Protecting Wisconsin's Buried Treasure

Two Decades of Coordinated Groundwater Research and Monitoring

Accomplishments of the Wisconsin Groundwater Coordinating Council

Overview

Wisconsin depends on groundwater. Each day we use more than 800 million gallons of it. Most of us rely on it for our drinking water. Protecting groundwater quality and quantity is critical to protecting public health and ensuring a sustainable economy. Recognizing the vital importance of this natural resource, Wisconsin in 1984 established the **Groundwater Coordinating Council (GCC)—**a nationally unique, multi-agency institution charged with overseeing and orchestrating all state-supported groundwater research and monitoring efforts.

The GCC has had resounding success. Over the last two decades, the council has leveraged just **$13.4 million** in state funds with additional monies from local and federal sources to support more than **330 groundwater research and monitoring projects.**

These projects have:

- **Documented the geographical distribution of Wisconsin's groundwater**
- **Identified both qualitative and quantitative threats to groundwater supplies**
- **Established the sources and health effects of groundwater contaminants**
- **Assessed public health risks and economic costs of diminished groundwater quality and quantity**
- **Developed progressive new policies, technologies and management solutions to mitigate threats to our groundwater supplies**

This booklet highlights some of the GCC's most notable success stories—research that has helped protect and improve both the quality and quantity of groundwater available to Wisconsin citizens and industries. It also explains the roles of the many dedicated state agencies that work together through GCC guidance to manage and preserve this priceless buried treasure.

The GCC's first two decades have generated many benefits for Wisconsin's citizens. It is hoped this review will renew Wisconsin's commitment to a strong groundwater program. Only through extensive, focused research and monitoring can the state develop **sound, science-based groundwater policies**. Only through continued vigilance can we ensure our groundwater remains a treasured resource for generations to come.

A Critical Resource

Wellsprings of Water: More than 70 percent of Wisconsin's residents get their drinking water from groundwater sources via 800,000 private wells, 12,000 high-volume wells for farms and businesses, and 12,000 public water system wells.

Groundwater is essential to Wisconsin's public health and economy. More than 70 percent of all state residents rely on groundwater for drinking water, among them 97 percent of all inland communities. Many of the state's iconic industries would not survive without a clean and plentiful supply of groundwater. The state's 1.3 million dairy cows, for example, consume more than 58 million gallons of water every day, and the production of the 8.5 million barrels of beer produced annually in Wisconsin requires nearly 13 billion gallons of water.

Fortunately, Wisconsin has been blessed with a great abundance of groundwater. Yet we should not, we cannot, take this buried treasure for granted. Not all of our groundwater is accessible, nor is all of it suitable for consumption. And less than a third of Wisconsin's average 32 inches of annual rainfall percolates down into the state's aquifers to recharge them each year; the rest is used by plants, evaporates, or drains into streams and rivers. In short, our supply of groundwater *is finite*.

A Brief History of Wisconsin Groundwater Legislation

To protect our critical groundwater resources, Wisconsin has established one of the most comprehensive groundwater protection and research programs in the nation. The Comprehensive Groundwater Protection Act (1983 Wisconsin Act 410) established state groundwater quality standards. The law also mandated scientific research to describe the character of the state's groundwater supply as well as regular monitoring to determine existing and potential threats to groundwater quality.

On Earth Day 2004, another significant step occurred when Governor Jim Doyle signed Wisconsin's Groundwater Protection Act (2003 Wisconsin Act 310) to address the impacts of high-capacity wells and the link between surface waters and groundwater quality and quantity.

Wisconsin's Groundwater Coordinating Council

Established in 1984, Wisconsin's Groundwater Coordinating Council (GCC) is nationally unique. Composed of representatives from several state agencies and the University of Wisconsin system, it ensures that the state's groundwater research and monitoring are coordinated and cost effective and that state agencies provide consistent communications with the public.

