WISCONSIN GEOLOGICAL & NATURAL HISTORY SURVEY

The Wisconsin Geological & Natural History Survey (WGNHS), University of Wisconsin-Extension, performs basic and applied groundwater research and provides technical assistance, maps, and other information and education to aid in the management of Wisconsin’s groundwater resources. The WGNHS groundwater program is complemented by the Survey’s geology programs, which provide maps and research-based information essential to the understanding of groundwater recharge, occurrence, quality, movement and protection. The Survey distributes maps, reports and data related to Wisconsin’s geology and groundwater. The Director of the WGNHS is a permanent member of the Wisconsin Groundwater Coordinating Council (GCC) and several WGNHS staff members serve on GCC subcommittees.

FY 2019 Highlights (see https://wgnhs.wisc.edu/2018-year-in-review/; also see this story map describing the projects in more detail: https://arcg.is/1aCrXG)

- Investigating groundwater quality in southwestern Wisconsin
- Developing a groundwater atlas for Bayfield County
- Building background hydrogeology for the central sands lakes study
- Completing a study of groundwater resources in the Chequamegon-Nicolet National Forest
- Investigating changes in nitrate concentrations in groundwater beneath agricultural fields and near the Village of Waupaca
- Conducting new geologic mapping in Bayfield, Dodge, Jefferson, and Waushara Counties
- Conducting new geologic mapping in Wisconsin’s Driftless Area
- Investigating groundwater-surface water relationships in Wisconsin streams, lakes, and wetlands
- Upgrading Wisconsin’s statewide groundwater monitoring network
Details of Ongoing Activities

Groundwater-Level Monitoring Network

The WGNHS continues to cooperate with the Department of Natural Resources and U.S. Geological Survey in the operation and maintenance of Wisconsin’s statewide groundwater-level monitoring network. The WGNHS supports evaluation and maintenance of the monitoring network, aids in data collection, interpretation, and provides information to public and private clients. Visit: http://wgnhs.wisc.edu/water-environment/groundwater-monitoring-network.

County and Local Groundwater Studies

Geologic and groundwater studies at county and local scales continue to be an important part of WGNHS programs. With funding from the federal STATEMAP program or local sources, WGNHS scientists initiated or carried out county or locally focused geologic and/or groundwater studies during 2018 in eight counties. New geologic mapping is the fundamental starting point for understanding groundwater resources in Wisconsin. Many of these studies will generate or have generated water-table maps or depth-to-bedrock maps. (Maps: https://wgnhs.wisc.edu/maps-data/maps/)

- **Bayfield County groundwater atlas.** In FY 2016, the Bayfield County Board requested WGNHS assistance to complete characterization of their groundwater resources, including a water well database, recharge analysis, depth to bedrock and groundwater contamination potential. Project completion is scheduled for 2019; interim products are available here: http://wgnhs.wisc.edu/pubs/wofr201702/.

- **Southwest Wisconsin groundwater and geology (SWIGG) project.** The purpose of this project is to improve our understanding of groundwater quality in southwest Wisconsin (Iowa, Lafayette, and Grant Counties) and how groundwater quality is related to local hydrogeologic properties and well construction characteristics. Southwest Wisconsin is an area of shallow carbonate bedrock beneath generally thin soils. Due to the shallow fractured bedrock and the presence of minor karst features this area is considered very vulnerable to groundwater contamination, but prior to this study regional groundwater sampling has been sparse. Project objectives are to (1) Evaluate private well contamination in three counties using indicator bacteria (total coliform and E. coli) and nitrate based on randomized synoptic sampling events; (2) Assess well construction and geological characteristics (e.g., well age, depth to bedrock) that affect total coliform and nitrate contamination; and (3) Identify the source of contamination in...
a subset of total coliform- and nitrate-positive wells using microbial tests that distinguish between human, bovine, and swine fecal sources. More information: https://wgnhs.wisc.edu/southwest-wisconsin-groundwater-and-geology-study-swigg/

- **Hydrogeology and groundwater flow model of Columbia County.** This multi-year study is a cooperative effort between the WGNHS and USGS, sponsored by the Columbia County Department of Land Conservation and the Wisconsin DNR. The project involved characterization of the county’s groundwater system and included development of a groundwater flow model. The model is used extensively at the request of county officials to evaluate potential sources of poor groundwater quality in many private and public groundwater supply systems.

