Muskego Lake at the mouth of Jewel Creek was discontinued September 30, 2003. Monitoring of flow from Big Muskego Lake continued. Flow in a small tributary with intermittent diversions to Devils Lake was monitored. Water levels in Big Muskego and Wind Lakes were monitored. Five near-lake piezometers were installed and sampled at Desair Lake in Barron County to assess the significance of ground water as a source of phosphorus to the lake.

PLANS (JULY 2004–JUNE 2005)

Monitoring at last year's sites will continue. An effort will be made to restore funding for the Jewel Creek site in order to resume water, sediment, and phosphorus monitoring. Data will be published in the annual reports "Water Resources Data–Wisconsin" and "Water-Quality and Lake-Stage Data for Wisconsin Lakes."

Wisconsin Lakes, Green Lake Tributary Monitoring

Cooperator: Green Lake Sanitary District

Project Chief: William J. Rose

Location: Green Lake County

Project Number: 9KB27

Period of Project: October 1977–Continuing

PROBLEM

Silver Creek is the primary source of phosphorus to Green Lake, the deepest natural inland lake in Wisconsin. Continued documentation of suspended sediment and phosphorus loads from major tributaries are needed to evaluate 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 and to monitor the lake's water quality.

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. Lake water quality will be measured at two locations six times per year.

PROGRESS (JULY 2003–JUNE 2004)

Streamflow and water quality were monitored at the Silver Creek inlet to Green Lake and at the mouth of White Creek. The Silver Creek site is equipped with a Doppler velocity meter, a stage gage, and an automatic water sampler. The White Creek site is a conventional stream-gaging site and is equipped with an automatic water sampler. Streamflow, phosphorus, and suspended-sediment loading to the lake were determined for both sites.

A gage on the Puchyan River near the outlet of Green Lake was operated to monitor flow from the lake. Water samples were collected manually for phosphorus analysis. Streamflow, loads, and concentration data were published in the report "Water Resources Data–Wisconsin, Water Year 2003."

USGS began monitoring lake water-quality in Green Lake in May 2004.

PLANS (JULY 2004–JUNE 2005)

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." Lake water-quality monitoring will continue. These data will be published in the annual lakes data report, "Water-Quality and Lake-Stage Data for Wisconsin."

Assessment of Phosphorus Loading, Winter Anoxia, and Stage Regulation of Little St. Germain Lake, Vilas County

Cooperator: Little St. Germain Lake District

Project Chiefs: William J. Rose; Dale M. Robertson

Location: 10 miles west of Eagle River

Project Number: 9KB29

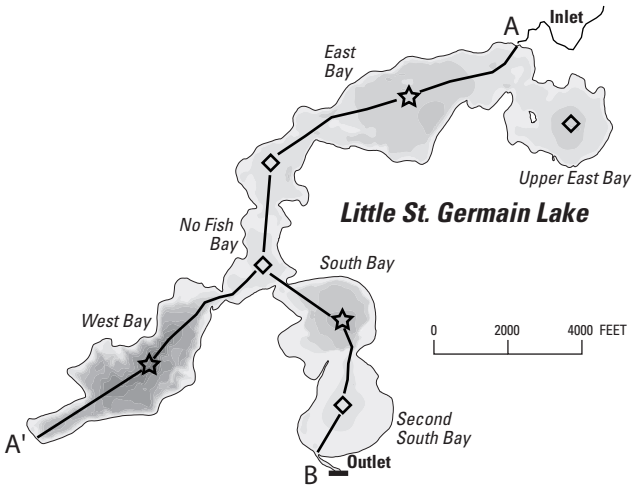
Period of Project: August 1996–September 2004

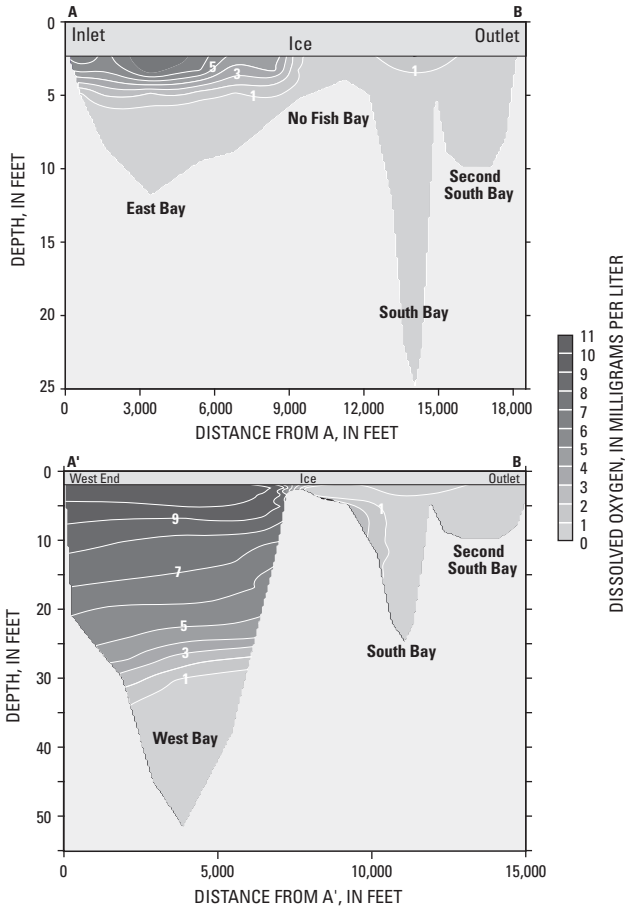
PROBLEM

Little St. Germain Lake consists of four main basins (East Bay, Upper East Bay, South Bay, and West Bay) separated by narrows. Muskellunge Creek, the lake's only inlet stream, enters East Bay. A dam at the lake's outlet is used to regulate lake stage and flow from South Bay. Hence, the net flow of water is from East 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 poor to very poor in the East Bay, based on monitoring from 1992–1994. Dissolved oxygen was absent at the South Bay monitoring site in late winter each year from 1992–1994. The areal extent and cause of the oxygen problem was identified in studies from 1994–2000. The Lake District is considering various measures to improve lake water quality. These include aeration of Upper East and South Bays in winter and possible treatment of Muskellunge Creek water before it enters the lake.

OBJECTIVE

The primary objectives of this project are to: (1) continue the water-quality trend monitoring at sites in the four main basins of the lake, (2) continue monitoring to determine water and phosphorus loading to the lake from Muskellunge Creek, (3) identify sources of phosphorus to Muskellunge Creek, (4) determine spatial and temporal distribution of oxygen in winter before and after installation of aeration systems, (5) model ground-water/lake-water interaction and estimate loading of phosphorus to the lake from ground water, and (6) synthesize all data, new and old, to evaluate the effectiveness of aeration systems and refine lake water and phosphorus budgets.





APPROACH

The lake's water and phosphorus budgets will be defined to better resolution than in previous studies by quantifying ground-water inflow and outflow through modeling aided by data from piezometers installed around the lake's perimeter. Determination of inflow to the lake from Muskellunge Creek will be improved by the operation of a continuous stage monitor. Measurements of flow and phosphorus concentration will be made at three locations along Muskellunge Creek to identify general source areas for phosphorus. Phosphorus loading from ground water will be based on data from sampled near-lake piezometers and inflow estimates generated by the ground-water model (GFLOW). Lake-water quality trend monitoring will continue at the four main basins of the lake. Measurements will be made to determine the spatial and temporal distribution of oxygen in winter before and after installation of aeration systems. All new and old data will be synthesized to evaluate the effectiveness of the aerations systems and to refine lake water and phosphorus budgets.

PROGRESS (JULY 2003–JUNE 2004)

Data monitoring continued as scheduled. The Lake District installed an aerator in the Upper South Bay and continued operation of the aerators in East Bay and Northeast Bay, which were installed two year earlier. Ground-water modeling was completed.

PLANS (JULY 2002–JUNE 2003)

A report containing refined water and phosphorus budgets for the lake and an evaluation of the effectiveness of the aerators will be prepared.

REPORTS

Robertson, D.M., and Rose, W.J., 2000, Hydrology, water quality, and phosphorus loading of Little St. Germain Lake, Vilas County, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 00–4209, 8 p.

Assessment of the Water Quality, Hydrology, and Biology of Geneva Lake

Cooperator: Geneva Lake Environmental Agency

Project Chief: Dale M. Robertson

Location: Walworth County

Project Number: 9KB30

Period of Project: March 1997–Continuing

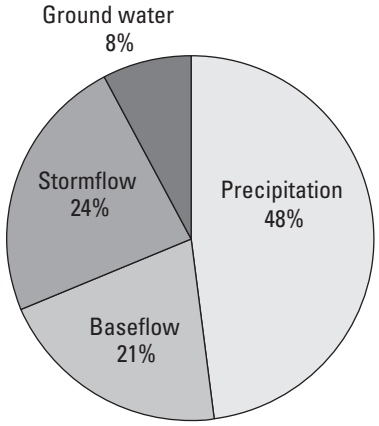
PROBLEM

Concerns continue to arise over the potential decline in the water quality of Geneva Lake because of increased urban development and recreational use. To reduce the impact on the lake, efforts have been and are continuing to be made to decrease the point- and nonpoint-source pollution to the lake. As part of past cooperative studies on Geneva Lake, historical water-quality data collected on the lake were assembled and compared with that collected by the USGS from 1997 through 1999. Empirical eutrophication models were also developed for the lake and used to demonstrate that the changes in the water quality of the lake were consistent with the reductions in the phosphorus loading to the lake. Continued water-quality and biological information are needed to determine the effectiveness of pollution prevention-strategies implemented in the basin.

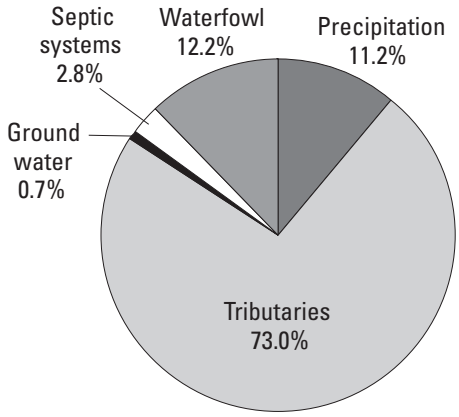
OBJECTIVE

The objectives of this project are to document the water quality and planktonic populations in the lake.

1998 Inflow (total – 37,500,000 cubic meters)



1998 - Phosphorus Input (total – 3,2900 kilograms)



Sources of water and phosphorus to Geneva Lake in 1998.

APPROACH

Standard limnological procedures are being used to monitor water quality and plankton populations in the lake.