GCC members represent the:

- **Department of Agriculture, Trade & Consumer Protection (DATCP),**
- **Department of Commerce (Commerce),**
- **Department of Health and Family Services (DHFS),**
- **Department of Natural Resources (DNR),**
- **Department of Transportation (DOT),**
- **University of Wisconsin System (UWS),**
- **Wisconsin Geological and Natural History Survey (WGNHS),** and the
- **Wisconsin Office of the Governor.**

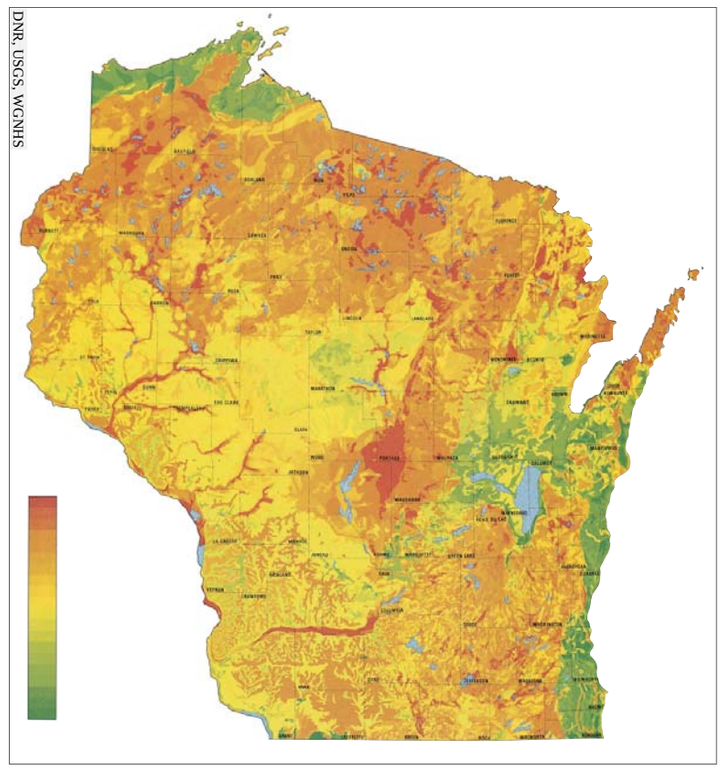
For over 20 years, the GCC has coordinated an annual joint solicitation process through which its members have supported more than 330 groundwater-related projects. These projects have resulted in significant scientific advancements and cost-effective protection of public health and groundwater-related economic resources. This joint solicitation process ensures research funded by each agency is complementary and not duplicative of the work done by others. Moreover, the GCC helps to leverage funding from the federal Water Resources Research Institutes, U.S. Geological Survey, and other sources to address efficiently Wisconsin's most pressing groundwater issues.

Threats to Groundwater

The GCC's research and monitoring projects address two groups of threats to Wisconsin's groundwater—threats to quality and threats to quantity. Threats to groundwater quality include arsenic, nitrates, pesticides, viruses and bacteria, pharmaceuticals, and other contaminants, including volatile organic compounds (VOCs) and petroleum—all of which result from various land use practices, urban stormwater and agricultural runoff, municipal landfills, industrial wastewater discharges as well as natural sources.

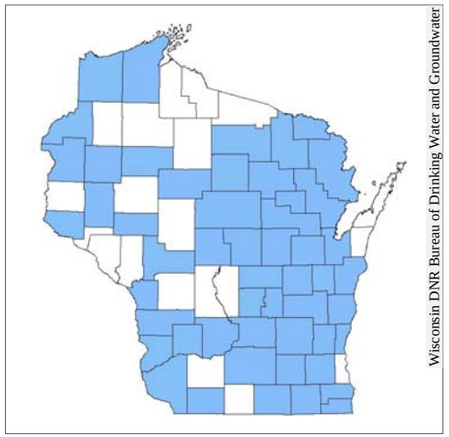
In recent years, the GCC has also brought greater attention to bear on threats to the quantity of the state's groundwater, as well as some surface waters, in areas where demand and use exceed sustainable rates. Growing demands placed on groundwater by new housing, irrigation and industries require vigilant monitoring and management to ensure future generations will enjoy adequate supplies of high-quality water.

The GCC agencies have been addressing these threats through protective regulations, developing and presenting outreach and education programs, and funding innovative research and monitoring projects. The following pages present some examples of the GCC's response to major threats to groundwater quality and quantity.



Susceptibility: Using the data compiled from GCC-funded and other research projects, Wisconsin's regulatory agencies have developed a detailed statewide map, showing areas that are more susceptible to groundwater contamination, based on soil characteristics and depth of local aquifers. On this map, greater susceptibility is indicated by red and lesser susceptibility by green.