- **Hydrogeology of the frac-sand mining district in western Chippewa County.** This five-year study, commissioned by the Chippewa County Department of Land Conservation and Forest Management in 2012, is a cooperative effort between the USGS and WGNHS. The project evaluates potential impacts to groundwater resources from industrial sand mining and irrigated agriculture. This effort includes development of a groundwater flow model and a series of annual informational meetings to update the public about study results and water resources in this region of Wisconsin. A final WGNHS bulletin documenting this work was released in early 2019: https://wgnhs.wisc.edu/pubs/b112/.

- **Water quality indicators of human impacts to the wetlands of Door County.** Door County is home to wetlands that are important habitat for endangered species such as the Hines Emerald dragonfly, as well as nesting and spawning areas for waterfowl and fish. Most of these wetlands depend on groundwater inputs to maintain water levels and quality. We collected groundwater discharging to the wetlands and tested it for human and agricultural indicators such as artificial sweeteners (indicators of septic waste) and pesticides. We are determining whether these indicators are linked to land use with the hope that they will serve as early detection for potential human and agricultural impacts to the water quality of these wetlands.

- **Bedrock geology of Dodge County.** With cooperative funding from the USGS STATEMAP program, the WGNHS is conducting new mapping of the bedrock geology and bedrock topography of Dodge County. This work is scheduled for completion in FY2019.

- **Bedrock geology of Fond du Lac County.** The WGNHS completed new mapping of the bedrock geology and depth to bedrock of Fond du Lac County. These maps were released in early 2019: https://wgnhs.wisc.edu/pubs/000963/.

Regional Groundwater Studies

Regional groundwater studies usually span multiple counties. During 2018 the WGNHS was involved in several regional projects, including the following:
• **Hydrogeology of the Chequamegon-Nicolet National Forest.** In cooperation with the USGS, and with funding from the U.S. Forest Service, the WGNHS completed a multi-year study of the hydrogeology of Wisconsin’s National Forests. This effort consists of characterization of the groundwater system and development of groundwater flow models to improve management of forest resources. The project covers four forest units across eight counties in northern Wisconsin. A comprehensive technical report for each forest unit was released in early 2019, see [https://wgnhs.wisc.edu/pubs/000961/](https://wgnhs.wisc.edu/pubs/000961/).

• **Groundwater flow in the Mukwonago Basin.** In cooperation with the USGS, and with funding from The Nature Conservancy, the WGNHS built and calibrated a groundwater flow model. This model will be used to understand the impacts of possible land use changes and groundwater pumping to groundwater dominated wetlands in the Mukwonago Basin. The model has been used to estimate potential impacts to selected wetlands, streams and lakes in the basin from increased pumping. The results will be part of a decision support tool for land use planning in the basin. That tool will be web based and directly provide users with an understanding of how a proposed well will affect stream flow and water levels of surface waters and wetlands in the basin.

• **Multi-instrument Stream Surveys.** Improved modelling of groundwater and surface water interactions are needed now more than ever as we need to understand the complex interactions between societal, agricultural and natural systems. We have developed methodology to continuously measure water chemistry, depth and sediment type along with video of streams using instruments mounted in a canoe. We have begun collecting data on a series of five smaller streams located across Wisconsin. The data is expected to show locations of groundwater inflow and impacts. The goal is to provide data over miles of the streams that can be collected in less than a day that would otherwise not be available.

• **Central Sands Lakes Study.** In early 2018, the Wisconsin Geological and Natural History Survey was contracted by the DNR to assist them in a 4-year study to evaluate and model the hydrology of Long and Plainfield Lakes in Waushara County, and Pleasant Lake along the border of Waushara and Marquette Counties. The WGNHS is coordinating efforts with DNR staff, as well as researchers at UW–Stevens Point, and USGS. The WGNHS’ primary objectives are to improve the geologic and hydrogeologic characterization of the Central Sands, develop a hydrogeological framework for groundwater modeling and collect water-level measurements for use in model calibration.
Groundwater Research Activities

The WGNHS carries out specific groundwater research projects focused on understanding topics important to groundwater use and management in Wisconsin and elsewhere. Active research areas during 2018 included the following:

- **Radium studies.** In 2018, WGNHS scientists completed an investigation of geologic sources of radium to groundwater in Wisconsin’s sandstone aquifer. The work demonstrated that geologic sources of radium are common throughout the aquifer stratigraphy, but geochemical conditions, such as dissolved oxygen levels, control radium concentrations in groundwater. These findings and ongoing related studies address a significant problem for many municipal water supply systems, such as the City of Waukesha, where deep wells produce water with elevated radium.