PROGRESS (JULY 2003–JUNE 2004)

Lake sampling continued at the deep hole in the West Basin. Lake data were compiled for publication in the report, "Water Resources Data–Wisconsin, Water Year 2003" and "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2003."

PLANS (JULY 2004–JUNE 2005)

Lake sampling will continue in the West Bay of the lake. Lake data will be compiled and published in the Water Resources Data–Wisconsin reports.

REPORTS

Robertson, D.M., Goddard, G.L., Mergener, E.A., Rose, W.J., and Garrison, P.J., 2002, Hydrology and water quality of Geneva Lake, Walworth County, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 02–4039, 73 p.

Assessment of the Water Quality of Wazee Lake, Jackson County

Cooperator: Jackson County

Project Chief: Dale M. Robertson

Location: Jackson County

Project Number: 9KB32

Period of Project: October 2002–September 2004

PROBLEM

Because Wazee Lake is only about 20 years old, it is undergoing the very early stages in its aging process. Some intermittent measurements of the lake's water quality have been made in recent years and changes have been observed. One change is that the lake has gone from being dimictic, a lake with complete mixing during spring and fall, to being meromictic, or a lake with a monimolimnion (a lower zone which does not mix with the primary mass of lake water). A program of systematic water-quality monitoring is needed to document changes, to allow for early detection of undesirable changes, and to aid in making management decisions.

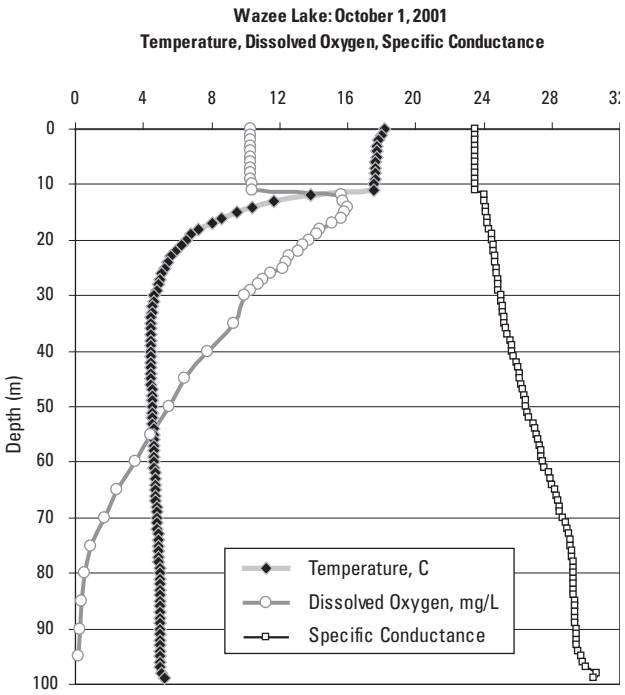
Because Wazee Lake is such a valuable and unique resource to Jackson County, the region, and the State of Wisconsin, the County wants to manage and develop the lake and surrounding park for public use in ways that avoid damaging the quality of the lake. The primary reason for the proposed monitoring of Wazee Lake is to build on the lake's water-quality data base.

OBJECTIVE

The goals of the proposed program are to (1) determine the current water quality and trophic status of the lake, (2) begin evaluating the impact of the beach area on the water quality of the lake, and (3) build a quantitative database so that improving or worsening changes or trends that might occur in the future can be detected quickly and evaluated objectively.

APPROACH

Measurements and analyses will be made at the deepest location in the lake to characterize the trophic status (degree of nutrient enrichment) of the lake, the chemical composition of the water, and the temperature and dissolved oxygen distribution within the lake. Profiles (from surface to bottom) of temperature, specific conductance, pH, dissolved oxygen, and turbidity will be measured during each of seven sampling visits during the year. These data will define the nature of stratification and mixing during the year. Sampling for chemical characterization of the water will be done at spring turnover when the water above the monimolimnion is uniformly mixed.



PROGRESS (JULY 2003–JUNE 2004)

Lake sampling, water level measurements, and beach sampling was completed. Lake data were compiled and published in the report, "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2003."

PLANS (JULY 2004–JUNE 2005)

Begin development of a future study to define and quantify lake/ground-water interactions and define the recharge area for ground water entering the lake.

Assessment of the Hydrology, Water Quality, and Biology of Delavan Lake

Cooperator: Delavan Lake Sanitary District

Project Chiefs: Dale M. Robertson; Gerald L. Goddard

Location: Walworth County

Project Number: 9KB33

Period of Project: August 1983–Continuing

PROBLEM

Eutrophication of Delavan Lake accelerated from the 1940s to 1980s, resulting in a hypereutrophic lake with severe blue-green algae blooms. Extensive rehabilitation efforts were implemented from 1990–1993 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 rehabilitation efforts and guide future management decisions.

OBJECTIVE

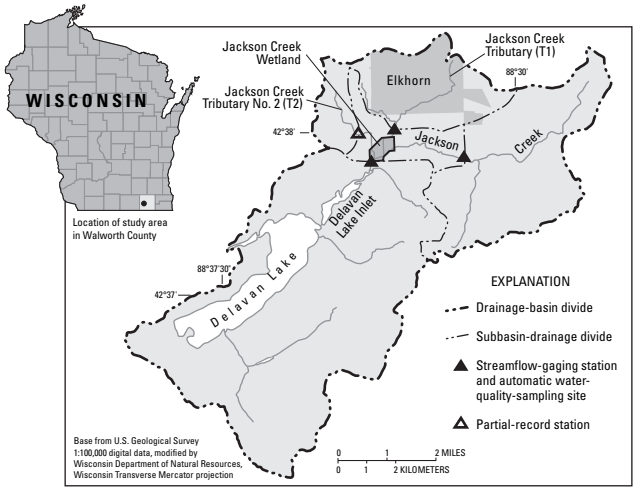
The objectives of this project are to: (1) quantify the effectiveness of rehabilitation efforts by measuring nutrient and suspended sediment loads at Jackson Creek tributary near Elkhorn, Jackson Creek at Mound Road (wetland outlet), Delavan Lake Inlet at Highway 50, and at the lake's outlet, (2) measure water quality, and plankton populations in the lake, and (3) determine the trapping efficiency of the upstream wetlands for phosphorus and suspended sediment.

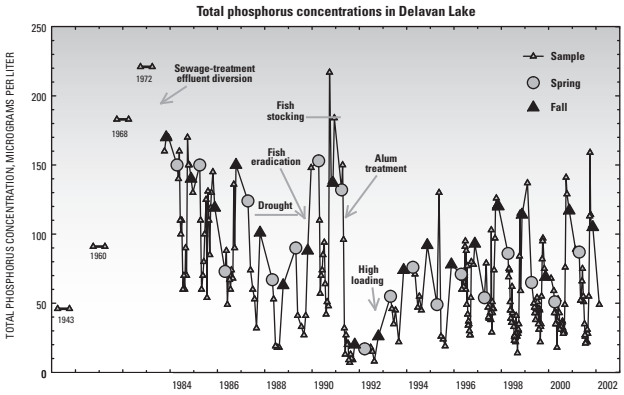
APPROACH

Nutrients, suspended sediments, and streamflow are monitored at Jackson Creek tributary, the wetland outlet at Mound Road, at Highway 50, and the lake outlet. Nutrient concentrations, dissolved oxygen, water temperature, pH, specific conductance, and planktonic populations are monitored within the lake. The effectiveness of the wetland is estimated by examining changes in the morphometry of the wetland ponds and changes in phosphorus and suspended sediment export at Mound Road.

PROGRESS (JULY 2003–JUNE 2004)

Streamflow was monitored continuously at three inflow sites and at one outflow site. Water samples were collected monthly and during storm-runoff events at all stream sites. Water samples were collected at the center of the lake and analyzed for nutrients and plankton populations. The 2003 water-year data were compiled and published in USGS annual reports, "Water Resources Data–Wisconsin, Water Year 2003" and "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2003." Although summer average total phosphorus concentrations have increased since 1993 (to about 40 µg/L), chlorophyll *a* concentrations remain relatively low and water clarity remains very good. Additional sediment deposition was measured in the wetland ponds.





PLANS (JULY 2004–JUNE 2005)

Reconfiguration of the wetlands is planned for this period. The monitoring program for the tributaries and the lake will be continued and the effects of changes to the wetland will be documented. Data will be compiled for publication.

REPORTS

Robertson, D.M., Goddard, G.L., Helsel, D.R., and MacKinnon, K.L., 2000, Rehabilitation of Delavan Lake, Wisconsin: Lake and Reservoir Management, v. 20, no. 1, p. 155–176.

Panuska, J.C., and Robertson, D.M., 1999, Estimating phosphorus concentrations following alum treatment using apparent settling velocities: Lakes and Reservoir Management, v. 15, no. 1, p. 28–38.

Robertson, D.M., Elder, J.F., Goddard, G.L., and James, W.F., 1998, Dynamics in phosphorus retention in wetlands upstream of Delavan Lake, Wisconsin: Lakes and Reservoir Management, v. 14, no. 4, p. 466–477.

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

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

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

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

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

Assessment of the Hydrology, Water Quality, and Phosphorus Loading of Butternut Lake

Cooperator: Price County

Project Chief: William J. Rose

Location: Ashland and Price Counties

Project Number: 9KB34

Period of Project: October 2002–December 2006

PROBLEM

Butternut Lake area residents and authorities would like to improve the lake's water quality, which they feel was degraded by past activities in the watershed. Prior to the 1960s, untreated municipal and cheese factory waste and losses from agricultural fields and inadequate failing septic systems were the main sources of nutrients to the lake. Since the 1960s, implementation and enforcement of a zoning ordinance regulating these systems has likely eliminated or significantly reduced these sources of nutrients. Agricultural activity in the watershed, particularly dairy farming, has declined considerably in the last 30 years. In the early 1980s, conditions in the lake appeared to be improving (written commun., Wisconsin Department of Natural Resources, 1982); however, the lake is still quite eutrophic, having occasional algal blooms and excessive weed growth. Recycling of accumulated phosphorus from bottom sediments, rather than loading from external sources, is now believed to be the major cause of current poor water quality.

Lake-area residents and lake users would like to implement management or restoration steps to return the lake to a more natural, pre-settlement state. Before management decisions are made, a good understanding of the lake's hydrology, nutrient loading by specific source, and internal recycling of nutrients is needed. In addition, the lake's likely response to incremental increases or decreases in phosphorus loading needs to be determined.

