Wisconsin Groundwater Coordinating Council

REPORT TO THE LEGISLATURE

August 2004

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August, 2004

To: The Citizens of Wisconsin
The Honorable Governor Jim Doyle
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The Groundwater Coordinating Council (GCC) is pleased to release its 2004 Report to the Legislature. The GCC was formed in 1984 to help state agencies coordinate non-regulatory activities and exchange information on groundwater. For the past 20 years, the GCC has served as a model for interagency coordination and cooperation among state agencies, the Governor, local and federal government, and the university. It is one of the few groups in the nation to effectively coordinate groundwater activities in its state from an advisory position.

This report summarizes GCC and agency activities related to groundwater protection and management in FY 04 (July 1, 2003 to June 30, 2004) and provides an overview of the condition of the groundwater resource. See the *Executive Summary* for highlights and the GCC's recommendations in *Future Directions for Groundwater Protection*. The full report is available online at *http://dnr.wi.gov/org/water/dwg/gcc/rtl/gccreport.htm*.

A significant focus of the State's groundwater protection activities this past year has been on groundwater quantity. Highlights include:

- Providing scientific and technical expertise for the drafting of legislation to address acute and chronic impacts of groundwater withdrawals, which went into effect in May 2004;
- Developing a statewide strategy to guide agency monitoring activities for groundwater quality, levels, and use;
- Completing groundwater flow models and developing scenarios of groundwater pumping in southeastern Wisconsin;
- Launching an educational website on Groundwater in the Great Lakes Basin;
- Summarizing groundwater management issues at the local and regional level in a *Wisconsin Natural Resources* magazine article;
- Supporting research related to groundwater drawdowns and withdrawals through the Water Resources Institute.

We hope you will find this report to be a useful reference in protecting Wisconsin's valuable groundwater resource.

Sincerely,

Todd Ambs, Chair
Groundwater Coordinating Council

The GCC is an interagency group that is directed by law to assist State agencies in the coordination and exchange of information related to groundwater programs. See the GCC web site for more information (http://dnr.wi.gov/org/water/dwg/GCC/).

EXECUTIVE SUMMARY

This is Executive Summary of the annual Report to the Legislature by the Groundwater Coordinating Council (GCC) as required by s. 15.347, Wisconsin Statutes. The report describes the condition and management of the groundwater resource and summarizes the GCC's activities for fiscal year (FY) 2004. The full report along with several appendices can be accessed online at http://dnr.wi.gov/org/water/dwg/gcc/rtl/gccreport.htm.

In 1984, the Legislature enacted 1983 Wisconsin Act 410 to improve the management of the state's groundwater. The GCC is directed by s. 160.50, Wis. Stats., to "serve as a means of increasing the efficiency and facilitating the effective functioning of state agencies in activities related to groundwater management. The Groundwater Coordinating Council shall advise and assist state agencies in the coordination of non-regulatory programs and the exchange of information related to groundwater, including, but not limited to, agency budgets for groundwater programs, groundwater monitoring, data management, public information and education, laboratory analysis and facilities, research activities and the appropriation and allocation of state funds for research."

Membership of the GCC includes the Secretaries of the Departments of Natural Resources (DNR); Commerce; Agriculture, Trade and Consumer Protection (DATCP); Health and Family Services (DHFS); Transportation (DOT); the President of the University of Wisconsin System (UWS); the State Geologist; and a representative of the Governor. Agency designees are listed on the inside of the front cover. More information about the GCC and its activities can be found on the GCC web pages: (http://dnr.wi.gov/org/water/dwg/gcc/index.htm).

Highlights from each of the major parts of the Report are summarized below.

GROUNDWATER COORDINATION

The GCC, its Subcommittees, and member agencies worked together to address groundwater management issues and coordinate groundwater activities in FY 04. Examples include:

1. *The GCC was an active participant in the process to draft and develop comprehensive groundwater quantity legislation, 2003 Wisconsin Act 310 through its Quantity Subcommittee and discussions at its quarterly meetings.* Many subcommittee members and agency representatives contributed data, research findings, maps, modeling scenarios, and technical expertise to help answer questions and ensure that the legislation was based on sound scientific principles. The GCC will continue to play a role in the implementation of the legislation, through its research and monitoring oversight, as well as making technical information and expertise available to the DNR and the Groundwater Advisory Committee created by the legislation.

2. *The GCC sponsored several collaborative efforts to promote groundwater protection in the comprehensive planning process by local governments*. Last fall, the Planning and Mapping and the Local Government Subcommittees met jointly to share information on some of the existing state groundwater databases and to solicit input from local government representatives on their needs related to groundwater planning. Through the Wisconsin Groundwater Research and Monitoring Program, two projects have been funded to address how to make groundwater information available to local governments for use in comprehensive plans.

3. *The second annual "Wisconsin Groundwater Festival" was held in Waukesha on April 23, 2004*. The Statewide Groundwater Guardian Coordinator, the Waukesha Groundwater Guardian Team and the Wisconsin Groundwater Association organized this event, with planning and participation from many state agencies, the USGS, and UW Extension. The event attracted over 600 5th and 6th graders plus teachers from around the State and offered a host of hands-on learning activities about various groundwater topics. Senator Neal Kedzie, one of the co-authors of the recent groundwater quantity law, was a featured speaker. The third annual festival is planned for northwest Wisconsin in 2005.

4. *For the fourth year in a row, three groundwater workshops for teachers were taught jointly by staff from the DNR, WGNHS and the Center for Watershed Science and Education at UW Stevens Point.* The workshop leaders taught the teachers how to use a groundwater sand tank model and gave them additional resources to incorporate groundwater concepts into their classroom. Teachers from eight different schools attended each workshop and took a groundwater model back to their school free of charge. With funding from an EPA grant, nearly 100 groundwater models have been given to schools since 2001.

5. *The GCC Monitoring and Data Management Subcommittee worked with DNR Groundwater staff and interested groups to develop a statewide groundwater monitoring strategy.* This effort was initiated from recommendations made at the Groundwater Summit and Waters of Wisconsin meetings. The strategy identifies three general goals of monitoring: documenting the status and trends of groundwater quality and quantity; gaining a better understanding of groundwater hydrology; and communicating groundwater information to citizens and decision-makers. Specific monitoring components for water use, groundwater levels, and water quality were outlined, along with phases for implementing the strategy. The group also identified funding, data coordination, access, and other needs in the strategy. The strategy will be finalized by September 2004.

6. *The GCC and the UWS Groundwater Research Advisory Council (GRAC) continued coordination of the annual solicitation for groundwater research and monitoring proposals among state agencies*. The GCC approved the FY 05 solicitation for groundwater research and monitoring proposals, which was sent out in September 2003 (see *Appendix D*). A total of 15 project proposals were received. A comprehensive review process resulted in the selection of 8 new projects for funding for FY 05. The GCC unanimously approved the proposed UWS groundwater research plan as required by s. 160.50(1m), Wis. Stats. The FY 05 groundwater monitoring and research projects are listed by funding agency in Table 2, including projects that were carried over from FY 04.

7. *Wisconsin Groundwater Directory*. In 2004, the Center for Watershed Science and Education at UW Stevens Point, with the assistance of the GCC Education Subcommittee, developed a new publication called the Wisconsin Groundwater Directory. The intention of the directory is to provide a handy reference for "who does what" related to groundwater in Wisconsin, and to guide citizens, educators, and groundwater professionals to the right agency. Websites and phone numbers are included, as well as a limited number of publications and resources. The directory can be accessed through the GCC website (*http://dnr.wi.gov/org/water/dwg/gcc/index.htm*).

SUMMARY OF AGENCY GROUNDWATER ACTIVITIES

State agencies and the University of Wisconsin System addressed a number of issues related to groundwater protection and management and implementation of Chapter 160 in FY 04:

1. *Groundwater Protection Act* – In May of 2004, the statutes regarding high capacity wells were expanded to give the DNR the authority to consider environmental impacts of wells in order to protect critical surface water resources. Other statutory changes include notification and fees to be collected along with all new well construction and requirements for reporting water use on an annual basis for new and existing high capacity wells. Further provisions in the Groundwater Protection Act include designation of two Groundwater Management Areas to address regional groundwater issues and the creation of a Groundwater Advisory Committee to recommend management approaches in these areas and further statutory changes. The DNR is currently working through a separate appropriation process to obtain the necessary staff positions and funding to implement the new programs created by the law. The DNR must also write administrative rules to provide further guidance on various aspects of the new regulations.

2. *Arsenic standards* - The state groundwater quality standards for arsenic were revised in FY 04. Arsenic is a known human carcinogen, and the federal drinking water maximum contaminant level (MCL) for the substance has been lowered from 50 µg/L to 10 µg/L. The NR 140 Enforcement Standard (ES) for arsenic was lowered from 50 µg/L to 10 µg/L, and the Preventive Action Limit (PAL) dropped from 5 µg/L to 1 µg/L. The Natural

Resources Board authorized these NR 140 revisions at their October 2003 meeting and the new revised arsenic groundwater quality standards became effective March 1, 2004.

3. *Source Water Assessments* - The DNR has committed to complete assessments for all, approximately 11,500, public water supply systems in the State by December 2004. Progress to date indicates that this goal will be met. Regional SWAP staff have hand-delivered completed assessments to most municipal systems. Smaller systems are being notified when their assessment is available. The results of all of the assessments are being made available on the Internet. Visit the DNR's web page to see the assessment results: http://dnr.wi.gov/org/water/dwg/swap/index.htm.

4. *Site Assessment Grants* - In FY 04, DNR announced the awarding of 50 Site Assessment Grants to fund the removal of approximately 35 aboveground and underground storage tanks and 39 abandoned drums and other containers of hazardous substances. Approximately $1.7 million was awarded to 35 communities across the state. These grants will also be used to fund 77 environmental site assessments and investigations. To date, 212 grants have been awarded to properties around the state representing around 742 acres of land.

5. *New Wisconsin's Brownfields Insurance Program* - On April 22, Governor Doyle signed 2003 Wisconsin Act 315 which authorized the DNR to create a new environmental insurance program. This program was recommended by the Wisconsin Brownfields Study Group and will encourage more cleanup and redevelopment of brownfield sites throughout the state, many of which have groundwater contamination. The DNR is currently working with the Department of Administration Risk Management program to create this new program that will provide insurance coverage to private businesses and local governments to address the risks associated with contaminated real estate.

6. *Atrazine use prohibition modifications* - Based on an exceedence of the atrazine groundwater standard, DATCP modified its rules on Pesticide Product Restrictions (ATCP 30) to add approximately 3,000 acres of land to the 1.2 million acres currently under an atrazine use prohibition. In addition DATCP expanded the atrazine application period by two weeks based on groundwater modeling results which showed minimal additional risk of atrazine contamination.

7. *Environmental Health Tracking Network* - DHFS has begun work on developing environmental public health tracking modules for childhood cancer, multiple sclerosis (MS) and amyotrophic lateral sclerosis (ALS) to create data systems that link information on relevant hazards, exposures and health outcomes. In support of this CDC-funded initiative, DHFS is working with DNR to access groundwater and drinking water data to improve the tools available to state and local health officials to investigate reports of disease clusters and respond to other environmental health inquiries. Other partners in this project include DATCP, the University of Wisconsin - Madison's School of Medicine and Division of Information Technology (DoIT), and the Wisconsin State Laboratory of Hygiene.

8. *Groundwater project reports online* - The WRI Water Resources Library partnered with the UW Libraries Digital Collections Center to digitize and put online the full text of most WRI and selected DNR project final reports. The WRI Groundwater Research & Monitoring Program Web site links to the full-text reports, which are included in the UW Ecology and Natural Resources Digital Collection at http://uwdc.library.wisc.edu/collections.html. Inclusion in the UW Ecology and Natural Resources online collection should also make a wider audience aware of this important groundwater research information.

9. *Wisconsin Water Policies Inventory (WWPI)* - This Web-based online tool for researching the state's major policies pertaining to water was developed by the WRI in cooperation with a UW-Madison graduate seminar. This project, undertaken for the 2003 Year of Water observance, enables Wisconsinites to browse state water policies by category or to search the database by using key words. The URL is www.aqua.wisc.edu/waterpolicy. This public resource provides Wisconsin citizens with easy access to state laws, rules and programs governing Wisconsin's water resources.

10. *New groundwater use project* - In FY 04, the WGNHS was awarded funding for a two-year project investigating changes in groundwater pumping. The project will begin in FY 05 and focus on determining the cause of exponential growth in groundwater pumping that has occurred in Waukesha County over the last several decades, and compare this to changes in groundwater pumping that have occurred in a predominantly rural area (Sauk County). This study, funded by the USGS and the Water Resources Institute, will also evaluate methods for tracking groundwater pumping in Wisconsin.

11. *Groundwater in the Great Lakes Basin website* - An educational website has been developed by the USGS in cooperation with the Great Lakes Protection Fund to highlight the hydrology of groundwater in the Great Lakes Basin. The web site is titled "Ground water in the Great Lakes Basin: The case of southeastern Wisconsin" (*http://wi.water.usgs.gov/glpf/*). The website simulates groundwater flow in southeast Wisconsin (both shallow and deep aquifers) for conditions from pre-development to present. This work provides a hydrologic framework for the southeast Wisconsin groundwater management area.

CONDITION OF THE GROUNDWATER RESOURCE

Major groundwater quality and quantity concerns in Wisconsin include:

1. *Volatile Organic Compounds (VOCs):* Sources of VOCs in Wisconsin's groundwater include landfills, underground storage tanks, and hazardous substance spills. Thousands of wells have been sampled for VOCs. Fifty-nine different VOCs have been found in Wisconsin groundwater. Trichloroethylene is the VOC found most often in Wisconsin's groundwater.

2. *Pesticides*: Pesticide contamination in groundwater results from field applications, pesticide spills, misuse, or improper storage and disposal. The most commonly detected pesticides in Wisconsin groundwater are: metabolites of alachlor (Lasso) and metolachlor (Dual); atrazine and its metabolites; metribuzin (Sencor); and a metabolite of cyanazine (Bladex). DATCP databases show that about 9% of private wells tested have atrazine detections, while about 1% have atrazine over the groundwater enforcement standard of 3 µg/L. A recent DATCP survey of 336 private drinking water supplies showed that 38% of wells contain a detectable level of a herbicide or herbicide metabolite.

3. *Nitrate*: Nitrate-nitrogen is the most common contaminant found in Wisconsin's groundwater. Nitrate can enter groundwater and surface water from a variety of sources including farm fields, animal feedlots, septic tanks, urban storm water, and decaying vegetation. Concentrations of nitrate in private water supplies frequently exceed the state drinking water standard of 10 mg/L. Of 10,105 well samples in a recent survey of DNR's groundwater databases, 2016 (20%) equaled or exceeded the enforcement standard of 10 mg/L. In the same data set, 5113 (50%) were equal to or exceeded the PAL or preventive action limit (2 mg/L). A statewide groundwater sampling program competed by DATCP in 2001 estimated that 14.1% of private drinking water wells in the state exceed the 10 mg/L standard.

4. *Microbial agents*: Microbiological contamination often occurs in areas where the depth to groundwater or the depth of soil cover is shallow, or in areas of fractured bedrock. Microbial agents include bacteria, viruses, and parasites. These agents can cause acute illness and result in life-threatening conditions for some population groups. In one assessment, approximately 23% of private well water samples statewide tested positive for total coliform bacteria, an indicator species of other biological agents. Approximately 3% tested positive for *E. coli*, an indicator of water borne disease that originates in the mammalian intestinal tract. Viruses are increasingly becoming a concern as new analytical techniques have detected viral material in private wells and public water supplies.

5. *Radionuclides*: Naturally-occurring radionuclides, including uranium, radium, radon, and gross alpha are becoming an increasing concern for groundwater quality, particularly in the Cambro-Ordovician aquifer system in eastern Wisconsin. The water produced from this aquifer often contains combined radium activities in excess of 5 pCi/L, in some cases in excess of 30 pCi/L. Nearly 60 public water systems exceed the drinking water

standard of 15 pCi/L for gross alpha activity. New federal standards are causing many communities to search for alternative water supplies.

6. *Arsenic*: Naturally occurring arsenic has been detected in wells throughout the State of Wisconsin. DNR historic data show that 3,830 public wells and 3,013 private wells have detectable levels of arsenic. About 10% of these wells exceed the new Federal drinking water standard of 10 µg/L. The highest concentration of arsenic detected in a private well in Wisconsin is 13,000 µg/L. The State continues to proactively address arsenic concerns through well drilling advisories, health studies, well testing campaigns, and studies aimed at improving geological understanding and developing innovative treatment technologies.

7. *Groundwater quantity*. Despite a general abundance of groundwater in Wisconsin, there is a growing concern about the overall availability of good quality groundwater for municipal, industrial, agricultural, and domestic use and for adequate baseflow to our lakes, streams, and wetlands. Groundwater use grew from 570 to 804 million gallons per day (Mgal/d) from 1985 to 2000. Groundwater quantity problems have occurred naturally and from human activities, and often affect groundwater quality. Regional effects of groundwater withdrawals are well documented in the Lower Fox River Valley, southeastern Wisconsin, and Dane County. Localized effects of groundwater pumping on trout streams, springs, and wetlands have been documented throughout the state. Recent groundwater quantity legislation represents a first step at managing groundwater quantity on a comprehensive basis.

BENEFITS OF MONITORING AND RESEARCH PROJECTS

Two fact sheets produced by the UW Water Resources Institute in FY 04 illustrate the benefits of groundwater projects supported by the Wisconsin Groundwater Research and Monitoring Program (*http://wri.wisc.edu/waterfactsheets.asp*). The major findings are summarized below.

1. *Groundwater Drawdowns* - State-supported research is compiling information and developing flow models to address a number of concerns related to groundwater drawdowns:
   - In Washington County, researchers are working with the city of Richfield to develop a protocol for quantifying its groundwater budget. That information will be coupled with projected changes in land use and pumping demand to define the effects of several development scenarios on the community's water supply. Once developed, this protocol will enable other communities to decide how to best protect vital groundwater recharge areas, local streams, lakes and wetlands.
   - Another project is investigating the sources of high salinity and radium in the deep sandstone aquifer that supplies water to residents of eastern Wisconsin. This project is examining in detail the chemistry of the groundwater and the rock formations of this complex aquifer and determining whether high pumping rates are raising salinity and radium levels. This will help city planners and water utility directors better understand the relationship between well operations and water quality in this region, and evaluate effects of urban growth on water supplies.
   - Other State-supported research is investigating the viability of aquifer storage and recovery (ASR) for Wisconsin, a technology already accepted in other parts of the country, where excess water is stored in aquifers when demand is low and withdrawn for use when demand increases. Computer models of groundwater flow and transport in ASR systems are being developed for three representative groundwater systems in Wisconsin. A better understanding of pumping rates, storage times and other factors that affect recovery efficiency of ASR systems will help guide future decision-making about using these systems in Wisconsin.

2. *Arsenic* - The State supports a comprehensive package of projects that address the sources, release mechanisms, public health effects, and treatment and removal of arsenic in groundwater:
   - Current studies indicate the geologic and hydrogeologic conditions contributing to arsenic contamination in southeast Wisconsin differ from those in the Fox River Valley. Understanding the geological sources and geochemical mechanisms of arsenic release can help us develop water well siting and construction techniques to minimize arsenic contamination of well water.

- A recent study evaluated arsenic exposure and the health of residents in rural Outagamie and Winnebago counties. The study found that people who consumed water containing arsenic levels above 5 ppb for 10 years or longer were more likely to report incidences of skin cancer than others. People with a history of cigarette smoking were three times more likely to report skin cancer than nonsmokers. These results, along with those from earlier studies, underscore the importance of testing private wells for arsenic and closely following water-use advisories.
- State-supported researchers are currently developing and testing inexpensive adsorption media for simultaneously removing two toxic arsenic species—As(III) and As(V)—from groundwater using thin, UV-irradiated photoactive films. This technique offers a simple, effective means of removing both arsenic species without requiring pH adjustment or the addition of other chemicals, which could prove especially beneficial to small water systems as well as point-of-use and at-the-tap devices for private well owners.
- Other research has determined that how a well is constructed and used can be critical to reducing arsenic concentrations. Designing a well to reduce the volume of water stored over time and to allow the mixing of water from different levels in the aquifer—along with fully purging the well before using the water—can result in lower concentrations of arsenic coming out of the tap.

FUTURE DIRECTIONS FOR GROUNDWATER PROTECTION

The GCC recommends the following priorities for future groundwater protection and management:

1. **Maintain adequate funding for groundwater monitoring and research**: State budget cuts have severely limited the number and scope of groundwater research and monitoring projects that were funded in the past three fiscal years (see Table 3 in Chapter 2). Continued cuts will hamper the State's ability to address critical groundwater monitoring and research needs in the future. The GCC encourages its member agencies and the legislature to maintain adequate resources for groundwater monitoring and research and to seek partnerships to leverage additional funds.

2. **Address groundwater quantity management issues at both statewide and regional levels:** Groundwater quantity issues came to the forefront of public discussion in FY 04, with the development and passage of landmark groundwater quantity legislation, 2003 Wisconsin Act 310. This legislation has the potential to address needs identified by two recent forums, the 2001 Groundwater Summit and the Waters of Wisconsin Initiative. Common themes included the need for a statewide management plan for water quantity, water conservation, high capacity well reform, reevaluation of water pricing structures and regional approaches to water quantity issues. The GCC will continue to serve as a resource for addressing scientific and technical questions related to groundwater quantity and facilitate further dialogue among all parties on potential approaches and solutions.

3. **Support implementation of a Statewide Groundwater Monitoring Strategy:** Chapter 160 of the Wisconsin Statutes requires the DNR to work with other agencies and GCC to develop and operate a system for monitoring and sampling groundwater to determine whether harmful substances are present. In FY 04, several agencies worked together to develop a Statewide Groundwater Monitoring Strategy to guide agency monitoring efforts for the next ten years. The GCC encourages agencies, the university, and federal and local partners to implement the various components of the strategy and to seek funding to support its implementation.

4. **Coordinate and facilitate consistent messages on groundwater related issues:** The public has benefited from the consistent educational messages that have been endorsed by the GCC. In 2004, the GCC's Education Subcommittee will launch a "Groundwater Information Network" with non-governmental organizations to further its mission of promoting consistent messages regarding groundwater protection. Priorities include promoting water stewardship and awareness of water quantity issues, finding innovative ways to encourage testing of private water supplies, and providing materials for local communities to support comprehensive planning activities.

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Chapter 1 -- INTRODUCTION

PURPOSE OF THE REPORT

The Groundwater Coordinating Council (GCC) is required by s. 15.347, Wis. Stats., to prepare a report which "summarizes the operations and activities of the council..., describes the state of the groundwater resource and its management and sets forth the recommendations of the council. The annual report shall include a description of the current groundwater quality of the state, an assessment of groundwater management programs, information on the implementation of ch. 160, Wis. Stats., and a list and description of current and anticipated groundwater problems." This report is due each August. The purpose of this report is to fulfill this requirement for fiscal year 2004 (FY 04).

The activities of the Council and its subcommittees, including coordination of groundwater monitoring and research programs, are described in the chapter titled *Groundwater Coordination*. The chapter *Summary of Agency Groundwater Activities* describes groundwater management programs and implementation of ch. 160, Wis. Stats., by the individual state agencies in FY 04. *Condition of the Groundwater Resource* provides an assessment of Wisconsin's groundwater quality and quantity, as well as current and anticipated groundwater problems. The *Benefits from Monitoring and Research Projects* chapter describes how research and monitoring findings are used to better manage groundwater resources in Wisconsin. The recommendations of the Council are contained in *Future Directions for Groundwater Protection*.

SUMMARY OF WISCONSIN'S GROUNDWATER LEGISLATION

1983 Wisconsin Act 410, Wisconsin's Comprehensive Groundwater Protection Act

Wisconsin has a long history of groundwater protection. The first major milestone in this effort was adoption and implementation of 1983 Wisconsin Act 410, Wisconsin's Comprehensive Groundwater Protection Act, which was signed into law on May 4, 1984. The law expanded Wisconsin's legal, organizational, and financial capacity for controlling groundwater pollution. 1983 Wisconsin Act 410created Chapter 160, Wisconsin Statutes, which serves as the backbone of Wisconsin's program. Chapter 160 provides a multi-agency comprehensive regulatory approach, using two-tiered numerical standards, based on the premise that all groundwater aquifers in Wisconsin are entitled to equal protection. There are a number of major components to Wisconsin's groundwater quality protection program:

1) Standards. Under chapter 160, Wis. Stats., the Department of Natural Resources (DNR) must establish state groundwater quality standards based on recommendations from the Department of Health and Family Services (DHFS). Standard setting is a continuing process based on a priority list of substances detected in groundwater or having a high possibility of being detected, established by the DNR in conjunction with other state agencies. The state groundwater standards are contained in chapter NR 140, Wisconsin Administrative Code. For each substance there is an enforcement standard (ES) which determines when a violation has occurred and a preventive action limit (PAL) which is set at a percentage of the ES. The PAL serves as a trigger for possible remedial action.

2) Regulatory Programs. Once groundwater quality standards are established, all state agencies must manage their regulatory programs to comply. Each state regulatory agency must promulgate rules to assure that the groundwater standards are met and to require appropriate responses when the standards are not met. The state regulatory agencies are the DNR (solid and hazardous waste, industrial and municipal wastewater, spills, wetlands and water supply); the Department of Commerce (private sewage systems, petroleum product storage tanks); the Department of Agriculture, Trade and Consumer Protection (DATCP) (pesticide use and storage and fertilizer storage); and the Department of Transportation (DOT) (salt storage).

3) Aquifer Classification. One of the most important features of Wisconsin's groundwater law is an item that was

omitted. When Wisconsin was debating the groundwater protection legislation, the U. S. Environmental Protection Agency (EPA) tried to develop a nationwide groundwater approach. A keystone of EPA's proposal was aquifer classification - a scheme whereby each aquifer would be classified according to its potential use, value or vulnerability, and then would be protected to that classification level. This entails "writing off" certain aquifers as industrial aquifers not entitled to protection and never again usable for human water supply. Wisconsin said "no" to aquifer classification. The philosophical underpinning of Wisconsin's groundwater law is the belief that all groundwater in Wisconsin must be protected equally to assure that it can be used for people to drink today and in the future.

4) Monitoring and Data Management. At the time the groundwater legislation was created, there was concern that Wisconsin needed a groundwater monitoring program to determine whether the groundwater standards were being met. Therefore, a groundwater monitoring program was created under s. 160.27, Wis. Stats. Money from the Groundwater Account of the Environmental Fund has been used for problem-assessment monitoring, regulatory monitoring, at-risk monitoring, and management-practice monitoring, as well as establishment of a data management system for collection and management of the groundwater data.

5) Research. Although all state agencies must comply with the groundwater standards, the processes by which groundwater becomes contaminated, the technology for cleanup, the mechanisms to prevent contamination, and the environmental and health effects of the contamination are often not well understood. In addition, the basic data on geology, soils, and groundwater hydrology is often not available. The UWS and the state agencies have recognized that additional efforts in these research areas are badly needed. The Governor and the Legislature included a new groundwater research appropriation for the UWS beginning with the 1989-1991 biennial budget. Since 1992, the UWS, DATCP, DNR and Commerce have participated in a joint solicitation for groundwater-related research and monitoring proposals.

6) Coordination. In establishing the groundwater law, the Legislature recognized that management of the state's groundwater resources was a responsibility divided among a number of state agencies. Therefore, the GCC was created to advise and assist state agencies in the coordination of non-regulatory programs and the exchange of information related to groundwater. The Council has been meeting since 1984.

7) Local Groundwater Management. The Groundwater Protection Act clarified the powers and responsibilities of local governments to protect groundwater in partnership and consistent with state law.

   a. Zoning authority for cities, villages, towns and counties was expanded to "encourage the protection of groundwater."

   b. Counties can adopt ordinances regulating disposal of septage on land (consistent with DNR requirements); cities, villages, or towns may do so, if the county does not.

   c. Counties can regulate (under DNR supervision) well construction and pump installation for certain private wells.

   d. Property assessors must consider the time and expense of repairing or replacing a contaminated well or water supply when assessing the market value of real property; they must consider the "environmental impairment" of the property value due to the presence of a solid or hazardous waste disposal facility.

Wisconsin's *New* Groundwater Protection Act, 2003 Wisconsin Act 310

On Earth Day, April 22, 2004, Governor Doyle signed a new groundwater protection law, 2003 Wisconsin Act 310, that expands the State's authority to consider environmental impacts of high capacity wells and institutes a framework for addressing water quantity issues in rapidly growing areas of the state.[1] Significantly, this legislation

1 More details can be found at the Wisconsin State Legislature website:
Text of Act 310: *http://www.legis.state.wi.us/2003/data/acts/03Act310.pdf*

for the first time recognizes the link between surface water and groundwater, and that all wells have an impact on groundwater quality and quantity. The law applies many principles of adaptive management, allowing for changes in the regulation of high capacity wells as relevant information becomes available or groundwater conditions change.

The passage of the legislation represents the culmination of several years of discussion on groundwater quantity issues and concerns expressed by citizens, experts, water users, and agency personnel about the lack of a comprehensive approach to managing groundwater quantity in Wisconsin. The GCC was alerted to this issue in the mid-1990's, and directed the formation of a Groundwater Quantity Working Group to prepare a report. The 1997 report titled "Status of Groundwater Quantity in Wisconsin" concluded that a coordinated effort was needed to determine appropriate management options for addressing groundwater withdrawals and to implement data collection, information and education programs. Public attention to this issue surfaced in 2000 and 2001 with the attempt by a major bottled water operation to locate a facility in Wisconsin, and increased attention to groundwater issues in southeastern Wisconsin. In October 2001, the GCC facilitated an event called the Groundwater Summit, at which groundwater quantity issues were raised and discussed by a diverse assemblage of groundwater users, citizens, elected officials, and groundwater professionals. Shortly thereafter, several groups began discussing various groundwater quantity legislative initiatives to address these concerns.

In 2003, Waters of Wisconsin released a report calling for comprehensive approach to managing groundwater quantity. Governor Doyle formally received the report on Earth Day, April 22, 2003 and issued a challenge to legislators to have groundwater quantity legislation for him to sign on the next Earth Day. Senator Neal Kedzie and Rep. DuWayne Johnsrud took up this challenge and convened a group of stakeholders to draft legislation in late summer of 2003. Throughout the fall and winter of 2003 and 2004, various groups and individuals commented on the legislative proposals and forwarded their own ideas. A hallmark of these discussions was the open and inclusive process and the reliance on experts to develop a proposal based on sound science. In March of 2004, a bill was formally introduced to floor of both houses and was passed with only one dissenting vote.

Here are some of the major components of the legislation:

1) Tracking well construction and water use. The Act requires well owners to obtain approval of a high capacity well (pumping more than 100,000 gallons per day) by the DNR prior to construction, pay a fee of $500, and submit an annual pumping report to DNR. For any new well that is not a high capacity well the owner must notify DNR of the well location prior to construction and pay a fee of $50. The fees will directly support the administration of this Act, including tracking well construction, review of high capacity well applications, and collection of groundwater data. In addition, fees will support increased inspections and enforcement of well construction activities, helping to ensure a safe drinking water supply.

   The law requires all high capacity well owners to report water use on an annual basis, including ones with existing approvals. Previously, only municipal water supply wells were required to submit pumping reports, along with some high capacity wells that required reporting as part of their approval. The collection of this information will assist in evaluating proposed new wells, monitoring approval conditions, identifying trends, calibrating groundwater flow models, and improving water use estimates, all contributing to better understanding and management of groundwater resources.