Groundwater Quality Issues



Wisconsin DNR Bureau of Drinking Water and Groundwater

Arsenic Susceptibility: The federal standard for arsenic in drinking water is 10 parts per billion. On this map, the 52 Wisconsin counties that have had public and/or private wells exceeding this standard are highlighted in blue.

Arsenic

Arsenic occurs naturally in many rock formations, resulting in elevated concentrations of arsenic detected in some public and private wells in 52 of the state's 72 counties. Long-term exposure to higher levels of arsenic may lead to increased risks of cancer as well as neurological damage, hypertension and other health problems. In Wisconsin, elevated arsenic levels are especially prevalent in southeastern Wisconsin and the Fox River Valley. In parts of Brown, Outagamie, Shawano and Winnebago counties, 20 percent of drinking water supplies exceed state arsenic standards.

Given this threat, GCC agencies have funded comprehensive studies and monitoring of the origins and extent of arsenic contamination to protect public health and to mitigate potential economic burdens of arsenic-contaminated water supplies.

- Two DNR-funded studies discovered new areas of arsenic contamination, and as a result 72,000 households were informed of the need to reduce their exposure to arsenic in their drinking water.
- A 2001 DNR-DHFS study confirmed the health risks of elevated levels of arsenic in drinking water, including skin cancers, adult onset diabetes and cardiovascular disease.
- A 2002 DNR-WGNHS study found that a main cause of elevated arsenic levels in the Fox River Valley is the drawdown of groundwater levels from pumping, which exposes arsenic-bearing minerals in the aquifer to oxygen, causing a chemical reaction that makes the arsenic water-soluble. The DNR used the findings of this study to develop safer well construction guidelines.
- As a result of these and other GCC studies of arsenic in groundwater, Wisconsin established a Special Well Casing Depth Area between Oshkosh and Green Bay, where certain methods of constructing wells are required to minimize the likelihood of arsenic contamination of well water.

Nitrate

The most common groundwater contaminant in Wisconsin is nitrate, with at least 10 percent of the state's private wells exceeding state standards. Fifteen municipal water systems are also affected and require treatment to deliver water below the state nitrate standard. High levels of nitrate can affect the ability of blood to carry oxygen, potentially leading to a serious condition in infants and young children known as "blue baby syndrome." Some studies also suggest that there is an increased risk of birth defects in the babies of pregnant women who drink water with high nitrate levels.

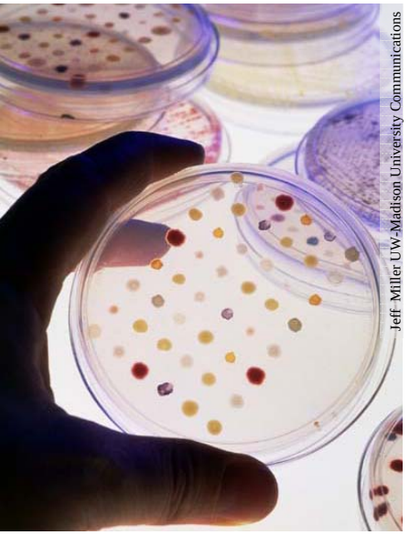
An estimated 200 million pounds of nitrate enters Wisconsin's groundwater every year, with up to 90 percent of it resulting from the over-application of agricultural fertilizers and manure.

Robert Queen

Nitrate: Over-application of agricultural fertilizers and manure is the primary source of nitrate in groundwater. Exposure to excessive nitrate levels can affect the ability of blood to carry oxygen. The standard for nitrate in public drinking water is 10 parts per million.

- A 1992 DNR-funded study in the Central Sands region of Wisconsin found that, in addition to fertilizers, septic systems may contribute significant amounts of nitrate to groundwater. The DNR now advises regular water quality sampling in wells near septic fields.
- A 1997 DNR-DHFS study determined few families with high nitrate levels in their wells try to reduce nitrate exposure, although pregnant women are usually careful to follow nitrate advisories. Even when expectant families try to reduce exposure, they tend to test their water only late in pregnancy. Moreover, the study found most private wells are tested less than once a year for nitrate. This prompted the state to redouble its nitrate education efforts.
- A 2001 DATCP report, following up on two earlier statewide surveys, estimated that 14 percent of rural drinking water wells exceed the state's nitrate enforcement standards.
- A 2004 DNR-DATCP-Central Wisconsin Groundwater Center study found a relationship between nitrate concentration and the age of groundwater being sampled. This observation reflects the increasing use of nitrogen fertilizer over the last half century and suggests that, in many parts of Wisconsin, nitrate pollutant loads in groundwater will continue to increase.