OBJECTIVE

The objectives are to: (1) Define hydrology and water budget of the lake, (2) determine the phosphorus loads from various sources and develop a phosphorus budget for the lake, (3) evaluate current lake water quality (trophic state) in relation to longer-term trends and in relation to current nutrient loading from external sources, and (4) evaluate the effects of increases or decreases in phosphorus loading on the trophic status of the lake using the BATHTUB model.

APPROACH

Stream data will be collected from November 2002 through October 2004. Lake water-quality monitoring will begin in March 2003 and continue through September 2004. Instrumentation needed for the water and phosphorus budget determination will be installed in October 2002. Data collection for water and phosphorus budget determination will be for two years, November 2002 through October 2004. Water and phosphorus budgets will be compiled using the measured major inputs and outputs and estimated minor inputs and outputs. Lake water quality will be evaluated using data collected for this study in addition to available historical data. The BATHTUB model will be calibrated using the detailed data collected during this study and then the model will be used to simulate lake water-quality response to incremental increases and decreases in phosphorus loading.

PROGRESS (JULY 2003–JUNE 2004)

Operation of the data-collection network on the lake, streams, precipitation, and ground water continued. First-year data were published in the annual data reports, "Water Resources Data—Wisconsin" and "Water-Quality Data and Lake-Stage Data for Wisconsin Lakes." Preliminary water and phosphorus budgets for the first year of data collection were constructed.

PLANS (JULY 2004–JUNE 2005)

Continue operation of the data collection network through October 31, 2004 and publish second-year data in the annual data reports. Complete interpretation of data and begin preparing the final report for the study.

Water Quality of Nagawicka Lake in Response to Hydrologic and Phosphorus Loading

Cooperator: City of Delafield

Project Chief: Herbert S. Garn

Location: Waukesha County

Project Number: 9KB35

Period of Project: October 2002–September 2006

PROBLEM

The trophic state of Nagawicka Lake is mesotrophic-borderline eutrophic, and quantified information on actual phosphorus loading sources and rates are not available to accurately evaluate the potential changes in lake condition under increased or decreased loading. Critical information to the City of Delafield, Lake Welfare Committee necessary for the management of

Nagawicka Lake is needed to address identified nonpoint-pollution sources and stormwater management. Potential changes in the water quality of Nagawicka Lake due to human activities and development in the watershed, and operation of lake outlet structures to maintain water levels and reduce flooding were identified as issues in the lake-management plan. The effects of increasing development in the watershed and possible resulting increased stormwater runoff and nutrient loading are a concern to residents, the City, and other entities. In order to establish realistic water-quality goals for Nagawicka Lake, accurate nutrient loading estimates are needed to enable water-quality models to be calibrated and used to simulate future response of the lake. With a calibrated model, the lake's response to incremental increases or decreases in phosphorus loading can be evaluated and used to refine the lake-management plan.

OBJECTIVE

This study will quantify the actual phosphorus and sediment loads entering and leaving Nagawicka Lake from the Bark River watershed, and will determine how incoming loads affect lake water quality.

The objectives of the proposed project are to:

- quantify the flows, phosphorus and sediment loads entering and leaving Nagawicka Lake;
- determine measured water and phosphorus budgets for Nagawicka Lake, thereby providing a better understanding of the problems and sources of nutrients for developing future lake management actions;
- relate the measured water and contaminant loads to observed and modeled water-quality responses within the Lake; and
- model the response of the Lake to future phosphorus-loading scenarios and to specific management actions aimed at reducing phosphorus loads to Nagawicka Lake.

A better understanding of the hydrologic and phosphorus inputs and potential response of the lake to various management scenarios will enhance the management of Nagawicka Lake.

APPROACH

The study will consist of gage installation and two years of data collection followed by data analysis and report preparation. Water quality will be sampled six times per year in Nagawicka Lake and water levels will be recorded continuously at a lake gage. To estimate the nutrient loading at the Bark River inlet and outlet, daily streamflow will be measured and samples will be collected by automatic water sampler at the inlet and manually at the outlet. To estimate nutrient loading from other direct tributaries, three miscellaneous sites will also be sampled manually and with siphon samplers. Phosphorus load data at the stream sites will be used to estimate unit-area loads for unmonitored portions of the basin. These measured data, along with other estimates, will be used to develop complete hydrologic and phosphorus budgets for the lake. Concurrent water and phosphorus budgets for the lake and in-lake water-quality data will be used to calibrate WiLMS (Wisconsin Lake Modeling Suite) and used to estimate the response of the lake to various phosphorus-loading scenarios.

PROGRESS (JULY 2003–JUNE 2004)

The project is in the second year of data-collection phase. The project began October 2002 with installation of two recording streamflow-gaging stations (Bark River inlet and outflow from dam) and a recording lake gage. An automatic water sampler is installed at the Bark River inlet site. Operated continuous-record monitoring stations for the first year of data collection. Collected suspended sediment, total phosphorus, and dissolved orthophosphorus data at streamflow stations for computation of loads; collected water samples at 3 miscellaneous water-quality sites. In-lake water quality was sampled at one main site on the lake. Installed and sampled 5 piezometers located near the shoreline around the lake. Stream data were compiled and published in the report "Water Resources Data–Wisconsin, Water Year 2003." Lake data were compiled and published in "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2003."

PLANS (JULY 2004 TO JUNE 2005)

Continue on-going streamflow and water-quality data collection at continuous-record monitoring stations, miscellaneous sites, and the lake. Prepare final data and compute records from second year of monitoring for publication in annual data reports. Begin draft of summary interpretive report.

REPORTS

Contributions published in annual data reports for Water Year 2003.

Eutrophication Modeling to Aid in the Development of a TMDL for the Salton Sea, California

Cooperator: University of California, Davis

Project Chief: Dale M. Robertson

Location: Southern California

Project Number: 9KM32

Period of Project: October 2003–September 2004

PROBLEM

The Salton Sea is a eutrophic to hypereutrophic water body in southern California characterized by high nutrient concentrations, high algal biomass as demonstrated by high chlorophyll *a* concentrations, high fish productivity, low clarity, frequent very low dissolved oxygen concentrations, massive fish kills, and noxious odors. Its eutrophic condition is primarily controlled or limited by phosphorus concentrations in the Sea. Most of the phosphorus input to the Salton Sea on an annual basis is from tributary loading; however, it is uncertain how important the release of phosphorus from the sediments of the Sea (associated with resuspension or redox conditions at the sediment surface) is to driving short-term algal blooms and anoxic conditions. To reduce the phosphorus loading to the Sea, a Total Maximum Daily Load (TMDL) is being prepared by the California Regional Water Quality Control Board, that, if implemented, is intended to improve the water quality and eliminate/reduce the problems with eutrophication.

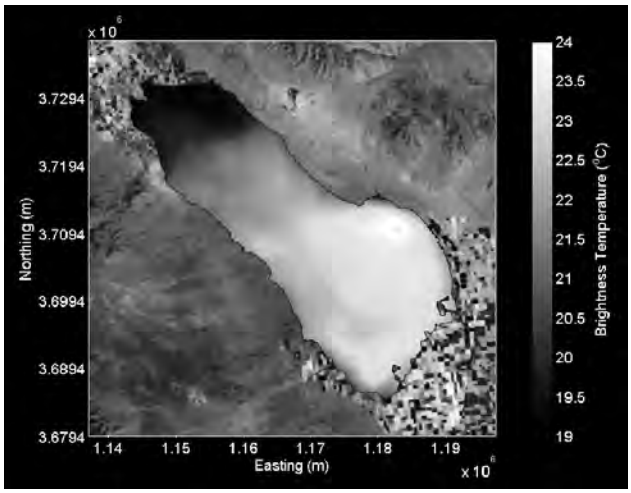
To determine a TMDL for phosphorus that will reduce the productivity of the Salton Sea to acceptable limits and reduce the extent of fish kill and noxious odors, a better understanding is needed for the link between nutrient loading from the watershed and sediments and the water quality of the Sea.

OBJECTIVES

The work proposed by the USGS is part of a collaborative effort with the University of California, Davis (Dr. S. Geoff Schladow, Dept. of Civil and Environmental Engineering), and the National Aeronautics and Space Administration (Dr. Simon Hook). The objectives of the USGS part of the study are: (1) refine all of the inputs (hydrologic and nutrient loading) to the Salton Sea, (2) determine what are the most important factors influencing short-term (daily) and long-term (annual and longer) productivity of the Salton Sea, (3) determine how modifications to the nutrient loading to the Sea should affect its short- and long-term productivity, and (4) in collaboration with the University of California, help the California Regional Water Quality Control Board establish a TMDL for the Salton Sea.

APPROACH

Historical data describing water quality in the Salton Sea and its tributaries will be assembled from the various agencies that collected the original data. Tributary loading will be estimated using the USGS load-estimating program Estimator, based on flow-to-load relations based on water-quality data and corresponding daily flow estimates from 1969 to 1999. To determine the sensitivity of the Salton Sea to decreases and increases in phosphorus loading, the BATHTUB model and other empirical models will be calibrated using lake and tributary data collected in 1999 and used to simulate conditions in the Sea with incremental increases and decreases in phosphorus loading. A dynamical model will also be developed by the University of California, Davis to describe how changes in the water quality of the Salton Sea should respond to decreases and increases in phosphorus loading. The results of the two different approaches will be compared.



An upwelling on the north end of the Salton Sea, induced by northerly winds, can be observed on May 28, 2001, from this MODIS/Terra thermal infrared image. On the following day, a fish kill totaling an estimated 1,269,200 fish was reported as having occurred at the north end of the Sea, between Desert Shores and Mecca.

PROGRESS (JULY 2003–JUNE 2004)

All of the hydrologic, loading, and in-lake data for the Salton Sea were assembled and summarized. Loading inputs were estimated from 1965 through 2002. Empirical eutrophication models were developed and response curves were estimated for changes in phosphorus loading. Phosphorus response curves of the empirical eutrophication models were compared with those generated using a dynamic model produced for the Salton Sea. A first draft of the final report was produced and provided to the California Regional Water Quality Control Board for review.

PLANS (JULY 2004–JUNE 2005)

Complete final report and publish individual journal articles.

Surface-Water Quality Monitoring Team

OFFICE OF THE ASSISTANT DISTRICT CHIEF FOR SURFACE-WATER MONITORING

MISSION

The mission of the Water-Quality Monitoring Team is to collect, store, interpret, and disseminate water-quality data at the state and local levels. The multi-disciplinary team will focus on water-quality issues utilizing new technologies and techniques to study the physical, chemical, biological, geological interactions in rivers and streams in Wisconsin. The use of current, innovative techniques and the latest technology will enable the Water-Quality Monitoring Team to work with cooperators to address emerging water-quality issues. Water quality issues may include occurrence and distribution, trends, and modeling of certain pollutants, relationships between natural factors, land use and water quality, and the relationship between ecological responses and water quality. Understanding the various components of the hydrologic system and their relationship to water quality will aid Federal, Tribal, State, and local governments in the management and protection of their water-quality resources.