2) Expanded regulation of high capacity wells. The Act requires DNR to undertake an environmental review (under ch. NR 150, Wis. Adm. Code), for the following proposed high capacity wells:
   - Wells located in a “groundwater protection area” (an area within 1,200 feet of an outstanding or exceptional resource water or any class I, II, or III trout stream).
   - Wells that may have a significant environmental impact on a spring with a flow of at least one cubic foot per second for at least 80% of the time.
   - Wells where more than 95% of the amount of water withdrawn will be lost from the basin.

Legislative Council memo: *http://www.legis.state.wi.us/lc/act_memo/2003/act310-ab926.pdf*

In these cases, DNR may deny or limit an approval to assure that these wells do not cause significant environmental impact. There are also protections and exceptions for public water utility wells. For example, the DNR must weigh the public health and safety benefits of a proposed well in a groundwater protection area or near a spring if it is to be used for a public water supply. In these cases, the DNR must balance the well's environmental impact and its public health and safety benefits. Some of the criteria that might be used for this "balance test" include provisions for water conservation, appropriate use (drinking water vs. lawn watering or car washing), and long range water supply planning. The DNR must also ensure that a public utility's water supply is not impaired by another high capacity well, maintaining a long-standing requirement from previous statutes.

3) Designation of groundwater management areas. The Act directs the DNR to establish two groundwater management areas in Southeastern Wisconsin and the Lower Fox River Valley. These areas will include Waukesha and Brown Counties, and surrounding cities, villages and towns where the water level of the deep sandstone aquifer has been drawn down more than 150 feet since pre-development. In the Lower Fox River Valley, this could include portions of Outagamie and Calumet Counties, while in Southeastern Wisconsin it could include Kenosha, Racine, Milwaukee, and Ozaukee Counties, and portions of Washington and Walworth Counties.

   The intention of the groundwater management area is to encourage a coordinated management strategy among the state, local government units, regional planning commissions, and public and private users of groundwater to address problems caused by over-pumping of the deep aquifer, including increased levels of radium, arsenic and salinity. The DNR will assist local government units and regional planning commissions in those areas as they undertake research and planning related to groundwater management.

4) Creation of a Groundwater Advisory Committee. The Act establishes a Groundwater Advisory Committee. Members will be appointed by the Governor and Legislature and will represent municipal, environmental, agricultural and industrial interests. The Committee will review the implementation of the Act and recommend further changes in the regulation of high capacity wells.

   Specifically, the committee is to make recommendations regarding:
   - the regulation of wells in groundwater protection areas, that have a water loss of 95 percent or more, or that have a significant environmental impact on a spring;
   - the definition of springs;
   - adaptive management approaches;
   - the potential for the use of general permits; and
   - factors to be considered in determining whether a high capacity well causes significant environmental impact.

   The Act also directs the Committee to recommend legislation that addresses the management of groundwater within groundwater management areas and any other areas of the state where a coordinated strategy is needed. The Committee may identify other parts of the state that should be designated as groundwater management areas, and will recommend how and when this designation may be removed.

   The Committee is to issue reports to the legislature no later than December 31, 2006 regarding groundwater management areas, and December 31, 2007 regarding its review of the implementation of the new regulations. If the committee fails to submit these reports, the DNR may adopt rules to address management of groundwater in the groundwater management areas.

During the coming year, the DNR will be seeking appropriations and positions to begin implementing the new legislation. The GCC will track progress of the implementation and provide assistance on education, research, monitoring, planning, and data management needs related to the new legislation.

Chapter 2 -- GROUNDWATER COORDINATION

The Groundwater Coordinating Council (GCC) is directed by s. 160.50, Wis. Stats., to "advise and assist state agencies in the coordination of non-regulatory programs and the exchange of information related to groundwater, including, but not limited to, agency budgets for groundwater programs, groundwater monitoring, data management, public information and education, laboratory analysis and facilities, research activities and the appropriation and allocation of state funds for research." To assist in this work, the GCC is authorized to create subcommittees on "the subjects within the scope of its general duties…and other subjects deemed appropriate by the Council." Additionally, the GCC is directed to "advise the Secretary of Administration on the allocation of funds appropriated to the Board of Regents of the University of Wisconsin under s. 20.285(1)(a) for groundwater research."

The purpose of this chapter is to describe the activities of the Council and its Subcommittees during FY 04, as well as the coordination of the Wisconsin Groundwater Research and Monitoring Program. Through these activities, the GCC continues to play an important role in ensuring agency coordination, increasing efficiency and facilitating the effective functioning of state agencies in activities related to groundwater protection and management. Ultimately groundwater is better protected, which protects public health and preserves Wisconsin's natural resources for future generations.

GROUNDWATER COORDINATING COUNCIL

The GCC consists of the heads of all state agencies with some responsibility for groundwater management plus a Governor's representative. The agency heads have appointed high-level administrators with groundwater responsibilities to sit on the Council. The state agencies include the DNR, Commerce, DHFS, DATCP, DOT, WGNHS, and the UW System. The GCC has created six subcommittees to assist in its work. The subcommittees are composed of approximately 60 people including members of the GCC, employees of state and federal agencies, university researchers and educators, representatives of counties and municipalities and public members. Additionally the DNR has one permanent position with half of its responsibilities related to coordination of the GCC.

The GCC took an active role in many groundwater issues and activities during FY 04, several of which are highlighted and summarized here.

Addressing Long-Term Groundwater Management Needs

In October 2001, the GCC facilitated an event called "Wisconsin's Groundwater Summit." The Summit brought together a broad spectrum of groundwater users and stakeholders to discuss issues facing groundwater protection and management and develop solutions to better protect Wisconsin's groundwater. Representatives from over 50 organizations, agencies, and other groups with a stake in safe and adequate groundwater supplies attended the meeting. These included environmental, conservation, and agricultural groups, industrial users, water utilities, local and tribal government, planning agencies, state and federal agencies, and university researchers and educators. Findings and recommendations from the Summit are contained in the document *Sharing Our Buried Treasure: A Summary of the 2001 Groundwater Summit* available at http://dnr.wi.gov/org/water/dwg/gcc/SOBT.pdf.

Summit participants identified 9 "Key Themes" to guide groundwater management activities over the next decade:

1) Clarifying "Whose Water is it?"
2) Recognizing the Connections Between Groundwater and Surface Water
3) Evaluating and Managing Threats to Groundwater Quality
4) Linking Land Use Planning and Groundwater Protection

5) Developing a Comprehensive Approach to Groundwater Quantity
6) Addressing Water Use and Conservation Issues
7) Exploring Options for Regionalization of Water Management
8) Building a Groundwater Constituency through Public Education and Involvement
9) Collecting Long-Term Groundwater Data to Address Long-term Problems

During the past year, the GCC and its Subcommittees continued to address strategies suggested by these Key Themes. The Education Subcommittee initiated an effort to make linkages to a broader base of people involved in groundwater education, including non-profit groups, consultants, well drillers, and water utilities (*Building a Groundwater Constituency through Public Education and Involvement)*. The Monitoring and Data Management Subcommittee continued a process to evaluate the state's long term groundwater monitoring strategy (*Collecting Long-Term Groundwater Data to Address Long-term Problems*). The Planning and Mapping Subcommittee compiled information on GIS data layers to assist communities with land use planning activities (*Linking Land Use Planning and Groundwater Protection)*. Several research priorities identified at the Summit were incorporated into the FY 05 Solicitation for Proposals, particularly those related to groundwater/surface water interactions *(Recognizing the Connections Between Groundwater and Surface Water).*

There have been a number of collaborative efforts to promote groundwater protection in the comprehensive planning process by local governments (*Linking Land Use Planning and Groundwater Protection*). In 2002, representatives from three GCC Subcommittees prepared and distributed three Comprehensive Planning and Groundwater Fact Sheets to promote inclusion of groundwater information in comprehensive plans. Last fall, the Planning and Mapping and the Local Government Subcommittees met jointly to share information on some of the existing state groundwater databases and to solicit input from local government representatives on their needs related to groundwater planning. Through the Wisconsin groundwater research and monitoring program, two projects have been funded to address how to make groundwater information available to local governments for use in comprehensive plans. In addition, the DNR's Land Use Team held two Changing Landscape workshops in the past year to get input from local government representatives on computer tools that would be useful for planning purposes. Eleven tools were identified as being most useful. Training around the state on use of these tools is being planned.

The historic efforts to draft and pass groundwater quantity legislation during the past year also addressed several key themes of the Groundwater Summit (see *Introduction* and groundwater quantity discussion in *Condition of the Resource* chapter). While focused on strengthening the State's high capacity well regulations, the legislation recognized that many groundwater quantity issues needed a more comprehensive approach (*Developing a Comprehensive Approach to Groundwater Quantity).* For the first time, impacts of groundwater withdrawals on surface waters were acknowledged in statutory language *(Recognizing the Connections Between Groundwater and Surface Water).* Provisions requiring reporting of water use for high capacity wells *(Addressing Water Use and Conservation Issues*) and the creation of Groundwater Management Areas *(Exploring Options for Regionalization of Water Management*) also reflect a more comprehensive approach .

While the legislation was developed under the auspices of a bipartisan legislative committee with input from a broad representation of stakeholders, the GCC was an active participant in the process, through the creation of a Quantity Subcommittee and discussions at its quarterly meetings. Many subcommittee members and agency representatives contributed data, research findings, maps, modeling scenarios, and technical expertise to help answer questions and ensure that the legislation was based on sound scientific principles. The GCC will continue to play a role in the implementation of the legislation, through its research and monitoring oversight, as well as making technical information and expertise available to the Department of Natural Resources and the Groundwater Advisory Committee created by the legislation.

Developing a Statewide Groundwater Monitoring Strategy

Implementation of the Clean Water Act, Wisconsin's Groundwater Law (1983 Wisconsin Act 410) and recently enacted groundwater quantity legislation (2003 Wisconsin Act 310) all require an understanding of groundwater

that involves monitoring. The Clean Water Act gives Wisconsin primary responsibility for protecting and restoring water quality including monitoring and assessing the nation's waters and reporting on their quality. Chapter 160 of the Wisconsin Statues requires the DNR to work with other agencies and the GCC, to develop and operate a system for monitoring and sampling groundwater to determine whether harmful substances are present (s. 160.27, Wis. Stats.). Recently enacted groundwater quantity legislation (2003 Wisconsin Act 310) directs the DNR to issue well approvals and track water use for high capacity wells.

Over the past year, representatives from the DNR, DATCP, WGNHS, USGS, the Groundwater Center at UW Stevens Point's Center for Watershed Science and Education and the Wisconsin Academy of Sciences, Arts, and Letters (Waters of Wisconsin), reviewed existing monitoring programs and determined common goals and components for a comprehensive groundwater monitoring strategy.

The objective of the new monitoring strategy is to coordinate groundwater monitoring between all state agencies that regulate groundwater to get a complete picture of groundwater quality, quantity and use in Wisconsin. To accomplish this objective three goals have been identified: 1) provide enough data to determine how groundwater is changing over time; 2) provide data to increase understanding of groundwater systems; and 3) provide data to citizens to increase their understanding of how their actions affect groundwater.

The eight common components necessary to address the three goals include:
1) A comprehensive assessment of existing databases
2) A fixed network of groundwater level monitoring locations
3) A common, statistically correct process for stratified random sampling of private wells
4) A fixed network of water quality monitoring sites
5) A fixed network of surface water monitoring stations
6) A water use reporting program
7) A common data management program
8) A common communication approach

These components were derived from existing monitoring programs in Wisconsin and other state and federal monitoring programs. The above components will be used to develop a groundwater monitoring network that can be used to assess groundwater quality, quantity and use, determine trends, and study groundwater systems. State agencies will use this network to assess groundwater in the state by watershed, basin and aquifer or other selected strata. Groundwater trends can be tracked using fixed monitoring locations. The network will be maintained for use by the different state and federal agencies or other entities such as universities, local governments and consultants for special studies.

Potential partners include federal, state, and local governments, universities and other entities involved in groundwater management and research. In addition, volunteers (citizens, schools and others) will have opportunities to monitor wells. Data will be managed by different agencies but will have a common format and portal on the GCC website. Educational and informational materials derived from the data and developed by the partners will be available through the GCC web page.

GCC Information and Outreach Activities

Wisconsin Groundwater Information Directory. In 1991, the Education Subcommittee created a Groundwater Education Resources Directory targeted at educators to assist them in finding contacts, publications, and other resources for groundwater educational programs. This directory has not been updated since 1995. In 2004, the groundwater educator at UW Stevens Point, with the assistance of the Education Subcommittee, developed a new publication called the Wisconsin Groundwater Directory. The intention of the directory is to provide a handy reference for "who does what" related to groundwater in Wisconsin, and to guide citizens, educators, and groundwater professionals to the right agency. Websites and phone numbers are included, as well as a limited number of publications and resources. While not as comprehensive as the original education resource directory, this publication will be more useful and easier to keep current.

Website updates. Several updates to the GCC website have been made in the past year (*http://dnr.wi.gov/org/water/dwg/gcc/*). The site provides information on the activities of the council, a list of members on the council and members of the subcommittees, information on the annual solicitation for groundwater research proposals, Subcommittee projects, GCC meeting minutes and reports, and links to other relevant groundwater web sites. Links can also be found to GCC-related information on other institution's web sites, including research summaries at the Water Resources Institute and a karst information web page at the WGNHS.

Coordination of Groundwater Research and Monitoring Program

The GCC, the UW System, and the Groundwater Research Advisory Council (GRAC) continued coordination of the annual solicitation for groundwater research and monitoring proposals among state agencies, as specified in a November 2002 Memorandum of Understanding (MOU). (Details are found in the section on *Wisconsin's Groundwater Research and Monitoring Program*). The GCC approved the FY 05 Solicitation for Proposals in August of 2003 (see *Appendix D*). In January 2004, Members of 2 GCC Subcommittees reviewed the proposals that were submitted and made their recommendations to the agencies and GRAC. Three GCC members participated in the GRAC review in March 2004. Via email, the GCC unanimously approved the proposed UWS groundwater research plan as required by s. 160.50(1m), Wis. Stats., and a letter was sent to the UW System president and the Department of Administration to this effect on April 13, 2004.

Through these coordination activities, the GCC helps create efficiencies in the proposal submittal process and help ensure that taxpayer dollars are directed at the most pressing needs for groundwater information.

Other Coordination Activities

The GCC continued to promote communication, coordination, and cooperation between the state agencies through its quarterly meetings. The meeting minutes are included in *Appendix B*. In addition to the activities listed above, the GCC received briefings and heard presentations on:

- Subcommittee activities (see below)
- 2003 and 2004 GCC Report to the Legislature
- UWS FY 05 groundwater research plan
- State budget updates and effects on agency groundwater programs
- Development of a statewide groundwater monitoring strategy
- Groundwater quantity legislation: 2003 Wisconsin Act 310
- Source Water Assessment Program (SWAP) mapping applications
- Development of statewide environmental and human health tracking network
- EPA's evaluation of state and regional water quality monitoring councils
- Susceptibility of La Crosse municipal wells to enteric virus contamination from surface water contributions
- Stormwater infiltration, water re-use, and groundwater protection
- DATCP water quality monitoring
- Hydrogeology of the Coon Creek Watershed and insights on Driftless Area hydrology
- Water research fact sheets from Water Resources Institute
- State of Wisconsin Closure Protocol Study
- Annex 2001 and Great Lakes issues
- Geophysics at the Wisconsin Geological and Natural History Survey

SUBCOMMITTEE SUMMARIES

The GCC is directed to "serve as a means of increasing the efficiency and facilitating the effective functioning of state agencies in activities related to groundwater management". The Subcommittees of the GCC carry out this charge by regularly bringing together staff from over 15 different agencies, institutions, and organizations to

communicate and work together on a variety of research, monitoring and data management, planning and mapping, educational, and local government issues.

In addition to the specific Subcommittee activities reported below, several collaborative efforts among agencies and Subcommittees were accomplished in FY 04:

- The second annual "Wisconsin Groundwater Festival" was held in Waukesha on April 23, 2004. The Statewide Groundwater Guardian Coordinator, the Waukesha Groundwater Guardian Team and the Wisconsin Groundwater Association organized this event, with planning and participation from many state agencies, the USGS, and UW Extension. The event attracted over 600 5th and 6th graders plus teachers from around the State and offered a host of hands-on learning activities about various groundwater topics. Senator Neal Kedzie, one of the co-authors of the recent groundwater quantity law, was a featured speaker. The third annual festival is planned for northwest Wisconsin in 2005.

- Several subcommittees have paid particular attention to groundwater quantity issues in FY 04. The Education Subcommittee and the Local Government Subcommittee have identified areas for improved education and information. The Research and Monitoring and Data Management Subcommittees added several quantity-related research priorities to the annual solicitation for research proposals. The GCC added a list of Groundwater Quantity Resources to its web page with plans to more fully expand the information in FY 05. In addition, several subcommittees contributed members to the new Groundwater Quantity Subcommittee (see description below).

- Two subcommittees addressed the continued need to improve the ability of data sharing among different agencies and university partners. The Monitoring and Data Management Subcommittee helped to focus the issue on increasing the use of Wisconsin unique well numbers to match water quality data with specific wells. It suggested that the Education Subcommittee write a statement about the importance of unique well numbers to be provided through future water testing campaigns, brochures, and information provided by laboratories with test kits. The Water and Environmental Research Laboratory at UW Stevens Point and the State Laboratory of Hygiene both agreed to update their forms, while the DNR began adding information to various well testing brochures as revisions were made.

- The DNR and the Department of Commerce are jointly working on a study of natural attenuation processes at closed remediation sites that were contaminated with petroleum products. The purpose of the study is to determine if criteria used to close the site were valid. This study has many partners, including USGS, UW Madison, and the WGNHS. In addition, staff from DOT and other agencies are providing assistance in locating suitable sites.

- For the fourth year in a row, three groundwater workshops for teachers were taught jointly by staff from the DNR, WGNHS and the Center for Watershed Science and Education at UW Stevens Point. The workshop leaders taught the teachers how to use a groundwater sand tank model and gave them additional resources to incorporate groundwater concepts into their classroom. Teachers from eight different schools attended each workshop and took a groundwater model back to their school free of charge. With funding from an EPA grant, nearly 100 groundwater models have been given to schools since 2001.

In addition, numerous contacts and informal conversations are generated both at meetings and through email communications among Subcommittee members, leading to better communication across agency lines on a variety of issues. These activities are related to participation of agency staff on GCC Subcommittees and create efficiencies and provide intangible benefits to Wisconsin's taxpayers.

Research Subcommittee

The purpose of the Research Subcommittee is to assist the GCC in establishing priorities for groundwater research and monitoring activities and to review proposals submitted through the Wisconsin Groundwater Research and Monitoring Program. To this end, the subcommittee reviewed and revised the priorities for the DNR's groundwater management practice monitoring program for FY 05. The revised priorities were included in the joint solicitation for proposals that was distributed by the UWS, DNR, Commerce, and DATCP in September 2003.

The subcommittee met with the Monitoring and Data Management Subcommittee in January 2004 to review 15 proposals that were submitted in response to the FY 05 solicitation. Subcommittee members made recommendations that were used by the UWS in deciding which groundwater-related proposals to fund for FY 05. The projects to be funded in FY 05 are listed in Table 2. None of the state agencies will be funding new projects in FY 05.

The Research Subcommittee discussed the need for more access and dissemination of research and monitoring findings, as well as ensuring that future proposals address pressing state needs, especially in light of reduced state funds for research. Two ideas were advanced. One idea was to hold periodic meetings of the subcommittee to discuss recently completed reports and findings generated by state funded projects. Another idea is to require that future proposals explicitly make reference to past funded projects on similar topics. Both of these ideas would help to ensure that past research projects are consulted before embarking on new projects, eliminating duplication of efforts and maximizing use of state dollars.

Monitoring & Data Management Subcommittee

The goal of the Monitoring & Data Management Subcommittee (MDMS) is to coordinate groundwater monitoring and data management activities of state agencies to maximize value and efficiency. MDMS members continued to work collectively, individually, and in small groups on GCC activities or action items targeted by the subcommittee. Several key issues were addressed in FY 04:

- The subcommittee reviewed the priorities for the DNR's groundwater management practice monitoring program for FY 05. A meeting was held with the Research Subcommittee in January to review 15 research and monitoring proposals that were submitted in response to the FY 05 solicitation. Subcommittee members made recommendations that were used by the UWS in deciding which groundwater-related proposals to fund for FY 05. The subcommittee also began reviewing DNR's research and monitoring priorities for FY 06 in an effort to narrow the list to reflect more limited funding.
- Several subcommittee members worked with DNR Groundwater Section staff to draft a unified groundwater monitoring strategy. This effort was initiated from recommendations made at the Groundwater Summit and Waters of Wisconsin meetings. The group listed general goals and specific objectives; and addressed implementation, data coordination, access, and other considerations. The subcommittee will be focusing on data management and sharing issues as it continues to be involved in this effort in FY 05.
- The subcommittee continued to address the need to improve the ability of data sharing among different agencies and university partners. One key issue is increasing the use of Wisconsin unique well numbers to match water quality data with specific wells. The subcommittee suggested that a statement about the importance of unique well numbers be provided through water testing campaigns, brochures, and test kit information provided by laboratories and recommended that the Education Subcommittee take up this issue.
- Subcommittee members were involved in producing several new digital groundwater data products. These products include a new CD-ROM product from WGNHS called *wisc*LITH, which contains a database of geologic logs associated with high capacity well construction and an electronic database of variances associated with landfills, septic systems and setback requirements for private wells included on the DNR Water Well CD.
- An ongoing goal for the subcommittee is to prevent duplication of efforts and increase the utility of monitoring data. This goal is met through regular meetings where members can update one another on their agencies' activities. In FY 04 the subcommittee discussed current relevant topics such as DHFS's Environmental Health Tracking Program, DNR's source water assessment and well data availability, EPA's evaluation of State monitoring councils, DATCP's pesticide monitoring, and WGNHS's release of digital groundwater data.

Planning and Mapping Subcommittee

The purpose of the Planning and Mapping Subcommittee is to help the State integrate groundwater management and protection strategies into local and regional land use planning with an emphasis on identifying and prioritizing specific physical (water quantity) and chemical (water quality) hydrogeologic mapping needs (natural resources and anthropogenic impacts). A key function of the subcommittee is providing Agency updates of groundwater related mapping efforts. This important dialogue enables each Agency to share information and not duplicate efforts.

During this reporting period the subcommittee held one meeting on October 15th, 2003 (joint meeting with the Local Government Subcommittee), summarized below. A key goal of this meeting was to solicit feedback and ideas from local and regional planning partners on groundwater information needs, and to showcase new groundwater mapping tools being developed by state agencies. The subcommittee is also in the process of organizing groundwater specific land information into a reference index catalog.

Education Subcommittee

The Education Subcommittee met four times during the past year. Its mission is to review public information and education materials, coordinate educational messages among agencies, and serve as a forum to identify groundwater education needs, ideas and concerns. At each meeting, representatives share information about current agency activities related to groundwater.

Groundwater quantity has been the top priority issue over the last year. The subcommittee began their work on this issue with discussions about the availability of material on groundwater quantity issues and the most effective methods for reaching the desired audiences. The Wisconsin Geological and Natural History Survey identified two studies conducted in southern Wisconsin as possible resources. The first study was a survey of springs in Dane County that was compared to a similar survey from 1950. Another study on groundwater utilized a computer model for groundwater in southeast Wisconsin for locating source water protection areas in the village of Eagle. As part of this work, an educational web site was created by the United States Geological Survey. A web-based tutorial about groundwater and its role in the water cycle starts the program, which then progresses to more detailed information for the southeast region of Wisconsin. Additionally, an article was published in the June issue of Wisconsin Natural Resources Magazine about groundwater quantity issues.

The subcommittee also worked to expand its membership over the last year to attempt to increase access to other groups that work on groundwater education issues in the state. After careful consideration, it was decided that having an email advisory group would be the most effective method to reach the largest audience. This group will receive meeting minutes, can share their thoughts and ideas via email, and request to be on meeting agendas.

Members of the subcommittee participated in a variety of educational and outreach efforts related to groundwater, including the second annual "Wisconsin Groundwater Festival," the Wisconsin Lakes Convention, the Wisconsin Water Well Association annual meeting, and Farm Technology Days. In addition, several members led or assisted at 3 training sessions for teachers on the use of a groundwater sand tank model. The groundwater model each participating school receives offers a "slice" or cross-section representation of the earth, allowing students to "see" groundwater. Teachers and students can use the model to demonstrate a variety of groundwater flow principles, including water table levels, how groundwater supplies are replenished, how groundwater flows through different geologic materials, and how contaminants from a variety of sources can leak into groundwater. The model also contains "wells" which can be used to show the effects of pumping on the groundwater flow system.

The subcommittee continued its investigation on home water test kits available at local home improvement centers and hardware stores. The DATCP laboratory has continued evaluating the accuracy of the kits that test for pesticides. The DNR and SLOH updated some of their publications on tests for drinking water to include information about these kits.

The members of the subcommittee continue to work together when writing new publications or updating existing documents. This year, subcommittee members assisted DNR in updating their Nitrate and Tests for Drinking Water brochures. These brochures included new information about the test kits for home drinking water. The DNR also revised and updated a publication originally published by the Stevens Point-Whiting-Plover Wellhead Protection Project called *Better Homes and Groundwater* with significant input from the subcommittee.

Local Government Subcommittee

The Local Government Subcommittee (LGS) was formed in 1993 to represent local units of government and organizations representing local units of government. The subcommittee was created by the GCC in response to recommendations from the 1991 conference "Working Together to Manage Wisconsin's Groundwater – Next Steps?" The purpose of the subcommittee is to serve as a means of communication between local governments and the state regarding groundwater issues. The LGS provides an opportunity for local units of government to share concerns about groundwater as well as to allow the GCC and its subcommittees to share information and get input from local governments about groundwater data, publications and programs.

The LGS met twice, focusing on groundwater quantity issues and resources for including groundwater protection in comprehensive planning efforts.

The LGS and Planning and Mapping Subcommittee met jointly in October, 2003 in Plover to discuss the planning and mapping needs of local governments related to comprehensive planning, water supply planning and wellhead protection. Information was presented on a number of available groundwater resources, including the draft Groundwater GIS and Mapping Index, WGNHS data sources, DNR Source Water Assessment tools, and Groundwater and Comprehensive Planning Fact Sheets. Substantial time was devoted to getting input from local government representatives regarding their data management needs. Representatives of local government were very interested in the information presented at the meeting and encouraged state agencies to work toward allowing access to this data by local governments. Much of this information would be quite valuable for comprehensive planning efforts being undertaken by local governments. A number of suggestions were made for making this information more easily available and for making more people aware that the information exists.

The LGS met again in May in Madison to continue discussion of comprehensive planning tools and the groundwater quantity legislation signed by Governor Doyle on Earth Day. Attendees heard about the Changing Landscapes effort by the DNR's Land Use Team to identify computer tools that could be used by local governments to make land use decisions and to provide training in use of these tools around the state. The subcommittee also provided input on a proposal to develop guidance for incorporating groundwater information into comprehensive plans.

Groundwater Quantity Subcommittee

In July of 2003, the chair of the GCC requested that the Council form a Quantity Subcommittee composed of members of each of the agencies represented on the Council, as well as each of the existing subcommittees. Additional members were recruited from UW campuses and the US Geological Survey.

The initial purpose of the Groundwater Quantity Subcommittee was to help answer some of the technical and scientific questions associated with efforts to draft groundwater quantity legislation. The subcommittee met often between August 2003 and January 2004 and reviewed several versions of the draft legislation. Some of the issues that the subcommittee identified and/or addressed included:

- The lack of monitoring data and capacity to be able to address regional water quantity issues, as well as impacts of wells on surface waters.
- Delineating groundwater management areas.
- Cumulative impacts of many low capacity wells in areas with high population density
- Defining the term "significant adverse environmental impact" as it pertains to groundwater protection areas.

- Identifying sensitive surface waters that should be protected and determining how they should be protected.
- The importance of water use reporting and determining the frequency of reporting
- Incorporating conservation measures more definitively in legislation.

The subcommittee shared enthusiasm for the idea that legislation would address both regional groundwater quantity problems and surface water impacts. With successful passage of the legislation, the GCC has directed the subcommittee to meet as needed to address technical and scientific questions arising during implementation of the law.

WISCONSIN'S GROUNDWATER RESEARCH AND MONITORING PROGRAM

The GCC provides consistency and coordination among state agencies in funding groundwater monitoring and research to meet state agency needs. Approximately $12.3 million has been spent through FY 04 on 311 different projects dealing with groundwater or related topics (see *Appendix C* for a complete listing). The four programs, collectively called the Wisconsin Groundwater Research and Monitoring Program, have different sources of money and purposes, which are summarized as follows: include:

1. DNR Management Practice Monitoring - The DNR has had at least $125,000 available each year since FY 86 to support groundwater monitoring studies evaluating existing design and/or management practices associated with potential sources of groundwater contamination. The intent of these studies is to identify appropriate management practices to reduce the impacts of potential sources of contamination. The money comes from the Groundwater Account of the Environmental Fund (which is funded by various fees). Additional funds have been available in some years through various Federal and State sources, enabling the DNR to fund additional projects. Through FY 04, the DNR has spent approximately $5.6 million on 173 monitoring projects. Several of these projects have been co-funded with DATCP, Commerce and/or UWS.

2. UWS Groundwater Research - The UWS, through its UW-Madison Water Resources Institute (WRI), has received funding since FY 90 for groundwater research. Projects may be of a fundamental or applied nature on any aspect of groundwater research in the natural sciences, engineering, social sciences or law. Through FY 04, the UWS has spent $4.4 million on 122 groundwater research projects. Several projects have been co-funded with DNR, Commerce and/or DATCP and eleven were co-funded with WRI through the US Geological Survey.

3. DATCP Pesticide Research - Since 1989, DATCP has had up to $135,000 available annually to fund research on pesticide issues of regulatory importance. The money comes from fees paid by pesticide manufacturers to sell their products in Wisconsin. Starting in FY 03, these funds have not been available for new research. Through FY 04, DATCP has spent about $1.8 million on 42 pesticide projects. Several of these projects have been co-funded with DNR and/or UWS.

4. Department of Commerce Private Onsite Wastewater Treatment System (POWTS) Research - The Division of Safety & Buildings (formerly in the Department of Industry, Labor, and Human Relations) received a special GPR appropriation of $50,000 from 1990 to 1993 to fund research on alternatives to current POWTS technology. In 1994, when the appropriation expired, $75,000 generated through plan review and licensing fees became available each year for research on POWTS. However, due to budget shortfalls, Commerce has not been able to fund research projects since FY02. Through FY 04, DILHR/Commerce has spent approximately $600,000 on eight projects. Two projects were co-funded with DNR and UWS.

Solicitation and Selection of Proposals

The UWS, DNR, DATCP, and Commerce annually participate in a joint solicitation for research and monitoring proposals dealing with groundwater, pesticides and/or onsite wastewater treatment systems.

In 1988, the GCC requested that the UWS create a Groundwater Research Advisory Council (GRAC) to establish a long-range groundwater research plan and develop a groundwater research decision item narrative (DIN) for inclusion in the University's biennial budget. The GRAC consists of university, state agency, and public representatives. During the summer of 1990, the GRAC and GCC developed and endorsed a plan to coordinate the solicitation of projects for funding in FY 92 and subsequent years. The joint solicitation provides for only one submittal of project proposals, rather than four as had been the case. The intent of the joint solicitation is to determine the most appropriate funding source for a particular project.

Statutory language requires that there be agreement between the UWS and the GCC on the use of the UWS research funds before the funds can be released by the Department of Administration (s. 160.50(1m), Wis. Stats). To expedite this agreement, a Memorandum of Understanding (MOU) was signed in 1989 and 1991 by representatives of the GCC, the GRAC, and the UWS on use of the UWS groundwater research funds. This MOU was reviewed and updated in November 2002. The MOU spells out the procedures for establishing priorities and selection of projects for funding of UW groundwater research. The MOU recognizes that the GCC has a substantive role in establishing research priorities and an advisory role in project selection to minimize overlap and duplication.