Viruses and Bacteria



Jeff Miller UW-Madison University Communications

Bacteria and Viruses: An increasing focus of GCC research is the potential for pathogenic bacteria and viruses to contaminate groundwater supplies.

Viruses and bacteria are potentially very serious groundwater quality threats. Because many water tests do not yet include bacteria and viruses, the GCC has directed more funding in recent years toward research to develop better tests to ascertain the extent of virus and bacterial contamination of Wisconsin's groundwater.

- A 1997 Commerce-funded study developed a rapid and sensitive soil-testing method that can detect the presence of harmful *E. coli* bacteria that can contaminate groundwater.
- Commerce- and DNR-funded projects in 1997 and 1999 examined whether viruses and bacteria in private wells cause infectious diarrhea. While the studies revealed that diarrhea generally is not associated with drinking well water, an estimated four to 12 percent of Wisconsin's private wells occasionally become contaminated with harmful bacteria and viruses that potentially can cause illness.
- A multi-year UWS-funded study developed ways of rapidly and easily detecting the presence of beneficial *methanotroph* bacteria that remove impurities from groundwater. This same technique will be useful for detecting harmful bacteria as well.

Pesticides

Agricultural, commercial and domestic applications of pesticides and herbicides pose a substantial threat to Wisconsin's groundwater quality. More than 35 percent of all Wisconsin's wells contain detectable levels of herbicides or the breakdown products of herbicides. Slow rates of groundwater movement mean that many wells contaminated by pesticides today will remain contaminated for decades by pesticides.

Research on pesticide contamination has resulted in many significant policy changes—for example, providing the scientific basis for rules adopted in 1992 that reduced statewide use of the herbicide atrazine. As of 2006, the DATCP had established 102 atrazine prohibition areas covering about 1.2 million acres, including parts of 34 counties and the entire Lower Wisconsin River.

- Atrazine was first identified as a significant groundwater contamination threat in a 1989 DATCP-funded study, which estimated the chemical was present in 12 percent of wells on dairy farms in Wisconsin and that seven percent of wells contained concentrations above preventive action limits.
- DATCP and DNR research in 1991 demonstrated that even normal agricultural applications of atrazine, rather than mishandling or spills, could cause well contamination—especially in the Lower Wisconsin River Valley.
- A 1993 DATCP-funded study conducted by the State Laboratory of Hygiene (WSLH) revealed atrazine's breakdown products are widespread in groundwater and present as serious a public health risk as atrazine itself. These findings prompted the DNR and the DATCP to enact more protective regulations.
- A 1993 DNR-WGNHS study determined that then-preferred groundwater susceptibility models were inadequate in predicting contamination by atrazine and other pesticides. In their place, the study recommended more accurate alternatives based on regional hydrogeologic models that take into account potential sources of contamination, as well as land uses and the amount of atrazine applied within given areas.
- A 2001 DATCP report found that atrazine has not been detected as frequently in rural drinking wells since state atrazine rules went into effect, but that atrazine's breakdown products are still found at largely unchanged rates. More than 11 percent of wells in Wisconsin still contain atrazine residues. Columbia, Dane, Dodge, Green, Jefferson and Rock counties have the highest proportion of wells containing herbicides.

