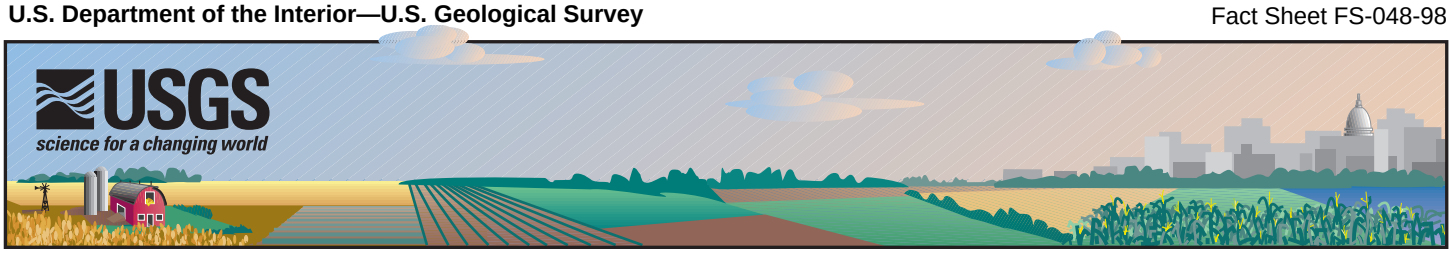


Plan for an Integrated Long-Term Water-Monitoring Network for Wisconsin

Wisconsin's water-monitoring network is in danger of losing critical ground-water, surface-water, and water-quality monitoring stations. Since 1995, the ground-water network has decreased by 43 observation wells, the surface-water network by 7 stations, and the surface-water-quality network by 30 stations. Reductions in Wisconsin's water-monitoring network could cause serious risk to the residents of Wisconsin. This reduction increases the uncertainty of water-resource plans and decisions, which ultimately could increase the potential for damages from extreme events and increase construction costs of water-related facilities.

In May 1997, most of Grand Forks, N. Dak. was under water. The estimated cost to rebuild that city is $800 million. In 1993, thousands of Milwaukee residents fell ill and many died due to an outbreak of *Cryptosporidium* in the City's water supply. In 1993 and 1996, many cities along the Mississippi River and in central Wisconsin were devastated by floods. These are only a few examples that illustrate the impact of water on our welfare.

Water use within the state has been steadily increasing (fig. 1), whereas the number of long-term water-monitoring stations in Wisconsin peaked in the 1940's and has since been declining. Present water-data networks in Wisconsin are less than optimum for most state and federal agencies to make decisions and probably are not adequate for the specific needs of many local government units, industry, utilities, and recreational users. Wisconsin's present data-collection network is not a planned, coordinated network, but a result of several agencies' different needs, special projects, or compliance monitoring. This has resulted in a fragmented network that lacks an overall goal, consistency, and adequate geographic coverage. Furthermore, the funding of many of these sites is uncertain from year to year. Wisconsin needs an integrated network in which stations are optimally located from a watershed perspective and that is stable for extended periods of time. Water monitoring is essential for accurate forecasting of floods, for ensuring safe drinking-water supplies, for design and operation of water-treatment plants, dams and other facilities; for planning and management of water and water-related resources; and for many other activities.

This fact sheet is a synopsis of a more detailed report by the Team for Evaluating the Wisconsin Water-Monitoring Network (1998). The report presents the justification, costs, and description of an integrated water-monitoring network for Wisconsin. The proposed network includes stations to monitor streamflow, ground-water levels, and quality of surface water. The proposed network would result in a significant benefit to state residents in both the short and long term. The 1997 cost of operating the proposed network was estimated at $1,377,000, an additional annual cost of about $387,600 over current network costs; other one-time costs amount to $233,000 for installation of new sites. The detailed report identifies specific sites and makes recommendations for sharing the cost of funding the proposed network. The plan is intended to improve the understanding and management of Wisconsin's water resources by providing a better information base for making decisions.

Effects of an Inadequate Network

As a result of cutbacks in federal and state budgets, the current data network was reduced in 1997 and could possibly lose more sites in subsequent years. These cuts will affect data availability and the network may not be able to meet future information needs of the citizens of Wisconsin.