FY 04 Proposal Solicitation. The Solicitation for Proposals (SFP) for FY 04 was distributed in September 2002. A total of 31 project proposals were submitted in response to the SFP. To assist in the review process, a joint meeting of the Monitoring & Data Management and Research Subcommittees of the GCC was held in January 2002 to review and rank the projects that were submitted for funding. As a result of the subcommittee meeting, the GRAC meeting in March, and review of the proposals by agency staff, 13 new projects were selected for funding in FY 04. Three on-going projects were carried over into FY 04. A total of 16 projects were funded through the joint solicitation at a cost of approximately $391,000 (see Table 1).

FY 05 Proposal Solicitation. The SFP was distributed in September 2003 for funding in FY 05. The SFP package contained a listing of the monitoring and research priorities for each of the agencies, as determined by agency staff, the GRAC, and members of the GCC Monitoring & Data Management and Research Subcommittees (see *Appendix D*). The deadline for proposals was November 24, 2003.

The entire submission and review process was conducted online through a secure web site administered by the WRI. Investigators could upload and modify contact information, proposal narratives, and budget information at any time up to the deadline. Reviewers were able to simply log on to the site to review proposals at their convenience. A total of 15 proposals were submitted, representing six institutions or campuses and requesting over $400,000 in funding. A minimum of 3 external peer reviews was solicited for each proposal from experts within the field. GCC Subcommittee members and agency staff also reviewed the proposals and met in January to rank the proposals. In addition, the GRAC met in March to select projects to recommend to the GCC for UWS funding.

Eight of the 15 proposals will be funded in full or in part by the University of Wisconsin System. DNR, DATCP, and Commerce will not be funding new projects in FY 05. With the assistance of Federal (USGS) dollars leveraged through the Water Resources Institute, all of the continuing UWS projects that began in FY 04 will be funded through FY 05. The projects to be funded in FY 05 are listed in Table 2 and online at *http://www.wri.wisc.edu/index.html*.

State budget shortfalls have severely limited the number of new projects that were selected for funding during the past three fiscal years. DNR's funding for projects has been cut by over two-thirds since FY 02 (see Table 3). The UWS budget was cut by 10% in FY 04 and again in FY 05. DATCP and Commerce have been unable to fund new projects in the last three fiscal years. Continued cuts will hamper the State's ability to address critical groundwater monitoring and research needs in the future. The GCC will continue to encourage its member agencies to maintain adequate resources for groundwater monitoring and research and to seek partnerships to leverage additional funds.

Coordination with Other Research Programs

The GCC attempts to compile information about other groundwater research programs within Wisconsin. For example, many groundwater-related research projects are funded through the Wisconsin Fertilizer Research Council (*http://www.soils.wisc.edu/frc/*). Staff from the GCC, the WFRC, and DATCP met in February of 2002 to discuss ways to identify common research needs, share information about submitted proposals, and communicate research findings. Some preliminary efforts to bring these two processes closer together were made during the FY 04 Solicitation for Proposals.

Contact was also made this year with the Research Committee of the Wisconsin Water Association (WWA), the state affiliate of the American Water Works Association (AWWA). This committee meets annually to suggest drinking water research needs to the AWWA Research Foundation (AWWARF), which funds research to benefit the drinking water industry. AWWARF has funded many investigators who regularly submit proposals to the Groundwater Research and Monitoring Program. In the future, more communication will occur between the Research Subcommittee of the GCC and the WWA Research Committee to help address mutual research needs and optimize available resources.

The GCC continues to contact other states with groundwater research programs to prevent research duplication and to make efficient use of limited research funds. The strategy for interstate coordination of groundwater research consists of identifying groundwater research program contacts in each neighboring state and sending each contact information on the GCC, the joint solicitation process, the state groundwater monitoring and research programs, and the project summaries.

Finally, the GCC is actively involved in efforts to use state funded research projects to leverage Federal funds, through the USGS, EPA, and the Centers for Disease Control (CDC). Proposals submitted to Wisconsin's Groundwater Research and Monitoring Program are occasionally forwarded to these federal partners, or re-worked to meet the specific needs of the funding source. State agency personnel often are asked to assist with proposal development and review to ensure that proposed research meets state needs. Examples of this in the past year include assistance with proposals submitted to the National Water Institute Research program on water use information, USGS Science Initiative, and the EPA Star grant program for microbial indicators.

Distributing Project Results

Final reports are required for each project funded through Wisconsin's Groundwater Research and Monitoring Program. Reports from UWS funded projects are kept in the Water Resources Institute Library. DATCP, Commerce, and DNR funded reports are kept on file with the respective agencies, but many are provided to the WRI Library for public distribution as well. All project investigators must submit a 2-page Project Summary upon completion of the final report. These summaries are made available on the WRI web site (*http://www.wri.wisc.edu/wgrmp/wgrmp.htm*). Over 120 summaries are currently provided. Summaries from older reports are printed in *Wisconsin Groundwater Research and Monitoring Project Summaries* (DNR PUBL-WR-423-95 and DNR PUBL-WR-205-90) both of which are available from the WRI Library or the DNR.

Previously, only summaries of the funded projects were available online. During the past year, the Water Resources Library partnered with UW Libraries' Digital Collections Center to digitize and put online most WRI and selected DNR final project reports. The WRI Groundwater Research and Monitoring Program Web site now links to the full-text reports, which are included in the University of Wisconsin Ecology and Natural Resources Digital Collection at *http://uwdc.library.wisc.edu/collections.html*. Inclusion in the UW Ecology and Natural Resources online collection should make a wider audience aware of this important groundwater research.

Projects funded through Wisconsin's Groundwater Research and Monitoring Program have provided valuable information regarding the Wisconsin's groundwater resources, helped evaluate existing regulatory programs, increased the knowledge of the movement of contaminants in the subsurface, and developed new methods for groundwater evaluation and protection. Chapter 6, *Benefits from Monitoring and Research Projects*, highlights some of these projects and illustrates how agencies have used the project results to improve the management of the state's groundwater resources.

Table 1: Groundwater Research and Monitoring Projects Funded in FY 04

Agency	*Title*	*Author(s)*	*Affiliation*	*FY 04 Budget*
DNR				
	Monitoring and Predictive Modeling of Subdivision Impacts on Groundwater in Wisconsin	K. Bradbury & J. Bahr	WGNHS & UW-Madison	$35,853
	Field and Laboratory Validation of Photoactivated Adsorption for Removal of Arsenic in Groundwaters	Marc Anderson	UW-Madison	$30,215
	Development of a Groundwater Flow Model for the Mukwonago River Watershed, Southeastern Wisconsin	J. Bahr	UW-Madison	$29,010
	Groundwater Pollutant Transfer and Export in Northern Mississippi Loess Hills Watersheds	G. Kraft & B. Browne	UW-Stevens Point	$29,417

The total cost for all new projects funded by DNR through the FY 04 solicitation for proposals is $124,495.

UWS				
	*Role of the Hyporheic Zone in Methylmercury Production and Transport to Lake Superior	D. Armstrong and C. Babiarz	UW-Madison	$33,272#
	*Arsenic Contamination in Southeast Wisconsin: Sources of Arsenic and Mechanisms of Arsenic Release	J. Bahr and M. Gotkowitz	UW-Madison & WGNHS	$28,628#
	*Monitoring the Effectiveness of Phytoremediation and Hydrogeologic Response at an Agricultural Chemical Facility	W. DeVita and M. Dawson	UW-Stevens Point	$15,170
	Design and Evaluation of Rain Gardens for Enhancement of Groundwater Recharge	K. Potter	UW-Madison	$22,116
	Fate Of Representative Fluoroquinolone, Macrolide, Sulfonamide and Tetracycline Antibiotics in Subsurface Environments	K. Karthikeyan and J. Pedersen	UW-Madison	$48,882
	Evaluation of Contamination of Groundwater around Landfills	T. Edil, C. Benson and J. Connelly	UW-Madison & WDNR	$23,916
	An Assessment of Aquifer Storage Recovery for Selected Generic Hydrogeologic Settings in Wisconsin	Mary Anderson	UW-Madison	$22,716
	What Happens When the Confined Cambrian-Ordovician Aquifer in SE Wisconsin is "Dewatered"?	T. Eaton	WGNHS	$17,139
	Coupled Modeling of Gravity and Aeromagnetic Data For Analysis of the Waukesha Fault, Southeastern Wisconsin	J. Skalbeck	UW-Parkside	$19,993
	Combination of Surfactant Solubilization with Permanganate Oxidation for Groundwater Remediation	Z. Li	UW-Parkside	$10,605
	Providing Communities with the Groundwater Information Needed for Comprehensive Planning	D. Cherkauer	UW-Milwaukee	$35,916
	A Combined Hydrogeologic/Geochemical Investigation of Groundwater Conditions in the Waukesha County Area, WI	T. Grundl, K. Bradbury, D. Feinstein & D. Hart	UW-Milwaukee, WGNHS & USGS	$50,140

The total cost for all new projects funded by the UWS through the FY 04 solicitation for proposals is $251,423.

The total cost for all projects funded by the UWS in FY 04 was $283,393 (including fringe benefits and 6% administration costs and excluding USGS co-funding).

funded by U.S.G.S. base funding of WRI
* denotes continuing project from FY 03

Table 2: Groundwater Research and Monitoring Projects to be Funded in FY 05

Agency	*Title*	*Author(s)*	*Affiliation*	*FY 05 Budget*
DNR				
	*Monitoring and Predictive Modeling of Subdivision Impacts on Groundwater in Wisconsin	K. Bradbury & J. Bahr	WGNHS & UW-Madison	$43,719
	*Development of a Groundwater Flow Model for the Mukwonago River Watershed, Southeastern Wisconsin	J. Bahr	UW-Madison	$21,511
	*Groundwater Pollutant Transfer and Export in Northern Mississippi Loess Hills Watersheds	G. Kraft & B. Browne	UW-Stevens Point	$27,350

The total cost for all projects to be funded by DNR in FY 05 is $92,580. No new projects were selected from the FY 05 solicitation for proposals.

UWS				
	*Design and Evaluation of Rain Gardens for Enhancement of Groundwater Recharge	K. Potter	UW-Madison	$36,242#
	*Fate Of Representative Fluoroquinolone, Macrolide, Sulfonamide and Tetracycline Antibiotics in Subsurface Environments	K. Karthikeyan and J. Pedersen	UW-Madison	$24,715 (+$31,592#)
	*Evaluation of Contamination of Groundwater around Landfills	T. Edil, C. Benson and J. Connelly	UW-Madison & WDNR	$25,625
	*Combination of Surfactant Solubilization with Permanganate Oxidation for Groundwater Remediation	Z. Li	UW-Parkside	$20,121
	*Providing Communities with the Groundwater Information Needed for Comprehensive Planning	D. Cherkauer	UW-Milwaukee	$33,717
	*A Combined Hydrogeologic/Geochemical Investigation of Groundwater Conditions in the Waukesha County Area, WI	T. Grundl, K. Bradbury, D. Feinstein & D. Hart	UW-Milwaukee, WGNHS & USGS	$39,209
	Mercury Speciation along a Groundwater Flowpath	D. Armstrong and C. Babiarz	UW-Madison	$25,425
	Delineation of Flow Paths, Capture Zones, and Source Areas, Allequash Basin, Vilas County, Wisconsin	Mary Anderson	UW-Madison	$24,065
	A comparison of USEPA approved enzyme-based total coliform/E. coli tests for microbiological groundwater monitoring and laboratory consultation	J. Schauer, J. Olstadt, J. Standridge, and S. Kluender	WSLH	$16,260
	Occurrence of Estrogenic Endocrine Disruptors in Groundwater	W. Sonzogni, J. Hemming, M. Barman and S. Geis	WSLH	$13,800
	Development of tools to address groundwater in comprehensive planning	L. Markham, C. Dunning, and C. Tang	UW-Stevens Point & USGS	$5,873
	Hydrostratigraphy of west-central Wisconsin: A new approach to groundwater management	D. LePain and K. Bradbury	WGNHS	$23,615
	Monitoring Environmental Effects at an Established Phytoremediation Site	W. DeVita and M. Dawson	UW-Stevens Point	$17,820
	Foundry Slag for Treating Arsenic in Ground Water and Drinking Water	C. Benson and D. Blowes	UW-Madison	$3,644

The total cost for all new projects funded by the UWS through the FY 05 solicitation for proposals is $130,502.

The total cost for all projects to be funded by the UWS in FY 05 is $294,202 (including fringe benefits and 6% administration costs and excluding USGS co-funding).

funded by USGS base funding of WRI
* denotes continuing project from FY 04

Table 3: Groundwater Research and Monitoring Projects Funded from FY 1999 through FY 2004

Fiscal Year	Total		DNR		UWS		DATCP		Commerce	
	#	$	#	$	#	$	#	$	#	$
New projects										
1999	**16**	**438,689**	5	186,766	8	160,333	4	91,590	0	0
2000	**14**	**327,338**	6	115,321	9	196,266	1	15,751	0	0
2001	**19**	**[1]578,895**	8	276,090	7	165,924	4	78,881	1	58,000
2002	**21**	**626,068**	9	281,259	10	252,619	3	92,190	0	0
2003	**7**	**180,621**	2	17,864	6	162,757	0	0	0	0
2004	**13**	**347,835**	4	124,495	9	251,423	0	0	0	0
Continuing Projects										
1999	**8**	**237,900**	3	102,360	5	121,647	1	13,893	0	0
2000	**11**	**321,171**	5	186,221	4	87,000	2	47,950	0	0
2001	**8**	**179,441**	2	60,623	7	[2]118,818	0	0	0	0
2002	**11**	**234,913**	5	155,026	4	[2]37,077	3	42,810	0	0
2003	**13**	**311,237**	4	110,198	7	[2]121,039	3	80,000	0	0
2004	**3**	**15,170**	0	0	3	[2]15,170	0	0	0	0
All Projects										
1999	**24**	**676,589**	**8**	**289,126**	**13**	**281,980**	**5**	**105,483**	**0**	**0**
2000	**25**	**648,509**	**11**	**301,542**	**13**	**283,266**	**3**	**63,701**	**0**	**0**
2001	**27**	**758,336**	**10**	**336,713**	**14**	**284,742**	**4**	**78,881**	**1**	**58,000**
2002	**32**	**860,981**	**14**	**436,285**	**14**	**289,696**	**6**	**135,000**	**0**	**0**
2003	**20**	**491,858**	**6**	**128,062**	**13**	**283,796**	**3**	**80,000**	**0**	**0**
2004	**16**	**391,088**	**4**	**124,495**	**12**	**266,593**	**0**	**0**	**0**	**0**

[1]2001 DNR figures do not include 71K from Federal 106 funds applied toward FY02 projects
[2]2001-2004 UWS figures do not include matching USGS funds (approximately 46K per year)

Chapter 3 -- SUMMARY OF AGENCY GROUNDWATER ACTIVITIES

The 1983 Groundwater Protection Act created Chapter 160, Wis. Stats., which serves as the backbone of Wisconsin's groundwater protection program. Chapter 160 provides a multi-agency comprehensive regulatory approach, using two-tiered numerical standards, based on the premise that all groundwater aquifers in Wisconsin are entitled to equal protection. Each state regulatory agency must promulgate rules to assure that the groundwater standards are met and to require appropriate responses when the standards are not met.

The state regulatory agencies are the Department of Natural Resources (DNR) (solid and hazardous waste, industrial and municipal wastewater, spills, wetlands and water supply); the Department of Commerce (private sewage systems, petroleum product storage tanks); the Department of Agriculture, Trade and Consumer Protection (DATCP) (pesticide use and storage and fertilizer storage); and the Department of Transportation (DOT) (salt storage). In addition, Chapter 160 directs the Department of Health and Family Services (DHFS) to recommend health-based enforcement standards for substances found in groundwater and specifies the protocol for developing the recommended standards.

The purpose of this chapter is to describe groundwater management programs and implementation of ch. 160, Wis. Stats., by the individual state agencies in FY 04. In addition, the University of Wisconsin System, UW Extension and the Wisconsin Geological and Natural History Survey (WGNHS) carry out numerous educational, research, monitoring, and outreach activities related to groundwater protection that are described here. The groundwater management efforts undertaken by the member agencies of the Groundwater Coordinating Council during the past year show that Wisconsin continues to have a strong commitment to protection of its groundwater resource.

DEPARTMENT OF NATURAL RESOURCES

The Department of Natural Resources (DNR) has statutory authority as the central unit of state government to protect, maintain and improve the quality and management of the waters of the state, ground and surface, public and private (s. 281.11 Wis. Stats.). The DNR establishes the groundwater quality standards for the state under authority of ch. 160, Wis. Stats. DNR regulatory activities to protect groundwater are the responsibility of four programs:

1. *Drinking Water and Groundwater (DG)* – Regulates public water systems, private drinking water supply wells, well abandonment and high capacity wells. DG is responsible for adoption and implementation of groundwater standards contained in ch. NR 140, Wis. Adm. Code, and works closely with other programs and agencies to implement Chapter 160, Wis. Stats., including groundwater monitoring, database management, and staffing the GCC. DG also coordinates the state's Wellhead Protection program and the Source Water Assessment Program. *http://dnr.wi.gov/org/water/dwg/index.htm*

2. *Waste Management (WA)* - Regulates and monitors groundwater at proposed, active, and inactive solid waste facilities and landfills. WA reviews investigations of groundwater contamination and implementation of remedial actions at active solid waste facilities and landfills. WA also maintains a Groundwater and Environmental Monitoring System (GEMS) database of groundwater quality data from over 600 solid waste facilities and landfills and uses reports from GEMS to evaluate whether sites are impacting groundwater quality. *http://dnr.wi.gov/org/aw/wm/index.htm*

3. *Remediation and Redevelopment (RR)*- Oversees response actions at spills, hazardous substance release sites, abandoned containers, drycleaners, brownfields (including the Site Assessment Grant program), “high priority” leaking underground storage tanks, closed wastewater and solid waste facilities, hazardous waste corrective

action and generator closures, and sediment cleanup actions. A significant amount of the RR's work relates to groundwater contamination. http://dnr.wi.gov/org/aw/rr/index.htm

4. *Watershed Management (WT)*- Regulates the discharge of municipal and industrial wastewater, by-product solids and sludge disposal from wastewater treatment systems and wastewater land treatment/disposal systems. WT also issues permits for discharges associated with clean-up sites regulated by WT for the RR program. WT also has primary responsibility for regulating stormwater and agricultural runoff as well as managing waste from large animal feeding operations. http://dnr.wi.gov/org/water/wm/index.htm

The DNR made significant strides in protecting groundwater in FY 04:

1. *Groundwater Protection Act* – In May of 2004, the statutes regarding high capacity wells were expanded to give the DNR the authority to consider environmental impacts of wells in order to protect critical surface water resources. Other statutory changes include notification and fees to be collected along with all new well construction and requirements for reporting water use on an annual basis for new and existing high capacity wells. Further provisions in the Groundwater Protection Act include designation of two Groundwater Management Areas to address regional groundwater issues and the creation of a Groundwater Advisory Committee to recommend management approaches in these areas and further statutory changes.

   This important first step in water quantity management was the result of open and inclusive negotiations throughout FY 2004. DNR staff played a key role in providing scientific information to legislative committee members on topics including:
   - Location of and availability of pumping data for current high-capacity wells
   - Location of and suitable buffers for sensitive areas such as Outstanding and Exceptional Resource Waters and trout streams
   - Approximate numbers of large springs
   - Location of areas with significant drawdown
   - Groundwater quantity management strategies in place outside the State.

2. *Magazine article on groundwater quantity* - Written by DNR staff, "A growing thirst for groundwater" appeared in the June 2004 issue of the *Wisconsin Natural Resources* magazine. It summarizes the complex issues surrounding groundwater management in Wisconsin, with a focus on solutions being pursued by communities in southeastern Wisconsin (http://www.wnrmag.com/stories/2004/jun04/ground.htm).

3. *Arsenic standards* - The state groundwater quality standards for arsenic were revised in FY 04. Arsenic is a known human carcinogen, and the federal drinking water maximum contaminant level (MCL) for the substance has been lowered from 50 µg/L to 10 µg/L. The NR 140 Enforcement Standard (ES) for arsenic was lowered from 50 µg/L to 10 µg/L, and the Preventive Action Limit (PAL) dropped from 5 µg/L to 1 µg/L. The Natural Resources Board authorized these NR 140 revisions at their October 2003 meeting and the new revised arsenic groundwater quality standards became effective March 1, 2004.

4. *Groundwater monitoring strategy* - In FY 04, DNR staff participated in an effort to draft a new statewide groundwater monitoring strategy with representatives from the DATCP, USGS, WGNHS, UW Stevens Point, and the Wisconsin Academy of Sciences, Arts, and Letters. The objective of the new monitoring strategy is to coordinate groundwater monitoring between all state agencies that regulate groundwater to assess groundwater quality and quantity in the state. The statewide groundwater monitoring strategy will help DNR meet the prerequisites of the Clean Water Act Section 106(e)(1) as described in the EPA's "Elements of a State Water Monitoring and Assessment Programs" guidance document. Over the next ten years, components of the strategy will be integrated into DNR's overall water monitoring plan.

5. *Source Water Assessments* - The DNR has committed to complete assessments for all (approximately 11,500) active public water supply systems in the State by December 2004. Progress to date indicates that this goal will be met. DNR staff have hand-delivered completed assessments to most municipal systems. Smaller systems are being notified when their assessment is available. The results of all of the assessments are being made

available on the Internet. Visit the DNR's web page to see the assessment results: http://dnr.wi.gov/org/water/dwg/swap/index.htm.

6. *Enforcement of well drilling requirements* - A significant program activity for the past fiscal year involved the surveillance and referral of several grouting violators to the Department of Justice for prosecution. Failure to grout or failure to properly grout is a threat to groundwater because the empty space around the well casing pipe provides an easy conduit for contamination to enter the groundwater and contaminate lower aquifers.

7. *Brownfields Green Space and Public Facilities Grants*. This new grant program provides funds to help local governments clean up contaminated soil or groundwater at brownfield sites that will then be used as green space, recreational areas or use of the property by a local government. DNR awarded 11 grants in FY 04 with a total of $1 million in state funding to 10 communities. The scoring system considers environmental risk and priorities for the grant program. Applications to cleanup sites where there is groundwater impacted or threatened groundwater receive extra points when applications are scored.

8. *Site Assessment Grants* - In FY 04, DNR awarded 50 Site Assessment Grants to local governments to fund site assessments and removal of potential contamination sources. Approximately $1.7 million was awarded to 35 communities across the state. Small grants of up to $30,000 make up 43 of the awards, while 7 are large grants of between $30,000 and $100,000. These grants will fund the removal of approximately 35 aboveground and underground storage tanks and 39 abandoned drums and other containers of hazardous substances. These grants will also be used to fund 77 environmental site assessments and investigations. To date, 212 grants have been awarded to properties around the state representing around 742 acres of land.

9. *New Brownfields Insurance Program* - On April 22, Governor Doyle signed 2003 Wisconsin Act 315 which authorized the DNR to create a new environmental insurance program. This program was recommended by the Wisconsin Brownfields Study Group and will encourage more cleanup and redevelopment of brownfield sites throughout the state, many of which have groundwater contamination. The DNR is currently working with the Department of Administration Risk Management program to create this new program that will provide insurance coverage to private businesses and local governments to address the risks associated with contaminated real estate.

10. *"Ready for Reuse" - Wisconsin Brownfields Coalition Revolving Loan Fund Grant Application*. DNR worked in coalition with the Departments of Administration and Commerce, and the nine Regional Planning Commissions in the state to apply for $4 million in federal funding to establish a brownfields revolving loan fund. If the grant application is funded, money will be made available to local governmental units in FY 05 to conduct remediation and other eligible activities at brownfields.

11. *Storm water* – DNR is currently working on revising its storm water regulations under ch. NR 216, Wis. Adm. Code, in order to comply with federal storm water regulations that took effect on March 10, 2003. It is expected that the revised rules will be finalized and become effective in the second half of 2004. The proposed state rules will require nearly 200 municipal storm sewer systems to obtain permit coverage statewide and also require construction sites down to one acre of land disturbance to have permit coverage to control erosion during construction. Permit holders will also be required to install post-construction practices to limit pollutant discharge after construction is completed (storm water management). The DNR has developed performance standards (i.e. 80% sediment control, infiltration, peak flow, buffer requirements, etc.) that will protect groundwater quality and promote recharge.

More information about the groundwater programs and activities of the DNR is detailed in the following pages.

Drinking Water and Groundwater Program

Groundwater standards. Chapter 160, Wis. Stats., requires the DNR to develop numerical groundwater quality standards, consisting of enforcement standards and preventive action limits, for substances detected in, or having a reasonable probability of entering, the groundwater resources of the state. Chapter NR 140, Wis. Adm. Code, establishes these groundwater standards and creates a framework for their implementation. There are currently groundwater quality standards for 122 substances of public health concern, 8 substances of public welfare concern and 15 indicator parameter substances in ch. NR 140.

DG maintains a table listing NR 140 groundwater quality standards, NR 809 state drinking water standards, and established health advisory levels (HALs) for substances in water (*http://dnr.wi.gov/org/water/dwg/health/hal.htm*). This table of regulatory standards and advisory levels provides a useful source of information to members of the public concerned about the safety of their drinking water and also is a valuable resource for DNR staff involved with groundwater contamination and remediation cases. Links in this table allow users to obtain additional toxicological and health related information on many of the substances listed.

DG staff work closely with the RR program to identify policy issues, develop guidance, and provide training regarding the implementation of chs. NR 720, 722, 724 and 726 dealing with soil cleanup standards, selecting and implementing remedial actions, and case closures. DG staff also provide advice and assistance on site investigations, soil and groundwater remediation, and general case closure decisions. This coordination is critical in obtaining statewide consistency on how the DNR evaluates, addresses and closes soil and groundwater contamination sites.

DG staff work with Runoff Management staff to ensure that new performance standards for stormwater infiltration (NR 151) comply with groundwater standards specified in NR 140. DG is also participating on a team writing guidance for developers, land use planners and government agencies regarding stormwater practices that will meet the performance standards while preserving groundwater quality.

Public hearings have been held on proposed amendments to NR 140 that revise existing groundwater quality standards for butylate, dacthal and naphthalene, and establish new NR 140 groundwater quality standards for molybdenum and alachlor ESA (ethane sulfonic acid), a breakdown product of the pesticide alachlor. These revisions to NR 140 are currently "on hold" pending review, by staff at the Department of Health & Family Services, of the results of a new alachlor ESA toxicological study initiated by Monsanto, the manufacturer of alachlor.

The state groundwater quality standards for arsenic were revised in FY 04. Arsenic is a known human carcinogen, and the federal drinking water maximum contaminant level (MCL) for the substance has been lowered from 50 µg/L to 10 µg/L. The NR 140 Enforcement Standard (ES) for arsenic was lowered from 50 µg/L to 10 µg/L, and the Preventive Action Limit (PAL) dropped from 5 µg/L to 1 µg/L. The Natural Resources Board authorized these NR 140 revisions at their October 2003 meeting and the new revised arsenic groundwater quality standards became effective March 1, 2004.

Well construction and abandonment. DG sets and enforces minimum standards for well construction, pump installation and well abandonment through ch. NR 812, Wis. Adm. Code. The standards are intended not only to provide health protection but also to protect groundwater through requirements for: sealing the space around the casing (grouting) so that contaminated surface water or near surface water is not able to enter the groundwater; and for properly sealing unused or noncomplying wells that may act as a conduit to aquifers. DG also licenses and educates well drillers under ch. NR 146, Wis. Adm. Code so that they are qualified to construct wells in a way that won't contaminate groundwater. Drillers submit reports to the DNR describing the construction of each well drilled. The reports are reviewed in detail by DG staff to verify that the construction is not a threat to health or groundwater. Well abandonment reports are also reviewed to make sure the wells were sealed properly to protect groundwater. Field staff in the program conduct surveillance and inspections to enforce the minimum well construction standards.

DG continues to promote electronic management of well construction and other information through its website at *http://dnr.wi.gov/org/water/dwg/gw/software.htm* and through semiannual releases of a Water Well Data CD.

Groundwater monitoring well requirements, as specified under NR 141, are administered by DG staff. Activities include consultation on well construction with Remediation and Redevelopment, Waste Management, Watershed Management and Department of Commerce staff, consultants and drillers. Random inspections of environmental drilling operations provide an opportunity for DNR hydrogeologists to update drillers and consultants about NR 141 requirements and enhance compliance with the code. Review of new technologies and their application also continue to be a priority.

A significant program activity for the past fiscal year involved the surveillance and referral of several grouting violators to the Department of Justice for prosecution. Failure to grout or failure to properly grout is a threat to groundwater because the empty space around the well casing pipe provides an easy conduit for contamination to enter the groundwater and contaminate lower aquifers.

Another activity involved the designation and enforcement of special well construction requirements in areas where arsenic is known to exist. These requirements, if not followed, could allow naturally occurring arsenic to enter groundwater at higher levels. The DNR has designated special casing areas in the Town of Algoma, 2 sections in Greenville township, adjoining sections in Grand Chute and Center townships, and adjoining sections in Clayton and Neenah townships. The special casing area in the Town of Algoma has led to the construction of a municipal water system (currently 2 wells and water mains). The DNR is evaluating whether the special casing areas should be expanded to include all the affected areas within Winnebago and Outagamie counties.

High capacity wells. The DNR is authorized under statute to regulate wells on each property where the combined capacity of all wells on the property, pumped or flowing, is greater than about 70 gallons per minute (100,000 gallons per day over a 30-day period). Such wells are defined as high capacity wells. When the operation of a high capacity well is anticipated to have an adverse impact on the quality or quantity of water available to a public utility well, the DNR is obligated to deny approval or to limit operation of the high capacity well so that their operation does not adversely impact a public utility well.

In May of 2004, the statutes regarding high capacity wells were expanded to give the DNR the authority to consider environmental impacts of wells in order to protect critical surface water resources. Specifically, the DNR is mandated to complete an environmental review under ch. NR 150, Wis. Adm. Code, for the following proposed high capacity wells:

- Wells located within 1,200 feet of an outstanding or exceptional resource water or a trout stream
- Wells that may have a significant environmental impact on a high volume spring
- Wells where more than 95% of the water will be lost from the basin

In these cases, DNR may allow, deny or limit an approval to assure that these wells do not cause significant environmental impact. Other statutory changes affecting high capacity wells include a new fee to be collected along with the application for approval and requirements for reporting water use on an annual basis for new and existing high capacity wells.

The DNR is currently working through a separate appropriation process to obtain the necessary staff positions and funding to implement the new programs created by the law. The DNR must also write administrative rules to provide further guidance on various aspects of the new regulations.

Public water systems. DG oversees monitoring and operation of public water systems through ch. NR 809 (Safe Drinking Water), Wis. Admin. Code to ensure all public water systems are safe to drink and use. Working in cooperation with owners and operators of water systems DG ensures that samples are collected and analyses completed to determine if the water meets federal Safe Drinking Water Act (SDWA) standards. Also, through ch. NR 811 (Requirements for the Operation and Design of Community Water Systems), DG regulates the general operation, design and construction of public water systems. DG also works to educate water system owners and operators concerning proper operation and maintenance of water systems to ensure safe drinking water for Wisconsin consumers.

DG developed and continues to maintain data about Wisconsin's drinking water and groundwater quality through the Drinking Water System database. The Drinking Water System is an important tool used to efficiently enforce SDWA regulations for public water systems. It contains the monitoring and reporting requirements for each public water system and their drinking water sampling results. It also includes violations for any missing requirements and exceedances of the maximum contaminant levels (MCLs).