- **Nitrate study.** In 2018, WGNHS continued to assist the DNR with source water protection at public supply wells impacted by elevated nitrate. The WGNHS operates monitoring systems at two sites. The WGNHS is continuing this research in partnership with cooperating land managers to quantify nitrate loading to the underlying aquifer under an irrigated corn crop. In addition, the WGNHS supported field research and modeling to determine nitrate sources and movement near municipal wells at Waupaca, Wisconsin.

- **Groundwater/surface water interactions in the Marengo watershed in the Chequamegon National Forest.** Water temperature is important to the health and habitat of streams. Groundwater discharge to the stream helps moderate and cool a stream. That cooler water provides improved habitat for trout. We are working with the U.S. Forest Service to collect data on temperatures, flows and water quality in the Marengo River in northern Wisconsin. These data will be used to construct a groundwater/temperature model of the river. The model will allow the U.S. Forest Service to understand how temperatures in the stream might change in the future and how managing stream conditions such as increasing shade or placing structures in the channel will affect the stream temperature.
• **Mapping the base of the Cambrian aquifer through geophysical modeling of Precambrian topography, southern Wisconsin.** The Survey’s bedrock geologists are using geophysical techniques combined with field mapping to determine the base of the Cambrian sandstone aquifer in parts of Columbia and Sauk Counties. This project, funded through the Wisconsin Joint Solicitation, is critical for determining aquifer thickness for use in hydrogeologic analyses.

• **Investigations of natural groundwater contamination by trace metals in western Wisconsin.** Water-quality tests of private wells drawing water from the rocks where the Wonewoc Formation meets the Tunnel City Group have found elevated concentrations of arsenic, cadmium, lead, and other trace metals. We sampled the elemental composition of these rock formations across west-central, south-central, and southwest Wisconsin. The regional geochemical and mineralogical database developed in this study provides evidence that the rocks of the Wonewoc–Tunnel City contact interval in west-central Wisconsin are a potential natural source of trace metal concentrations observed in some process-water ponds at industrial sand mines and groundwater in private wells that draw water from these rocks.  
  https://wgnhs.wisc.edu/pubs/wofr201901/.

Groundwater Data Management and Support

In 2018 the WGNHS continued to collect geologic and groundwater data and provide this data to a variety of users. Significant databases and data efforts include the following:

• **An updated springs inventory for the state of Wisconsin.** The WGNHS completed a 3-year effort to inventory the springs of Wisconsin. This inventory resulted in a comprehensive database with information on flow rate, water quality and other physical attributes relevant to the classification of springs. The database (https://dnrmaps.wi.gov/H5/?viewer=Water_Use_Viewer) is used by the DNR for approving high-capacity well permits. In addition to developing this database, WGNHS staff began a long-term monitoring program of eight reference springs. These springs were selected in representative hydrogeological and ecological settings to provide a more robust understanding of springs and potential impacts from land use and groundwater withdrawals. A two-year extension for the baseline monitoring began in September 2017. The analysis includes quarterly measurements of spring flow and water chemistry and surveys of aquatic plants and animals. In 2019 the WGNHS will release a published report on the statewide survey and also guidelines for surveying springs.

One of the many springs inventoried as part of our multiyear project inventorying the springs of Wisconsin. Photo: Grace Graham, WGNHS.
• **Collection of downhole geophysical logs.** The WGNHS continually collects and compiles downhole geophysical logs from research wells and “wells of opportunity,” such as municipal wells. The logs, including natural gamma radiation, temperature, caliper, fluid conductivity, borehole diameter and optical imaging, are important tools for understanding water-quality problems in individual wells, and for correlating geologic units in the subsurface. In addition to municipal wells, geophysical logging has been used to troubleshoot problems in private wells and wells owned by state agencies including Department of Corrections, Department of Natural Resources and Department of Transportation.