TEAM MEMBERS

Kevin D. Richards, Physical Scientist (Team Leader)
Herbert S. Garn, Supervisory Hydrologist (Assistant District Chief)
Dale M. Robertson, Research Hydrologist (Limnology)
David J. Graczyk, Hydrologist
Sharon Fitzgerald, Research Hydrologist
Brett Esser, Hydrologic Technician
Michelle Lutz, Physical Scientist
Rob Waschbusch, Hydrologist
Barb Scudder, Biologist
Judith Thomas, Hydrologist
David Hall, Hydrologist
Rebecca Woll, Geographer
Bernard Lenz, Engineer
Krista Stensvold, Student Trainee (Hydrology)
Laura Rozumalski, Hydrologic Technician (Student)

PROJECTS

STATEWIDE PROJECTS

9KP43 Impact of Phosphorus and Nitrogen Concentrations on the Biological Integrity of Wisconsin Streams

LOCATION-SPECIFIC PROJECTS

TRIBAL

Menominee Indian Reservation

9KM44 Benthic algae of streams in the Menominee Indian Reservation

Oneida Indian Reservation

9KP44 Oneida Nation Hydrologic Investigations

COUNTY

Dane

9KP41 Dane County Water-Quality Program

Brown

9KP42 Water Quality of the Lower Fox River Tributaries and Duck Creek Watersheds

Jackson, Juneau, Monroe, Sauk, Shawano, Wood

9KP45 Surface Water Resources of the Ho-Chunk Tribe

Milwaukee, Ozaukee, Racine, Washington, Waukesha

9KP46 Milwaukee Metropolitan Sewerage District Corridor Study

MUNICIPAL

Madison

9KP32 Collection of Real-Time and Pathogen Data at Recreational Beaches in Madison

LOCAL

Milwaukee River and Root River Basins

9KP47 Collection of Water-Quality Data for Calibration and Verification of the HSPF Watershed Model for the Milwaukee and Root River Watersheds

Benthic Algae of Streams in the Menominee Indian Reservation

Cooperator: Menominee Indian Tribe of Wisconsin

Project Chief: Barbara C. Scudder

Location: Menominee Indian Reservation

Project Number: 9KM44

Period of Project: October 2003–October 2004

PROBLEM

Information from this project is desired by the Menominee Indian Tribe to construct a baseline status assessment of the water quality of streams in their reservation. Currently, the only previous algal sampling conducted in streams of the reservation was at two sites sampled by Scudder in 1998 (Garn and others, 2001). Analyses of these algal samples also would provide information for the USGS NAWQA program for the Western Lake Michigan Drainages Study Unit.

OBJECTIVE

The objectives of this project are to provide analysis of benthic algae samples and interpretation of water quality for 12 streams in the Menominee Indian Reservation as reflected by the abundance and distribution of algae in those streams. The project scope includes only the single set of algal samples collected in October 2000 for the 12 streams and would complement water quality and invertebrate information that was collected concurrently.

APPROACH

In October 2000, quantitative samples of benthic algae (periphyton) were collected from 12 streams of the Menominee Indian Reservation. A composite sample from woody snags in each stream was collected to allow calculation of metrics for water-quality assessment. Methods used were the same as those used to collect algae in the USGS's National Water-Quality Assessment (NAWQA) program (method described in Porter and others, 1993). The sampling was done in conjunction with a USGS water-quality reconnaissance of these streams that included invertebrate sampling. At the time, funding was not available for analysis and interpretation of the algae samples. The Menominee Indian Tribe of Wisconsin (MITW) has submitted a proposal to the USEPA for funding to analyze the algae samples and interpret results.

PROGRESS (JULY 2003–JUNE 2004)

Algae samples were sent to the Academy of Natural Sciences in Philadelphia (currently under contract by USGS NAWQA program) for identification and enumeration (relative count) in December 2003.

PLANS (JULY 2002–JUNE 2003)

Data interpretation will include a list of benthic algal taxa occurring at each stream site, selected metrics related to water quality such as the relative proportion of each algal group including diatoms, taxa richness, and data interpretation with regard to water quality and biotic integrity of sampled streams. A limited distribution report will include interpretation of data and algal species and abundance information and will include a CD-ROM with data tables.

Collection of Real-Time and Pathogen Data at Recreational Beaches in Madison

Cooperator: City of Madison

Project Chiefs: Robert J. Waschbusch; Steven R. Corsi

Location: Madison

Project Number: 9KP32

Period of Project: January 2002–September 2004

PROBLEM

The City of Madison, Wisconsin contains three lakes with over 20 miles of shoreline. For over 50 years, the Madison Department of Public Health (MDPH) has conducted weekly microbiological testing of the 13 beaches surrounding these lakes. The MDPH has developed beach-closing criteria based on testing results, combined with physical observations of conditions at the beach site. Traditionally the decision to close a beach has been communicated via posting of signs at the beach site as well as press releases. Since 1999, the MDPH has also posted a rating system on their web page to communicate beach conditions.

Although the MDPH has developed beach-closing criteria based on microbial indicators, there is a concern that the criteria may not reflect the actual risk to swimmers since the occurrence of pathogenic microorganisms during periods of high indicator levels has never been determined. The historic records demonstrate that bacterial indicator levels may vary significantly from one beach to another and from location to location within a beach with no apparent explanation for the differences. This variation confounds the beach closing decision-making process. There is a need to gather data to clarify the decision process.

OBJECTIVE

The objectives of this project were to:

(1) develop a mathematical model that predicts the probability of high *E. coli* levels based on environmental data that can be monitored and reported in real-time,

(2) evaluate and implement a new sensitive analytical method for detecting *E.coli* 0157:H7,

(3) develop a model that estimates the risk of pathogen occurrence, and

(4) provide real-time, user-friendly, state-of-the-art water-quality information to the public, including education regarding recreational water-quality issues.

APPROACH

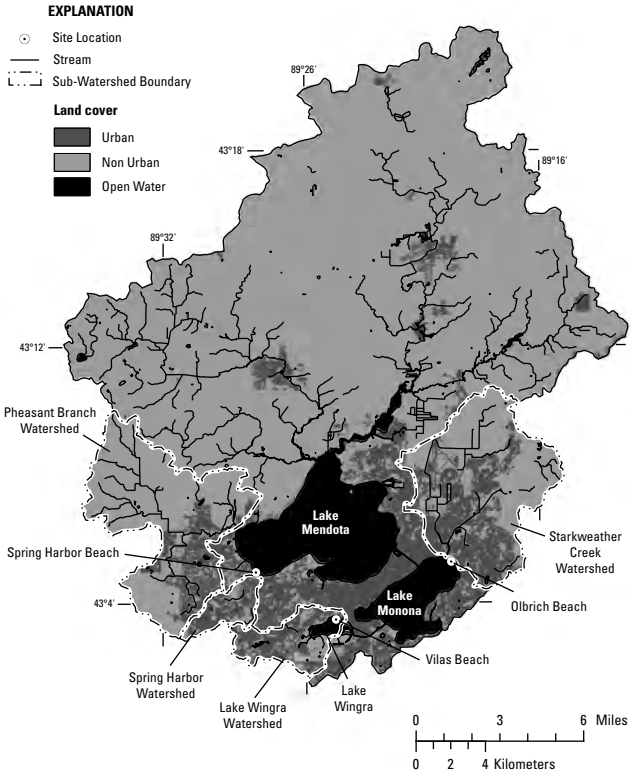
Three public swimming beaches were selected for monitoring, one on each of the three lakes representing differing lake morphology and beach user levels. The three beaches selected were:

Vilas Beach: Lake Wingra; high user levels.

Olbrich Beach: Lake Monona; medium user levels.

Spring Harbor Beach: Lake Mendota; low user levels.

During the swimming seasons of 2002 and 2003, the three beaches were continuously monitored for numerous water quality, meteorological and physical parameters. City of Madison beach personnel recorded daily swimmer and waterfowl counts. Madison Department of Public Health personnel collected fixed-interval samples at each beach five days per week for indicator organism and pathogen analysis. Custom-designed automatic water-quality samplers collected indicator organism and pathogen samples from 12 events at each beach. Events were defined as rainfall-runoff periods, high-turbidity periods, periods of high user counts or high wind/wave periods.



Land cover data source: WISCLAND Land Cover, 1992-93 (Lillesand and others, 1998)
Base from U.S. Geological Survey 1:24,000 digital data

PROGRESS (JULY 2003–JUNE 2004)

The continuously monitored water quality, meteorological, physical data and indicator organism data were checked, compiled and used to develop probability-based models for real-time assessment of the risk of pathogen and high-level indicator organism occurrence. Although the indicator model significantly improved the prediction of high levels of *E. coli* the other model did not provide improved predictive ability for pathogen occurrence.

PLANS (JULY 2004–JUNE 2005)

Publication of the final report.

REPORTS

A final report entitled "Data Collection and Modeling of Enteric Pathogens, Fecal Indicators and Real-Time Environmental Data at Madison, Wisconsin Recreational Beaches for Timely Public Access to Water Quality Information" has been submitted for USGS and USEPA review.

Dane County Water-Quality Program

Cooperator: Dane County Regional Planning Commission

Location: Dane County

Project Number: 9KP41

Period of Project: March 1992–Continuing

PROBLEM

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

OBJECTIVE

The objectives of this program are to collect long-term water-quality data to establish a database, including (1) operating four continuous-record streamflow-gaging stations with automatic water-quality samplers to compute sediment and total-phosphorus loads of selected major tributaries to Lake Mendota, (2) operating one continuous-record streamflow gage on Black Earth Creek, and (3) conducting base-flow water-quality

sampling six times per year during the open-water season at selected sites on streams throughout Dane County as agreed upon in an annual work plan.

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 stations. On a rotating basis, various water-quality constituents (field measurements, nutrients, and common ions) are measured six times during the year at base flow of four selected streams in the county.

PROGRESS (JULY 2003–JUNE 2004)

Streamflow and water-quality data collection at four continuous-record monitoring sites (Pheasant Branch at Middleton, Spring Harbor Storm Sewer at Madison, and Yahara River at Windsor and at SH113 at Madison) continued. Suspended-sediment loads were computed for Spring Harbor Storm Sewer; suspended sediment and total phosphorus loads were computed for Yahara River at Windsor and SH113 and at Pheasant Branch for the 2003 water year. Continuous streamflow monitoring at Black Earth Creek near Black Earth was continued for the year.