This fiscal year, DG has been working with private laboratories to allow electronic submission of data to continuously improve the process in which we receive water quality sampling results. Additionally, DG has been working on new federal rules and updates to existing rules dealing with Consumer Confidence Reports, Radionuclides, Public Notice, and Arsenic.

Wellhead protection. The DNR is the lead state agency for developing and implementing the Wisconsin Wellhead Protection (WHP) Plan. The specific goal of Wisconsin's plan is to achieve groundwater pollution prevention in public water supply wellhead areas consistent with the state's overall goal of groundwater protection. A WHP plan is required for new municipal wells and must be approved by the DNR before it can be used. A WHP plan is voluntary for any public water supply well approved prior to May 1, 1992; the DNR promotes and encourages but does not require wellhead protection planning for these older wells.

The DNR coordinates a statewide public information effort aimed at encouraging water utilities to protect their water supplies from potential sources of contamination through wellhead protection planning. DNR staff assist communities with WHP planning, whether it be providing information, reviewing documents or making presentations to promote the WHP program. The DNR has prepared a video and several publications to assist communities in their wellhead protection efforts. The DNR also works with the Wisconsin Rural Water Association in providing assistance to local water utilities. Information is shared with local communities through a spring and fall wellhead protection newsletter.

The DNR continues to update its WHP web pages (*http://dnr.wi.gov/org/water/dwg/gw/wellhead.htm*) as new information becomes available. It currently includes information on developing a WHP plan, a list of available publications that can be ordered or downloaded, example WHP ordinances, an annotated bibliography, a PowerPoint presentation, a list of contacts for more information, and past and current issues of the Wisconsin Wellhead Protection News newsletter. In addition, the DNR has developed a tracking system for both wellhead protection and source water assessment activities in the DNR's Drinking Water System database. The DNR updates the database as new information becomes available and uses this information to report annually to EPA on WHP and source water assessment progress.

Wellhead protection staff responded to nearly 40 requests for information during FY 04. Staff answered questions, sent publications, reviewed draft plans and ordinances and visited communities to assist in their WHP efforts. Other highlights include:

- *New wellhead protection plans*. In FY 04, 38 communities received DNR approval of required WHP plans (for new wells) or submitted voluntary plans to the DNR. (There were 22 communities with approved plans and 16 communities with voluntary plans.) There are now over 225 communities who have a WHP plan for at least one of their wells.

- *Teacher training*. For the fourth year in a row, DNR staff worked with the Groundwater Center at the Center for Watershed Science and Education (CWSE) and the Wisconsin Geological and Natural History Survey (WGNHS) to sponsor three groundwater workshops for teachers in January. Teachers from 24 school districts were given training in the use of the groundwater sand tank model and given the models to take back to their schools. Forty-two teachers took part in the workshops held in Green Bay, Spooner and at Treehaven (near Tomahawk). In addition to the models, teachers were given a variety of educational materials and an assignment to report how they used the model in their classroom. The intent is to provide information for teachers to educate students –and their parents – to protect groundwater in their own communities.

- *Promoting the Groundwater Guardian Program*. In December, the DNR contracted with the Center for Watershed Science and Education to hire a person to continue promoting the Groundwater Guardian program in Wisconsin. The person prepares materials, makes presentations to encourage local governments to become Groundwater Guardian communities, works with existing Groundwater Guardian communities and organizes an annual Groundwater Festival and the annual statewide meeting of Groundwater Guardian communities. Several new communities have become Groundwater Guardian communities and three organizations have become Groundwater Guardian Affiliates.

- *Coordinating efforts with the Source Water Assessment Program.* In May 2003, the DNR requested and received wellhead protection set-aside funds from EPA to complete the source water assessments and provide help to communities in using their assessments to develop wellhead protection plans. In order to provide the most accurate information available to assist in WHP planning, the DNR has funded regional groundwater modeling projects in all or parts of 24 counties (see Source Water Assessment discussion below). In addition to providing a valuable planning tool for communities in these counties, the projects have provided delineations of capture zones for each of the municipal wells in these areas.

Source water assessments. The DNR received USEPA approval of Wisconsin's Source Water Assessment Program (SWAP) Plan in November 1999. The plan was submitted to meet the requirements of the 1996 Safe Drinking Water Act Amendments. The purpose of the program is to assess the risks that potential sources of contamination pose to public drinking water supplies, both groundwater and surface water. The goal of Wisconsin's SWAP is to provide information that will assist communities in preparing WHP and Source Water Protection plans.

When completed, the program will have: 1) delineated source water assessment areas for all public water systems in the state; 2) conducted inventories of significant potential sources of contamination within those areas; 3) determined the susceptibility for each system; and 4) made the results of the assessments available to the public.

Source water areas for many municipal groundwater systems have been delineated through regional groundwater flow modeling studies (**Figure 3.1).** These studies were completed for the Lower Fox Valley, Central Sands Area, and the following counties: Dane, Eau Claire, Fond du Lac, Kenosha, La Crosse, Milwaukee, Ozaukee, Pierce, Racine, Rock, Sauk, St. Croix, Walworth, Washington, and Waukesha. For the other municipal systems and smaller systems, radius delineations are being used.

In coordination with the State's Vulnerability Assessment Program, maps of source water areas were sent to each system with a request for system operators to identify potential contaminant sources within the delineated areas. Additionally, through SWAP, the DNR has collected potential contaminant-source location data from existing databases and from field projects by the Remediation and Redevelopment, Waste Management, and Watershed Management programs as well as from other State agencies.

The information on potential sources of contamination is being used with water quality monitoring, well construction, hydrologic, geologic, and other information to determine each system's susceptibility to contamination.

The DNR has committed to complete assessments for all active public water supply systems in the State by December 2004. Progress to date indicates that this goal will be met. Staff have hand-delivered completed assessments to most municipal systems. Smaller systems are being notified when their assessment is available. The results of all of the assessments are being made available on the Internet. However, security concerns resulting from the 2001 terrorist attacks curtailed the program's initial goal of making all aspects of the assessment available to the public. Visit the DNR's web page to see the assessment results: *http://dnr.wi.gov/org/water/dwg/swap/index.htm*.

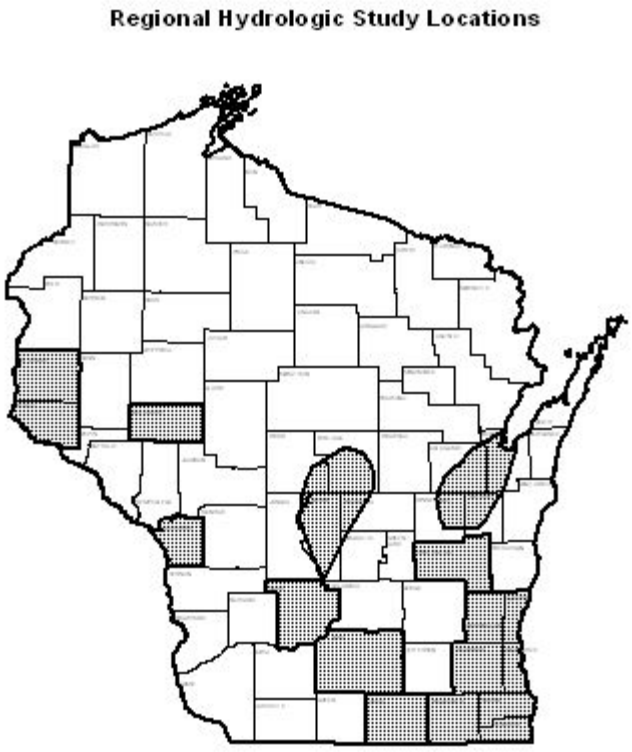

Figure 3.1: Areas where regional groundwater modeling studies have delineated source water areas for groundwater-supplied municipal systems. Source: WDNR

Aquifer Storage & Recovery (ASR) pilot testing. Aquifer storage and recovery (ASR) is a water supply management technique involving the injection of water into an underground aquifer for storage and later recovery. The technique has been proposed in Wisconsin to address the problem of peak seasonal water supply demand. A water utility may not have the storage reservoir volume or water treatment plant capacity to provide enough water to users during summer high, "peak", water demand periods. Using ASR a utility might store "surplus water", water treated during periods of "low" demand, underground for later recovery during peak demand periods. ASR has been proposed as a lower cost alternative to address peak seasonal water demand, than construction of additional "above ground" water storage structures, or upgrading to increase existing water treatment facility capacity.

An ASR Technical Advisory Group made up of geologists, hydrogeologists and toxicologists from the USGS, UW System, and state DHFS drafted a report in 2002, titled *A Review of Aquifer Storage Recovery Techniques*, which identified several potential concerns associated with use of ASR. These include:
1) the potential introduction of contaminants present in injected ASR water (including trihalomethane (THM) disinfection byproducts), into an ASR storage aquifer;
2) potential changes to ambient groundwater quality caused by geochemical reactions created when ASR water, with a different chemical composition than "native" groundwater, is introduced into an aquifer; and
3) potential changes to local and regional groundwater flow patterns due to injection into an aquifer of relatively large quantities of ASR water.

Rules have been established by the DNR to regulate the use of ASR technology in Wisconsin. These regulations, in ch. NR 811, Wis. Adm. Code, limit use of ASR to municipal water systems and require that any water, placed underground for ASR storage, meet state drinking water (ch. 809, Wis. Adm. Code) and groundwater quality (ch. NR 140, Wis. Adm. Code) standards. Chapter NR 811 also requires that water recovered from ASR storage meet drinking water standards prior to being placed in a municipal water distribution system and that operation of an ASR system not cause exceedances of state NR 140 groundwater quality standards in the aquifer used for ASR water storage. Before "long term" operational approval of an ASR system is granted in Wisconsin, pilot testing of the system is required.

To date, two municipalities in Wisconsin, Oak Creek and Green Bay, have conducted ASR pilot tests. Both pilots have tested the viability of storing treated Lake Michigan surface water in the Ordovician - Cambrian carbonate/sandstone aquifer ("deep sandstone aquifer") system. Both tests were designed to inject and recover ASR water through a single test site ASR well, and both pilot tests have included a monitoring well to assess ASR impacts on ambient groundwater quality.

Both of the ASR pilot tests conducted so far in Wisconsin have failed to demonstrate that the technology, as tested, is viable and can comply with state ASR regulations. Both ASR pilot tests conducted to date have resulted in trace elements, from aquifer matrix material, being mobilized in groundwater to levels above state groundwater quality standards. This appears to have been caused by the injection of highly oxidized, "reactive" Lake Michigan surface water into the relatively reduced redox environment of the deep sandstone aquifer system. It also appears that some trihalomethane disinfection byproducts present in the disinfected Lake Michigan surface water, and also generated in the aquifer during ASR storage, are not degrading as readily as originally suggested. Because the proposed operation of the ASR systems pilot tested results in some of the stored ASR water remaining in the aquifer after each ASR pumpout cycle is completed, there is the potential for THM disinfection byproducts to accumulate over time in the aquifer used for ASR storage. The increasing accumulation of THM disinfection byproducts in an ASR storage zone over time is likely to eventually result in exceedances of state groundwater quality standards for these substances at the ASR system compliance boundary. For these reasons, it does not appear that ASR systems designed to store "oxidized" Lake Michigan surface water in the deep Ordovician - Cambrian carbonate/sandstone aquifer system in Wisconsin are viable as currently designed and operated.

Coordination of groundwater components of basin plans. DG staff work with basin teams to develop specific groundwater priorities for watershed basins or Geographic Management Units (GMU). Priorities are based on GRN data, land cover information and information provided by regional DG program staff.

State of the Basin (or GMU) Reports have now been completed for all 23 basins in the state. These reports provide baseline information on surface water, groundwater and land resources and document environmental needs in each basin. Basin Teams, made up of DNR staff and partnership groups, are responsible for setting priorities in each basin. The plans identify geographic priorities for the watershed management program and will be used to help rank projects eligible for grant funds. The DG is involved in integrated planning by providing basic data on groundwater quality and quantity for each basin and more detailed information as needed.

Groundwater monitoring and research. Chapter 160 of the Wisconsin Statues requires the DNR to work with other agencies and the GCC to develop and operate a system for monitoring and sampling groundwater to determine whether harmful substances are present (s. 160.27, Wis. Stats.). The DNR has also supported groundwater monitoring studies evaluating existing design and/or management practices associated with potential sources of groundwater contamination. The intent of these studies is to reduce the impacts of potential sources of contamination by changing the way land activities that may impact groundwater are conducted. Final reports and 2-page research summaries are available for most projects.

DG staff maintain and distribute the DNR's Groundwater Sampling Desk Reference and Field Manual. These documents provide detailed instructions on how to consistently collect high quality, representative groundwater samples and make accurate monitoring measurements. Both the Groundwater Sampling Desk Reference and Field Manual have been widely distributed and well received by both environmental professionals and the regulated

community. The two documents are available at the following web page: http://dnr.wi.gov/org/water/dwg/gw/pubdnld.htm.

In FY 04, DG staff participated in an effort to draft a new statewide groundwater monitoring strategy with representatives from the DATCP, USGS, WGNHS, UW Stevens Point, and the Wisconsin Academy of Sciences, Arts, and Letters. The objective of the new monitoring strategy is to coordinate groundwater monitoring between all state agencies that regulate groundwater to assess groundwater quality and quantity in the state. The statewide groundwater monitoring strategy will help DNR meet the prerequisites of the Clean Water Act Section 106(e)(1) as described in the EPA's "Elements of a State Water Monitoring and Assessment Programs" guidance document. Specific goals include:

- Documenting status and trends in groundwater quality, quantity and use;
- Improving of understanding of groundwater systems and groundwater/surface water interactions; and
- Communicating groundwater information to citizens, policy makers and resource managers.

Over the next ten years, components of the strategy will be integrated into DNR's overall water monitoring plan. Other agencies will also continue to make improvements in their monitoring efforts based on the comprehensive strategy. The components of the strategy may change over time according to needs of the different agencies. The requirements of Chapter 160, Wis. Stats., will continue to be met under the strategy.

During FY 04, $124,495 was spent on 4 management practice monitoring projects selected during the joint solicitation process described under *Wisconsin's Groundwater Research and Monitoring Program* in this report (see Tables 1 and 2 in Chapter 2). Topics addressed include:

- Monitoring and predictive modeling of subdivision impacts on groundwater
- Field and laboratory validation of photoactivated adsorption for removal of arsenic in groundwater
- Development of a groundwater flow model for the Mukwonago River Watershed in SE Wisconsin
- Groundwater pollutant transfer and export in the Upper Fever River Watershed in SW Wisconsin.

Three of the 4 projects begun in FY 04 will continue for an additional year, at an aggregate cost of $92,580 in FY 05.

Due to limited funds, no new projects were selected for funding during FY 05. However, DG staff will be working closely with researchers from Marshfield Clinic and USGS on a 3-year $1.8 million EPA Star Grant to conduct a study of human health and virus occurrence in 14 groundwater-fed drinking water systems in Wisconsin. DNR is providing a small amount of seed money ($10,000) to USGS to conduct limited hydrogeological investigations of the systems to be included in the study, as well as facilitating needed approvals and providing technical support.

Final reports received by the DNR in FY 04 include:

Arndt, M., and L. West. 2004. A study of the factors affecting the gross alpha measurement and a radiochemical analysis of some groundwater samples from the state of Wisconsin exhibiting an elevated gross alpha activity.

Dunning, C and R. Bannerman. 2003. Monitoring contaminant transport from a stormwater infiltration facility to ground water

Karthikeyan, KG, and W. Bleam. 2003. Occurrence of antibiotics in wastewater effluents and their mobility in soils: A case study for Wisconsin

Kraft, G. J., B. A. Browne, W. DeVita, and D. J. Mechenich. 2004. Nitrate and pesticide residue penetration into aquifers - The Springfield Corners profile.

Kraft, G. J., B. A. Browne, W. DeVita, and D. J. Mechenich. 2004. Nitrate and pesticide residue penetration into a Wisconsin Central Sand Plain aquifer.

Sonzogni, W. C., A. Clary, G. Bowman, and J. Standridge. 2004. Importance of disinfection on arsenic release from wells

Strauss, J. 2004. Evaluation of Enzyme Linked Immunosorbent Assay (ELISA) for diaminoatrazine analysis of water samples in comparison to gas chromatography

More details on the DNR's groundwater monitoring and research activities can be found at *http://dnr.wi.gov/org/water/dwg/gw/research.htm*.

Groundwater data management. Groundwater data from the DNR's consolidated Groundwater Retrieval Network (GRN) system is available on the following website: *http://dnr.wi.gov/org/water/dwg/data.htm*. GRN accesses groundwater data from three database systems in the Waste Management and Drinking Water and Groundwater programs including information on over 293,500 wells. These wells represent public and private water supply wells, piezometers, monitoring wells, non-potable wells, and groundwater extraction wells.

In FY 04, DG staff improved the locational data associated with GRN's wells. Around 300,000 well records were added in this project by bringing in historical well construction report information to GRN. Staff also added data from the WT database system to include locational data from monitoring wells associated with wastewater discharge permits. Because GRN receives its data from many different sources, it was necessary to develop a system to enable customers to always identify the best location for a particular well. A process was developed to make sure that each well in GRN had the most accurate location regardless of its origin.

The DNR continued to make progress on several groundwater-related data initiatives in FY 04 through the State's Source Water Assessment Program (SWAP). DG continued to improve its public water supply well data and coordinated efforts with the RR, WA, and WT programs to improve the DNR's data on significant potential sources of contamination that may threaten these wells. Additionally the WGNHS and DNR continue to improve their searchable index of scanned images of more than 350,000 well construction reports (see WGNHS section) for SWAP and other program uses.

Numerous data management tools have been developed and implemented to complete the source water assessments. The SWAP Assessment Form and Mapping Application are two such tools. The Mapping Application is a Geographic Information System that maps locations of public wells, source water areas, and potential contaminant sources in a format consistent with SWAP, vulnerability assessment program, WHP, and other DNR needs. The Assessment Form uses the mapped potential contaminant sources along with well construction, monitoring, and geologic information to help DNR staff determine susceptibility of public wells to contamination. These applications are at the leading edge of DNR's efforts in integrating spatial and tabular data toward the goal of public health protection.

Waste Management Program

The Bureau of Waste Management (WA) implements the DNR's Groundwater Standards Program in several ways during the life of a landfill. Whenever staff review an applicant's "Feasibility Report," which proposes to site a landfill in a particular location, they review baseline data submitted by the applicant to determine whether exemptions and alternative concentration limits are needed for the public health and welfare parameters listed under NR 140. In addition, the reviewers establish preventive action limits for indicator parameters based on calculations submitted by the applicant. During the active life of a landfill and after closure, staff evaluate groundwater conditions at the landfill site to determine compliance with NR 140 Standards. Should conditions warrant, staff require groundwater investigation reports that include proposals for further evaluations and recommendations for remediation at landfills that exceed groundwater standards. Staff review results of site investigations triggered by the exceedances of groundwater standards and evaluate the effectiveness of remedial actions at active solid waste facilities and at closed landfills.

As of July 1, 2002, WA only accepts electronic submittal (via diskette) of environmental monitoring data from

landfill owners, labs and consultants. Establishment of electronic signature standards from DOA continues to delay progress in implementing a pilot program to allow facilities to submit environmental monitoring data via e-mail. Within the next year, WA plans to provide facilities and the public access to the environmental monitoring data contained in its Groundwater and Environmental Monitoring System (GEMS) database. We hope to provide a web interface to allow facilities to upload environmental monitoring data into GEMS in the next 2 years, if funding is available to implement the necessary changes to the system.

WA has been concerned that staff might not be aware of some old, closed landfills that may be impacting groundwater. Program staff used several reports from the Groundwater and Environmental Monitoring System to do a rough screening of old, closed town, city and village landfills with monitoring wells. In July 2003 we sent the screening reports, identifying landfills that need further attention to each of the regions for follow-up evaluations. Program staff have since reviewed many of the identified sites.

Between July 2000 and July 2001 WA studied 31 landfills that accept municipal solid waste, to try to determine whether VOC contamination in groundwater at these landfills is increasing, decreasing or remaining stable. We chose sites with 10 years of data and summarized the trends over this period of time. One purpose of this study was to determine whether natural attenuation is occurring in groundwater near leaking landfills. The study showed that natural attenuation processes were occurring at most of the landfills as evidenced by the large number of stable or decreasing concentration trends. However, the concentrations took longer to stabilize and stabilized at higher levels than at other types of VOC contamination sites described in the literature.

WA and the UW Stevens Point received funding from July 1999 to July 2001 to evaluate the effectiveness of chemical oxygen demand (COD) as an indicator parameter at landfills. One reason for evaluating COD is that mercury waste is generated when COD is analyzed in the laboratory. The DNR's overall goal is to reduce amount of mercury that gets into the environment so eliminating COD sampling at the 400+ landfills that currently sample for it would help us meet that goal. Findings from the first year of the study indicate that there is potential to eliminate COD monitoring at some types of landfills. The second year of the study evaluated possible alternatives to sampling for COD. Dissolved organic carbon (DOC) appears to be an acceptable alternative in certain circumstances. WA staff will incorporate the recommendations of this study into code changes that are being written this year.

WA received funding for the period October 2002 to October 2003 to study groundwater quality at solid waste landfills to determine whether they are a source of pesticide contamination. We sampled 11 sites this spring and summer and are currently summarizing the findings. Groundwater samples were analyzed for 14 common Wisconsin pesticides using immunoassays and additional GC/MS methods. The findings will be available in the fall of 2004.

Remediation and Redevelopment Program

The Bureau for Remediation and Redevelopment (RR) has primary responsibility for implementing and aiding cleanups under the Spill Law, the Environmental Repair Law, federal programs (Superfund, Hazardous Waste Corrective Action, LUST, Brownfields), the Land Recycling Law and State Brownfield Initiatives, the Drycleaner Environmental Response Fund and at closed landfills. The RR program provides technical assistance, helps to clarify legal liability, provides financial assistance primarily to local governmental units and provides technical project oversight of cleanup projects.

All cleanups are conducted according to the NR 700 rule series, Wis. Adm. Code, Investigation and Remediation of Environmental Contamination, and NR 140, Groundwater Quality. The majority of cleanups are done by persons responsible under the laws, or persons or groups involved in the redevelopment of potentially contaminated properties. Program staff provide technical assistance on cleanups conducted by consultants at the direction of responsible parties. In addition, RR staff contract and direct consultants on state-funded cleanups.

Cleanup of groundwater contamination. The program used the Environmental Fund to initiate or continue environmental cleanup actions at approximately 45 locations where groundwater contamination is known or suspected. The Environmental Fund is used when contamination is significant but private parties do not undertake the cleanup because no one has legal responsibility for the contamination, the person(s) legally responsible do not have the financial ability to proceed, or the responsible person simply refuses to proceed. Private contractors conduct these cleanups with oversight by DNR staff. The program spends an average of $5 million per year from the fund to address contamination at new and continuing project sites. Whenever feasible, the RR program and legal staff attempt to recover costs from responsible persons after the cleanups are undertaken.

Brownfields program. Brownfields are abandoned, idle or underused industrial or commercial facilities or sites whose expansion or development is adversely affected by actual or perceived environmental contamination. The RR program coordinates several efforts to encourage local governments and private businesses to cleanup and redevelop brownfield properties. At many brownfields sites, the release of hazardous substance threaten groundwater quality.

One of the financial assistance programs implemented by the DNR is the Brownfields Site Assessment Grant (SAG) program. The SAG program benefits groundwater by serving as a funding source for (1) the removal of potential sources of groundwater contamination, and (2) site investigations to determine whether groundwater is contaminated, including the determination of the extent and degree of contamination. This program provides grants to local governmental units to conduct environmental site assessments and other eligible activities at contaminated properties. Eligible activities include site assessment and investigation, demolition, asbestos abatement, removal of petroleum and hazardous substance storage tanks and removal of abandoned containers. Although the SAG program does not fund remediation activities, it funds preliminary activities to determine whether remediation is necessary. Sites are eligible for funding only if the persons responsible for the contamination are unknown, cannot be located, or cannot pay for the activities for which grant funding is requested.

In FY 04, DNR awarded 50 Site Assessment Grants totaling approximately $1.7 million to 35 communities across the state. Small grants of up to $30,000 make up 43 of the awards, while 7 are large grants of between $30,000 and $100,000. These grants will fund the removal of approximately 35 aboveground and underground storage tanks and 39 abandoned drums and other containers of hazardous substances. These grants will also be used to fund 77 environmental site assessments and investigations. To date, 212 grants have been awarded to properties around the state representing around 742 acres of land.

The RR program has added a new program that funds environmental remediation at brownfield properties that will have a long-term public benefit. The Brownfields Green Space and Public Facilities Grant program provides funds to help local governments clean up contaminated soil or groundwater at brownfield sites that will then be used as green space, recreational areas or use of the property by a local government. DNR evaluated the grant applications that were submitted in January 2003 and awarded 11 grants in FY 04 with a total of $1 million in state funding to 10 communities. The scoring system considers environmental risk and priorities for the grant program. Applications to cleanup sites where there is groundwater impacted or threatened groundwater receive extra points when applications are scored.

The RR program provides redevelopment assistance at brownfield sites with groundwater contamination. RR staff assist local governments and private businesses with the cleanup and redevelopment of brownfields by providing technical assistance. In many cases, these properties have groundwater contamination or soil contamination that poses a threat to groundwater.

The RR program also provides a number of different assurance, comfort or general liability clarification letters related to properties with groundwater contamination. Collectively, these letters facilitate the reuse and development of properties. The RR program provided liability clarification letters and other redevelopment assistance reviews (off-site exemption letters, cleanup agreements for tax delinquent properties, etc.) for parties at 45 properties throughout the state in FY 04.

The RR program also continues to provide technical assistance and assist parties with voluntary investigations and cleanups of Brownfield properties through the Voluntary Party Liability Exemption (VPLE) process. Many sites that follow the VPLE process have contaminated groundwater. After a person has conducted an environmental investigation of the property, and cleaned up soil and groundwater contamination, the DNR will issue a "Certificate of Completion" which provides a release from future liability for any contamination that occurred on the property prior to issuance of the certificate. In FY 04, there were 5 completed cleanups where the DNR issued a Certificate of Completion and 14 new sites that began the voluntary cleanup process.

An innovative addition to the Voluntary Party Liability Exemption program is the state's master environmental insurance program that provides coverage for those properties that have completed the cleanup and are relying on natural attenuation as a remedy for any remaining contamination. In FY 04, three cleanup sites paid for this insurance that can cover investigation and cleanup expenses if the remedy fails.

Dry Cleaner Environmental Response Fund (DERF) Program. The DERF program reimburses dry cleaner owners and operators for eligible costs associated with the cleanup of soil and groundwater at sites contaminated by dry cleaning solvents. Fees paid by the dry cleaning industry provide program funding. Environmental cleanups at dry cleaner sites are conducted following the NR 700 rule series. To date, there are more than 80 sites in the program, at various stages of investigation and cleanup. The program is implemented through ch. NR 169, Wis. Adm. Code.

Site closure rules for Petroleum Contaminated Sites (under PECFA). NR 746 (and its counterpart, Comm 46) was promulgated in February 2001. The bulk of the rule establishes risk and closure criteria to determine whether petroleum contaminated sites can be closed using natural attenuation as a final remedy for groundwater contamination. NR 746 also defines which petroleum-contaminated sites DNR and Department of Commerce have authority to administer; summarizes site investigation requirements, and delineates other administrative requirements such as when remediation and remediation funding is terminated, tracking and transfer of sites, staff training and dispute resolution. The rule provides that sites with contamination in low permeability (clay) materials can close after a site investigation if all risk criteria are met and the groundwater contamination is stable or receding. For contamination in permeable materials, sites must meet all risk criteria and demonstrate through monitoring that groundwater contaminants are declining. Sites requesting closure with groundwater contamination above NR 140 enforcement standards are placed on the GIS Registry of Closed Remediation Sites. Depending on the extent of soil contamination remaining at a contaminated site, a deed restriction may also be required.

NR 726 provides closure requirements for all other sites.

GIS Registry. Revisions to NR 726, 716, 749, and 811/812 implement a GIS Registry of Closed Remediation Sites to replace the requirement to record soil and groundwater use restrictions at the County Register of Deeds Office. The GIS Registry currently includes locational information on sites closed with residual groundwater contamination above the NR 140 enforcement standards, as well as site specific information pertaining to where the contamination is on the property in question and at what concentration it was found at the time the closure decision was made. The Registry can be accessed on the Internet (*http://dnr.wi.gov/org/aw/rr/gis/index.htm*). Inclusion on the GIS Registry on the Internet will provide a means of notifying future owners or users of the property of the existence of soil and/or groundwater contamination.

This database is to be used with well construction requirements for private wells, and with a setback distance for new municipal wells. Beginning in July 2004, the DNR makes the GIS Registry information available to well drillers through a Well Construction CD that will be updated twice a year. Before drilling, well drillers are asked to consult the CD to determine if a well is proposed for a property listed on the Registry. If the proposed well is located on a closed remediation site, then the driller must contact regional Drinking Water and Groundwater staff prior to any well construction activities.

The RR Program continues to make improvements to the GIS Registry System. The existing application is intended to be converted to ESRI's software product, ARCIMS, so that the programming and other maintenance tasks can be accomplished more quickly and at a lower cost. In addition to the ongoing efforts, work continues on quality assurance and quality control (QA/QC) of existing data.

Another database, the Bureau of Remediation and Redevelopment Tracking System (BRRTS) has been available on the Internet for public access for the past 3 years (*http://dnr.wi.gov/org/aw/rr/brrts/index.htm*). These two databases are linked for greater ease of information access. BRRTS is useful for locating potential contamination sites when evaluating new municipal well placement. These databases make site specific information on open and closed remediation sites much more available and accessible to the public and specific interested groups, particularly those wanting to install or replace a potable well on an affected property, as well as those buying properties. Sites regulated by the Departments of Commerce and Agriculture, Trade and Consumer Protection are also included in the GIS Registry of Closed Remediation Sites and BRRTS.

Watershed Management Program

The Bureau of Watershed Management (WT) is responsible for statewide implementation of DNR's groundwater standards primarily through the issuance of discharge permits to facilities, operations and activities that discharge treated wastewater and residuals to groundwater. Field staff that work on integrated basin teams carry out compliance and enforcement activities using policies, codes and guidelines developed by the WT program. Integrated basin planning carried out in the field under guidelines developed by WT assess and evaluate groundwater (and surface water) and provide general and specific recommendations for the protection and enhancement of the basin's groundwater.

Wastewater discharges. WT issues Wisconsin Pollutant Discharge Elimination System (WPDES) permits to all communities, industrial facilities, and large privately owned wastewater systems which discharge treated domestic or industrial wastewater to groundwater through land treatment/disposal systems. These systems are primarily spray irrigation, seepage cell, subsurface absorption systems, and ridge & furrow treatment systems. WPDES permits issued to these facilities contain groundwater monitoring and data submittal requirements that are used to evaluate facility compliance with ch. NR 140, Wis. Adm. Code, groundwater quality standards. Groundwater monitoring systems at existing facilities are evaluated and upgraded as necessary at permit re-issuance.

WT maintains a database, designated the System for Wastewater Applications, Monitoring, and Permits (SWAMP), for holders of specific WPDES and general permits. This database system stores facility specific information such as address, contacts, location, permit requirements, monitoring results, and violations of permit requirements for private and municipal wastewater treatment facilities. The system contains current information on groundwater, wastewater, and biosolids treatment/management. Historical sampling data from groundwater monitoring wells is available through the system and current sample results are added on a monthly basis. Sampling results and site loading information are also available for land application of municipal sludge, septage and industrial sludge, by-product solids and wastewater.