• **Hydrogeologic Data Viewer maintenance.** The WGNHS continues to support the Hydrogeologic Data Viewer, a map-based application to access a statewide catalog of hydrogeologic data. The application provides DNR staff with online access to data and publications and includes several methods to search by area for data of interest, such as geologic and geophysical logs or well construction reports. Many of the geophysical logs are collected for the DNR in wells where water quality or lack of data is an issue.

• **wiscLITH database.** When requested, the Survey provides updates of the digital database, wiscLITH, which contains lithologic and stratigraphic descriptions of geologic samples collected in Wisconsin. This is a publicly available database, and current work efforts focus on including more data for areas of the state with active geologic and hydrogeologic projects. Database: [https://wgnhs.wisc.edu/pubs/wofr200903/](https://wgnhs.wisc.edu/pubs/wofr200903/).

• **Well construction reports.** The WGNHS serves as the repository for well construction reports (WCRs) from wells installed between 1936 and 1989 and can provide digital or paper copies to those who request them. In FY 2016, WGNHS released a new interactive map, providing online access to these historical WCRs for state agencies, consulting firms and private well owners. In addition, WGNHS serves as a point-of-contact for questions about WCRs and updates records when errors are found during project work.

• **High-capacity well approval tracking.** WGNHS continues to track high-capacity well approvals in an internal database. This enables a more proactive approach for WGNHS researchers, in collaboration with the DNR, to work with well drillers, pump installers and consultants to collect samples and borehole geophysical logs from priority areas of the state.

• **WGNHS Research Collections and Education Center.** The WGNHS archives geologic records, rock samples, core samples and other materials in Mount Horeb, Wisconsin. Our core repository contains over 2.5 million feet worth of drillhole cuttings, more than 650,000 feet of drill core and more than 51,000 individual hand samples of rock from across the state. Examination tables and basic laboratory facilities allow convenient analysis and study of these materials by qualified individuals. More about the repository: [https://wgnhs.wisc.edu/research/core-repository/](https://wgnhs.wisc.edu/research/core-repository/).
**Groundwater Education**

WGNHS groundwater education programs for the general public are usually coordinated with the DNR or the Central Wisconsin Groundwater Center at UW–Stevens Point or with the UW–Madison science outreach community as well as with UW-Extension. WGNHS produces and serves as a distributor of many groundwater educational publications from our sales counter at our office and from our website (https://wgnhs.wisc.edu). We also distribute information about Wisconsin groundwater on our website at https://wgnhs.uwex.edu/water-environment. Our outreach efforts reach different and broader audiences through a variety of social media tools, including:

- **Facebook** - https://www.facebook.com/WGNHS
- **Twitter** - https://twitter.com/wgnhs
- **Pinterest** – http://www.pinterest.com/WGNHS/
- **YouTube** – https://www.youtube.com/channel/UCwwucf9-W1qocovGx-uzs7w

WGNHS presents groundwater educational activities at various museums and schools and at UW-Madison outreach events (such as at Science Expeditions and at the Science Festival).

In 2018, WGNHS staff members participated in groundwater educational meetings in counties where mapping and/or hydrogeologic studies are in progress, particularly in Bayfield, Chippewa and Trempealeau Counties. Staff members will continue to work with the DNR and the Central Wisconsin Groundwater Center on teacher-education programs connected to the distribution of groundwater sand tank models.

The WGNHS maintains a long commitment to the continuing education of water well drillers, pump installers and plumbing contractors through participation in the programs of the DNR and the Wisconsin Water Well Association. Geologic and hydrogeologic field trips and presentations for DNR water staff and new DNR employees have been held in the past and will continue as requested.

The WGNHS Research Collections and Education Center is providing a locale for various groups to conduct related educational programs. Researchers and consultants also use our core holdings in that collection to better understand the subsurface and its aquifers. Staff of WGNHS organize and annually present papers at the Wisconsin Section of the American Water Resources Association reaching consultants, academics, and state and federal agency scientists with results of our research.

**For more information:**

*Visit [https://wgnhs.wisc.edu/](https://wgnhs.wisc.edu/)*

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