Base-flow water-quality sampling was completed at a set of four streams (054064509 Black Earth Creek (Stagecoach Rd) near Cross Plains, 05427270 Koshkonong Creek near Sun Prairie, 05427507 Koshkonong Creek at Rockdale, and 05435980 West Branch Sugar River near Mt. Vernon) in the County for 2003. Extra low-flow measurements were made during the prolonged dry period at all sites in September 2003. Base-flow sampling will begin at a new set of four streams in the County for 2004.

All streamflow, load, and concentration data were published in the annual data report "Water Resources Data–Wisconsin, Water Year 2003."

PLANS (JULY 2004–JUNE 2005)

Streamflow monitoring will be continued at Black Earth Creek; streamflow and water-quality monitoring will be continued at the four continuous-record stations on tributaries to Lake Mendota. Six base-flow water-quality samples will be collected from Six Mile Creek near Waunakee (05427900), Door Creek near Cottage Grove (05429580), Yahara River near Stoughton (05429720), and Mount Vernon Creek near Mt. Vernon (05436000) during calendar year 2004. Final data will be prepared and published in the annual data report, "Water Resources Data–Wisconsin."

REPORTS

Contribution published in annual data report for Water Year 2003.

Water Quality of the Lower Fox River Tributaries and Duck Creek Watersheds

Cooperator: University of Wisconsin-Green Bay

Project Chiefs: David J. Graczyk; Dale M. Robertson

Location: Brown County

Project Number: 9KP42

Period of Project: July 2003–Continuing

PROBLEM

Nonpoint-source pollution is a major concern in Wisconsin. An evaluation strategy will be used to assess the effectiveness of nonpoint-source pollution control measures in five watersheds in the Lower Fox River and Duck Creek watersheds.

OBJECTIVE

In-stream water-quality parameters (nutrients and suspended solids) will be monitored. The overall objective of this monitoring is to compare daily phosphorus and suspended solids loads for each watershed. Measured loads will be compared with those modeled by the University of Wisconsin Green Bay (UWGB).

APPROACH

Sampling will consist of fixed-interval and event-based sampling. Fixed interval monitoring consists of a predetermined sampling schedule that results in a set of data that captures natural variability in water quality due to a variety of unpredictable environmental conditions. Event-based monitoring consists of intensive sampling during periods of extreme variation in concentration and streamflow, which are important in accurately defining loads. Routine sampling will be conducted by the USGS and UWGB. Automated samples will be retrieved with the assistance from the UWGB. The USGS will determine which samples should be analyzed to represent the changes in water quality in the streams. All samples will be analyzed at the Green Bay Metropolitan Sewerage Treatment Water Quality Laboratory.

PROGRESS (JULY 2003–JUNE 2004)

Streamflow and water-quality gaging stations were installed on three streams (Apple Creek, Ashwaubenon Creek and Baird Creek). A water-quality sampler was installed at Duck Creek.

An acoustic velocity meter (AVM) and water-quality sampler were installed at the East River at Monroe Street. Over 220 water-quality samples were collected during events and low flows and analyzed for suspended solids, total and dissolved phosphorus. Median concentrations of total phosphorus ranged from 0.43 mg/L in Duck Creek to 0.92 mg/L in Baird Creek. Median suspended solids concentrations ranged from 22 mg/L in the East River to 199 mg/L in Baird Creek. Streamflow measurements were made at all sites to determine stage–discharge relations.

PLANS (JULY 2004–JUNE 2005)

Apple, Ashwaubenon, Baird, and Duck Creeks will continue to be monitored for streamflow and water quality. Water-quality samples will be collected bi-weekly from April through October, and monthly from December through March. Samples will be collected at all sites during runoff periods. Land-use information will be updated for each basin. Water-quality loads for total phosphorus and suspended solids will be calculated and compared to modeled data by the UWGB. The data will be analyzed to determine if there are any apparent trends in water quality during implementation of best-management plans. All streamflow and water-quality data collected in 2004 will be summarized and published in the report "Water Resources Data–Wisconsin, Water Year 2004."

Impact of Phosphorus and Nitrogen Concentrations on the Biological Integrity of Wisconsin Streams

Cooperator: Wisconsin Department of Natural Resources

Project Chiefs: David J. Graczyk; Dale M. Robertson

Location: Statewide

Project Number: 9KP43

Period of Project: March 2001–June 2005

PROBLEM

Excessive nutrient (primarily phosphorus and nitrogen) loss from the watershed is frequently associated with water-quality problems in Wisconsin's water bodies. The implementation of the WDNR's proposed agricultural performance standards and prohibitions should decrease the risk of excessive nutrient loss from croplands and livestock operations. Implementation of TMDLs and the enforcement of phosphorus criteria would also reduce the problems caused by nutrients. The expected water-quality improvements due to the application of agricultural performance standards may vary due to possible differences in nutrient responses in each water body dependent upon where the stream is located. In order to evaluate the environmental benefits of the proposed performance standards and phosphorus criteria, sufficient data need to be collected in various types of streams to define the nutrient response.

OBJECTIVE

The objectives of the project are to: (1) describe the water quality and biological communities in streams throughout the state, (2) determine how phosphorus and nitrogen concentrations impair the biological integrity of streams, (3) develop a database that can be used to refine the phosphorus criteria for Wisconsin streams, (4) determine how watershed characteristics affect the relations between phosphorus and nitrogen concentrations in streams and the biological integrity of the streams, and (5) improve our biological assessment of nutrient impairments by developing a nutrient index of biological integrity.

APPROACH

The approach for the project is to collect water-quality and biological-community data from streams throughout the state and statistically determine if significant relations exist between a stream's nutrient concentrations, biological integrity, and watershed characteristics. Multivariate statistical analyses will be used to sort out the importance of the many different variables. Since these nutrient relations are expected to vary with stream size and the location of the stream in the state, streams will be grouped by size, and by four nutrient ecoregions and four nutrient zones. Streams will be divided into wadeable and non-wadeable streams.

The variables in the statistical analysis will include indicators of biological integrity, habitat characteristics, nutrient concentrations, and specific watershed characteristics. The biological indicators will include fish abundance and diversity, macroinvertebrate diversity, and periphyton biomass. Water samples collected from the stream will be analyzed for total phosphorus, dissolved phosphorus, nitrate, total Kjeldahl nitrogen, ammonia, turbidity, conductivity, and suspended chlorophyll *a*. Watershed characteristics will include drainage-area size, stream gradient, climate data, land use, annual runoff, surficial deposits data, and soil characteristics types.

Approximately 160 small streams will be monitored in the first year of the study. Approximately 80 larger wadeable streams will be monitored in the second year of the study and approximately 40 larger non-wadeable larger streams will be sampled in the third year of the study. The fish and habitat data in the wadeable streams were collected using similar protocols at all sites and the data are stored in a readily accessible database.

A total of six water-quality samples will be collected between the months of May and October at each site. A flow measurement will be collected at the time of the water-quality grab sample.

PROGRESS (TO JUNE 2004)

Water quality and biological community data were collected at 158 small wadeable streams in 2001, 78 larger wadeable streams in 2002, and 5 small wadeable and 40 large non-wadeable streams in 2003. Samples were analyzed for nutrients and chlorophyll *a*. Field measurements included stream discharge, water temperature, dissolved oxygen, pH, turbidity, conductance, and stream clarity. Most of the sites were sampled for attached algae, diatoms, and macroinvertebrates by the Wisconsin Department of Natural Resources. All data collected were summarized and published in "Water Resources Data–Wisconsin, Water Year 2001, 2002, and 2003."

Preliminary analysis of the wadeable streams has been conducted and presented at the Midwest Surface Water Monitoring and Standards (SWiMS) Conference in Chicago, Ill., in 2003 and at several RTAG meetings with the USEPA in Chicago, Ill.

PLANS (JULY 2004–JUNE 2005)

Complete the analysis examining the relations between watershed characteristics and water quality, between water quality and diatom communities, between water quality and macroinvertebrate and fish communities, and the analysis examining the interrelations between all aspects of water quality and biological integrity of streams. A final report will be written describing the impact of phosphorus and nitrogen concentrations on the biological integrity of wadeable streams in Wisconsin. Preliminary analysis of the data collected on the non-wadeable streams will be started.

Oneida Nation Hydrologic Investigations

Cooperator: Oneida Nation of Wisconsin

Project Chief: Kevin D. Richards

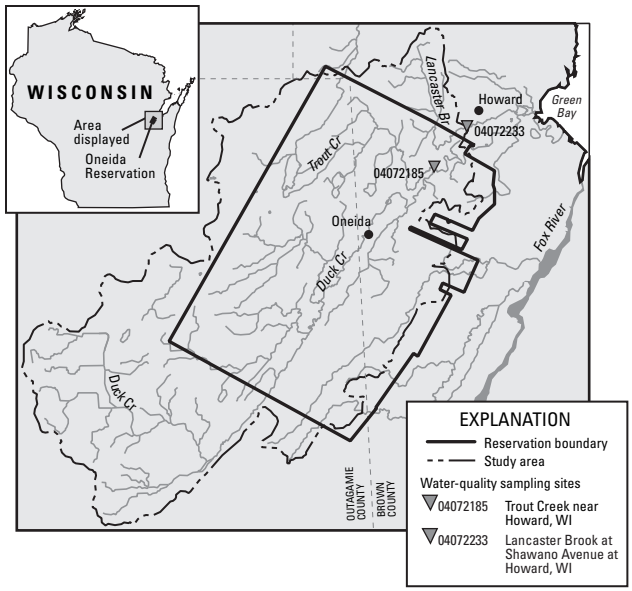
Location: Oneida Indian Reservation

Project Number: 9KP44

Period of Project: August 1997–September 2007

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. The Oneida Nation needs continuing information regarding water-quality conditions entering and within their Nation's boundaries. The information is needed to determine trends in water quality and to provide data to assess the Tribe's water resources.



OBJECTIVE

The objective is to collect long-term data at two sites to perform trend analyses for pesticides, nutrients, and suspended sediment.

APPROACH

Sampling will be conducted at two sites to determine concentrations of nutrients, pesticides, and suspended sediment. Field parameters will also be collected and sampling will take place on a fixed interval. The National Water Quality Lab will analyze the water samples. National Water-Quality Assessment protocols will be followed in the collection and handling of the water-column samples. A staff person from the Oneida Nation Environmental Section will work with a USGS staff person in the collection of data.