WT continues to assist unsewered communities, served by failing or inadequate individual on-site treatment systems in their efforts to construct centralized wastewater treatment facilities.

The DNR is continuing to refine procedures, guidance, and rules for the review and permitting of large private onsite wastewater treatment systems (POWTS). The DNR started issuing permits to large POWTS in early 2000, as a result of changes to Commerce Rules and a revised DNR/Commerce MOU. In general, large POWTS are defined as those with a capacity of greater than 12,000 gallons per day (gpd). WT is drafting a general permit to cover these types of systems to streamline regulation.

Septage and sludge management. WT implements the regulations in chapters NR 113, NR 204 and NR 214, Wis. Adm. Code. NR 113 relates to septage management and NR 204 governs the treatment quality, use, and disposition of municipal wastewater treatment plant sludge. NR 113 and NR 204 incorporate federal septage and sludge standards. WT regulates the land application of industrial sludge, liquid wastes and by-product solids through NR 214. Chapters NR 113, NR 204 and NR 214 contain treatment quality standards and land application site requirements and restrictions that are designed to prevent runoff to surface water or leaching of nutrients and pollutants to groundwater.

WT continues to implement a new statewide computer system that records and monitors treatment and disposal of municipal sludge, septage, and industrial land applied wastes. This system includes an inventory and a history of all sites used for land application. Wisconsin became the fourth state delegated authority by EPA to implement municipal sludge regulations, through it's delegated NPDES (WPDES) permit program, in July of 2000.

Agricultural runoff. There are currently 113 WPDES permits issued under the NR 243 permitting program for livestock operations (83% dairy; 9% poultry; 8% swine & beef). In addition a single permit was issued to Jennie-O-Turkey Store that covers 55 of their operations. Before 2002, there were 17 separate permits covering each of the operations that were at 1000 animal units or higher. While this has resulted in a decrease in the number of permits issued, the overall number of operations covered under a permit has increased significantly. In addition, there are 14 large-scale livestock operations seeking permits for the first time. Regional and central office staff have successfully maintained the permit backlog at less than 10%. The trend of growing numbers of permit applications for operations with 1,000 or more animal units is expected to continue.

Rules outlining statewide performance standards and prohibitions for agricultural operations (nutrient management, manure storage design, clean water diversion, erosion control) became effective in October of 2002. The performance standards and prohibitions have been a key component of the DNR's Nonpoint Redesign Initiative and are intended to further address impacts from animal feeding operations with less than 1,000 animal units.

Storm water. DNR is currently working on revising its storm water regulations under ch. NR 216, Wis. Adm. Code, in order to comply with federal storm water regulations that took effect on March 10, 2003. The Natural Resources Board authorized public hearings on proposed rules during the spring of 2003 and approved the rules in early 2004. After legislative hearings, it is expected that the revised rules will be finalized and become effective in the second half of 2004. The proposed state rules will adhere to Federal Storm Water Phase 2 regulations and require nearly 200 municipal separate storm sewer systems to obtain permit coverage statewide and also require construction sites down to one acre of land disturbance to have permit coverage to control erosion during construction. Permit holders will also be required to install post-construction practices to limit pollutant discharge after construction is completed (storm water management). The DNR has developed performance standards (i.e. 80% sediment control, infiltration, peak flow, buffer requirements, etc.) that became effective in 2002. Many of these standards will be implemented through storm water permits, especially for new development. However, there are certain delays built into the performance standard rules including a 2-year delay (late 2004) for implementation of the storm water management performance standards.

Nutrient management plans. One of the performance standards included as part of the Nonpoint Redesign Initiative was a nutrient management standard, NRCS Standard 590. Under the rules, the performance standard itself becomes effective January 1, 2005 for high priority areas in the State (source water areas, impaired waters and outstanding/exceptional resource waters). The standard becomes effective for the remainder of the state in 2008. Before it becomes effective, federal, state and local agencies will be working to build the necessary resources and expertise to implement NRCS Standard 590.

For more information, visit the following website (http://dnr.wi.gov/) or contact Todd Ambs at 608-264-6278 (Todd.Ambs@dnr.state.wi.us), or Mike Lemcke at 608-266-2104 (Michael.Lemcke@dnr.state.wi.us), DNR, PO Box 7921, Madison, WI 53707-7921.

DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION

Protecting Wisconsin's groundwater is a priority for the Department of Agriculture, Trade and Consumer Protection (DATCP). DATCP's major activities in this area include management of pesticides and nutrients, research, and funding of local soil and water resource management projects.

In compliance with the Wisconsin Groundwater Law, DATCP manages pesticides and pesticide practices to assure that established groundwater standards for contaminants are not exceeded. This may include prohibition of certain

activities including pesticide use. The agency also manages practices to "minimize" groundwater contamination to the extent "technically and economically feasible." DATCP regulates storage, handling, use, and disposal of pesticides, and the storage of bulk quantities of fertilizer. DATCP has authority to develop a statewide nutrient management program through section 92.05 Wis. Stats. The program includes compliance, outreach, and incentive components.

DATCP is also responsible for coordinating the development of Wisconsin's "generic" and "pesticide-specific" state pesticide management plans (PMPs - previously known as SMPs) for protecting groundwater from pesticides. In FY 96, DATCP, in cooperation with DNR and other agencies, submitted Wisconsin's "Generic SMP for Protection of Groundwater from Pesticides" to the EPA for concurrence. EPA concurred with the Generic SMP in June 1996. According to the EPA document "Pesticides in Groundwater Strategy" (1991), when EPA determines that a pesticide presents a significant risk of leaching to groundwater in a state, it may either cancel the registration of that compound or allow the state to prepare an PMP describing how the state will manage the pesticide to protect groundwater. The generic PMP presents a comprehensive review of Wisconsin's regulatory and non-regulatory efforts to prevent groundwater contamination due to pesticides. This generic plan will serve as a framework for pesticide-specific PMPs that EPA may require.

Enforcement standards have been established in Wisconsin for many known and potential groundwater contaminants, including over 30 pesticides. Standards for additional pesticides have been proposed. DATCP applies these standards and the Groundwater Law when addressing nonpoint and point sources of pesticide contamination in groundwater.

Non-Point Source Activities

Pesticides. DATCP's primary effort related to nonpoint contamination (i.e., due to general use) of groundwater from pesticides continues to involve the herbicide atrazine. In response to concerns about atrazine contamination, DATCP amended administrative rule ch. ATCP 30 in 1992 to manage the use of atrazine in an effort to reduce or eliminate the potential for further groundwater impacts. Rule revisions have been made annually in response to additional detections of atrazine in groundwater. A set of 102 maps of new or existing prohibition areas is available from the Water Quality Section covering 1.2 million acres that have been incorporated into the rule. Information suggests that atrazine use has declined from peak levels in the late 1980's and is now holding roughly constant. The decline in use may have been a result of the atrazine management rule and concern about groundwater contamination.

Nutrients. DATCP, through its land and water resource management program, provides funding primarily to counties to assist in the protection of water resources through farmer adoption of nutrient management planning. A portion of this funding is dedicated to the development and implementation of improved nutrient and pesticide management practices. In FY 04 approximately $100,000 was provided to develop tools for nutrient management plans on farms to maximize profitability and to minimize excessive runoff of nutrients to surface and groundwater. Additionally, staff worked to train farmers, consultants, and local agencies on the principles of sound nutrient management and how to comply with performance standards.

Point Source Activities

Previous work by DATCP identified pesticide and fertilizer operations as possible point sources of groundwater contamination. Past problems included improper disposal of unwanted agricultural chemicals, lack of containment for spills, out-dated product handling methods, and poor understanding by workers in the industry of how small actions when continued over time lead to large problems. DATCP has worked to address these problems through point source prevention. In cases where environmental degradation has already occurred, DATCP oversees environmental cleanup of contaminated soil and groundwater.

Point source prevention for agrichemicals includes Agricultural Clean Sweep, enforcement of product containment rules and handling regulations, and education beyond the rule requirements through the Environmental Partners

program. Point source cleanup activities are performed under the Agricultural Chemical Cleanup Program (ACCP), which provides technical oversight and reimbursement to offset much of the costs for investigation and cleanup.

Since 1990, the Agricultural Clean Sweep program has helped farmers dispose of unwanted pesticides, farm chemicals, and empty pesticide containers. Beginning in 1996, the program extended collection services to small agricultural businesses. In 2003, DATCP provided $378,582 to fund Clean Sweep projects in 37 counties for collection and disposal of waste pesticides and containers. Approximately 282,746 pounds of waste were collected, reducing the potential for inadvertent environmental damage. In addition, DATCP now operates and manages the state's household hazardous waste program. Approximately $710,000 will be available during 2005 for both agricultural and household programs.

DATCP's rules for minimizing environmental damage from agrichemical storage and handling were put in place in 1988. Fifteen local DATCP specialists work with facilities across the state to keep them in compliance with the ATCP rules designed to protect the environment. DATCP staff also educate facility managers and employees about how routine practices may affect the environment.

The Environmental Partners program works to reduce the amount of agrichemicals that escape into the environment. 2004 will be the fourth year for this program. Participation in the program is voluntary with the agrichemical industry and Department working together to identify the problems and brainstorm ideas to reduce pollution. The ideas used to solve problems at each facility are shared so that everyone can learn and benefit from the program.

In August 1993, section 94.73 of the Wis. Stats. was created and established the Agricultural Chemical Cleanup Program (ACCP) to address point sources of contamination. The ACCP reimburses responsible parties for cleanup costs related to pesticide and fertilizer contamination at facilities and in nearby wells. The program may also handle point source contamination on farms. To date, more than 370 cases involving soil and/or groundwater remediation related to spills, misuse, and improper storage or mixing and loading have been initiated at pesticide and fertilizer facilities and on farms.

The ACCP also funds DATCP oversight of pesticide and fertilizer cleanup activities. Program staff respond to and investigate pesticide and fertilizer contaminated sites throughout the state. Investigations at these sites are prioritized based on suspected contamination levels, with the higher levels investigated first. Investigations include discussions with facility staff or farmers to determine the most likely locations of contamination at the site. Other oversight activities include, but are not limited to, sample collection, laboratory analysis, and financial auditing.

Groundwater Sampling Surveys

DATCP conducts a number of annual surveys (briefly described here) to investigate the occurrence of pesticides in groundwater resulting from nonpoint sources. Results of these surveys are provided in the "Pesticides" section under *Condition of the Resource - Groundwater Quality*.

Exceedence Survey. From 1995-2003 DATCP has conducted an annual sampling program of private wells that have previously exceeded a pesticide enforcement standard. 150 wells have been re-sampled at least once in this program for common pesticides and nitrate. Most of the wells are in atrazine prohibition areas. In FY 04, 53 private wells that have historically exceeded groundwater standards were sampled.

Pesticide and Groundwater Impacts Study. In 1985, DATCP began a study to determine if normal field application and use of pesticides and fertilizer was causing groundwater contamination at highly susceptible sites (e.g. sandy soils, less than 25 ft. to groundwater). In FY 04, this study entered its 18th program year. Over the years, as many as 50 different field sites have been sampled. Currently 15 sites are being monitored across the state. DATCP's Water Quality Section maintains this network of monitoring wells primarily as an early warning system for pesticides new to the marketplace.

Monitoring Reuse of Atrazine in Prohibition Areas. In FY 98, DATCP began monitoring the limited reuse of the herbicide atrazine in selected areas where atrazine use has been prohibited. Ch. ATCP 31, Wis. Adm. Code, requires DATCP to collect scientific data to show if renewed use of atrazine in prohibition areas will cause further groundwater contamination. DATCP is monitoring groundwater quarterly at 17 fields, 10-40 acres in size, for at least 5 years. In FY 04, 278 samples were collected in this program.

Atrazine Rule Evaluation Survey. In 1994 and 1996, DATCP completed groundwater sampling surveys designed to evaluate the effectiveness of the Atrazine Rule (ch. ATCP 30, Wis. Adm. Code). These surveys were designed to determine how levels of atrazine and its metabolites in groundwater were changing three and five years after the atrazine restrictions went into effect. In 2000 and 2001, Water Quality Section staff sampled 336 private wells across the state that included 122 of the same wells sampled in 1996. Results from this survey have been summarized in the May 2002 report "Groundwater Quality: Agricultural Chemicals in Wisconsin Groundwater", which may be downloaded at *http://datcp.state.wi.us/arm/agriculture/land-water/water-quality/monit_proj.html*.

Research Funding

Pesticide Research Due to budget constraints, DATCP did not have funding for new pesticide research projects in FY 04. However, final reports were submitted for two previously funded projects including John Norman's project to determine the impact of different nutrient applications on leaching of nitrogen, and John Stier's project to determine the impact of lawn chemical applications on surface water quality. Pesticide research projects that continued during FY 03 include three two-year projects funded to 1) evaluate pesticide and nitrate leaching on soils receiving manure, 2) evaluate agrichemical residues in two groundwater basins, and 3) to determine the occurrence of antibiotics in wastewater effluents and their mobility in soils.

Nutrient Research DATCP funds fertilizer research at approximately $130,000 per year. Five of ten research projects funded in FY03 were related to nutrient management. Three of eight research projects funded in FY 04 pertained to nutrient management and potential impacts on groundwater quality.

Groundwater Data Management

DATCP needs up-to-date, reliable data about pesticide and nitrate-N contamination of groundwater. DATCP uses these data to develop substance specific rules about pesticide use, such as DATCP's "Pesticide Product Restrictions" (Chapter ATCP 30, Wis. Adm. Code), to respond to citizen requests on groundwater quality data for specific locations, and to initiate timely investigations of pesticide contamination of groundwater. DATCP ensures the quality of its database by carefully checking and cross-referencing paper lab slips and computerized data received from DNR, DATCP's laboratory, and other sources. This scrutiny is important, because DATCP uses these data for regulatory purposes. DATCP also works closely with other local and state agencies to coordinate groundwater data collection and to improve the integrity of groundwater data in Wisconsin.

DATCP maintains two groundwater sample databases: the Drinking Water Well System and the Monitoring Well System. The Drinking Water Well System contains contact and location information, well characteristics, and pesticide and nitrate sample results for private and public drinking water wells. The Monitoring Well System contains similar information for monitoring wells, and also tracks specific pesticide use history, soils, crop history, well construction, and precipitation and irrigation at monitored sites. These data represent samples analyzed by DATCP, SLOH, and other public and private laboratories. DATCP's Drinking Water Well System currently contains information for over 37,500 wells and nearly 240,000 pesticide and nitrate-N results.

DATCP uses geographic information system (GIS) tools to analyze groundwater data and prepare maps for public hearings, DATCP board meetings, presentations, and other uses. DATCP prepares and maintains ArcInfo and ArcView data layers of well locations, atrazine concentrations, atrazine prohibition areas, and other pesticide and nitrate-N data. These GIS layers and associated database information are used to generate maps of statewide pesticide and nitrate-N detections in wells, as well as maps for chapter ATCP 30, Wis. Adm. Code (Pesticide

Product Restrictions). For example, see the map of "Private Wells Tested for Atrazine in Wisconsin" in Chapter 4, *Condition of the Groundwater Resource*. Other GIS analyses involve identifying groundwater wells that may be impacted by point sources of pesticide and nitrate-N contamination. DATCP also uses global positioning system (GPS) receivers to locate and map wells and other features, such as agrichemical facilities and spill sites, that may affect groundwater quality.

For further information, visit the following web site (http://datcp.state.wi.us) or contact Nicholas Neher, DATCP, 2811 Agriculture Drive, PO Box 8911, Madison, Wisconsin, 53708-8911; phone: 608-224-4567; e-mail: nicholas.neher@datcp.state.wi.us.

DEPARTMENT OF COMMERCE

Chapter Comm 10, Wis. Adm. Code, regulates flammable and combustible liquids and hazardous substance liquids on the Comprehensive Environmental Response Compensation Liability Act (CERCLA) list. The regulatory authority for the storage tank program is within the Division of Environmental and Regulatory Services (ERS) in the Department of Commerce. The ERS Division has two bureaus: Bureau of Petroleum Products and Tanks, and the Bureau of PECFA.

Under 145.02, Wis. Stats., the Department of Commerce also has the responsibility of safeguarding public health and the waters of the state relative to the construction, installation and maintenance of plumbing. One mechanism of the Department to fulfill this responsibility is to promulgate a state plumbing code, chapters Comm 81-87. Chapter Comm 83 of this code regulates Private Onsite Wastewater Treatment Systems and is administered by the Division of Buildings and Safety.

Plumbing – Reuse, Stormwater and Private Onsite Wastewater Treatment Systems (POWTS)

The State Uniform Plumbing Code, Chapters Comm 81 – 87, is going through a revision process and public hearings were held on May 19, 2004. In addition to public health and safety, the water supply and quality issues facing Wisconsin are a focus of the General Plumbing and POWTS programs in the Department of Commerce.

General Plumbing – Reuse and Stormwater Use. In May of 2003, Chapter Comm 82 of the plumbing code was revised to include standards for graywater reuse and stormwater use. The current draft is attempting to refine the reuse and storm water use standards to eliminate the irrigation of food crops. The proposed revisions include the entire section of storm water plumbing systems, s. Comm 82.36.The revisions will allow greater flexibility for designers of plumbing systems when designing systems to comply with NR 151 performance requirements. These NR 151 post-construction stormwater requirements will be effective on October 1, 2004 and Commerce expects the effective date of the plumbing stormwater revisions to be prior to January 1, 2005.

Private Onsite Wastewater Treatment Systems (POWTS). A revision to chapter Comm 83 was implemented on February 1, 2004. The revision primarily consisted of corrections to portions of the code where errors were discovered or clarification was needed since the last code revision. The code council that was formed to advise the Department on the latest revisions to Comm 83 met three months after the February 01, 2004 implementation date to reflect on the code change. The consensus of the council members was that while there are still a couple areas that need attention, generally the groups they represent are satisfied with the code. The Department continues to communicate with the DNR regarding mutual issues such as large onsite sewage systems and Underground Injection Control (UIC) regulations.

A new code council was formed to advise the Department regarding revisions to the WI Fund code – chapter Comm 87. The council met twice to discuss 22 issues that were identified as needing attention since the code was last revised in 1999. The proposed implementation date for this code revision is February 01, 2005.

Petroleum Product and Hazardous Substance Storage Tanks

The ERS Division continues to maintain regulatory oversight of aboveground and underground petroleum and CERCLA hazardous substance storage tanks in the Comm 10 administrative code. Underground storage tank regulations include the Federal EPA Underground Storage Tank (UST) requirements, as well as heating fuels, emergency generator tanks, and other tanks storing regulated liquid products. Comm 10 is progressing with the Phase II revision to address technical requirements associated with current day needs and technology. One objective of the code revision is to require underground system components that are more reliable than their predecessors and move systems to a configuration that are more acceptable for insurance coverage by companies providing financial responsibility coverage.

Since 1991 the database inventory of petroleum product tanks regulated under Comm 10 has increased from 143,681 to 177,799 USTs as previously unregistered tanks have become registered. In 1991 the database included 68,056 tanks classified as federally regulated with 51,088 of those tanks in use. As of May 20, 2004 the database reflects 79,564 federally regulated tanks with only 12,542 tanks in use. In order to maintain a federally regulated tank in use, the tank must have a valid "permit-to-operate" and an annual inspection. Annual inspections involve verification of leak detection, spill and overfill protection, and record keeping. Permit renewal administrative review includes compliance assessment of the owner's financial responsibility.

Program initiatives have resulted in identifying a larger population of underground tanks, reducing the number of underground tanks in use, and upgrading those in use to meet the state and federal upgrade requirements. The closure of federally regulated tanks will continue, but at a slower pace than experienced over the past few years. Closure of out-of-service residential heating fuel tanks is continuing as Realtors and lenders recognize the potential problems and liability.

The closure of underground storage tanks is being supplanted by private fueling moving to retail fueling and some operators moving storage tanks to above ground. Residential heating fuel has not been significantly impacted, as the closures are generally associated with the conversion to natural gas or liquid propane gas (LPG). Existing aboveground bulk storage facilities were subject to release prevention upgrade requirements in 2001 providing an enhanced measure of environmental protection over the former levels of acceptance.

Proactive educational outreach efforts and annual inspections by the Department and its agents have resulted in a high level of regulatory compliance, and a reduction of system failures and environmental contamination. The ongoing regulatory challenges are owner operational compliance with leak detection. Wisconsin's progress and regulatory oversight continues to reflect very favorably with the US EPA.

Petroleum Environmental Cleanup Fund Act (PECFA)

Since 1989, the PECFA program has reimbursed approximately $1.4 billion to petroleum storage tank system owners for costs associated with the investigation and remediation of petroleum contaminated sites. The program, in addition to auditing owner invoices and authorizing payments, performs technical reviews of site investigations, evaluates the feasibility of remedial options, conducts a competitive public bid process for scopes of work, and makes decisions regarding closures for the majority of the State's leaking underground storage tank (LUST) sites.

The petroleum inspection fee supports PECFA's spending authority. The annual spending authority is $68 million in FY 04 and $68 million in FY 05. In FY 04, the PECFA program reimbursed over $90 Million to more than 2000 claimants. Currently, costs claimed per month are at or below the monthly spending authority, and the program provides reimbursement within approximately three months of receiving the claim.

The budget bill, which passed in July 2003, increased the PECFA bonding authority by $94 million to a total of $436 million. The proceeds from the sale of revenue bonds have been used to pay down the backlog of audited claims awaiting payment.

In addition to administering the PECFA fund, the Department of Commerce PECFA Bureau has the administrative authority for low and medium risk petroleum contaminated sites (which includes both soil and groundwater sites). In addition, the Bureau is tasked with implementation of the public bidding process for remediation and investigation activities at PECFA-eligible sites.

PECFA continues to use competitive bidding to establish a reimbursement cap for investigation and cleanup activities at contaminated sites where total costs are expected to exceed $60,000. Competitive bidding allows PECFA-registered environmental consulting firms to review the site investigation report and, in compliance with the bid specifications, submit a cost through case closure, or costs to perform a specific work scope. Commerce has completed the bidding process for approximately 200 sites/bids this year for a total of approximately 600 sites since the inception of the bidding process in 1999. It is estimated that the public bidding process provides savings to the PECFA program of over 50% of remediation costs. This has had a significant impact on the reduction of costs submitted as claims.

The Site Review Section has completed a review of existing sites that have been reimbursed more than $200,000 through an interagency effort with the Department of Natural Resources. The Section will continue the evaluation of open sites to determine where savings can continue to be maximized, while ensuring health and safety of the public and the environment.

Data Management

Commerce is continuing its data integration information technology initiative. With regard to groundwater protection, Commerce maintains databases of underground petroleum storage tank systems and properties with petroleum contamination either in the past or currently. The database also stores information on activities associated with onsite sewage system design, installation and maintenance. The Department has initiated a pilot project involving a small group of governmental units (counties) that allows them to issue Sanitary Permits on demand using their own IT equipment. The goal is to reduce or eliminate duplicative records kept by the governmental units and the Department. Sanitary Permit information reporting and processing has been streamlined. Further efficiencies will be realized assuming the pilot project is successful and the process is expanded to other governmental units. The Department continues to participate in discussions with county code administrators, service providers and other interested parties relative to reporting and recording of inspection, maintenance and servicing events for onsite sewage systems. Several governmental units have enhanced their maintenance reporting abilities in the last year and more are expected to follow in the future.

For more information, visit the following web site (http://www.commerce.state.wi.us) or contact Berni Mattsson, ERS Division Administrator, P. O. Box 7839, Madison, Wisconsin 53707-7839, phone: 608-266-9403, fax: 608-267-1381; e-mail bmattson@commerce.state.wi.us.

DEPARTMENT OF TRANSPORTATION

The Department of Transportation (DOT) regulates the storage of highway salt (ss. 85.17 and 85.18, Wis. Stats.) to protect the waters of the state from harm due to contamination by dissolved chloride. DOT is also responsible for potable well sampling at 29 rest areas and 73 waysides. Other DOT groundwater related activities include: road salt research; hazardous material and waste investigation or remediation; wetland compensation and research; and storm water management and research. Various divisions and sections in DOT are responsible for these activities:

- Salt Use and Storage - Bureau of Highway Operations
- Salt Research - Bureau of Highway Construction (Geotechnical Section)
- Hazardous Materials (petroleum) - Environmental Services Section
- Hazardous Waste - Risk & Safety Management Section
- Wetlands - Environmental Services Section
- Erosion Control and Storm Water Management - Environmental Services Section

- Rest Area Potable Well Sampling - Bureau of Highway Operations

Salt Storage

Highway salt is stored statewide by suppliers, counties, cities, villages, and private companies. Annual inspections occur and reports are provided for salt storage sites to insure that storage practices are in accordance with ch. Trans 277, Wis. Adm. Code (Highway Salt Storage Requirements). The intent of the Code is to help prevent entry of highway salts into waters of the state from storage facilities. All salt must be covered and stored on an impermeable base. The base for stockpiles is required to function as a holding basin and to prevent runoff. The covers must consist of impermeable materials or structures to prevent contact with precipitation. State funded facilities are being added to the DOT salt storage program to provide greater capacity of indoor storage. This will improve groundwater protection and create greater flexibility for scheduling salt purchase at optimal prices.

The DOT annually updates salt storage facility records into a database and assists the DNR source water protection program in locating salt storage facilities for GIS mapping applications. There are currently 1,219 salt storage sites listed in the database and 2,320 sub-sites. Each county keeps detailed inventories of salt which are updated monthly. Facility inventories, inspections, repairs and improvements are included in the database.

Salt Use

The DOT Bureau of Highway Operations produces the Annual Winter Maintenance Report describing statewide salt use based on weekly reports from each county. Current policy in the State Highway Maintenance Manual restricts the spreading of deicer salts to a maximum of 400 pounds per lane mile per initial application, and 300 pounds per lane mile for subsequent applications. Electronic controls for salt spreader trucks are continually tested to record and verify application rates and coverage effectiveness. Other technology is used on county highway patrol trucks to keep salt on pavement surfaces (e.g., zero-velocity spreaders, ground speed controllers, and onboard liquid pre-wetting units). Additional efforts to minimize and conserve salt applications include the use of in situ weather monitoring system. Pavement temperature sensors recorded at 62 locations along major highway routes are used to determine application methods. Annual training for snowplowing and salt spreading techniques is provided for county snowplow operators.

Salt Monitoring and Research

Since 1970, DOT has investigated potential road salt impacts on the environment adjacent to highways. Early investigations (1970s to early 80s) were focused on evaluating road salt impacts to surface water runoff, vegetation, and soils. In the last several years DOT has conducted limited investigations evaluating road salt impacts to groundwater. Approximately 20 sites throughout the state have been studied. In general, 1 or 2 shallow monitoring wells at each site were monitored quarterly for a period of 5 years. The monitoring consists of analyzing soil, water, or vegetation samples for calcium, sodium, chloride, and electrical conductivity. Approximately 5 sites are currently monitored, and new sites are added periodically. Results from the studies are discussed in 5 separate DOT progress reports entitled: Investigation of Road Salt Content of Soil, Water and Vegetation Adjacent to Highways in Wisconsin (1972, 1975, 1979, 1989 and 1996).

For more information, visit the following web site (http://www.dot.state.wi.us) or contact Mr. Dan Scudder, Chief, Environmental Services Section, Room 451, P. O. Box 7965, Madison, Wisconsin 53707-7965; phone: 608-267-3615, or e-mail dan.scudder@dot.state.wi.us.

DEPARTMENT OF HEALTH AND FAMILY SERVICES

Chapter 160, Wis. Stats., directs the Department of Health and Family Services (DHFS) to recommend health-based enforcement standards for substances found in groundwater and specifies the protocol for developing the recommended standards. Recommended standards are sent to the DNR and are submitted through the rule-making

process as amendments to ch. NR 140, Wis. Adm. Code. DHFS staff serve as a primary resource for information about the health risks posed by drinking water contaminants, and are charged with investigating suspected cases of water-borne illness. Toxicologists, public health educators, and epidemiologists employed in the Department's Division of Public Health present this information to the public at meetings and conferences, and provide direct assistance to Wisconsin families via home visits, letters to well owners, and telephone consultations. DHFS staff review correspondence sent to well owners by DNR representatives. The agency frequently provides supplemental advice to owners of wells that are highly contaminated with volatile substances such as benzene and vinyl chloride, especially in cases where the contaminants may pose concerns from inhalation of indoor air. Follow-up letters sent by DHFS explain the health effects of specific contaminants and suggest strategies for reducing exposure until a safe water supply can be established. DHFS staff are also called upon to review the toxicity of constituents of well construction and rehabilitation products to ensure that products approved for use in Wisconsin can be used safely without risk of chemical overexposure. DHFS also prepares and distributes a wide variety of informational materials on groundwater and drinking water issues related to human health.

Summary of Agency Activities in FY 04

In November of 2003, DHFS sponsored a conference in Madison for local health department staff and others interested in assessing and addressing environmental health hazards. The program included sessions on both groundwater and surface water contaminants such as pesticides, well sampling and applying GIS technology to the management of groundwater quality.

Based on funding from the federal Centers for Disease Control and Prevention (CDC), DHFS has begun work on developing environmental public health tracking modules for childhood cancer, multiple sclerosis (MS) and amyotrophic lateral sclerosis (ALS) to create data systems that link information on relevant hazards, exposures and health outcomes. The most recent cooperative agreement commenced in September of 2003. In support of this initiative, DHFS is working with DNR to access groundwater and drinking water data to create exposure profiles and generate environmental hypotheses about the etiology of these conditions. Other partners in this developing program include DATCP, the Division of Information Technology (DoIT) and the medical school at the University of Wisconsin - Madison, and the Wisconsin State Laboratory of Hygiene

Through a separate cooperative agreement with CDC, DHFS oversaw the implementation of several environmental health capacity-building projects aimed at groundwater-related issues at local health departments across the state. In December of 2003, work was completed on several groundwater-related projects, including the following:

- The ***Eau Claire City-County Health Department*** conducted a well testing campaign for semi-volatile organic compounds, nitrate, bacteria and other contaminants in selected unincorporated rural and urban neighborhoods selected on the basis of knowledge of historical land use. As a result, enforcement standard exceedances were discovered for lead, cadmium, copper and nitrate.

- In concert with their local land and water conservation office, ***the St. Croix County Department of Health and Human Services*** undertook a project to identify unused or abandoned wells, abandoned underground manure storage sites and nonmetallic mines that have the potential of contaminating groundwater. County officials provided outreach and investigated the availability of funds for properly abandoning unused wells and reducing the likelihood that such a well might adversely affect local groundwater quality.

- In response to observed high arsenic levels in private wells, the ***Taylor County Health Department*** conducted an arsenic sampling campaign in randomly-selected and targeted drinking water wells. Nine wells with elevated arsenic were identified and the local health agency was able to better assess the contribution of geology and well construction to the arsenic contamination problem in the county.

In January of 2004, funding was awarded for new groundwater-related projects for local health departments in Dunn, Eau Claire and Wood counties.

For more information, visit the following web page (http://www.dhfs.state.wi.us/eh/Water/index.htm) or contact Henry Anderson (608-266-1253; anderha@dhfs.state.wi.us), Lynda Knobeloch (608-266-0923; knobelm@dhfs.state.wi.us) or Mark Werner (608-266-7480; wernema@dhfs.state.wi.us), 1 W. Wilson St., Rm. 150, Madison, Wisconsin, 53701.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

The Wisconsin Geological and Natural History Survey (WGNHS) 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 geology and soils programs, which provide maps and research-based information essential to the understanding of groundwater recharge, occurrence, quality, and movement.

In FY 04, the WGNHS continued to respond to requests for information and assistance from other local, state, and federal agencies, consultants, students, and the public. These requests ranged from the simple, "What will I find underground if I dig or drill here?" to more complex questions about groundwater flow, contaminant transport, or wellhead protection. Public information, records, and research results that the WGNHS stores and disseminates save the considerable expense of gathering the same geologic or groundwater information several times for different purposes, or "rediscovering" the same information over time.