Many of the surface-water stations that may be discontinued have 50- to 100-year records. These long records are critical to understanding the trends and variability of streamflow and water quality in the state and for estimating extreme events such as large, infrequent floods. Typically, for accurate evaluations, records must be at least 5 to 20 years in length to account for hydrologic variability. Because of cuts in funding of the ground-water network, large areas of northeastern and northwestern Wisconsin will be without observation wells to provide information for evaluation trends in ground-water levels or for developing water-supply plans.

Wisconsin could experience substantial changes in its water resources during the next decade due to increases in water use, changes in land use, climate change, natural disasters such as floods and droughts, or human-caused crises such as chemical spills. With a reduced network, decision-makers may not have the information they need to warn people of impending problems, or to plan corrective measures. Our ability to detect and manage the effects of land-use change will also be limited.

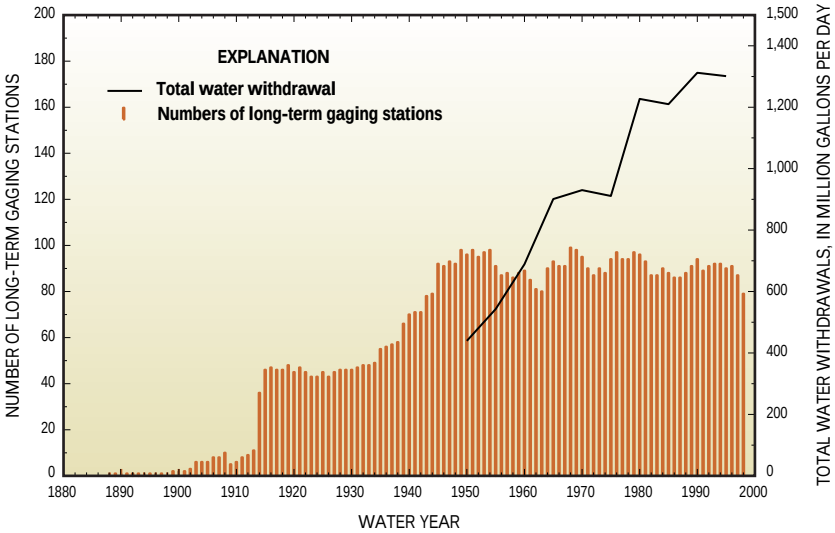


Figure 1. Trends in Wisconsin water use, 1950–95, and number of long-term continuous-record streamflow-gaging stations operated in Wisconsin, 1888–1998.

A More Detailed Description of One Network: The Surface-Water Network in Wisconsin

In 1996, the Wisconsin District of the U.S. Geological Survey (USGS) operated a network of 92 long-term streamflow-gaging stations throughout the state in cooperation with other agencies. These stations are funded by many sources, including the USGS, U.S. Army Corps of Engineers, Wisconsin Department of Natural Resources (WDNR), Southeastern Wisconsin Regional Planning Commission, counties and municipalities, planning commissions, sewerage districts, and Indian tribes. Almost all of these automatic-recording stations provide real-

time data via telephone line that is Internet accessible. Streamflow data are updated daily, but during floods data are retrieved more frequently.

As part of the flood forecasting and warning system, the National Weather Service uses data from these stations to predict the timing and peaks of floods. The U.S. Army Corps of Engineers uses the data to manage flood-control reservoirs. The Wisconsin Division of Emergency Government and many county emergency governments use the data to initiate evacuations and manage emergency response plans. Many agencies and municipalities use the data for non-emergency uses as well.

The density of stations in Wisconsin's surface-water network is low compared to that of neighboring states. Illinois, Indiana, and Michigan have approximately twice the density of stations compared to Wisconsin. The last evaluation of Wisconsin's stream-gaging program was done in 1984. Due to reduced federal and state budgets, 4 stations were discontinued in 1997 and an additional 5 stations could be discontinued in 1998 if long-term funding is not found.

Water monitoring may be thought of as an inverted pyramid, or hierarchy of monitoring. The dependence of upper levels of monitoring on basic streamflow monitoring is illustrated in figure 2. The streamflow-gaging network serves as the foundation for other types of monitoring and for a variety of assessments and activities.