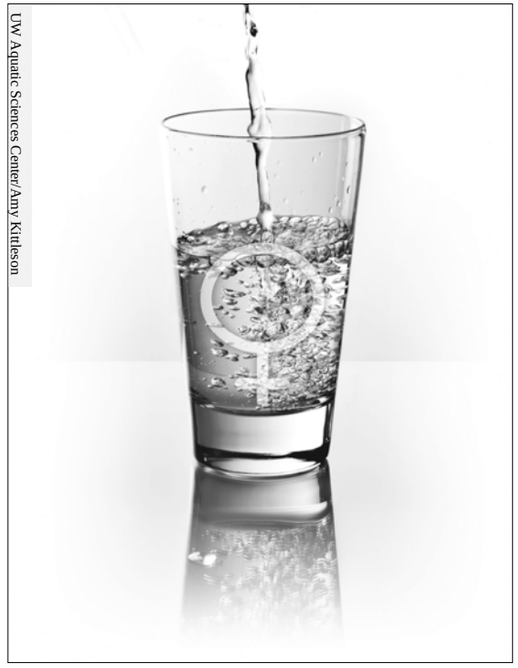
Robert Queen

Pesticide Applications: Pesticide use in agriculture and home landscaping contributes to groundwater contamination. The DATCP presently regulates more than 30 pesticides and has detected herbicides in more than 35 percent of Wisconsin's wells.

Pharmaceuticals and Hormone Mimics

A priority for current and future GCC-coordinated research and monitoring is to investigate new threats to groundwater quality, such as hormone-mimicking pharmaceuticals and personal care products that can enter groundwater from wastewater discharges. Researchers have already detected antibiotics, birth control medicines and other pharmaceuticals in water systems statewide. While the cumulative impacts of these substances in water are unknown, they have the potential to affect public health and the normal development of humans and other animals that use the water. Future research will help trace the occurrence, transport and fate of these substances in groundwater and develop new ways to prevent them from entering water systems and to remediate water that is contaminated by these substances.

- A 2003 DATCP- and DNR-funded study ascertained the presence of antibiotics in wastewater and wastewater effluents, including some test wells adjacent to where wastewaters discharge into surface waters.
- A 2006 WSLH study determined that estrogen-like compounds found in surface water discharges and septic fields typically do not infiltrate into neighboring groundwater supplies and that advanced wastewater treatment is effective at removing estrogenic compounds from effluents.
- Researchers at the WSLH are currently conducting a multi-year project to investigate the potential for hormones and hormone-mimicking substances in surface water to spread to groundwater, especially from concentrated animal feeding operations (CAFOs).



UW Aquatic Sciences Center/Amy Kitelson

Hormone Mimics: New GCC-funded research is focusing on water quality effects of chemicals that mimic hormones (such as estrogen) excreted by humans in wastewater and disposed of in pharmaceuticals and other personal care products, such as birth control pills, shampoos and over-the-counter medicines.

Contaminants from Landfills

GCC research has examined groundwater contamination by volatile organic compounds (VOCs) and other contaminants from landfills. VOCs are a group of chemicals frequently used in industrial and household products, such as fuels and cleaners, which can contaminate groundwater if improperly discarded. Some VOCs are toxic, and long-term exposure can cause health problems.

- A study in the 1980s and early 1990s revealed groundwater beneath many landfills—primarily those that were unlined and unengineered—was contaminated with VOCs. This study prompted state regulations requiring VOC testing at all municipal solid waste landfills.
- A study in 1995 evaluated two alternative methods for VOC sampling of groundwater near landfills that permitted flexibility in DNR regulations and spared many landfill operators the expense of installing costly testing equipment.
- A study in 2000 determined that separate testing for chemical oxygen demand (COD) in groundwater near landfills was unnecessary, as the desired information could be obtained through other required tests. Based on this information, the DNR no longer requires COD testing at most landfills.
- A multi-year DNR study determined that adverse effects to groundwater quality from construction and demolition waste, yard waste and roadkill disposal sites were not as extensive as originally believed and could be addressed through limits on the size of the disposal sites and through active management of the sites' materials. As a result, the DNR chose not to pursue additional groundwater protection regulations related to such operations.

Robert Queen

Landfill Leachate: Groundwater monitoring coordinated by the GCC around landfills has determined ways to prevent runoff of contaminant-laden leachate. New, simpler sampling protocols have helped protect public health while reducing testing costs for landfill operators as well as reducing mercury waste generated by older tests.

Groundwater Quantity Issues

Aquifer Drawdown and Recharge

The GCC is becoming increasingly concerned about groundwater quantity issues, such as declining groundwater levels and the effects of groundwater pumping on surface water resources across Wisconsin. Groundwater levels in aquifers in some areas of southeastern Wisconsin have dropped more than 450 feet below original levels due to intensive pumping. Groundwater drawdowns are of concern for many reasons—they can negatively affect groundwater quality and also require that new wells in an area are drilled deeper, making them more expensive. Intense pumping and lower water tables can also reduce the flow of groundwater into lakes and streams and reduce critical supplies of surface water for fish and other wildlife, especially during dry periods.