Groundwater Level Monitoring Network

The statewide groundwater-level monitoring network has been operated jointly with the U.S. Geological Survey (USGS) since 1946. Currently, the network consists of approximately 140 wells in 66 counties. The groundwater-level monitoring network provides a consistent, long-term record of fluctuations in water levels in deep and shallow aquifers. Such information is critical for accurate analyses of the effects of high-capacity wells pumping, the response of groundwater levels to droughts, and the effects of land-use changes on groundwater systems. The long-term data are also used for calibration of regional groundwater models.

In FY 04 the WGNHS, in cooperation with the USGS, will continue to compile and interpret data from the statewide network and will make the data available on the USGS web site at *http://wi.water.usgs.gov/public/gw/.* In addition, the WGNHS will continue to evaluate individual wells in the network for optimum data value at minimum cost. The WGNHS will continue to supply the information to public and private clients and aid in data interpretation.

County and Regional Groundwater Studies

County studies. Geologic and groundwater studies at the county scale continue to be an important part of WGNHS programs. During FY 04 the Survey carried out the following county-based groundwater studies:

Dane County:	Continued maintenance and updates of the Dane County regional groundwater flow model; conducted model simulations for local municipalities and industries; continued a multi-year study on the effects of new rural subdivisions on groundwater; assisted with University-based research projects on springs and wetlands in the county. Cooperated with researchers from the University of Waterloo (Ontario) on investigations at a solvent contamination site in eastern Dane County.
Calumet County:	Compiled a 1:100,000-scale water-table elevation map and hydrogeologic cross sections depicting the extent and thickness of the primary aquifers in Calumet County, and developed a contamination susceptibility map for the county.

Fond du Lac County: Collected new subsurface data (bedrock cores) and continued work on a new bedrock geologic map of the county.

La Crosse County: Published a report on the geology of the county and prepared a report on the hydrogeology of the county (for publication during FY 04). Cooperated with the USGS on a groundwater flow model and prepared an open-file report on contributing areas for municipal wells in the county. Staff members are continuing work on detailed studies of the hydrogeology beneath bedrock ridges.

Pierce and St. Croix Counties:

Received funding from the Groundwater Research Advisory Council for a new project to better define bedrock hydrostratigraphy of the Pierce/St. Croix area in support of future hydrogeologic studies in the region. This work will be carried out during 2004 and 2005. Also, the WGNHS received federal support through the STATEMAP program to do a detailed bedrock geologic map of the counties, which is currently in progress.

Sauk County: Completed a report on the hydrogeology of Sauk County.

Washington County: In cooperation with the City of West Bend and their engineering consultants, the WGNHS developed a proposal and received funding to construct a groundwater flow model for the city. This model will be used for wellhead protection and water-supply studies. The project will be carried out during 2004-2005.

Waukesha County: Conducted research on deep groundwater quality in Waukesha County, in cooperation with UW-Milwaukee and the USGS. Constructed a groundwater flow model of the area around Eagle, Wisconsin, to delineate contributing areas for new municipal wells at Eagle. This project was a demonstration of how the southeastern Wisconsin regional groundwater flow model can be used as a foundation for site-specific studies.

Winnebago County: Conducted research and collected new bedrock information in Winnebago County as part of a two-year project mapping the bedrock geology of Winnebago and Outagamie Counties supported in part under the federal STATEMAP program.

Geologic and hydrogeologic analyses in southeastern Wisconsin. In the past several years, much public attention has been focused on the problem of ensuring an adequate and inexpensive supply of potable water to southeastern Wisconsin for the next century. The southeastern Wisconsin communities of Waukesha, Brookfield, Germantown, Menominee Falls, and Pewaukee, among others, are prohibited by the Great Lakes Charter from diverting water out of the Great Lakes Basin, which precludes them from drawing surface water from Lake Michigan. Water utilities in these areas are concerned that rapidly falling groundwater levels indicate that water supply will not be able to keep pace with development. In response to these concerns, the Southeastern Wisconsin Regional Planning Commission (SEWRPC) joined with the WGNHS and USGS to carry out a quantitative study of the deep aquifer system. This deep system, known as the sandstone aquifer, provides most of the water to the high-capacity wells serving municipalities in southeastern Wisconsin. Funding for much of this work was obtained from SEWRPC and participating water utilities.

During FY 04, the WGNHS, SEWRPC, and the USGS completed a regional groundwater flow model for southeastern Wisconsin and prepared reports on model construction and use. During FY 05 the project team will use the model to simulate various water-management scenarios proposed by SEWRPC and the participating water utilities. The model has been used to delineate zones of contribution to all municipal wells in the SEWRPC region with additional support from the DNR's Source Water Protection program.

One notable offshoot of the SEWRPC project has been the acquisition of new borehole geophysical data. Over the past few years, with DNR support, the WGNHS has significantly upgraded its geophysical logging capabilities and experience. During FY 05 the Survey will continue to collect new geophysical logs from deep wells as they become available due to pump maintenance or other work.

Groundwater Research Activities

Aquitard research. Aquitards, low-permeability geologic materials such as clay or shale, are critical resources for protecting water-supply wells from contamination, yet are often difficult to characterize. In late 2001 the WGNHS received a grant from the American Water Works Association Research Foundation (AWWARF) for evaluation of the properties of aquitards. This project is being carried out cooperatively through FY 05 with Drs. John Cherry and Beth Parker at the University of Waterloo (Ontario) and is focusing on aquitards in Dane County and southeastern Wisconsin. During 2003 the project team completed a bibliography and state-of-the-science report on aquitard hydrogeology and tested new monitoring technologies at an aquitard research site in Dane County. During 2004 the team will complete a guidance manual for water utilities and their consultants describing the best and most economical ways to characterize aquitards.

Arsenic in groundwater. The WGNHS is continuing research on the source(s) and geochemical characteristics of arsenic contamination in water-supply wells in northeastern and southeastern Wisconsin. In FY 04 the WGNHS began an investigation of high arsenic levels in wells near Rosendale, in Fond du Lac County. Survey staff members continue to work with DNR Drinking Water and Groundwater Program staff as they develop well-construction guidelines for affected areas within Outagamie and Winnebago Counties.

In FY 04, the WGNHS completed the second year of a two-year study of sources and mechanisms of arsenic in groundwater in southeastern Wisconsin, conducted cooperatively with Dr. Jean Bahr of the UW-Madison Department of Geology and Geophysics. This investigation has documented the presence of several arsenic-rich horizons within the surficial sand and gravel aquifer and in a weathered bedrock unit that caps the uppermost bedrock aquifer. Communicating the results of this project to DNR staff in southeastern Wisconsin will be a focus in FY 05.

Groundwater recharge. Groundwater recharge is critical to maintaining the supply of Wisconsin's groundwater, but mapping and quantifying recharge areas and rates can be a difficult process. In cooperation with UW-Madison, the WGNHS has developed a computerized technique for rapidly delineating recharge areas for use in regional groundwater models. This method couples geographic information systems (GIS) techniques with basic landscape data and rainfall-runoff modeling and is being tested in Dane County. Currently, the WGNHS is incorporating the recharge delineation methodology into new projects and is cooperating with the USGS in using it in other areas of Wisconsin.

Effects of land-use changes on temperature in trout streams. During FY 02 and 03 the WGNHS conducted a study of how land-use changes affect groundwater recharge and how recharge changes, in turn, impact the discharge and surface-water temperatures in trout streams. This project was completed in 2003; technical publications of the results will be completed during 2004.

Fluid flow in carbonate rocks. Carbonate rocks (limestone and dolomite) underlie much of Wisconsin and form important aquifers over large parts of the state. Groundwater in carbonate rocks can move through fractures and solution features. Groundwater velocities in such rocks can be unusually high, and the rocks usually have very low ability to attenuate contaminants. Consequently, carbonate rocks are vulnerable to groundwater contamination. Predicting and monitoring groundwater flow in fractured carbonate rocks is challenging because these aquifers tend to develop two-component flow systems: rapid flow through small, discrete fractures and slower flow, but significant storage, in the matrix blocks. Work by the WGNHS on carbonate aquifers in eastern Wisconsin suggests that detailed stratigraphic analysis, coupled with geophysical and hydrogeologic data, may help predict the hydraulic properties of these complex and vulnerable aquifers.

Over the past few years, the WGNHS has developed a program of research and public education on groundwater movement in carbonate rocks and has provided assistance to various agencies facing carbonate-rock problems. Examples of recent work include verification of capture zones for municipal wells at Sturgeon Bay, investigation of groundwater under carbonate ridges in La Crosse County, and development of groundwater models for carbonate-rock areas in southeast Wisconsin. During FY 04 the WGNHS will continue these activities. Survey staff members are also involved in professional short courses on fractured-rock hydrogeology.

Karst features, including a variety of sinkholes, cavities, and solution openings, commonly are found in carbonate rock (limestone and dolomite). Environmental problems associated with karst features include rapid groundwater contamination, unpredictable groundwater flow, difficulty in groundwater monitoring, and unexpected failure or collapse of surface structures such as roads and foundations. In recent years there has been increased concern about the hazards and effects of karst features in many parts of Wisconsin, but little published information has been available. The WGNHS is serving as a clearinghouse for karst information, and has begun assembling a karst database for the state <*http://www.uwex.edu/wgnhs/karst.htm*>. During FY 04 the WGNHS will continue to provide data and consultation on karst issues as requested by various units of government and the public.

Crandon Mine. Until withdrawal of the permit application in late October 2003, the WGNHS was actively assisting the DNR in its review of the proposed massive sulfide mine near Crandon, Wisconsin. This review included development and testing of groundwater flow and contaminant transport models being used to evaluate the potential effects of the mine on local groundwater and surface-water features. During 2004 the WGNHS will finalize reports on technical aspects of these groundwater flow models so that the knowledge gained during the mine-permit review is available to future environmental projects.

Investigation of unsewered rural subdivisions. Population growth and urban expansion in many areas has resulted in residential development on formerly agricultural land, but there have been few studies of the impacts of such developments on groundwater quality. To document the effects of this land-use conversion on groundwater quality, the WGNHS initiated a monitoring program to collect water-quality data before, during, and after construction of a new, unsewered subdivision located on agricultural land several miles outside of Madison, Wisconsin. This project, in cooperation with the Dane County Executive and the Madison Builders Association, is one of the first scientifically rigorous studies of the before-and-after impacts of rural subdivisions in the United States.

Groundwater use. In FY 04, the WGNHS was awarded funding for a two-year project investigating changes in groundwater pumping. The project will begin in FY 05 and focus on determining the cause of exponential growth in groundwater pumping that has occurred in Waukesha County over the last several decades, and compare this to changes in groundwater pumping that have occurred in a predominantly rural area (Sauk County). This study, funded by the USGS and the Water Resources Institute, will also evaluate methods for tracking groundwater pumping in Wisconsin.

Groundwater Education

WGNHS groundwater education programs for the general public are usually coordinated with the UW-Extension network of county-based faculty, the DNR, the Central Wisconsin Groundwater Center, or the UW-Extension Environmental Resources Center. The WGNHS also produces and serves as a distributor of many groundwater educational publications and visual aids. Some of these materials are primarily DNR products, but it has proven to be convenient and effective to use our map and publication sales and distribution system.

In FY 04 WGNHS staff members participated in groundwater educational meetings in counties where county mapping and/or other hydrogeologic studies are in progress. Arsenic in groundwater and the potential groundwater implications of proposed quarries, gravel pits, and high-capacity wells have been popular topics recently and probably will continue to provide educational opportunities in FY 05. Several staff members will contribute to professional short courses that educate professionals (such as consultants, regulators, and officials) on technical aspects of well hydraulics, wellhead protection, waste disposal, etc.

Geologic and hydrogeologic field trips for DNR water staff and new DNR employees have been held in the past and will continue in FY 05. We also provide a collection of representative Wisconsin rocks for teachers to use, which include samples of our major aquifers.

Groundwater Data Management

Computerized groundwater databases, including GIS data, continue to be developed at the Survey, usually on a project basis to assist with ongoing research. The effort to integrate, standardize, and document our data holdings continues to be a priority. Another priority is to make high quality, accurate digital datasets available to state agencies and the public. In FY 04, the WGNHS developed and published a version of the primary geologic database for distribution to the general public in digital format. This database, called *wisc*LITH, contains lithologic and stratigraphic descriptions of geologic samples collected from across the state. The database is searchable by location, stratigraphy, and lithology.

The WGNHS serves as the repository for 1936–1995 Well Constructor's Reports, one- to two-page reports that are usually submitted to the DNR by a well driller within a few months of a well's completion. Approximately 400,000 of these reports are on file at the Survey. Approximately 350,000 of the Well Constructor's Reports (those covering 1936–1989) have been scanned and information has been entered into a basic database.

The database and scanned images are now available to state agencies, consulting firms, and private well owners on CD-ROM. The computerization of these records allows WGNHS to streamline record keeping and provide better, more usable information to the public. Locational information on the Well Constructor's Reports is scrutinized and updated during our county and regional studies. The development of a separate statewide database for approximately 36,000 geologic logs and drillcores is ongoing.

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For more information, contact Ken Bradbury, Wisconsin Geological and Natural History Survey, 3817 Mineral Point Road, Madison, WI, 53705-5100; phone: 608-263-7389; email: krbradbu@wisc.edu; Web site: http://www.uwex.edu/wgnhs/.

UNIVERSITY OF WISCONSIN SYSTEM

The University of Wisconsin System (UWS) has research, teaching and outreach responsibilities. These three missions are integrated through cooperation and joint appointments of teaching, research, and extension personnel who work on groundwater issues. UWS staff work with state and federal agencies and other partners to solve

groundwater resource issues. Citizen outreach is accomplished through use of publications, public meetings, teleconferences, and water testing and satellite programs. Activities of several specific programs follow.

The UW Water Resources Institute (WRI)

The UW Water Resources Institute (WRI) is one of 54 water resources institutes located at Land Grant universities across the nation. It promotes research, training, and information dissemination focused on the nation's water resources problems.

Research. The WRI research portfolio includes interdisciplinary projects in four broad areas: groundwater, surface water, groundwater-surface water interactions, and drinking water. Groundwater is a top priority and an area of particular strength at the Wisconsin WRI. Key areas of emphasis in FY 04 included studies of the behavior of mercury in the aquatic environment, potential for aquifer storage and recovery, and investigations into the presence of arsenic in drinking water supplies.

During FY 04, the WRI directed a wide-ranging program of priority groundwater research consisting of 12 projects. These included short- and long-term studies both applied and fundamental in nature. They provide a balanced program of laboratory, field and computer-modeling studies and applications aimed at preserving or improving groundwater quality. The groundwater problems investigated during the past year include:

- A study on the potential for antibiotics from municipal treatment plants and agricultural areas to leach into groundwater;
- Investigation of the potential for aquifer storage and recovery systems in specific geological formations in Wisconsin;
- Determination of the role of hyporheic zones (layers of sediment beneath or adjacent to a stream) in the production and transport of methylmercury to Lake Superior;
- Investigation into the sources of arsenic and the mechanisms of its release in southeastern Wisconsin;
- A study evaluating long-term viability of landfill liners in protecting groundwater quality;
- Determination of the effects of dewatering of important groundwater aquifers in southeastern Wisconsin (two projects);
- Studying the applicability of aeromagnetic data for better modeling subsurface aquifers;
- Evaluating the use of a two-phase approach to remediate groundwater contamination during “pump and treat” processes;
- Studying methods to best incorporate effects on groundwater resources as communities develop Smart Growth plans;
- Determination of the influence of trees on groundwater levels and contaminant concentrations;
- Testing the use of “rain gardens” for receiving runoff and recharging local aquifers;

These 12 funded projects provided training in several disciplines for post-doctoral research associates, graduate student research assistants and undergraduate students at UW-Madison, UW-Milwaukee, UW-Stevens Point, UW-Extension and UW-Parkside.

The UWS selected eight new groundwater research projects from this year's Solicitation for Proposals for support during FY 05 (July 1, 2004–June 30, 2005) (see Table 2). Six projects, selected from the previous year's solicitation, will receive continuation support during FY 05. The new projects are based at UW-Madison, UW-Extension, and UW-Stevens Point.

Teaching. Institutions within the UWS continue to offer undergraduate- and graduate-level courses and programs focusing on diverse issues regarding groundwater resources. Additionally, several campuses offer for-credit, field-oriented water curriculum courses for middle and high school teachers during summer sessions. The WRI views education as an important component of its total program and recognizes the importance of K-12 education as a fundamental component of its outreach and training effort. The WRI distributes two publications—*Local Watershed Problem Studies-Elementary Activities* and *Local Watershed Problem Studies-Middle and High School Curricula Guide*—upon request. These two guides assist educators in the development and dissemination of curricula concerning soil and water resources. In addition, the Water Resources Library has purchased a number of other guides with innovative approaches to teaching water-related science in K-12 classes.

Grants administration**.** WRI staff members developed a Web site that enables online proposal submission and review of the FY 05 Joint Solicitation of Groundwater and Related Research and Monitoring Proposals. The site allows investigators to submit proposals one section at a time, rather than waiting until the entire document is complete. Having proposals in electronic format also makes the proposal review process more convenient. Reviewers can simply log on to the site and review proposals at their convenience.

Information transfer**.** An effective system of water information dissemination is vital for researchers, state agency personnel, state legislators and legislative agencies, and the general public to make informed decisions on water policy and promulgate intelligent water-related regulations.

During the past year, WRI continued its established information transfer activities, but also began a number of innovative projects. WRI continued to develop and maintain a Web site to disseminate groundwater information and increase awareness of WRI activities; distribute news releases, provide a library of water-related printed and electronic materials; offer library reference services to interested individuals; sponsor conferences; and publish and distribute technical reports, and proceedings. New projects to disseminate groundwater information include Wisconsin's Water Library, Wisconsin's Water Policy Inventory, and fact sheets about the Institute and groundwater problems.

Results of WRI-supported research are published in a variety of formats. Most WRI research ultimately appears in refereed professional journals, although results are also published in technical reports, conference proceedings and abstracts, book chapters, dissertations and theses, and conference presentations. In addition, WRI disseminates the results of more than 120 groundwater research projects funded since 1989 by itself, DNR, DATCP and Commerce through its Web site devoted to the Wisconsin Groundwater Research and Monitoring Program at *http://www.wri.wisc.edu/wgrmp/wgrmp.htm*.

Previously, only summaries of the funded projects were available on the Web site and the Water Resources Library distributed paper copies of the full final reports. During the past year, WRI made most of the WRI and selected DNR full final research reports available online and redesigned the Groundwater Research and Monitoring Web site to make it searchable by author, title and key words. The Water Resources Library partnered with UW Libraries' Digital Collections Center to digitize and put online the WRI and DNR final project reports. The WRI Groundwater Research and Monitoring Program Web site links to the full-text reports which are included in the University of Wisconsin Ecology and Natural Resources Digital Collection at *http://uwdc.library.wisc.edu/collections.html*. Inclusion in the UW Ecology and Natural Resources online collection should also make a wider audience aware of this important groundwater research.

UW Water Resources Library and Wisconsin's Water Library. The Water Resources Library is a special collection of approximately 30,000 volumes of water-related information, more than 60 journals and 100 newsletters. The collection covers all major topics in water resources, but is particularly strong in groundwater-related publications.

The library has access to the major research collection, numerous online databases and full-text resources of the UW-Madison.

During 2003, initially as a special Year of Water project, the library made its collection and services available to all Wisconsin residents by developing Wisconsin's Water Library at http://aqua.wisc.edu/waterlibrary. Any Wisconsinite may check out books or ask for assistance free of charge. Books are sent to the requestor's local public library for pick up and return. Those needing individual assistance can query the Water Resources librarian via email. This outreach project makes it possible for users to search the collection online; peruse lists of recommended books, videos and Web sites by topic; and read water-related book reviews and special features. Groundwater-related materials have been and will continue to be featured. Building local support for groundwater protection is important and "Building Conservation Organizations", an annotated list of materials for those interested in starting or strengthening an environmental organization, has proven to be particularly popular

Wisconsin's Water Policy Inventory. During the past year, staff in cooperation with a University of Wisconsin-Madison graduate seminar developed the Wisconsin Water Policies Inventory (WWPI), a Web-based tool for researching the state's major policies pertaining to water. This project, undertaken for the Year of Water, enables Wisconsinites to browse state policies by category or to search using keywords. The URL is http://www.aqua.wisc.edu/waterpolicy. Steve Born, UW-Madison professor of planning and environmental studies, co-directed the project with Elisa Graffy, United States Geological Survey policy specialist. Wisconsin citizens should now be able to easily find state laws, rules and programs that govern Wisconsin's groundwater resources.

Groundwater Fact Sheets
Water Resources Institute staff published three fact sheets dealing with the Institute and groundwater problems in Wisconsin. The fact sheets are in .pdf format and can be viewed online at http://www.wri.wisc.edu.

Water Wealth, Water Woes
An introduction to the Wisconsin Water Resources Institute, one of 54 Water Resources Research Institutes nationwide dedicated to research, outreach and education to solve state, regional and national water problems.

Groundwater Drawdown
Large-scale pumping of groundwater has caused large drawdowns – long-term drops in groundwater levels – in the Lower Fox River Valley, southeastern Wisconsin and Dane County. Drawdowns can cause serious economic, health and environmental problems: wells run dry and must be drilled deeper; concentrations of arsenic, radium, salts and other naturally occurring substances can reach unhealthy levels; and streams, lakes and wetlands lose water or dry up, depriving fish, birds, amphibians and mammals of vital habitat.

Arsenic
Elevated levels of arsenic have been detected in public and/or private drinking water systems in 30 of Wisconsin's 72 counties. Long-term exposure to arsenic in drinking water has been linked to cancer of the skin, bladder, prostate, lungs, nasal passages, kidneys and liver.

Conferences, meetings, and presentations**.** The Wisconsin WRI co-sponsored the American Water Resources Association-Wisconsin Section 28th annual meeting, March 4-5, 2004, in Wisconsin Rapids. The title of this year's event was "Understanding and Managing Water Resources for the Future". This annual meeting is unique in that it encourages students to present papers or posters describing their original research. Students funded through the Wisconsin Groundwater Research and Monitoring Program are particularly encouraged to present results of their research.

UWS Publications, Patents and Presentations Resulting from Wisconsin Groundwater Research and Monitoring Program Projects in FY 04

Anderson, M. 2003. Photocatalytic Adsorption Media and Processes for Enhanced Removal of Arsenic from Groundwater. Groundwater Research Report WRI GRR 03-11. Madison: UW Water Resources Institute.

Anderson, M.L., D.J. Hart, and D. Alumbaugh. 2003. Determination of Aquitard and Crystalline Bedrock Depth Using Time Domain Electromagnetics. Groundwater Research Report WRI GRR 03-06. Madison: UW Water Resources Institute.

Anderson, M.L., D.J. Hart, and D. Alumbaugh. 2003. Use of the Time-Domain Electromagnetic Method for Determining the Presence and Depth of Aquitards. Presented at American Water Resources Association – Wisconsin Section, 27th Annual Meeting.

Anderson, M.L. 2003. Use of the Time-Domain Electromagnetic Method for Determining the Presence and Depth of Aquitards. Master's Thesis. University of Wisconsin.

Bradbury, K.R. and J.D. Wilcox. 2003. Impacts of Privately Sewered Subdivisions on Groundwater Quality in Dane County. Groundwater Research Report WRI-GRR 03-03. Madison: UW Water Resources Institute.

Browne, B.A. and N.M. Guldan. 2003. Monitoring and Scaling of Water Quality in the Tomorrow-Waupaca Watershed. Groundwater Research Report WRI GRR 03-09. Madison: UW Water Resources Institute.

Browne, B.A. 2003. Pumping Induced Ebullition: A Unified and Simplified Method for Measuring Multiple Dissolved Gases. For submission to Environmental Science and Technology.

Dussaillant, A.R., C. Wu, and K.W. Potter. 2004. Richards Equation Model of a Rain Garden. Journal of Hydrologic Engineering 9(3): 219-225.

Evangelista, F.S. and A.M. Pelayo. 2003. F Test for Natural Attenuation in Groundwater: Application on Benzene. Groundwater Research Report WRI GRR 03-10. Madison: UW Water Resources Institute.

Evans, C.V. and Z. Li. 2003. Removal of Heavy Metals and Radionuclides from Soils Using Cationic Surfactant Flushing. Groundwater Research Report WRI GRR 03-04. Madison: UW Water Resources Institute.

Furreness, A. 2003. What's in Your Food? Presented at the Wisconsin Environmental Health Association meeting.

_____. 2003. The Future of Rowan Creek Watershed: Connecting Land Use and Management with Water Quality. Madison: Gaylord Nelson Institute for Environmental Studies, University of Wisconsin-Madison.

Gaffield, S J., T.W. Rayne, L. Wang, and K.R. Bradbury. 2003. Impacts of Land Use and Groundwater Flow on the Temperature of Wisconsin Trout Streams. Groundwater Research Report WRI GRR 03-05. Madison: UW Water Resources Institute.

Jang, M., E.W. Shin, J.K. Park, and S.I. Choi. Mechanisms of Arsenate Adsorption by Highly-Ordered Nano-Structured Silicate Media Impregnated with Metal Oxides. Accepted by Environmental Science and Technology.

Jang, M., E.W. Shin, and J.K. Park. 2003. Removal of Arsenic Using Mesoporous Silicate Media Impregnated Metal Oxides Nano-Particles. Presentation at WEFTEC Research Section 41.

Li, Z., D. Alessi, and L. Allen. 2002. Influence of Quaternary Ammonium on Sorption of Selected Metal Cations onto Clinoptilolite Zeolite. J. Environ. Qual. 31: 1106-1114.

Ming, J., J.K. Park, and E.W. Shin. Lanthanum Functionalized Highly Ordered Mesoporous Media for Arsenic Removal. Submitted to Environmental Science and Technology.

Olson, H. 2003. Defining Pb Bioavailability: A Greenhouse Study. Presented at the Wisconsin Environmental Health Association meeting.

Park, J.K. 2003. Removal of Arsenic in Groundwater Using Novel Mesoporous Sorbent. Groundwater Research Report WRI GRR 03-07. Madison: UW Water Resources Institute.

Park, J.K. and M. Jang. Removal of Arsenic and Other Anions Using Novel Adsorbents. Patent (U.S. Patent) proceeding.

Pelayo, A.M. and F.S. Evangelista. 2003. A Statistical F Test for the Natural Attenuation of Contaminants in Groundwater. Environmental Monitoring and Assessment 83: 47-70.

Potter, K.W. 2003. Field Evaluation of Rain Gardens as a Method for Enhancing Groundwater Recharge. Groundwater Research Report WRI GRR 03-08. Madison: UW Water Resources Institute.

Rayne, T.W., S.J. Gaffield and K.R. Bradbury. 2003. Linking Groundwater Recharge, Flow, and Stream-Temperature Models to Simulate the Effects of Local Land-Use on a Stream. Geological Society of America Annual Meeting, Abstracts and Programs, abstract 65887.

Reardon, C.L. Allen, Z. Li, and C.V. Evans. Desorption of Lead from Kaolinite and Illite Using Cationic Surfactant. To be submitted to Journal of Environmental Quality.

Shin, E.W., J.S. Han, M. Jang, S.-H. Min, J.K. Park and R.M. Rowell. Phosphorus Adsorption on A1-Impregnated Mesoporous Silicate: Surface Structure and Adsorption Behavior. Submitted to Environmental Science and Technology.

Wilcox, J.D. 2003. Variability of Groundwater Chemistry in an Agricultural Setting and Implications for Assessing Impacts of Land Use Change. M.S. Thesis. University of Wisconsin-Madison.

Willms, C.A. 2003. Desorption of Cesium from Kaolinite and Illite Using Cationic Surfactants. Presented at the annual UW System Undergraduate Symposium at La Crosse, Wis.

Willms, C.Z. Li, L. Allen, and C.V. Evans. Desorption of Cesium from Kaolinite and Illite Using Alkylammonium Salts. Accepted by Applied Clay Science.

Wilcox, J.D., K.R. Bradbury, J.M. Bahr, and C.L. Thomas. 2003. Variability of Groundwater Quality beneath an Unsewered Rural Subdivision. Presentation at Geological Society of America.

Wilcox, J.D., J.M. Bahr, K.R. Bradbury, and C.L. Thomas. 2003. Variability in Groundwater Chemistry beneath Agricultural and Rural Residential Land Uses. Wisconsin Ground Water Association Annual Conference Program.

Wilcox, J.D., C.L. Thomas, K.R. Bradbury, and J.M. Bahr. 2003. Spatial and Temporal Variability of Groundwater Chemistry beneath Agricultural Land: Implications for Assessing Environmental Impacts of a New Unsewered Subdivision. Presented at American Water Resources Association – Wisconsin Section 27th Annual Meeting.

For more information, visit http://www.wri.wisc.edu/ or contact Dr. Anders W. Andren, director, UW-Madison Water Resources Institute, 1975 Willow Drive, Madison, WI 53706; phone (608) 262-0905, fax (608) 263-2063, or email awandren@seagrant.wisc.edu.

UW-Extension's Groundwater Center

The Groundwater Center provides groundwater education and technical assistance to the citizens and governments of Wisconsin. Programs range in breadth from answering citizen questions to helping communities with wellhead protection planning, describing the extent and causes of groundwater nonpoint pollution in Wisconsin, assessing drinking water quality, and working on groundwater policy. The center is part of the Center for Watershed Science and Education, an office of UW-Extension Cooperative Extension Service and the UW-Stevens Point College of Natural Resources, and frequently works through county Extension faculty in program delivery. More information can be found at *http://www.uwsp.edu/cnr/gndwater/*.

Drinking water programs. In 2003, the Center assisted over 2950 household in having their water tested in conjunction with county Extension offices and the Watershed Center's Water and Environmental Analysis Laboratory. Of these, 8% exceeded drinking water standards for nitrate-nitrogen. Sixteen percent of samples were unsafe because of coliform bacteria. Eleven Drinking Water Education Programs helped nearly 900 well users in six counties to understand potential remedies for these problems and the relationship of land use practices to groundwater quality.

Water quality database. The Groundwater Center maintains a database of private well testing data from the Water and Environmental Analysis Regional Laboratory at UW-Stevens Point, and Drinking Water Education Programs conducted through the Center. There are currently over 392,000 individual test results for approximately 54,000 samples covering the state. Chemistry data includes pH, conductivity, alkalinity, total hardness, nitrate-nitrogen, chloride, saturation index, and coliform bacteria. In 1998, a new sampling program for iron, sodium, potassium, copper, lead, calcium, magnesium, manganese, zinc, and triazine was also initiated. Arsenic and sulfate were added late in 1999. The database primarily covers the period 1985 to the present. The database is PC-based and can be easily queried to be a significant source of information for local communities and groundwater managers. Forty-four counties are represented by 100 or more samples in the databases and 27 counties are represented by 500 or more samples.

Policy. Center staff continues to play pivotal roles in a number of state groundwater issues. Working with partners in the private and public sectors on groundwater quantity policy and law has been a major priority for the Center this past year, and efforts have contributed to the passage of new groundwater quantity legislation.

Partnerships. Center staff works with agencies and private organizations, including the Wisconsin Agricultural Stewardship Initiative, Wisconsin Potato and Vegetable Growers Association Nonpoint Pollution subgroup, DATCP Atrazine Technical Advisory Committee, Golden Sands Resource Conservation and Development Area Water Resources Committee, and Extension Nutrient Management Self-Directed Team. The Center contributed heavily to the Wisconsin Academy's Waters of Wisconsin Initiative, and is involved with many local watershed based groups.