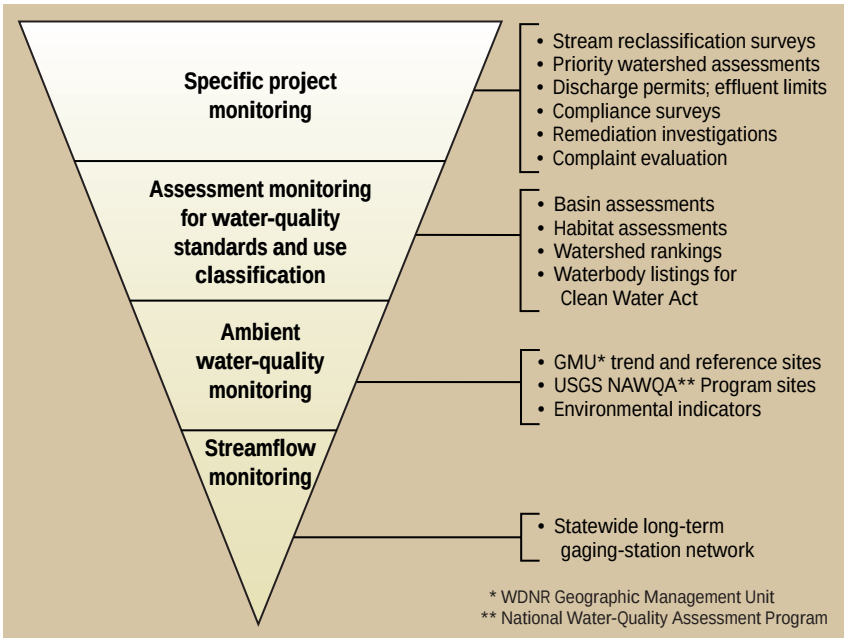


Figure 2. Pyramid diagram of surface-water monitoring levels and activities.

Importance of One Surface-Water Station

To illustrate the importance of just one monitoring station, consider the streamflow-gaging station on the Sugar River near Brodhead, in Green County. This station monitors a drainage area of 523 sq. miles and has a continuous record of stage and discharge since 1914. Data from this station have been used for:

- The planning and design of wastewater-treatment plants at Mt. Vernon, New Glarus, Verona, Belleville, Monticello, Albany, Brodhead, Brooklyn, and Monroe.
- Flood forecasting by the National Weather Service.
- Construction of numerous bridges and culverts.
- Disaster response by Wisconsin and Illinois state governments.
- Operation and management of dams and reservoirs on the Sugar River by several municipalities and downstream by the U.S. Army Corps of Engineers.
- Studies by the U.S. Geological Survey that evaluated long-term changes in flow conditions, regional low-flow relations, and flood-frequency characteristics.
- Land-use and drainage-basin planning by local and state agencies.
- Mapping of the 100-year flood plain, as well as management and local zoning of the flood plain for Verona, Belleville, and Brodhead.
- Development of a water-quality management plan for control of point and nonpoint sources of pollution as part of the WDNR priority watersheds program.
- Access to real-time data through the Internet by recreationists to determine current flow conditions for boating, canoeing, and fishing.

Long-term data from this station show that annual flood peaks have decreased by 30 percent and annual 7-day low flows increased by 25 percent (Gebert and Krug, 1996). These significant changes will have a major effect on design of facilities and structures. State funding for this station was eliminated in 1996 and long-term funding to continue its operation is in jeopardy.

Potential Benefits

Here are only a few examples of the benefits from an adequate network:

- Adequate streamflow data are essential for accurate flood forecasts in planning for a flood, evacuating a flood plain, building levees, or protecting structures. On a national basis, accurate flood forecasts may save about 10 percent of potential flood damage costs (Brian Hahn, National Weather Service, written commun., 1996). In 1996, property damages from floods in Wisconsin exceeded $127 million, representing a potential savings of almost $13 million.
- The network would result in substantial savings in cost for building wastewater-treatment plants. Better data from an integrated network to estimate low flows of a receiving stream could hypothetically save a community $1.2 million in construction costs for a single treatment plant.
- States have been delegated the authority for managing and implementing water programs under the Clean Water Act and Safe Drinking Water Act. Long-term water data are necessary to support the effective management and assessment of these programs, which involve millions of dollars, and in obtaining grant and research funds.