PROGRESS (JULY 2003–JUNE 2004)

Samples were collected at two sites monthly plus four events. Samples were analyzed for pesticides, nutrients and suspended-sediment concentrations. Data collected in 2003 were published in the report, "Water Resources Data–Wisconsin, Water Year 2003."

PLANS (JULY 2004–JUNE 2005)

Data from samples collected from October 1, 2003 through September 30, 2004, will be published in the report, "Water Resources Data–Wisconsin, Water Year 2004." Water-quality sampling will be conducted at two sites and continue indefinitely.

The Surface-Water Resources of the Ho-Chunk Tribe

Cooperator: Ho-Chunk Nation of Wisconsin

Project Chief: Judith C. Thomas

Location: Jackson, Sauk, Monroe, Juneau, Wood, and Shawano Counties

Project Number: 9KP45

Period of Project: September 2000–Continuing

PROBLEM

The Ho-Chunk Nation is concerned about the condition of streams and rivers on and around their residential lands because tribal members use these waters for food and recreation. Information regarding these waters is scarce and no summary of information is available.

OBJECTIVE

The objective is to provide the Nation with information about their surface-water resources that will allow them to: (1) make decisions about using these waters for food and recreation, and (2) initiate a monitoring program for important waters.

APPROACH

Information on physical, chemical and biological characteristics of streams within a 1-mile radius of Ho-Chunk residential lands was collected through a literature and database search and summarized in a retrospective report. This summary will provide a basis for designing a sampling plan that will be carried out on selected streams to augment historical information. A pesticide reconnaissance sampling study and sampling for aquatic fauna and benthic organisms will take place to fill data gaps.

PROGRESS (JULY 2003–JUNE 2004)

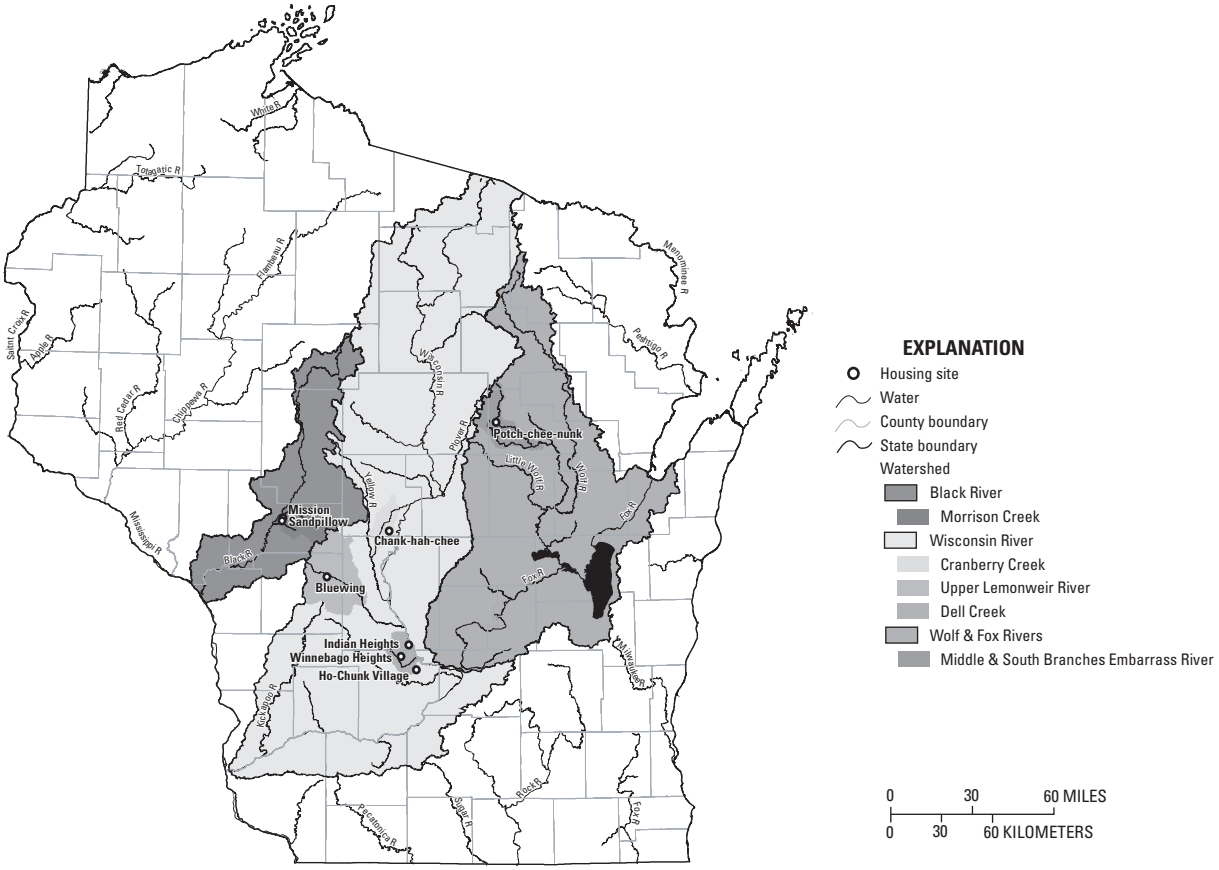
Report was published and distributed. Reconnaissance was conducted to locate sampling locations with Tribal representatives and sampling logistics were decided. Pesticide event sampling began in late spring 2004.

PLANS (JULY 2004–JUNE 2005)

Complete pesticide event sampling and sample fish and benthic organisms in late summer 2004.

REPORTS

Diebel, M.W. and Sullivan, D.J., 2002, Surface-water resources information for the Ho-Chunk Nation lands and vicinity, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 02–4307, 33 p.



Milwaukee Metropolitan Sewerage District Corridor Study

Cooperator: Milwaukee Metropolitan Sewerage District

Project Chief: David J. Graczyk and Judith C. Thomas

Location: Milwaukee County and parts of Waukesha, Washington, Ozaukee, and Racine Counties

Project Number: 9KP46

Period of Project: February 2001–Continuing

PROBLEM

The Milwaukee Metropolitan Sewerage District (MMSD) has a watercourse improvement program that is designed to integrate flood control with habitat and water-quality protection and enhancement. The MMSD Corridor Study will compile and collect historical and existing hydrologic, geographic, physical, biological, and chemical data for perennial streams and selected intermittent watercourses and their adjacent corridors within the MMSD planning area. The data will be used to help identify existing waterway limitations, and to evaluate and forecast the potential impacts or improvements from watercourse modifications. The MMSD Corridor Study is a cooperative effort between many local, state, and federal agencies that are represented on the Steering Committee. The Steering Committee is made up of members from the Milwaukee Metropolitan Sewerage District, the U.S. Geological Survey (USGS), the Wisconsin Department of Natural Resources (WDNR), the Southeastern Wisconsin Regional Planning Commission (SEWRPC), UW-Milwaukee, Marquette University, Wisconsin Lutheran College, and others.

OBJECTIVE

The primary objectives of the MMSD Corridor study include: (1) evaluating historic impacts and forecasting potential impacts of planned MMSD projects, (2) creating a comprehensive inventory of corridor conditions, (3) establishing a baseline assessment of existing watercourse and corridor conditions, (4) determining the existing and potential water-use objectives for watercourse reaches, (5) following up on flood control, habitat and water-quality improvement or protection projects to verify anticipated results, evaluate current technologies, and identify adjustments for future projects, and (6) providing long-term surveillance of stream and corridor conditions to monitor project impacts, track changes in impaired and unimpaired reaches, provide additional inventory information, and allow early detection of newly impaired reaches.

APPROACH

There is a three-phase approach to the MMSD Corridor study. Phase I will include the development of a data warehouse and evaluation of analytical procedures. A data warehouse will be compiled from different data sets with the purpose of assembling data from within the corridor study area. The assembled data will then be analyzed to summarize existing conditions and identify data gaps and future data needs. Phase II will consist of a baseline inventory of water-quality conditions in the MMSD study area. An intensive data-collection and analysis effort will be made to fill in data gaps and update historic data to define the existing characteristics of the watercourses and corridors and serve as the basis for future impact evaluations and trend analyses. Phase III will be the development of a long-term inventory of water-quality data and maintenance of the data warehouse. The data collected as part of field activities and the data maintained in the data warehouse will be used to assess future impacts, measure the benefits of watercourse modifications and other watershed management efforts, and detect new watercourse concerns or impairments.

PROGRESS (JULY 2003–JUNE 2004)

Milestones for this period include: the publication of the MMSD Retrospective Report and database compilation. Continued meetings with the Steering Committee and incorporation of their comments in the Phase II Work plan. Fifteen surface-water sites and six harbor sites were selected to sample quarterly and limited events to establish baseline conditions in the planning area and to fill in data gaps. Three new gaging stations were installed, and 4 sites had ISCO automatic water-quality samplers installed with Hydrolab continuous monitor probes. MMSD Staff were trained in collection of samples from the harbor; harbor samples are collected by MMSD and processed by the USGS. Samples were collected during ice cover conditions, “ice-melt” conditions (first event) and spring baseflow during this period. Sites were selected to have in-stream sediment samplers installed.

PLANS (JULY 2004–JUNE 2005)

In-stream sediment samplers will be installed at 14 sites. A summer high-flow event will be sampled and quarterly water-quality sampling will be continued at all 21 sites. Five to 10 events will be sampled at four locations (Milwaukee River at Cedarburg and Milwaukee, Kinnickinnic River at Milwaukee and the Menomonee River at Wauwatosa, Wis.). Samples will be collected with ISCO water-quality samplers and be analyzed for suspended sediment, total phosphorus, and chloride. For two of the planned events, sampling will be coordinated with an ongoing study done in cooperation with SEWRPC. A more extensive list of parameters will be analyzed. Biological sampling, including fish, algae, and benthic invertebrates and habitat survey will be conducted at the 15 surface-water sites late in the summer of 2004.

REPORTS

Schneider, M.S., Lutz, M.A. and others, 2003, Water-resources related information for the Milwaukee Metropolitan Sewerage District planning area, 1970–2002: U.S. Geological Survey Water-Resources Investigations Report 03–4240, 288 p.