Groundwater Guardian. A continuing effort this year involves using the national Groundwater Guardian program to build the groundwater knowledge and leadership skills of Wisconsin citizens in order to develop a Wisconsin grass-roots groundwater constituency. In partnership with the DNR, the Center has been supporting a statewide Groundwater Guardian program coordinator. The program has developed outreach materials including a display, presentation, and brochure; made numerous presentations to interested groups; assisted the seven existing Wisconsin Groundwater Guardian communities in carrying out their activities; and was heavily involved in coordinating the Second Annual WI Groundwater Festival in Waukesha which was attended by more than 600 students and attracted nearly 100 volunteers. More about Wisconsin Groundwater Guardian program can be found at *http://www.uwsp.edu/cnr/gwguardian/*.

Other UW-Extension Water Programs

UWS Farm and Home Environmental Management Program. The UWS Farm and Home Environmental Management Program encompasses voluntary pollution risk assessment and prevention activities. The program

was known originally for its Farm Assessment System (Farm*A*Syst) and Home Assessment System (Home*A*Syst) projects and materials. The "Farm and Home" program is currently launching new projects that build on previous lessons, and increasingly integrating water quality protection with other types of environmental citizenship. Projects are designed to enable and motivate urban and rural landowners, managers and residents to assess environmental and health risks and to take voluntary actions to prevent pollution from long-term investments such as the siting of structures, and from daily management practices. While the program continues to publish pollution prevention worksheets and fact sheets, increasingly it is making customized interactive worksheets available via the World Wide Web. The programs are available statewide.

The Wisconsin Dairy Environmental Management Systems (EMS) project coordinates interests among WDNR, DATCP commodity and farm organizations, environmental organizations, and private sector advocates of EMS. One tangible benefit to farmers that has emerged is reduced insurance rates for pollution and general liability. Using the project's 12 page Livestock EMS synopsis to create a template, a Green Bay insurance agent negotiated reduced liability insurance premiums for manure haulers and dairy farms. The project is working with the Dairy Business Association to integrate the EMS framework with the Dairy Quality Assurance audit program. The Wisconsin Milk Marketing Board is collaborating on a web site to explain to farmers the relationships among various state environmental programs. Farmers engaged with EMS implementation indicate that the framework has improved farm profitability, their sense of security about their farm's environmental and health impacts, and their greater sense of control over the whole farm's management and profitability, even in the face of rising regulatory scrutiny, and greater international competition. The Farm & Home program is in the final stages of editing an EMS Guidebook for Wisconsin Farms.

A new grant from the North Central Sustainable Agriculture, Research and Education Program (SARE) will analyze gaps and strengths of six different approaches to managing the environmental impacts of Midwestern dairy farming. Our goal is to identify whether and how each approach falls short of achieving (or promising to achieve) environmental sustainability, and how it might be complemented with an "Environmental Management System" to strengthen farm sustainability. The six management approaches are: certified organic, certified Midwest Food Alliance operation, grass-based Holistic Management, biodynamic, permitted Confined Animal Feeding Operation (CAFO) and a conventional farm which meets NRCS requirements for incentive payments. Methods include document analysis as well as six case studies to pinpoint environmental vulnerabilities and develop and publicize recommendations toward filling the gaps with each approach. Results of this project will be put on a web site as they become available.

The Healthy Homes Partnership, a subset of Home*A*Syst held a Healthy Homes offers materials via CD and on the Web as well as the current print edition of Help Yourself to a Healthy Home. The Home*A*Syst, Farm & Home Program is conducting social marketing research with landscape managers about pesticide use and practices in the Lake Monona Watershed. Data from this research is being compiled and analyzed. Preliminary work and subsequent reports and products can be found at *http://www.uwex.edu/farmandhome/monona*. Lessons will be relevant to encouraging landscape managers statewide to adopt more water pollution preventing techniques.

July 2003 – June 2004 Publications Produced By the Farm & Home Environmental Management Program

- *Agricultural Environmental Management Systems: Farm Management for Improving Your Environmental and Economic Bottom Line*. Produced by Farm and Home Environmental Management Programs/UW-Extension. Project supported by USDA/CSREES/IFAFS, USDA/NRCS, and the U.S. EPA.

- *Healthy Home Web Tool, "Help Yourself to a Healthy Home".* Interactive Web site and Demonstration CD. Produced by the Healthy Home Partnership, a joint education initiative sponsored by the Environmental Protection Agency (EPA), the Department of Housing and Urban Development (HUD), and the USDA's Cooperative Research, Extension and Education Service (CSREES). For more information, visit *http://www.uwex.edu/healthyhome*.

- Agriculture EMS web site for general public education about agricultural environmental management systems: http://www.uwex.edu/agems/

- Wisconsin EMS web site for dairy farmers to conduct environmental assessments and planning as part of their EMS development: http://ww.uwex.edu/agems/dairy/wisems

- Agricultural Electrical Energy Consumption: A Focus on Energy Initiative. Focus on Energy sponsored web tool for farm electricity conservation: http://www.soils.wisc.edu:9880/foe/login. An assessment was developed for greenhouses in 2004. This web tool is also accessible via the Focus on Energy web site at http://www.focusonenergy.org/.

UW Environmental Resources Center (ERC). The UW Environmental Resources Center (ERC) develops and coordinates a number of national youth water education initiatives related to groundwater. The ERC provides national coordination for two youth water education programs, *Educating Young People About Water* (EYPAW) and *Give Water a Hand* (GWAH). The EYPAW guides and water curricula database provide assistance for developing a community-based, youth water education program. The EYPAW web site, http://www.uwex.edu/erc/eypaw, provides access to a database of more than 140 water-related curricula that may be searched by grade level or water topic. The goals of the GWAH curriculum are to protect and improve local water quality by encouraging youth to investigate local issues, and plan and complete a service project. Youth then address a problem they identify with the assistance of a local natural resource expert. Program materials consist of an Action Guide for youth, with step-by-step instructions for addressing local watershed concerns, and a Leader Guidebook to assist teachers and youth leaders in facilitating projects. Both guides may be downloaded from the *Give Water a Hand* web site, http://www.uwex.edu/erc/gwah. Other ERC youth water education initiatives include: *Agua Pura*, a leader institute planning manual and guide for Latino water education; an evaluation of USGS water education materials to assist with USGS education program development decisions; and gap analyses of youth water curriculum for source water education and riparian education resources. New water education projects include the development of a national riparian curriculum and a collaboration with USDA/CSREES and other federal agency clean and safe water partners to develop and promote best education practices for water education and to improve access to education resources and strategies. Find links to these programs on the ERC web site at http://www.uwex.edu/erc.

UW Nutrient and Pest Management (NPM) program. In 1990 a broad coalition of agricultural organizations, environmentalists, and the University sought funding for a water quality program for farmers and the agricultural community. Over the past fourteen years, the NPM outreach program has conducted on-farm demonstrations and education throughout Wisconsin to address groundwater and surface water contamination from agriculture and the profitability of recommended practices.

A major portion of the program's focus has been nutrient management – the careful, profitable use of fertilizers and animal manures in crop production. During FY 03, NPM revised and distributed the *Nutrient Management Farmer Education Curriculum* that includes a discussion of nitrates in groundwater. In 2003-2004, the curriculum was taught in 15 counties to nearly 150 producers. NPM also coordinated two Training for Nutrient Management Planners workshops that taught 100 agricultural and conservation professionals how to write nutrient management plans following the new USDA-NRCS-Wisconsin 590 standard. The balance of the training and other NPM's nutrient management work dealt with phosphorus and surface water concerns during 2003-2004. To prevent pesticide contamination of groundwater resulting from field applications, the program delivered integrated pest management education and coordinated Wisconsin extension's WeedSoft development and delivery. WeedSoft is a computer program that helps growers makes cost effective, environmentally sound weed management decisions. One module includes leaching ratings to assist growers in herbicide selection.

NPM continues to work with Wisconsin farmers to ensure they are not over-applying nitrogen and other inputs so as to minimize potential losses to groundwater. The NPM field staff completed on-farm demonstrations, manure spreader calibration, and taught many farmers how to write and update their nutrient management plans. More information on these efforts and many publications are available at the NPM web site (http://ipcm.wisc.edu).

Basin Education Initiative. The UWS cooperates on community-focused educational programs with other state agencies involved with water resources and natural resource issues. Since 1998, UW-Extension had worked in partnership with the DNR and USDA-NRCS in Wisconsin to provide water and related natural resources education at the landscape and watershed level within the state's 22 major river basins. Fifteen Basin Educators work collaboratively at the local (basin) level and receive state-level support for publication/educational material development, evaluation, and administration. Collectively, the Basin Education Initiative works to support local conservation professionals such as county Extension agents, Land Conservation Department staff, and NRCS staff. The educational programs address a broad range of groundwater-related topics, including drinking water, threats to groundwater quality, impacts of land-use changes and land management decisions on groundwater quantity, information about localized groundwater problems such as karst, and a variety of other water quality issues. More information can be found at *http://clean-water.uwex.edu*.

Multi-Agency Land and Water Education Grant Program (MALWEG). UW-Extension coordinates the Multi-Agency Land and Water Education Grant Program (MALWEG) which has funded ten groundwater-focused projects since its inception in 1997. These projects, which totaled over $170,000 in educational assistance funds, examined the effects of intensive rotational grazing on groundwater quality, provided well testing for rural landowners, and conducted Farm*A*Syst assessments to help farmers identify and address groundwater contamination on their property. Altogether, between January 1, 1997, and December 31, 2002, 134 projects totaling over $1.8 million have been funded to improve Wisconsin's land and water resources. The source of this money has primarily been the USDA's Environmental Quality Incentives Program and Grazing Lands Conservation Initiative. The program has also reached more than 400 farmers through educational workshops addressing comprehensive nutrient management planning. More information can be found at *http://clean-water.uwex.edu/malweg/*.

For more information on UW Extension groundwater programs, contact Jim Peterson, UW Environmental Resources Center, 1545 Observatory Drive, WI 53706-1289, phone (608) 262-3799, fax (608) 262-2031, or email jopeters@wisc.edu; or George Kraft, Center for Watershed Science and Education, College of Natural Resources, UW-Stevens Point, Stevens Point, WI 54481; phone (715) 346-4270; email gndwater@uwsp.edu.

Wisconsin State Laboratory of Hygiene

General program description. At the Wisconsin State Laboratory of Hygiene (WSLH), a great deal of effort is focused on identifying and monitoring chemical and microbial contaminants in groundwater through routine testing, emergency response, education and outreach, and specialized research. The activities related to groundwater span several departments at WSLH and, collectively, their efforts make up the WSLH Drinking Water Quality Program. The mission of the WSLH Drinking Water Quality Program is to protect the health of drinking water consumers by providing analytical expertise, research and educational services to the scientific and regulatory communities.

The chemical and microbial groundwater contaminants routinely tested for include all contaminants regulated by the federal Safe Drinking Water Act as well as many emerging contaminants that appear on the USEPA Contaminant Candidate List. Examples include: fecal indicators (total coliform, *E. coli,* coliphage), *Helicobacter pylori, E. coli* O157:H7, *Salmonella*, waterborne viruses, parasites (*Cryptosporidium*, *Giardia*, and microsporidia), radioactivity, inorganic compounds (mercury, nitrate, arsenic) and organic compounds (atrazine, PCBs, PBDEs).

Another important focus of the WSLH Drinking Water Quality Program is emergency response to incidences involving groundwater. For example, WSLH works with DHFS and DNR to investigate outbreaks of illnesses of unknown (possibly food or water) origin. Staff provides background information on the outbreaks for local public health officials, local media, and the general public. WSLH also responds to spills and incidents and supports state agencies in remediation and emergency clean-up activities. Most recently, WSLH has focused its efforts on enhancing and expanding terrorism response programs.

WSLH also provides educational and outreach activities related to groundwater and drinking water including: instructional consultations for well owners and well drillers; on-site training of municipal water supply operators; and tours for a variety of international, educational, regulatory, and other governmental groups. Staff has developed an interactive study guide dealing with safety, sampling, and chemistry for drinking water operators and publications related to drinking water. Staff attends and presents papers at a variety of conferences and symposia and publishes research finding in professional journals.

Summary of groundwater-related activities accomplished in FY 04. Research projects conducted by the Drinking Water Quality program at WSLH focus on a variety of topics related to the analysis and monitoring of microbiological and chemical contaminants in groundwater.

Three research projects funded by the WDNR through the GCC's Groundwater Research and Monitoring Program were completed in FY 04:

Sonzogni, W.C., Clary, A., Bowman, G., Standridge, J., Johnson, D. and M. Gotkowitz. 2003. Importance of Disinfection on Arsenic Release in Wells, Wisconsin State Laboratory of Hygiene, University of Wisconsin, Madison, 57p.

Arndt, M.F., West, L. and W.C. Sonzogni. 2003. A Study of the Factors Affecting the Gross Alpha Measurement, and a Radiochemical Analysis of some Groundwater Samples from the State of Wisconsin Exhibiting an Elevated Gross Alpha Activity**,** Wisconsin State Laboratory of Hygiene, University of Wisconsin, Madison, 56p.

Strauss, J.C. 2003. Evaluation of Enzyme Linked Immunosorbent Assay (ELISA) for Diaminoatrazine Analysis of Water Samples in Comparison to Gas Chromatography, Wisconsin State Laboratory of Hygiene, University of Wisconsin, Madison, 18p.

Two research projects funded by the UW System through the GCC's Groundwater Research and Monitoring Program were awarded in FY 04 and are slated to begin in FY 05:

Occurrence of Estrogenic Endocrine Disruptors in Groundwater. Jocelyn Hemming, Wisconsin State Laboratory of Hygiene.

A comparison of USEPA approved enzyme-based total coliform/E. coli tests for microbiological groundwater monitoring and laboratory consultation. Jeremy Olstadt, Wisconsin State Laboratory of Hygiene.

Research projects that were on-going in FY 04 include:

Assessment of endocrine disrupting chemical in water reclamation systems (funded by the Water Environment Research Foundation, WERF)

Comparison of pesticide home water testing kits with certified analytical laboratory results (funded by WDNR)

For more information, visit the following website (http://www.slh.wisc.edu/) or contact William Sonzogni, Wisconsin State Laboratory of Hygiene, 2601 Agriculture Drive, Madison, WI 53703, phone (608) 224-6200, or email sonzogni@facstaff.wisc.edu.

FEDERAL AGENCY PARTNERS

U.S. Geological Survey: Water Resources Discipline - Wisconsin District

The mission of the U.S. Geological Survey-Water Resources Discipline 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, State and local 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 groundwater.

- 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.

The Wisconsin District is currently conducting cooperative projects that have a significant groundwater component with the DNR, WGNHS, Southeast Wisconsin Regional Planning Commission (SEWRPC), the Menominee, Stockbridge-Munsee, Ho-Chunk and Lac Court Oreilles Tribes of Wisconsin, and the Great Lakes Protection Fund. In addition, several projects are funded by Federal agencies: EPA-Region 5, National Park Service, and USGS. On-going projects that have a significant groundwater component are listed below.

Ongoing projects with state and local agencies

1. Groundwater observation well network.
2. Wisconsin water-use data file.
3. Southeast Wisconsin Hydrologic Study.
4. Susceptibility of La Crosse municipal wells to enteric virus contamination from surface water.
5. Simulation of shallow groundwater flow for parts of the Menominee, Stockbridge-Munsee, Ho-Chunk Reservations.
6. Educational website development highlighting Groundwater and the Great Lakes.
7. Impacts of urbanization on infiltration in the Black Earth Creek watershed
8. Simulation of groundwater/surface-water systems in Pierce, St. Croix, and Polk Counties

Ongoing projects with Federal agencies

1. Hydrologic and biogeochemical budgets in temperate lakes and their watersheds, Northern Wisconsin (USGS)
2. Western Lake Michigan Drainages National Water-Quality Assessment (USGS)
3. Simulation of groundwater/surface water interaction in the St. Croix River Basin, Wisconsin and Minnesota.
4. Spatial and temporal shallow groundwater recharge rates in Wisconsin.

The USGS contributed two significant accomplishments to help protect Wisconsin's groundwater in FY 04:

- In cooperation with WGNHS and SEWRPC, the groundwater flow of southeast Wisconsin (both shallow and deep aquifers) was simulated for conditions from pre-development to present. This work provides a hydrologic framework for the southeast Wisconsin groundwater management area.

- An educational website has been developed in cooperation with the Great Lakes Protection Fund to highlight the hydrology of groundwater in the Great Lakes Basin. The web site is titled "Ground water in the Great Lakes: The case of southeastern Wisconsin" (*http://wi.water.usgs.gov/glpf/*).

A summary of the Wisconsin District projects and listing of publications is published annually in "Water-Resources Investigations in Wisconsin." Copies of the summary are available at the Wisconsin District Office or by calling 608-821-3801.

For more information please contact Chuck Dunning USGS, 8505 Research Way, Middleton, Wisconsin, 53562-3581 (608-821-3827), cdunning@usgs.gov, Randy Hunt (608-821-3847), rjhunt@usgs.gov or visit the Wisconsin District web page (http://wi.water.usgs.gov).

USDA Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) is a federal agency within the US Department of Agriculture. The NRCS, formerly the Soil Conservation Service, works with private landowners to promote conservation of natural resources. In Federal fiscal year 2003 (Oct. 1, 2002 to Sept. 30, 2003), over 34,000 clients received some form of Conservation Technical Assistance (CTA) in cooperation with county Land Conservation Departments.

The agency protects groundwater by providing technical assistance to landowners through the following ongoing conservation practices and programs:

- *Nutrient management*: management of the amount, form, placement and timing of nutrients applied to the soil so that the amount applied is only what is needed to produce optimum crop yield. This reduces the potential for applied nutrients to pollute surface and groundwater. Last year 234,600 acres of nutrient management plans were implemented through federal programs.
- *Pest management*: utilization of environmentally sensitive prevention, avoidance, monitoring and suppression strategies to manage weeds, insects, diseases, animals and other organisms that directly or indirectly cause damage or annoyance. This enhances quantity and quality of commodities. It also minimizes negative impacts of pest control on soil resources, water resources, air resources, plant resources, animal resources and/or humans.
- *Animal waste storage*: proper waste storage siting and design is imperative to protect groundwater from contamination by nutrients in animal waste. Last year 69 animal manure storage structures were installed.
- *Comprehensive Nutrient Management Plan (CNMP):* a conservation system unique to livestock farms. It is a grouping of conservation practices and management activities to insure both production and resource protection goals. It addresses soil erosion, manure, and organic by-product impact on surface and groundwater quality. CNMP components include nutrient management based on phosphorus or nitrogen, manure and wastewater handling and storage, adequate erosion control of cropland, and proper record keeping. CNMPs entail a thorough review of the farmstead, ensuring that manure and wastewater are properly stored and handled, stormwater remains clean or is captured, and drinking water wells are properly protected. It may also include feed management to reduce phosphorus in manure and other manure use alternatives such as biofuel production and composting. Last year 45 CNMPs were written. CNMPs were implemented on 16 farms involving 5,700 acres.
- *Farm*A*Syst Program*: a site assessment program to determine areas of possible groundwater contamination on a farm or rural home - enables individuals to apply management practices to their own property. *http://www.uwex.edu/farmasyst*
- *Wetland Reserve Program*: restores wetlands through permanent or 30-year easements or 10-year contracts. Last year about 8,300 acres of wetlands were restored.

- *Environmental Quality Incentives Program*: provides cost sharing for conservation practices on agricultural land. Statewide priorities include groundwater protection practices such as well decommissioning and nutrient and pesticide management and prescribed grazing. Last year about 449,000 acres of conservation systems were planned, including 281,000 acres of erosion reduction, 78,000 acres of wildlife habitat, and 18,000 acres of managed grazing land.
- *Well decommissioning*: proper decommissioning is essential to prevent contaminants from entering groundwater through abandoned wells, which are direct conduits to the groundwater.
- *Conservation Reserve Program/Conservation Reserve Enhancement Program*: participants establish permanent vegetative cover on agricultural lands in return for guaranteed rental payments. Last year approximately 17,700 acres of riparian buffers were installed and 11,400 acres of trees and shrubs were established.
- *Dam rehabilitation pilot project*: From the 1950s to 1980s, through the Watershed Flood Prevention Act (PL566), NRCS built 87 small flood control dams in Wisconsin that reduced flooding and improved groundwater infiltration. Since 2000, NRCS has planned or completed the rehabilitation of 13 deteriorating dams in seven western counties as part of a four state pilot project. Planning will begin on 5 more dams soon. These accomplishments resulted in the obligation of $4 million in federal rehabilitation funds. In an average year, these projects reduce flood damages on crops, roads, and communities by an estimated $2 million. So far, with the heavy rains occurring in 2004, the estimated reduction in flood damages is $15 million.

The agency also provides leadership in the following:

- *Interagency committee to find improved joint sealers for concrete animal waste storage structures*. These sealers are critical to the groundwater protection provided by these structures.
- *Interagency Committee to revise NRCS Conservation Practice Standards*. Practice Standards benefit the public by helping to protect groundwater. For example NRCS Practice Standard Code 590 – Nutrient Management is being revised in 2004. This revision enhances groundwater protection by promoting better nutrient management and minimizing agricultural nonpoint source pollution of surface and groundwater resources.

To find out more information about NRCS, go to the home page at http://www.wi.nrcs.usda.gov, contact Renae Anderson at 608-662-4422 ext. 227, or Jim Kaap at 608-662-4422 ext. 266.

Chapter 4 -- CONDITION OF THE GROUNDWATER RESOURCE

The Groundwater Coordinating Council (GCC) is directed by s. 15.347(13)(g), Wis. Stats., to submit an annual report which "…describes the state of the groundwater resource…" and to "…include a description of the current groundwater quality of the state…and a list and description of current and anticipated groundwater problems."

The purpose of this chapter is to describe the state [condition] of the groundwater resource, provide an assessment of groundwater quality and quantity issues, as well as describe current and anticipated groundwater problems. In general, groundwater is plentiful and of high quality in Wisconsin, but concern is growing about its limits and the existence of persistent and emerging threats. In addition, there is growing recognition of the interdependence of groundwater and surface water resources, as well as the influence of groundwater quantity on water quality. Further recommendations of the Council are listed in Chapter 6, *Future Directions for Groundwater Protection*.

GROUNDWATER QUALITY

As part of 1983 Wisconsin Act 410, the Groundwater Account of the Environmental Fund was created to support groundwater monitoring by state agencies to determine the extent of groundwater contamination in Wisconsin and identify the sources of contamination. Groundwater monitoring has found that the primary contaminants of concern are volatile organic compounds (VOCs), pesticides and nitrate. Increased attention is also being given to several "emerging threats," including naturally occurring radioactivity, arsenic, and microbial agents (bacteria, viruses, and parasites). Each is discussed below.

Volatile Organic Compounds

VOCs are a group of common industrial and household chemicals that evaporate, or volatilize, when exposed to air. Examples of VOCs include gasoline and industrial solvents, paints, paint thinners, drain cleaners, air fresheners, and household products (such as spot and stain removers). Short-term exposure to high concentrations of many VOCs can cause nausea, dizziness, tremors or other health problems. Some VOCs are suspected of causing cancer upon long-term exposure. Sources of VOCs in Wisconsin's groundwater include landfills, underground storage tanks (USTs), and hazardous substance spills.

Thousands of wells have been sampled for VOCs. Fifty-nine different VOCs have been found in Wisconsin groundwater, though only 34 of those have associated health standards. Trichloroethylene is the VOC found most often in Wisconsin's groundwater. **Figure 4.1** shows the location of drinking water wells with ES and PAL exceedances based on data from 6,399 unique wells recorded in the GRN database.

Wisconsin has 72 active, licensed solid waste landfills, all of which are required to monitor groundwater. In addition, the DNR currently tracks more than 9,400 UST sites, 4,000 waste disposal facilities, and about 1,400 high priority Environmental Repair sites. Many of these sites have been identified as sources of VOCs. Facilities include gas stations, bulk petroleum and pipeline facilities, plating, dry cleaning, industrial facilities, and abandoned non-approved unlicensed landfills.

Landfills. Two studies conducted over four years, first revealed that VOCs were significant contributors to groundwater contamination at Wisconsin landfills (WDNR 1988, 1989). Out of a total of 45 unlined municipal and industrial landfills tested, 27 (60%) had VOC contamination in groundwater. All of these landfills are currently closed. Of 26 unlined municipal solid waste landfills tested, VOCs contaminated groundwater at 21 (81%). No VOCs were confirmed present at any of the six engineered (liner and leachate collection) landfills included in the studies. While 20 different VOCs were detected overall, 1,1 – Dichloroethane was the most commonly occurring VOC at all of the solid waste landfills.

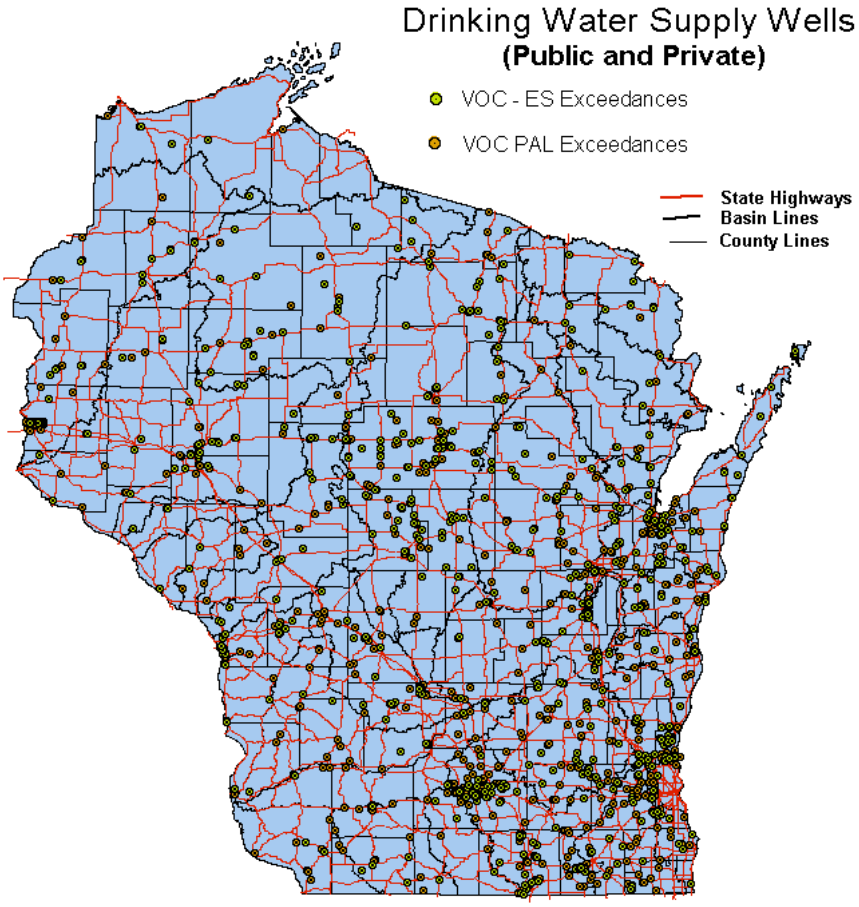

Figure 4.1 Volatile Organic Compounds (VOCs) enforcement standard (ES) and preventative action limit (PAL) exceedances for public and private drinking water supply wells. Source: WDNR

In a follow-up VOC study conducted from July 1992 through July 1994, the DNR reviewed historical data and sampled groundwater at 11 closed, unlined landfills and at six lined landfills. VOC levels had decreased after closure at all but two of the unlined landfills, though at many sites VOC levels did not show continued improvement. Also, the level of contamination, while below initial concentrations, remained high at many closed sites. No VOC contamination attributable to leachate migration was found at any of the six lined landfills investigated.

Over the past few years increasing numbers of residential developments have been located close to old, closed landfills. In 1998 and 1999 the DHFS sampled private wells down-gradient of 17 small, closed landfills in Ozaukee County. Eight of the private wells had VOC results above maximum contaminant levels. The results of this sampling showed that there may be more landfills with serious problems that have not yet been identified.

The DNR Bureaus of Waste Management, Remediation and Redevelopment, and Drinking Water and Groundwater in cooperation with the DHFS, responded to this issue in early 1999 by evaluating 16 old, closed landfills – at least three from each of the five DNR regions across the state. Private wells around each of the landfills were sampled in 1999 and significant levels of contamination found. Of the 113 wells that were tested, 31 had detects of VOCs. Fourteen of the homes had levels exceeding drinking water standards and have been given health advisories not to drink their water.

Underground storage tanks. Wisconsin requires underground storage tanks with a capacity of 60 gallons or greater

to be registered with the Department of Commerce. Since 1991, this registration program has identified a total of 177,799 tanks. As of May 20, 2004 the database reflects 79,564 federally regulated tanks with only 12,542 tanks in use. A federally regulated tank is any tank, excluding exempt tanks, that is over 110 gallons in size, has at least 10 percent of its volume underground, and is used to store a regulated substance. Exempt tanks include: farm or residential tanks of 1,100 gallons or less; tanks storing heating oil for consumptive use on the premises where stored; septic tanks; and storage tanks situated on or above the floor of underground areas, such as basements and cellars.

The contaminants most commonly associated with leaks from petroleum underground storage tanks are benzene, toluene, ethyl benzene, and xylene (BTEX compounds). More than 5,000 UST sites have BTEX groundwater standards exceedances. Drinking water at more than 600 households has been contaminated by leaks from underground storage tanks.

Hazardous waste. Hazardous waste treatment storage and disposal facilities are another VOC source. The DNR Bureau for Remediation and Redevelopment is investigating or remediating contamination at 27 sites. Approximately 140 sites statewide are subject to corrective action authorities. However, only a small percentage will follow the corrective action process because of minimal contamination at the site or jurisdiction under other regulatory authorities.

Generators improperly managing hazardous waste are another source of VOC contamination. All new generator remediation cases statewide and many existing actions are to be addressed in accordance with the NR 700 Wis. Adm. Code series.

Hazardous Substance Spills. The Hazardous Substance Spill Law, ch. NR 292.11 Wis. Stats., requires immediate notification when hazardous substances are discharged, as well as taking actions necessary to restore the environment to the extent practicable. Approximately 800 discharges are reported annually to the DNR, and of those, approximately 65% are petroleum related, with another 15% being agrichemicals. The NR 700 Wis. Adm. Code series, specifically ch. NR 706, contains the requirements for notification when a discharge or spill occurs. Chapter NR 708 contains requirements for taking immediate and/or interim actions when releases occur. Groundwater monitoring is performed when necessary to delineate the extent of contamination. The spills program develops outreach materials to help reduce the number and magnitude of spills and provide guidance for responding to spills. Topics addressed include spills from home fuel oil tanks, responses to illegal methamphetamine labs, and mercury spills, all of which can lead to significant environmental impacts, if not properly addressed.

References cited:

WDNR, 1988. Volatile Organic Compounds in Groundwater and Leachate at Wisconsin Landfills. Wisconsin Department of Natural Resources, Bureau of Solid and Hazardous Waste, February 1988.

WDNR, 1989. VOC Contamination at Selected Landfills – Sampling Results and Policy Implications. Wisconsin Department of Natural Resources, Bureau of Solid and Hazardous Waste, June 1989.

Pesticides

Pesticide contamination in groundwater results from field applications, pesticide spills, misuse, or improper storage and disposal. Serious concerns about pesticide contamination in Wisconsin were first raised in 1980 when aldicarb, a pesticide used on potatoes, was detected in groundwater near Stevens Point. The DNR, DATCP, and other agencies responded to these concerns by implementing monitoring programs and conducting groundwater surveys.

The DNR and DATCP expanded their sampling programs in 1983 to include analysis of pesticides commonly used in Wisconsin. The most commonly detected pesticides in Wisconsin groundwater are:

- Metabolites of alachlor (Lasso) and metolachlor (Dual)
- Atrazine and its metabolites

- Metribuzin (Sencor)
- A metabolite of Cyanazine (Bladex). Cyanazine is no longer manufactured.