Rain Gardens: UWS-funded GCC research is helping to promote use of decorative sunken rain gardens that capture runoff from the gutters of homes and businesses as a way of reducing nonpoint source pollution and increasing the amount of rainfall recharge of aquifers in urban areas.


Roger Bannerman, DNR

In recent years, the GCC has given priority to research and monitoring on the impacts of high-capacity wells on springs, streamflows and lake levels. Such research clarifies the linkages between surface waters and groundwater supplies and ways in which joint management may improve both resources.

- A 2001 UWS-funded study developed a methodology to estimate more accurately groundwater recharge from rainfall. The study found that accounting for recharge rate variations may improve planning to protect groundwater recharge areas.
- A 2002 UWS-funded study determined that rain gardens are highly effective at collecting stormwater runoff and increasing urban aquifer recharge, finding that a rain garden just 10 percent the size of adjacent areas can double local groundwater recharge rates.
- A 2003 UWS-funded study evaluated a new method for detecting aquitards–the layers of clay or rock that limit the flow of groundwater between aquifers.

Land Use Impacts

Research supported by the GCC directly informs and assists Wisconsin municipalities as they develop individual well-head protection plans along with broader groundwater protection strategies as part of legislatively mandated comprehensive land-use planning.

Several projects have examined the effects of land use on groundwater quantity (as well as quality) and collaborated with municipalities on improving land use planning.

- A 1996 DNR-funded study developed a better model for groundwater flow in the complex geology near municipal wells at Sturgeon Bay, which in turn improved the design of the municipality's Wellhead Protection Area.
- A 2005 UWS study collected and analyzed real-world cases of municipalities that incorporated groundwater into comprehensive land use planning to provide examples to Wisconsin municipalities of how future planning can also incorporate groundwater protection.
- An ongoing UWS- and DNR-funded study of an area of Dane County slated for unsewered subdivision development is evaluating the long-term effects of suburban development on rural groundwater quantity and quality.


Robert Queen

Supporting Smart Growth: The GCC is committed to helping local governments find ways to protect groundwater supplies as part of comprehensive land use planning, ensuring clean and plentiful water for families and businesses into the future.

Where Do We Go From Here?

Despite the significant achievements of GCC-coordinated research and monitoring to date, much more needs to be done. Besides continuing efforts to map groundwater supplies and to identify contaminants and their movements within groundwater systems, the GCC has identified several priorities to guide future research decision-making, including:

- **Acute and chronic impacts on groundwater from manure management practices**
- **Adverse impacts from groundwater withdrawals**
- **Extent and sources of naturally occurring contaminants in groundwater**
- **Extent and causes of recently discovered groundwater contaminants**
- **Land use management and its impact on groundwater resources**
- **Impacts on groundwater of bio-energy production, such as ethanol plants**
- **Potential effects of climate change on groundwater supplies**
- **Potential groundwater effects of carbon sequestration and other climate change mitigation strategies**

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Additional Information

One of the primary missions of the GCC is to educate Wisconsin's residents about groundwater resources and ways in which we can all protect this treasure buried beneath our feet. If you would like more information about the activities of the GCC and its research, visit the GCC website: **http://www.dnr.state.wi.us/org/water/dwg/gcc**. There you will also find a copy of the most recent GCC *Annual Report to the Legislature*.

Copies of all GCC reports are available through the Water Resources Library at the University of Wisconsin-Madison Water Resources Institute (WRI). The library's catalog is available online at **http://www.aqua.wisc.edu/waterlibrary**. Wisconsin residents may check out its materials for delivery to their local libraries free of charge.

The WRI website, **http://www.wri.wisc.edu**, has links to the summaries and final reports of many GCC-coordinated research and monitoring projects since 1989, as well as summaries for all projects funded since 2002.

For additional copies of this publication, visit the UW Aquatic Sciences Center's online Publications Store at **http://www.aqua.wisc.edu/publications**.