Collection of Water-Quality Data for Calibration and Verification of the HSPF Watershed Model for the Milwaukee and Root River Watersheds

Cooperator: Southeastern Wisconsin Regional Planning Commission

Project Chiefs: Judith C. Thomas; David W. Hall

Location: Milwaukee River and Root River Basins, Wisconsin

Project Number: 9KP47

Period of Project: March 2004–June 2005

PROBLEM

A Hydrological Simulation Program-FORTRAN (HSPF) watershed model is being developed for the Milwaukee Metropolitan Sewerage District (MMSD) Planning Area and areas contributing to the MMSD Planning Area to determine how various management strategies will affect the water quality of streams in these areas. To aid in the development of this model, a single database with water-quality data collected by various entities within the Milwaukee Metropolitan Sewerage District (MMSD) Planning Area has been developed through a cooperative effort of the MMSD, U.S. Geological Survey (USGS), and the Wisconsin Department of Natural Resources (WDNR). This database will be used as the primary source of data for the calibration and validation of the HSPF to be used to simulate various planning scenarios. For areas beyond the MMSD Planning Area, data from the WDNR, USGS, and other sources will be used as much as possible. There are abundant water-quality data available within the MMSD Planning Area; however, data are needed for the upstream area of the Milwaukee River watershed, the downstream area of the Root River watershed, and the area near the Root River Canal in Racine.

OBJECTIVE

The primary objective of this study is to collect stage/streamflow and water-quality data for the upstream area of the Milwaukee River watershed, the downstream area of the Root River watershed, and the area near the Root River Canal in Racine. These data will enable SEWRPC and its associates to calibrate and verify the HSPF watershed model for the MMSD Planning Area and adjacent areas.

APPROACH

Sampling will be conducted at six sites in the upper Milwaukee River Basin and three sites in the Root River Basin to define the changes in suspended solids, total phosphorus, chloride, conductivity, temperature, and dissolved oxygen (primary water-quality constituents simulated in HSPF) and a less-intensive sampling approach will be used to describe additional nutrients, suspended sediment, total BODs, chlorophyll *a*, alkalinity, pH, zinc, copper, mercury, *E. coli*, and fecal coliform. A total of six runoff events will be sampled at each site during 2004, with two of these events having the complete schedule of water-quality analyses performed and the remaining four runoff events having only total suspended solids, chloride, and total phosphorus analyzed. Two base-flow samples will also be collected at each of the nine sites and analyzed for the complete schedule of water-quality analyses. Continuous data will be collected at all sites for stage, conductivity, water temperature, and dissolved oxygen.

PROGRESS (TO JUNE 2004)

All nine sites selected by SEWRPC were instrumented during spring of 2004. Eight of nine sites are configured to enable stage-based techniques to compute discharge. The ninth site, at the mouth of the Root River in Racine, was additionally instrumented with a directional velocity meter. The velocity data are combined with stage data to compute Root River discharge to Lake Michigan as well as reverse flow when water from Lake Michigan briefly flows up the Root River channel as a result of elevated lake stage. The collection of quality-assurance samples began in mid-June prior to collection of the first set of scheduled samples.

PLANS (JULY 2004–JUNE 2005)

The remaining scheduled sample collections will occur at each of the nine sites during summer of 2004. All discharge and associated water-quality data will be forwarded to SEWRPC as soon as it has been reviewed by USGS personnel and is approved for release.

REPORTS

An interpretive Scientific Investigations Report (SIR), entitled “Spatial and Temporal Distribution of Selected Constituents in the Upper Milwaukee and Lower Root River Watersheds, 2004” will be prepared for publication in 2005.

Streamflow and Lake Stage Network Team

OFFICE OF THE ASSISTANT DISTRICT CHIEF FOR SURFACE-WATER MONITORING

MISSION

The Team's mission is to collect, store, compile, and disseminate water-resources data that address relevant issues and are responsive to the needs of cooperators and the general public. It provides relevant, credible, impartial, and timely data for understanding hydrologic systems, planning developments, designing facilities, forecasting floods, operating dams, wastewater treatment, and water-supply plants, managing lakes and wetlands, abating and preventing pollution, modeling, determining trends, and determining the occurrence and distribution of water. The real-time and historical data will be made available in various forms including the WWW Internet, computer disks, and printed reports.

TEAM MEMBERS

Herbert S. Garn, Assistant District Chief (Co-Team Leader)
Robert J. Waschbusch, Hydrologist (Co-Team Leader)
Steven A. March, Hydrologic Technician (Field Office Chief)
Thomas J. Popowski, Hydrologic Technician (Field Office Chief)
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Benjamin Siebers, Hydrologic Technician (Student)
Eric Dantoin, Hydrologic Technician (Student)

PROJECTS

Streamflow and Lake Stage Network

Project Chief: Robert J. Waschbusch

Location: Statewide

Project Number: WI 00100

Period of Project: July 1913–Continuing

Cooperators:

- Bad River Band of Lake Superior Chippewa Indians
- Bayfield County
- Black River Falls Utilities
- City of Barron
- City of Beaver Dam
- City of Hillsboro
- City of Peshtigo
- City of Sparta
- City of Waupun
- Dane County Department of Planning and Development
- Dane County Department of Public Works
- Dane County Regional Planning Commission
- Federal Energy Regulatory Commission Licensees
  - Black River Falls Municipal Utilities
  - Dairyland Power Cooperative
  - Northern States Power Company
  - Stora Enso, Niagra Mill
  - Wisconsin Electric Power Company
  - Wisconsin Public Service Corporation
  - Wisconsin Valley Improvement Company
- Fontana/Walworth Water Pollution Control Commission
- Green Bay Metropolitan Sewerage District
- Illinois Department of Natural Resources
- Kickapoo Valley Reserve
- Lac du Flambeau Band of Lake Superior Chippewa
- Lower Fox River Dischargers Association–Appleton Papers
- Madison Metropolitan Sewerage District
- Menominee Indian Tribe of Wisconsin
- Mole Lake Sokaogon Chippewa Community
- Oneida Tribe of Indians of Wisconsin
- Rock County Public Works Department
- Southeastern Wisconsin Regional Planning Commission
  - City of Racine
  - Kenosha Water Utility
  - Milwaukee Metropolitan Sewerage District
  - Waukesha County
- Stockbridge-Munsee Band of Mohican Indians
- U.S. Army Corps of Engineers
- Village of Wittenberg
- Village of Westport
- Walworth County Metropolitan Sewerage District
- Wisconsin Department of Natural Resources
- Wisconsin State Historical Society-Wade House Historic Site

PROBLEM

Streamflow and lake-stage information is needed for hazard warning, design and operation of dams, drinking and wastewater treatment plants, flood mitigation, irrigation, bridge and culvert design, wildlife management and pollution abatement. Data are necessary to efficiently perform these functions.

OBJECTIVE

The objective of this project is to collect data that meets the problem needs stated above.

APPROACH

A network of streamflow and lake-level stations is maintained throughout Wisconsin. Recording river or lake stages are made available on the USGS "Real-Time" web site (*http://wi.waterdata.usgs.gov/nwis/current/?type=flow*). Periodic discharge measurements are collected at streamflow stations to establish or verify data. The data are corrected and quality assured. The data are compiled and daily, monthly, and annual statistics are computed and published.

PROGRESS (JULY 2003–JUNE 2004)

During the last fiscal year, streamflow data were collected at 124 stream sites and lake-level data were collected at six. Computation of streamflow and lake-level records for all the network stations for the 2003 water year was completed, stored in our database, and published in the annual report "Water Resources Data–Wisconsin, Water Year 2003".

PLANS (JULY 2004–JUNE 2005)

Data will be collected, computed and published at 126 continuous-streamflow stations and lake levels at 8 stations. These sites are listed in the following table, "Surface-Water Gaging Stations Expected to be Operated in 2004 FY." A map showing the location of all continuous-record streamflow-gaging stations in Wisconsin is shown on page xiv.

SIGNIFICANT FINDINGS AND REPORTS

In addition to the paper version, the water year 2002 Wisconsin Water Resources data report was published on the USGS web site and the 2003 report was also produced in a compact disc version. The compact disc version contained both an electronic version of the report and data files for all continuously monitored data for the entire period of record. Having the data in electronic format and for the period of record should be a great benefit for data users.

In water year 2002, the following flood peaks of note were recorded:

- The Pine River near Florence recorded the highest peak flow on record (59 years), with an estimated 135-year recurrence interval.
- The Menominee River at Niagara recorded the highest peak flow on record (11 years), with an estimated 15-year recurrence interval.
- The Montreal River near Saxon recorded a peak flow with an estimated 90-year recurrence interval.
- The Popple River near Fence recorded a peak flow with an estimated 50-year recurrence interval.

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 2004 FY

Station number	Name and location	Drainage area	Period of record (water year)	Cooperator
464646092052900	Superior Bay, Duluth Ship Canal at Duluth, MN	4200	1994-	C of E, Detroit
04024430	Nemadji River - South Superior	420	1974-	WDNR
04025500	Bois Brule River - Brule	118	1943-81, 1984-	USGS Federal Program
040263205	Whittlesey Cr – Ashland	37.6	1999-	Bayfield County
04027000	Bad River - Odanah	597	1914-22, 1948-	Bad River Band of Lake Superior Chippewa Indians
04027500	White River - Ashland	301	1948-	NSP/WDNR
04029990	Montreal River - Saxon Falls	262	1987	NSP/WDNR
04063700	Popple River - Fence	139	1964-	USGS Federal Program
04064500	Pine River - Pine River Powerplant - Florence	533	1924-76, 1996-	WEPCO/WDNR
04065106	Menominee River - Niagara	2470	1993-	FERC
04066003	Menominee River - Pembine	3140	1950-	WEPCO/WDNR
04066030	Menominee River - White Rapids Dam - Banat, MI	3190	1999-	FERC
04066500	Pike River - Amberg	255	1914-70, 2000-	USGS Federal Program
04066800	Menominee River - Koss, MI	3700	1907-09, 1913-81, 1998-	FERC
04067500	Menominee River - McAllister	3930	1945-61, 1979-86, 1988-90, 1993-95, 1998-	WDNR
04067958	Peshtigo River - Wabeno	447	1998-	WPS/WDNR
04069416	Peshtigo River - Porterfield	1020	1998-	FERC
04069500	Peshtigo River - Peshtigo	1080	1953-	City of Peshtigo
04071000	Oconto River - Gillett	705	1906-09, 1914-	USGS Federal Program
04071765	Oconto River - Oconto	966	1989-90, 1998-	WDNR
04072150	Duck Creek - Howard	108	1988-	Oneida Tribe of Indians of WI
04073365	Fox River - Princeton	962	2001-	USGS Federal Program
04073500	Fox River - Berlin	1340	1898-	C of E, Detroit
04074538	Swamp Creek - above Rice Lake at Mole Lake	46.3	1977-83, 1984-86, 2001-	Sokaogan Chippewa Community
04074548	Swamp Creek - below Rice Lake at Mole Lake	56.8	1977-79, 1982-85, 2001-	Sokaogan Chippewa Community
04074950	Wolf River - Langlade	463	1966-79, 1981-	Menominee Indian Tribe of WI
04077630	Red River - Morgan	114	1993	Stockbridge-Munsee Band of Mohican Indians
0407809265	Middle Branch Embarrass River - Wittenberg	76.3	1990-	Village of Wittenberg
04078500	Embarrass River - Embarrass	384	1919-85, 1994-	USGS Federal Program
04079000	Wolf River - New London	2260	1896-	C of E, Detroit
04082400	Fox River - Oshkosh	5310	1991	C of E, Detroit
04084445	Fox River - Appleton	5950	1986-	C of E, Detroit
04084500	Fox River - Rapide Croche Dam - Wrightstown	6010	1896-	LFRDA/WDNR