Field measurements and water-quality samples for laboratory analysis are collected to assess the water quality of streams.

Proposed Integrated Network for Wisconsin

Surface-Water Stations

The recommended long-term network (fig. 3) consists of 139 continuous-record streamflow stations, including 7 stations operated by other USGS districts on state border streams and an addition of 30 new stations to the existing network.

Stations provide data on water-surface elevations (stage) and streamflow (discharge) of rivers. Typical uses of the data include:

- Improving management and understanding of Wisconsin's water resources.
- Managing WDNR's Geographic Management Units (GMU).
- Forecasting and decision-making during events or conditions such as floods, droughts, contamination, dam breaks, and spills.
- Operating dams, power plants, wastewater-treatment plants, industrial treatment plants, and public water supplies.
- Planning and design of bridges, culverts, dams, and sewage-treatment plants to avoid overdesign or underdesign.
- Urban planning and stormwater management to address changes due to increasing development and changing land use.

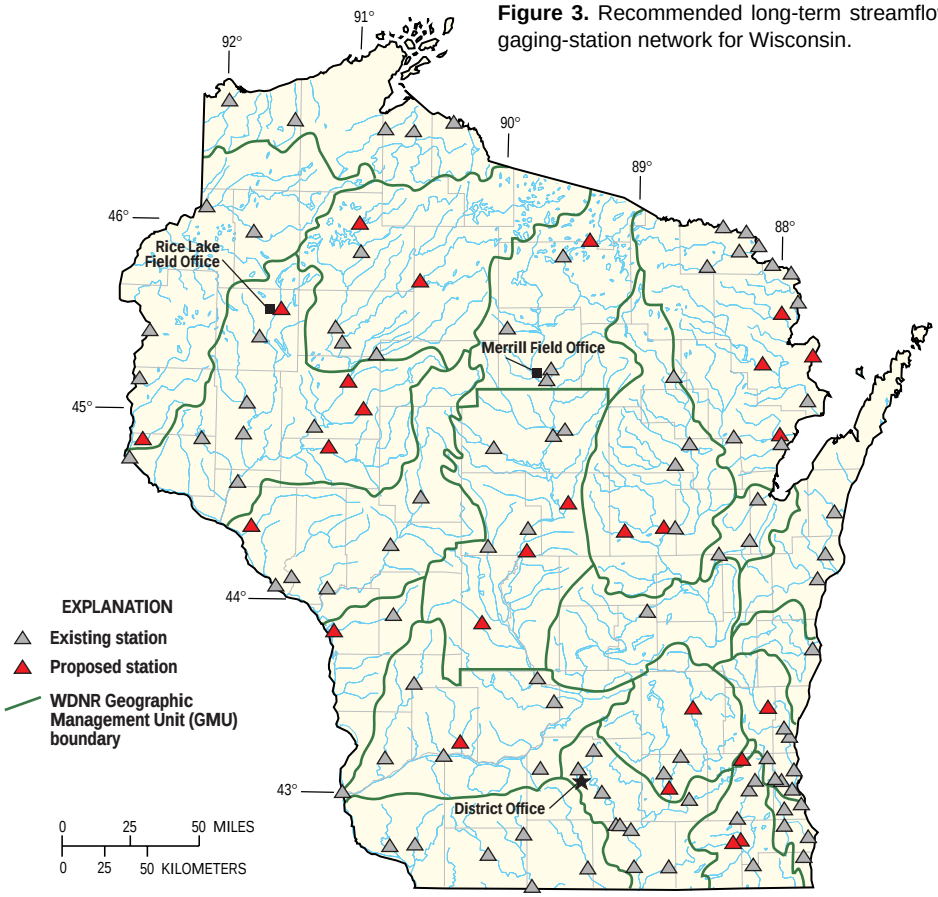
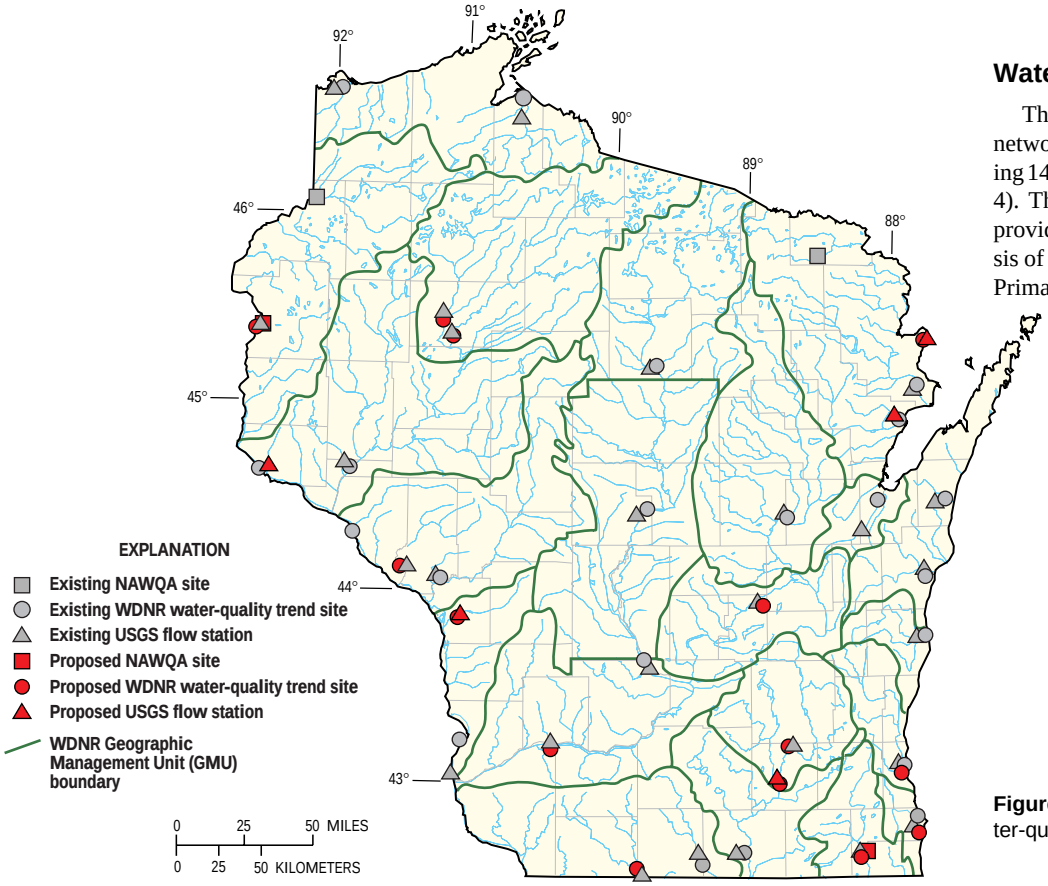