Communications, DNR Photo, Robert Queen, USGS Photo, Robert Queen, Robert Queen

Key Players in Wisconsin Groundwater Protection

Department of Agriculture, Trade & Consumer Protection (DATCP): The DATCP regulates use, storage and handling of pesticides and the storage of fertilizers that can affect surface and groundwater quality, enforcing health and safety standards for more than 30 pesticides. The DATCP also samples groundwater for pesticides and assists farmers in management plans to reduce nutrient runoff. Through the GCC, the DATCP has funded more than 40 innovative projects, helping farmers, scientists and regulators understand better the fate and behavior of agrichemicals in the environment.

http://datcp.state.wi.us/core/environment/environment.jsp

Department of Commerce: Commerce regulates five areas—private on-site sewage systems, reuse of graywater and stormwater, underground storage tanks, brownfields cleanup, and cleanup of petroleum contaminated areas—that can threaten groundwater quality with petroleum and other contaminants. Through the GCC, Commerce has funded eight research projects.

http://commerce.state.wi.us/SB/
http://commerce.state.wi.us/ER/




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Department of Health and Family Services (DHFS): The DHFS is responsible for developing health-based enforcement standards for pollutants that can contaminate groundwater quality. The DHFS also works extensively on public education and outreach, develops water screening tools and maintains databases about public health issues related to water.

http://dhfs.wisconsin.gov/eh/Water/index.htm

Department of Natural Resources (DNR): The DNR regulates more than 120 substances that affect groundwater quality and also protects Wisconsin's groundwater and public health through its Drinking Water & Groundwater, Waste & Materials Management, Remediation & Redevelopment, and Watershed Management programs. The DNR is committed to groundwater outreach and education. In the last 20 years, the DNR has funded more than 180 groundwater monitoring and research projects through the GCC's joint solicitation process.

http://dnr.wi.gov/environmentprotect/water.html
http://dnr.wi.gov/org/aw/wm/
http://dnr.wi.gov/org/aw/rr/




Robert Queen, Ken Bradbury, Robert Queen, DNR Photo

Department of Transportation (DOT): The DOT regulates storage of road salts and other chemicals that are spread on highways to maintain road conditions. The DOT also sets policies about how these substances can be applied to roads, as road runoff can affect surface and groundwater quality.

http://www.dot.state.wi.us/projects/env/index.htm

Water Resources Institute (WRI): The UW-Madison's WRI supports and manages groundwater-related research, outreach and education, and maintains the Water Resources Library. The WRI manages UWS projects funded through the GCC joint solicitation process as well as the U.S. Geological Survey's national Water Resources Research Institutes program, funding more than 130 projects to date. Over the last decade, the WRI has employed an equivalent number of graduate students, providing training for tomorrow's water professionals.

http://www.wri.wisc.edu

Wisconsin State Laboratory of Hygiene (WSLH): This UW-Madison laboratory samples groundwater to identify and monitor potential contaminants, educates about water-related issues, and serves as one of the state's primary testing laboratories for water quality samples and conducting research on groundwater issues.

http://www.slh.wisc.edu







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Central Wisconsin Groundwater Center: This UW-Extension center at UW-Stevens Point offers technical assistance to homeowners, water testing, educational outreach, groundwater research and maintains a statewide groundwater database.

http://www.uwsp.edu/cnr/gndwater

UW Environmental Resources Center (ERC): The UW-Extension's ERC coordinates youth water education initiatives related to groundwater, publishes several water curricula and guides, and supports applied research and outreach on groundwater protection through coordination with Extension's Basin Education Initiative, UW Discovery Farms, and other related efforts.

http://www.uwex.edu/erc

Wisconsin Geological and Natural History Survey (WGNHS): Part of the UW-Extension, WGNHS performs groundwater research statewide and provides mapping and technical assistance to researchers and communities regarding groundwater. This work includes jointly maintaining a statewide monitoring network with the U.S. Geological Survey. The WGNHS also investigates potential future threats and issues related to groundwater.

http://www.uwex.edu/wgnhs

Jeff Miller/UW-Madison University Communications, Bryant Browne, Robert Queen, Robert Queen

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For more information please visit the GCC website:
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Produced by the UW-Madison Water Resources Institute
on behalf of the Wisconsin Groundwater Coordinating Council
in collaboration with the GCC Education Subcommittee
Written by Peter Boger
Edited by Stephen Wittman
Cover Photo Credit: Ken Bradbury