Station number	Name and location	Drainage area	Period of record (water year)	Cooperator
040851385	Fox River - Oil Tank Depot - Green Bay	6330	1989-	Green Bay MSD
04085200	Kewaunee River - Kewaunee	127	1964-96, 1998-	WDNR
04085395	S.Br. Manitowoc River - Hayton	109	1993-	WDNR
04085427	Manitowoc River - Manitowoc	526	1972-96, 1998-	WDNR
04085746	Mullet River - Greenbush	24.3	2001-	Wisconsin State Historical Soc.
04086000	Sheboygan River - Sheboygan	418	1916-24, 1951-	WDNR
04086500	Cedar Creek - Cedarburg	120	1930-70, 73-81, 1983-87, 1991-	WDNR
04086600	Milwaukee River - Pioneer Road - Cedarburg	607	1982-	SEWRPC
04087000	Milwaukee River - Milwaukee	696	1914-	SEWRPC
04087030	Menomonee River - Menomonee Falls	34.7	1975-77, 1979-	SEWRPC
04087088	Underwood Creek - Wauwatosa	18.2	1975-	SEWRPC
04087120	Menomonee River - Wauwatosa	123	1962-	SEWRPC
04087160	Kinnickinnic River - Milwaukee	20.4	1976-	SEWRPC
04087204	Oak Creek - South Milwaukee	25	1964-	SEWRPC
04087220	Root River - Franklin	49.2	1964-	SEWRPC
04087233	Root River Canal - Franklin	57	1964-	SEWRPC
04087240	Root River - Racine	190	1963-	SEWRPC
04087257	Pike River - Racine	38.5	1972-	SEWRPC
05332500	Namekagon River - Trego	488	1928-70, 1988	NSP/WDNR
05333500	St. Croix River - Danbury	1580	1914-81, 1984-	USGS Federal Program
05340500	St. Croix River - St. Croix Falls	6240	1902-	NSP/WDNR
05341500	Apple River - Somerset	579	1901-70, 1987	NSP/WDNR
05342000	Kinnickinnic River – River Falls	165	1916-21, 1999, 2002-	USGS Federal Program
05356000	Chippewa River - Winter	790	1912-	NSP/WDNR
05356500	Chippewa River - Bruce	1650	1914-	NSP/WDNR
05357254	Trout River - CTH H - Boulder Junction	58.9	1999-	Lac du Flambeau Band of Lake Superior Chippewa (LDF)
05357335	Bear River - Manitowish Waters	81.3	1991	LDF
05360500	Flambeau River - Bruce	1860	1951-	NSP/WDNR, FERC
05362000	Jump River - Sheldon	576	1915-	USGS Federal Program
05365500	Chippewa River - Chippewa Falls	5650	1888-1983, 1987	NSP/WDNR
053674464	Yellow River - Barron	153	1991	City of Barron
05368000	Hay River - Wheeler	418	1951-	USGS Federal Program
05369000	Red Cedar River - Menomonie	1770	1907-08, 1913-	NSP/WDNR
05369500	Chippewa River - Durand	9010	1928-	C of E, St. Paul
05370000	Eau Galle River - Spring Valley	64.1	1944-	C of E, St. Paul
05379400	Trempealeau River - Arcadia	606	1960-77, 2001-	USGS Federal Program
05379500	Trempealeau River - Dodge	643	1914-19, 1934	C of E, St. Paul
05381000	Black River - Neillsville	749	1905-09, 1914-	USGS Federal Program
053813595	Black River - Black River Falls	1590	1985-	C of E, St. Paul, City of Black River Falls Utilities

Station number	Name and location	Drainage area	Period of record (water year)	Cooperator
05382000	Black River - Galesville	2080	1932-	C of E, St. Paul
05382325	La Crosse River - Sparta	167	1992-	City of Sparta
05383075	La Crosse River - La Crosse	471	2000-	WDNR
05391000	Wisconsin River - Lake Tomahawk	757	1936-	WVIC/WDNR
05393500	Spirit River - Spirit Falls	81.6	1942-	WVIC/WDNR
05394500	Prairie River - Merrill	184	1914-31, 1939	WVIC/WDNR
05395000	Wisconsin River - Merrill	2760	1903-	WVIC/WDNR
05397500	Eau Claire River - Kelly	375	1914-27, 1939-	WVIC/WDNR
05398000	Wisconsin River - Rothschild	4020	1945-	WVIC/WDNR
05399500	Big Eau Pleine River - Stratford	224	1914-26, 1937-	WVIC/WDNR
05400760	Wisconsin River - Wisconsin Rapids	5420	1914-50, 1958-	WVIC/WDNR
05401050	Tenmile Creek - Nekoosa	73.3	1963-79, 1988-94, 1998-	WDNR
05402000	Yellow River - Babcock	215	1944-	WVIC/WDNR
05404000	Wisconsin River - Wisconsin Dells	8090	1935-	WVIC/WDNR
05404116	S. Br. Baraboo River - Hillsboro	39.1	1988-	City of Hillsboro
05405000	Baraboo River - Baraboo	609	1914-22, 1943-	USGSFederal Program
05406500	Black Earth Creek - Black Earth	45.6	1954-	DCRPC
05407000	Wisconsin River - Muscoda	10400	1903-04, 1914-	C of E, St. Paul
05407470	Kickapoo River - Ontario	151	2001-	USGS Federal Program
05408000	Kickapoo River - La Farge	266	1939-	Kickapoo Reserve
05410490	Kickapoo River - Steuben	687	1933-	C of E, St. Paul
05413500	Grant River - Burton	269	1935-	C of E, R. Island
05414000	Platte River - Rockville	142	1935-	C of E, R. Island
05423500	S. Br. Rock River - Waupun	63.6	1948-69, 1987	City of Waupun
05423947	Kummel Cr. - Theresa	28.7	2004-	WDNR
05424009	Gill Cr. – Kekoskee	12.2	2004-	WDNR
05424013	Irish Cr. - Kekoskee	1.32	2004-	WDNR
05424057	Rock River - Horicon	456	1998-2000, 2002-	WDNR
05425500	Rock River - Watertown	969	1931-70, 1977-	C of E, R. Island, Rock County PWD
05425912	Beaverdam River - Beaver Dam	157	1984-	City of Beaver Dam
05426000	Crawfish River - Milford	762	1931-	Rock County PWD, Jefferson County
05426250	Bark River - Rome	122	1980-	SEWRPC
05427085	Rock River - Ft. Atkinson	2240	1998-	WDNR
05427570	Rock River - Indianford	2630	1975-	Rock County PWD
05427850	Yahara River at Hwy. 113 - Madison	114	2002-	WDNR, Town of Westport, DCRPC
054279509	Pheasant Branch Tributary - Madison	-	2001-	City of Middleton
05428500	Yahara River - Madison	233	2004-	DCDPW
05429500	Yahara River - McFarland	327	1930-	DCDPW
05429700	Yahara River - Stoughton	386	1930-	DCDPW
05430150	Badfish Creek - Cooksville	82.6	1977-	MMSD

Station number	Name and location	Drainage area	Period of record (water year)	Cooperator
05430175	Yahara River - Fulton	517	1977	MMSD
05430446	Markham Cr. - Janesville	9.32	2004-	WDNR
05430500	Rock River - Afton	3340	1914-	C of E, R. Island
05430541	Stevens Cr. - Footville	13.9	2004-	WDNR
05431032	Turtle Creek - Delavan	83.3	1996-	WALCOMET
05431486	Turtle Creek - Clinton	199	1939-	C of E, Rock Island, WALCOMET
05432500	Pecatonica River - Darlington	273	1939-	C of E, R. Island
05433000	E. Br. Pecatonica River - Blanchardville	221	1939-1986, 1988	C of E, R. Island
05434500	Pecatonica River - Martintown	1034	1940-	C of E, R. Island
05435943	Badger Mill Creek - Verona	20.3	1997-	MMSD
05436500	Sugar River - Brodhead	523	1914-	C of E, Rock Island
05438283	Piscasaw Creek - Walworth	9.58	1992-	Fontana/Walworth WPCC
05543830	Fox River - Waukesha	126	1963-	SEWRPC
05544200	Mukwonago River - Mukwonago	74.1	1973-	SEWRPC
05545750	Fox River - New Munster	811	1940-	IL. DNR
LAKES				
04082500	Lake Winnebago - Oshkosh	5880	1882-	C of E, Detroit
04084255	Lake Winnebago - Stockbridge	5880	1983-	C of E, Detroit
05404500	Devils Lake - Baraboo	4.79	1922-30, 1932, 1934-81, 1985-	WDNR
05427235	Lake Koshkonong - Newville	2560	1987	Rock County PWD
05428000	Lake Mendota - Madison	233	1903, 1916-	DCDP&D
05429000	Lake Monona - Madison	279	1915-	DCDP&D
05429485	Lake Waubesa - McFarland	327	2004-	DCDPW
425715089164700	Lake Kegonsa - Stoughton	-	2004-	DCDP&D

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
DCCPW – Dane County Department of Public Works
DCRPC – Dane County Regional Planning Commission
FERC – Federal Energy Regulatory Commission Licensees
Fontana/Walworth WPCC – Fontana/Walworth Water Pollution Control Commission
Green Bay MSD – Green Bay Metropolitan Sewerage District
IL. DNR – Illinois Department of Natural Resources
LFRDA – Lower Fox River Dischargers' Association
MMSD – Madison Metropolitan Sewerage District
NSP – Northern States Power Company
Rock County PWD – Rock County Public Works Department
SEWRPC – Southeastern Wisconsin Regional Planning Commission
WALCOMET – Walworth County Metropolitan Sewerage District
WDNR – Wisconsin Department of Natural Resources
WEPCO – Wisconsin Electric Power Company
WPS – Wisconsin Public Service
WVIC – Wisconsin Valley Improvement Company