Figure 3. Recommended long-term streamflow-gaging-station network for Wisconsin.



Water-Quality Stations

The recommended minimum water-quality network for the state consists of 43 sites, including 14 new sites added to the current network (fig. 4). These surface-water-quality stations would provide data collected at least quarterly for analysis of selected water properties and constituents. Primary uses of the data include:

- Identifying and quantifying trends in water quality GMU's.
- Providing baseline water-quality information in each GMU for making management decisions and to focus specific management activities.
- Improving response to spills and water contamination.
- Linking water-quality information with flow information to assess pollutant loads.

Figure 4. Recommended minimum ambient water-quality-monitoring network for Wisconsin.

Ground-Water Stations

The recommended statewide ground-water network consists of 170 observation wells, adding 44 wells to the current network (fig. 5). Water levels in the network wells represent water levels in the major aquifers in the state. Data uses include:

- More efficient design of wells, water-supply facilities, and waste-disposal facilities.
- Evaluating trends in ground-water-level fluctuations due to development or land-use changes.
- Improving drought preparedness by determining minimum ground-water levels on a regional basis.
- Relating changes in ground-water levels to precipitation and changes in storage in ground-water reservoirs.
- Providing a database for land-suitability assessments, studies, and water-related planning and management.

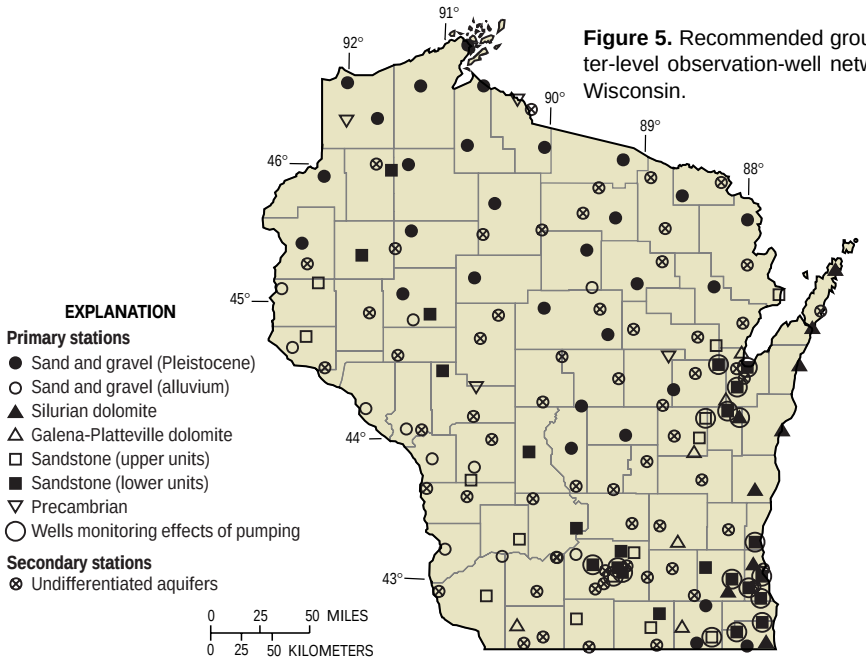


Figure 5. Recommended ground-water-level observation-well network for Wisconsin.

Table 1. Current and added annual operating expenses (1997 basis) of the recommended network for Wisconsin

Networks	Operating expense—added stations	Operating expense—current stations	One-time equipment and installation cost	Total cost of proposed network
Surface water	$305,900	$801,960	$233,000	$1,340,860
Water quality	42,140	94,240	0	136,380
Ground water	39,600	93,240	0	132,840
Total	387,640	989,440	233,000	1,610,080

Proposed Network Costs

The total cost of the statewide integrated network (table 1), consisting of its three parts, is estimated to be $1,610,080 in 1997; an additional $620,640 over the cost of the current network of $989,440. The costs of the proposed network were derived from the cost distribution of individual stations. It is suggested that implementation be phased in over a 2- to 3-year period for full funding by about the year 2001. The operating cost of the recommended streamflow-gaging network is $1,107,860 for 1997. In addition, there would be an initial construction cost of $233,000 for purchasing equipment and installing 30 additional stream-gaging stations, bringing the total cost for 1997 to $1,340,860. The cost of operating the proposed network is an additional $305,900 over the current network costs. The total cost of the recommended minimum water-quality monitoring network is $136,380 for 1997. The recommended network of 43 sites is a reduction from the 60–70 stations that were previously operated by the WDNR. The cost of the new sites is $42,140. The total cost of the recommended ground-water-level monitoring network is $132,840 for 1997. The additional cost of funding 44 wells is $39,600 annually.

While water data has many uses, some data users have a single purpose for the data. Data users rely on the availability of this "public" data and do not pay directly for their share of the data collection, operation, and maintenance expenses, and probably do not realize how the network is funded. Many of these users rely on the lead role and responsibility of federal and state agencies for funding and maintaining data collection networks. Federal, state and local government agencies must work together to support a stable network. A balance in funding should be sought among the users of the data to distribute the costs of the network more equitably among the users of the data.

Report prepared by the Team for Evaluating the Wisconsin Water-Monitoring Network (see box below)

References

Gebert, W.A., and Krug,W.R., 1996, Streamflow trends in Wisconsin's Driftless Area: Water Resources Bulletin, v. 32, no. 4, p. 733–744.

Team for Evaluating the Wisconsin Water-Monitoring Network, 1998, An integrated water-monitoring network for Wisconsin: University of Wisconsin Water Resources Center, WRC SR 98-01, Madison, Wis., 62 p.

In March 1996, a cross-section of concerned water-resources data collection agencies, educators, and industry formed a team to address the declining data-collection networks in Wisconsin. Team members included:

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