Federal and state groundwater quality standards for many of these compounds have also been adopted. To date, standards for over 30 pesticides are included in ch. NR 140, Wis. Adm. Code.

Atrazine, a herbicide used on corn, is the pesticide most often found in private drinking water wells in Wisconsin. The first systematic well sampling program to characterize atrazine contamination on a statewide basis was the 1988 DATCP Grade A Dairy Farm Well Water Quality Survey. This state-funded well survey estimated that atrazine was present in 12% of the Grade A Dairy Farm Wells in the State. Since that initial study, DATCP has collected data from many private and monitoring wells in the state as part of statewide surveys and focused monitoring projects (summarized below).

In April 2003, DATCP produced a map showing locations of private drinking water wells tested for atrazine in the state (**Figure 4.2**). DATCP databases show that about 9% of private wells tested have atrazine detections, while about 1% have atrazine over the groundwater enforcement standard of 3 µg/L. This standard includes parent atrazine and three of its breakdown products (metabolites).

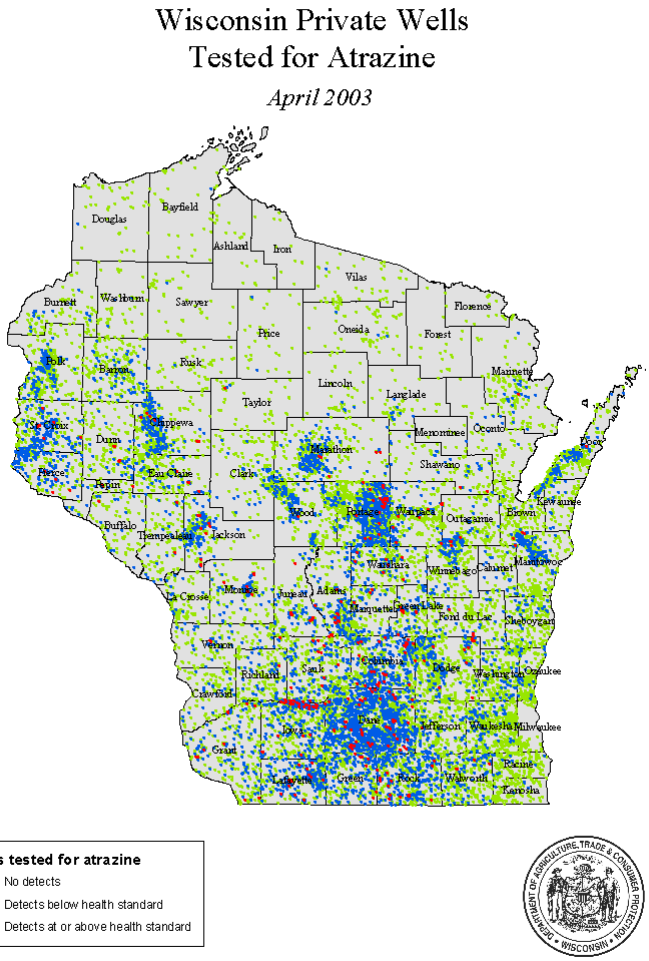

Figure 4.2 Private wells tested for atrazine in Wisconsin as of April 2003. Source: DATCP

Some pesticides, like atrazine, get into groundwater mostly through general use, while others are only found in groundwater if they have been spilled or mishandled. A combination of factors is most likely responsible for the widespread atrazine contamination shown on this map:

- atrazine has been the most widely used herbicide in Wisconsin for more than 30 years because it is effective and inexpensive
- atrazine was commonly used at much higher rates and applied more often before DATCP's Atrazine rule (ch. ATCP30, Wis. Adm. Code) began in 1991
- atrazine sinks (leaches) through the soil into groundwater faster than many other herbicides

Triazine screen. In 1991, the Wisconsin State Laboratory of Hygiene (WSLH) began a public testing program using an immunoassay screening test for triazine-based compounds, such as atrazine. The triazine immunoassay screen uses specific antibodies designed to selectively bind to target compounds that are present at low concentrations. While there is no enforcement standard (ES) for the triazine screen, comparing the triazine results to the ES and preventive action limit (PAL) for atrazine provides a reference point for the severity of contamination. In a recent survey of DNR groundwater databases, more than 14,000 triazine screen results have been recorded. Forty-two percent of the samples had a detection for a triazine compound; 13% exceeded the PAL for atrazine of 0.3 µg/L; and 1.6% exceeded the ES for atrazine of 3.0 µg/L.

One problem with the triazine screen is that it does not detect all the atrazine metabolites and therefore underestimates the total atrazine concentration. The WSLH advises homeowners that the triazine screen results should be used for initial screening purposes only. Higher triazine detects often receive a follow-up gas chromatography test. In 2002, the DNR funded a study with the WSLH to evaluate a new immunoassay test for the metabolite diamino atrazine. Results were delivered in late 2003 and it appears that a combination of new and existing tests can improve analytical accuracy greatly. Practical implementation of the findings will be discussed in 2004.

Chloroacetanilide herbicide metabolites are increasingly being detected in Wisconsin groundwater. In a study completed in 2000, 27 monitoring wells, 22 private drinking water wells, and 23 municipal wells in Wisconsin were sampled for alachlor, metolachlor, acetochlor, and their ethane sulfonic acid (ESA) and oxanillic acid (OA) metabolites. Wells were selected based on previous detections of pesticides or proximity to agricultural fields. Alachlor, metolachlor, and acetochlor are chloroacetanilide herbicides that are commonly used on corn and other crops in Wisconsin. With the exception of alachlor ESA, no historical data exists for these metabolites in Wisconsin groundwater because laboratory methods were not previously available. Over 80 percent of the monitoring wells and drinking water wells included in the survey contained the ESA and OA metabolites of alachlor and metolachlor. The metabolites of acetochlor showed a lower frequency of detection. Metabolite concentrations ranged from near the level of detection to 42 µg/L. Monitoring wells and private drinking water wells showed higher detection frequencies and concentrations than the deeper municipal wells, but the municipal wells did show significant impacts. Fifty-two percent of the municipal wells had at least one detection. No municipal well had pesticide levels that exceeded an enforcement standard.

Beginning in October 2000 and ending in May 2001, DATCP collected 336 samples from private drinking water supplies to determine the statewide impact of pesticides on groundwater resources (DATCP 2002). DATCP analyzed the samples for commonly used herbicides including the chloroacetanilide herbicides and their metabolites. This study also was compared to previous surveys to attempt to understand trends in groundwater quality over time. A total of seven common herbicides, ten metabolites and nitrate were included in the latest survey. Highlights from this overall study show:

- The proportion of wells that contain a detectable level of a herbicide or herbicide metabolite is 37.7%.
- Alachlor ESA and metolachlor ESA are the most commonly detected herbicide compounds with proportion estimates of 27.8 and 25.2%, respectively.
- A significant decline in parent atrazine concentrations between 1994 and 2001.

The following are other DATCP pesticide related studies conducted recently or as part of ongoing research.

Exceedence Survey. In 1995, DATCP completed a re-sampling of 122 Wisconsin wells that previously exceeded a pesticide enforcement standard. Most of the wells in the survey had exceeded standards for atrazine. Most were also within an atrazine prohibition area. Of wells exceeding standards for atrazine, 84% had declined in concentration and 16% had increased. About 50% of well owners continued to use their contaminated well and about 25% had installed new wells at an average cost of $6,300. This well survey has been repeated annually through 2002, with samples collected from 150 different wells at least once during this time period. As of 2002, atrazine levels have gone down in 78% of the wells, up in 17%, and stayed about the same in 5%. Twenty-eight wells remain above the enforcement standard.

Pesticide and Groundwater Impacts Study. In 1985, DATCP began a 2-year study funded by the Wisconsin DNR to evaluate the potential impact of agriculture on groundwater quality. The study focused on areas of the state with high groundwater contamination potential. In 2003, this study entered its 18th program year. In 2003, samples from monitoring wells near 15 agricultural fields were sampled. A total of ten compounds were detected in groundwater. Three of these (nitrate, alachlor ESA and atrazine + metabolites) were found at levels above an existing water quality standard. Other compounds detected include alachlor, acetochlor ESA, bentazon, metribuzin, metolachlor and its ESA and OA metabolites, and cyanazine amide.

Monitoring Reuse of Atrazine in Prohibition Areas - In FY 98, DATCP began monitoring the limited reuse of the herbicide atrazine in selected areas where atrazine use has been prohibited. DATCP is gathering data to see if renewed atrazine use at current restricted use rates will cause groundwater contamination. DATCP is monitoring groundwater quarterly at 17 fields, 10-40 acres in size, for 5 years. Although it is too early in the project to make recommendations, 1998 through 2002 summary data showed that atrazine concentrations increased at all but one site. One or more wells at 14 of 17 of sites exceeded the enforcement standard for atrazine (3.0 parts per billion) at some time during the first 3 years of the project. The nitrate enforcement standard was exceeded at 100% of these sites over the same sampling period.

Atrazine Rule Evaluation Survey. In FY 97, DATCP completed a groundwater sampling survey designed to evaluate the effectiveness of the Atrazine Rule (ch. ATCP 30, Wis. Adm. Code). The survey, required under ATCP 30, was to determine if a "statistically significant change" occurred in groundwater concentrations of atrazine and its three chlorinated metabolites between Phases 1 (1994) and 2 (1996) of the survey. The survey showed a statistically significant decline in the level of atrazine contamination in Wisconsin groundwater between 1994 and 1996. However, atrazine still reaches groundwater and in some cases exceeds the enforcement standard. The Atrazine Rule appears to be effective in reducing atrazine contamination of groundwater. DATCP recommends that current limits on atrazine use be continued.

In 2000 and 2001, Water Quality Section staff sampled 336 private wells across the state that included 122 of the same wells sampled in 1996. Results of this survey show that the proportion of wells that contained a detectable level of parent atrazine showed a statistically significant decline between 1994 and 2001. However, a decline in total chlorinated residues of atrazine was not apparent.

References cited:

DATCP, 2002. Groundwater Quality: Agricultural Chemicals in Wisconsin Groundwater. Wisconsin Department of Agriculture, Trade and Consumer Protection, Water Quality Section, ARMPUB98.qxd. 18 p.

Copies of this survey, as well as summaries of other DATCP monitoring projects are available at *http://datcp.state.wi.us/arm/agriculture/land-water/water-quality/monit_proj.html*.

Nitrate

Nitrate-nitrogen is the most common contaminant found in Wisconsin's groundwater. Detections of nitrate in private water supplies frequently exceed the state drinking water standard of 10 milligrams/liter (mg/L). A 1994

study by WGNHS and DHFS estimated that 9 to 14% of private water wells in Wisconsin exceed the nitrate standard. As part of an analysis to provide baseline groundwater data for the State of the Basin Reports, the most recent nitrate sample from each well in the DNR's Groundwater Retrieval Network (GRN) database was extracted. Of 10,105 well samples, 2016 (20%) equaled or exceeded the enforcement standard of 10 mg/L. In the same data set, 5113 (50%) were equal to or exceeded the PAL (2 mg/L). A statewide groundwater sampling program competed by DATCP in 2001 estimated that the proportion of private drinking water wells in the state that exceed the 10 mg/L health standard was 14.1%.

Nitrate exceedances are not spread evenly across the state. Counties in southern and west-central Wisconsin have much higher percentages of wells that exceed the 10 mg/L enforcement standard (**Figure 4.3**), likely due to the prevalence of row crop agriculture and associated use of nitrogen-based fertilizer in these areas.

Consumption of water that contains high concentrations of nitrate by infants under 6 months of age can induce a condition called methemoglobinemia or "blue baby syndrome." This condition occurs when red cell hemoglobin is oxidized to a form that is unable to carry oxygen to the body's tissues. All infants are at risk of nitrate poisoning, but those suffering from gastrointestinal illnesses appear to be more sensitive than are healthy infants. DHFS staff completed a summary of two cases from southern Wisconsin in which infants developed methemoglobinemia after being fed formula that was prepared with well water (Knobeloch et al. 2000). One of these infants required emergency air transport and life-saving therapy. The nitrate levels involved in these cases ranged from 22.9 to 28 mg/L (as N).

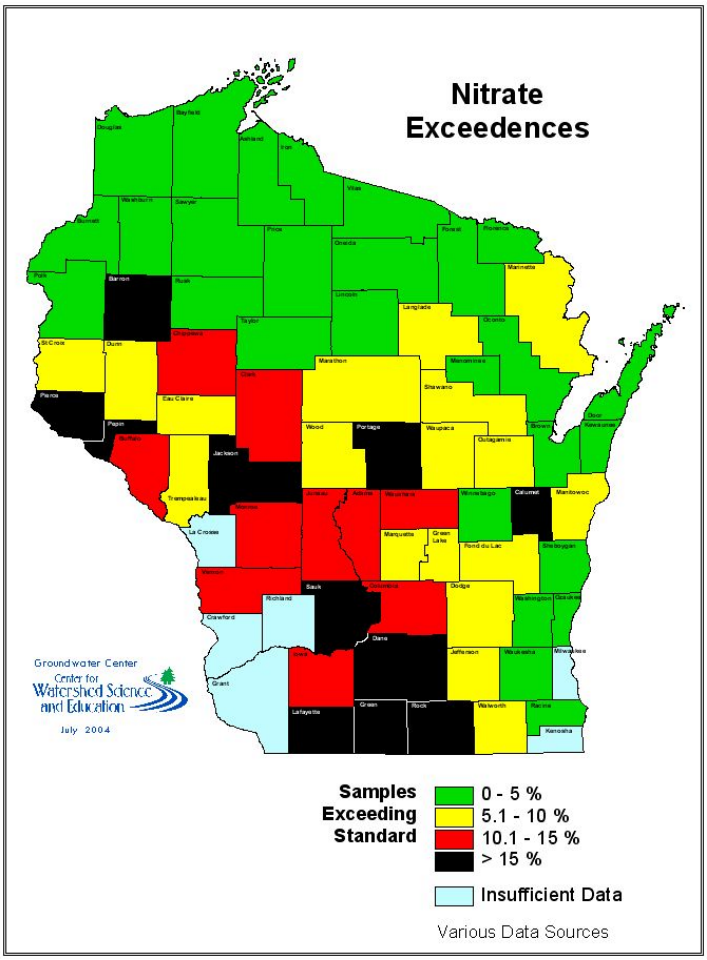

Figure 4.3. Percentage of nitrate samples from private wells exceeding 10mg/L by county. Source: Center for Watershed Science and Education, based on data from a variety of sources.

The chronic health effects of nitrate exposure are not well understood; however, many experts believe that long-term exposure may increase the risk of cancer. This theory is supported by some scientific studies. For example, in 1996 researchers in the Netherlands found that residents who consumed water that was high in nitrate had higher levels of cancer-causing nitroso compounds in their urine (Van Maanen et al., 1996). These researchers also found that genes in the blood cells of these individuals had higher numbers of mutations. Two years earlier, these same researchers had reported a link between consumption of high-nitrate water and the incidence of thyroid disorders (Van Maanen et al., 1994). In 1996, a study conducted jointly by the National Cancer Institute, the University of Nebraska, and Johns Hopkins University found an association between nitrate-contaminated water and Non-Hodgkin's lymphoma (Ward et al., 1996). A large cohort study conducted jointly by the University of Iowa, Mayo Clinic and the University of Minnesota found a positive association between nitrate levels in municipal water supplies and the incidence of bladder and ovarian cancer among adult women (Weyer et al. 2001).

Because of these health concerns, private water supply wells should be tested for nitrate at the time of installation and at least every five years during their use. In 1989, the GCC endorsed a resolution recommending that newly constructed water supply wells be sampled for nitrate in addition to coliform bacteria. Testing is also recommended for wells used by pregnant women and is essential for wells that serve infants less than 6 months of age.

Nitrate can enter groundwater and surface water from a variety of sources including farm fields, animal feedlots, septic tanks, urban storm water, and decaying vegetation. Contamination is difficult to prevent. Although the Department of Commerce continues to evaluate state-of-the-art septic system designs for nitrate removal, septic tanks continue to be a significant source of nitrate in heavily populated, unsewered areas.

In 1997, Wisconsin Act 27 required the development of performance standards for a number of agricultural and non-agricultural practices to reduce non-point sources of pollution of surface and groundwater. These performance standards include nutrients applied to cropland, such as nitrate. During 2000 and 2001, DATCP and DNR conducted public hearings and proposed changes to their non-point pollution control rules to include nutrient management standards and practices. These rules were adopted by the Natural Resources Board in spring of 2002 and subsequently passed legislative review. The rules were promulgated in October 2002. Adoption and implementation of nutrient management standards based on UW recommendations will reduce the over-application of nitrogen that occurs on some farms. This practice has the potential to reduce the amount of nitrate that would be available to leach to groundwater.

Owners of nitrate-contaminated water supplies have few options. They do not qualify for well-compensation funding unless the nitrate level in their well exceeds 40 mg/L (as N) and a dairy herd uses the well. In order to establish a safe water supply, they may opt to replace an existing well with a deeper, better cased well or to connect to a nearby public water supply. Alternatively, they may choose to install a water treatment system or to use bottled water. A study published by DHFS in 1999 examined this issue (Schubert et al. 1999). Their survey of 1500 families found that few took any action to reduce nitrate exposure. Of those who did, most purchased bottled water for use by an infant or pregnant woman.

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Schubert, C., L. Knobeloch, M.S. Kanarek, and H.A. Anderson. 1999. Public response to elevated nitrate in drinking water wells in Wisconsin. Arch. Environ. Health 54(4):242-2247.

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Microbial Agents

Microbiological contamination often occurs in areas where there is little natural attenuation potential. This is common in areas where the depth to groundwater or the depth of soil cover is shallow, or in areas of fractured bedrock. Microbial agents include bacteria, viruses, and parasites. These agents can cause acute illness and result in life-threatening conditions for some population groups. In one assessment, approximately 23% of private well water samples statewide tested positive for total coliform bacteria, an indicator species of other biological agents (Warzecha et al 1995). Approximately 3% of private well water samples tested positive for *E. coli*, an indicator of water borne disease that originates in the mammalian intestinal tract.

Some parts of the state are particularly vulnerable to microbial contamination. In a recent survey of 25 private wells in Door County, 18 had detections of total coliform in at least one monthly sample over a 1-year period (Braatz, 2004). 40% had detections of a fecal indicator (*E. coli* or enterococci). Fractured bedrock and shallow wells contribute to the severity of the problem. Significant seasonal trends were also apparent, with higher percentages of wells with fecal indicators in the summer months.

Researchers at the Marshfield Medical Research and Education Foundation have investigated the association of pathogenic viruses and bacteria in private wells with incidences of infectious diarrhea and indicators of well water contamination (Borchardt et al. 2003b). In general, infectious diarrhea was not associated with drinking from private wells, nor was it associated with drinking from wells positive for total coliform. However, wells positive for enterococci were associated with children having diarrhea of unknown etiology, which was likely caused by Norwalk-like viruses. Results from a subsequent study of 50 private wells throughout the state indicate that 4-12% of private wells may be subject to virus contamination (Borchardt et al. 2003a). Wells positive for viruses were not consistent seasonally, nor were they associated with commonly used indicators of microbial contamination such as total coliform or fecal enterococci. These studies suggest that increased monitoring and detection methods for viruses are needed to assess the risk of drinking water with potential microbial contamination.

In another recently completed study with the US Geological Survey, Marshfield researchers found that 50% of water samples collected from four La Crosse municipal wells were positive for enteric viruses, including enteroviruses, rotavirus, hepatitis A virus, and Norwalk-like virus (Hunt and Borchardt, 2003). As with the private well study, there was no correspondence to common indicators of sanitary quality, nor was there a consistent seasonal trend. More surprising, there was no relationship between presence of surface water in the well water samples as determined by isotope analysis and virus occurrence. These findings suggest that viruses may be more common than expected in drinking water samples, although they do not indicate whether or not the viruses are inactivated through disinfection processes, or result in illness in the community. Follow-up testing determined that most of the samples did not contain culturable viruses. However, limitations of the study design and available culture methods preclude knowing for sure that viable viruses are not entering the drinking water supply. Research into the link between virus occurrence and human health is needed to answer these questions.

The DNR recommends that well owners test for microbial water quality annually or when there is a change in taste, color, or odor of the water. Public drinking water systems that disinfect their water supplies are required to sample, on a quarterly basis, for bacteria from the raw water (before treatment) in each well. These raw water samples are

representative of the source from which the wells draw groundwater. The DNR has recently begun tracking total coliform detects in the raw water samples through its Drinking Water System database. The number of public water systems and locations where groundwater samples are collected quarterly for microbial analysis, along with the number of total coliform (TC) positive samples for the period January 1 through June 30, 2004 are listed in the following table.

System type	# systems	# locations	#TC positives	# of systems
Municipal (MC)	468	1322	92	39 (8.3%)
Other-than-municipal (OTM)	60	95	7	6 (10%)
Non-transient, non-community (NN)	34	53	0	0 (0%)
Transient non-community (TN)	40	41	3	3 (7.5%)

In addition to the quarterly samples collected from groundwater above, most wells belonging to the group of transient non-community systems (TN), such as restaurants and convenience stores, sample for bacteria on an annual basis. These systems have very small distribution systems and are similar to private water systems in that their water samples represent the groundwater source. There are 9360 TN active systems in Wisconsin.

Because of the increasing evidence for widespread occurrence of microbial contaminants, additional monitoring requirements for vulnerable public water systems are on the horizon. The Environmental Protection Agency (EPA) is developing a strategy, known as the "Groundwater Rule," which would modify Safe Drinking Water Act requirements to prevent groundwater contamination and illness outbreaks from occurring. The Groundwater Rule will include 5 preventative strategies that prior EPA drinking water legislation did not adequately address. The first aspect includes sanitary surveys of public systems to identify deficiencies. The second aspect is a hydrogeologic sensitivity assessment of each public system to identify wells sensitive to fecal contamination. The third aspect is source water monitoring. Currently, the Safe Drinking Water Act focuses on sampling for microbial indicators in the distribution system. The fourth aspect of the law will require corrective action for non-complying features found in the water system and eliminating fecal contamination with treatment or providing an alternative permanent source of water. The fifth aspect of the law is monitoring requirements to ensure that treatment equipment is maintained (EPA 2000.) Wisconsin already conducts inspections and requires correction of non-complying features. Therefore, the major changes the proposed EPA law will be additional monitoring of source water for sensitive systems and the wells found to contain fecal contamination will require installation of approved treatment devices or a new water source.

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Borchardt, M. A., P. D. Bertz, S. K. Spencer, and D. A. Battigelli. 2003. Incidence of enteric viruses in groundwater from household wells in Wisconsin. Applied and Environmental Microbiology, 2003, Vol 69, Iss 2, pp 1172-1180.

Borchardt, M. A., P. H. Chyou, E. O. DeVries, E. A. Belongia. 2003. Septic system density and infectious diarrhea in a defined population of children. Environmental Health Perspectives, 2003, Vol 111, Iss 5, pp 742-748

Braatz, L., 2004. A study of fecal indicators in 25 private well water sites located in Door County and factors that influence well water quality that could lead to human illnesses. Draft report submitted to the Wisconsin Department of Natural Resources, July 22, 2004.

Hunt, R., and M. Borchardt. 2003. Susceptibility of La Crosse municipal wells to enteric virus contamination from surface water contributions. Final report submitted to Wisconsin Department of Natural Resources, June 23, 2003.

Warzecha, C., R. Gerhardt, and S. Kluender. 1995. Wisconsin private well water quality survey. Wisconsin Department of Health and Social Services, Department of Natural Resources, and State Laboratory of Hygiene. Unpublished report.

Naturally-Occurring Radionuclides

Naturally-occurring radionuclides, including uranium, radium, radon, and gross alpha are becoming an increasing concern for groundwater quality, particularly in the Cambro-Ordovician aquifer system in eastern Wisconsin. The water produced from this aquifer often contains combined radium activities in excess of 5 pCi/L, in some cases in excess of 30 pCi/L. Nearly 60 public water systems exceed the drinking water standard of 15 pCi/L for gross alpha activity (**Figure 4.4**). The DNR is enforcing the revised radionuclide standard adopted into NR 809 in October 2001. The DNR has entered into consent orders with approximately 40 community water systems that will bring them into compliance with drinking water standards for radium and gross alpha by December of 2006.

Previous studies have shown that radium concentrations in excess of approximately 5 pCi/L are not supportable by the presence of parent isotopes in the aquifer solids. It is possible that high radium concentrations in Cambro-Ordovician water originate from downward flow of recharge water through the Maquoketa Shale. Indeed, high radium activity occurs in the Cambro-Ordovician in a band roughly coincident with the Maquoketa subcrop pattern (Grundl, 2001). This pattern extends across the entire eastern portion of the state from Brown County in the north to Racine County in the south. Radium activities have remained relatively constant from the middle 1970s to the present. High gross alpha activity also occurs in a band roughly coincident with the Maquoketa subcrop pattern extending along the entire eastern portion of the state. Gross alpha activity has been steadily rising from the middle 1970s to the present.

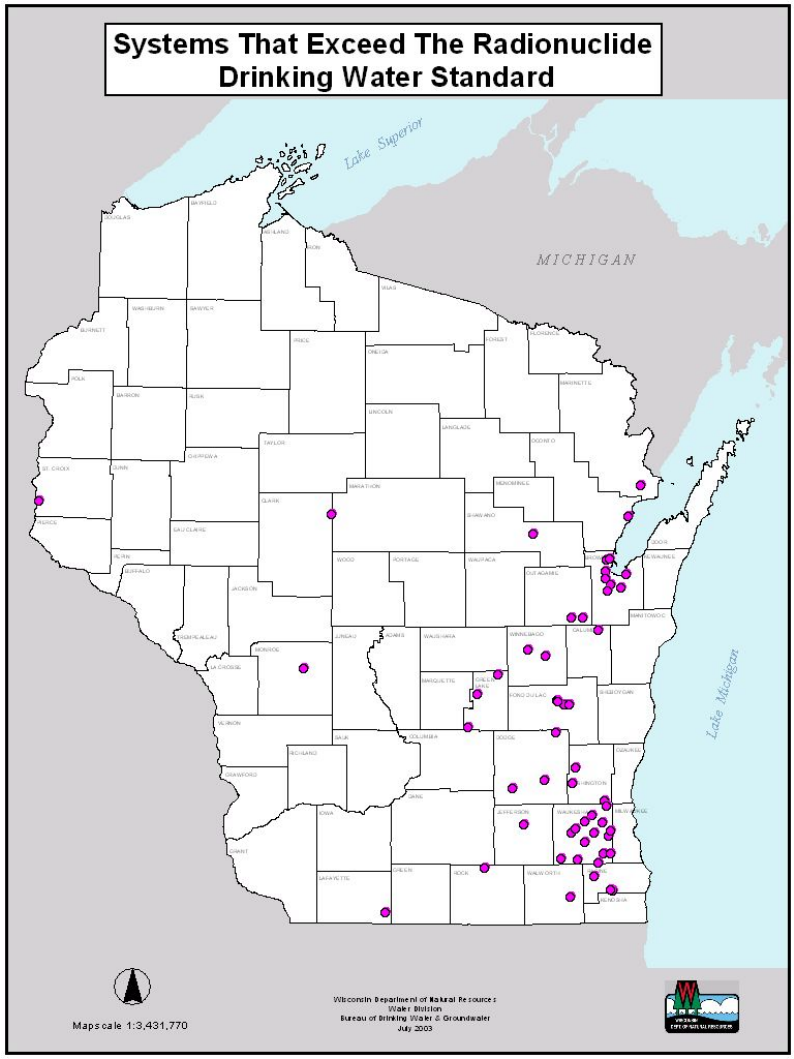

Figure 4.4 Public water systems that exceed 15 pCi/L for gross alpha activity as of July 2003. Source: WDNR

The Maquoketa outcrop pattern forms the demarcation between unconfined conditions in the underlying Cambro-Ordovician aquifer to the west and confined conditions to the east. Strong downward gradients exist across the Maquoketa and flow across the unit is maximal near the outcrop where total thickness is at a minimum. This strong downward gradient is very recent and is caused by heavy pumpage of the Cambro-Ordovician in urban areas.

The actual cause for high radium and gross alpha activities in the Cambro-Ordovician is undoubtedly a combination of multiple, sometimes subtle, processes that may differ from location to location. Determining which process(es) control the release of solid- phase radioactivity in the Cambro-Ordovician into the groundwater will require a more thorough understanding of the system. Because the source of this radium is not fully understood, basic questions as to how best to manage this increasingly important source of drinking water may be difficult to answer.

Two additional studies have been initiated by the DNR to address concerns about radioactive compounds in groundwater. In 2000 and 2001, DNR staff collected samples from about 100 community and nontransient noncommunity public water wells. The WSLH analyzed each sample for several alpha-emitting radiochemicals (total Uranium (U-238, U-234, U-235), total Thorium (Th-228, Th-230, Th-232), Radium 226, and Polonium 210) in an attempt to identify and quantify the relative contribution of each chemical to the total gross alpha activity in the samples (Arndt and West, 2004).

Results indicate that total uranium is the major contributor to high gross alpha activities. Small quantities of polonium and thorium have also been detected but they do not appear to be major contributors to the total gross alpha activity in public water system wells. Another important finding was that total gross alpha measurements do not account for all of the radionuclides that may occur in a water sample. The WSLH has developed models to account for the discrepancy between the total gross alpha activity and measurements of individual radionuclides.

In addition, the study showed that the gross alpha activity depends appreciably on the radionuclide used as the calibration standard, the time between sample collection and sample preparation, the time between sample preparation and sample analysis, and whether a radiochemical or a gravimetric method is used to determine the total uranium activity. This is important since according to EPA regulations an adjusted gross alpha activity exceeding 15 pCi/L is considered to be a gross alpha violation. Using the model, it is shown that for some water samples the value obtained for the adjusted gross alpha activity can range from being well within compliance to being well out of compliance. Thus the use of the model developed in this work should be of assistance in helping a water utility with a gross alpha violation determine the reason for the violation, and, therefore, how to correct it.

A second study "Factors Effecting the Determination of Radon in Groundwater" will help determine the impact of expected new EPA standards for radon in drinking water. Staff from the DNR will sample about 340 noncommunity, nontransient and other than municipal water systems per year. To date, approximately 250 samples have been collected from nontransient, noncommunity wells. Preliminary results tend to support findings from earlier community water system monitoring which indicated that approximately 50% of the public water systems monitored in Wisconsin exceed the proposed radon standard of 300 pCi/L. As of July 2002, EPA has not finalized the drinking water standard for radon.

References cited:

Arndt, M. F., and L. West. 2004. A Study of the Factors Affecting the Gross Alpha Measurement, and a Radiochemical Analysis of some Groundwater Samples from the State of Wisconsin Exhibiting an Elevated Gross Alpha Activity. Final report submitted to the Wisconsin Department of Natural Resources, DNR Project Number 176.

Grundl, T. 2001. Maquoketa Shale as Radium Source for the Cambro-Ordovician Aquifer in Eastern Wisconsin. Final report submitted to the Wisconsin Department of Natural Resources, DNR Project Number 141.

Summaries of the gross alpha and radon studies are available on the WSLH web site at *http://www.slh.wisc.edu/radiochem/research.html*.

Arsenic

Naturally occurring arsenic has been detected in wells throughout the State of Wisconsin. DNR historic data show that 3,830 public wells and 3,013 private wells have detectable levels of arsenic. About 10% of these wells exceed the Federal drinking water standard of 10 µg/L. The highest concentration of arsenic detected in a private well in Wisconsin is 13,000 µg/L.

Arsenic has been detected in well water samples in every county in Wisconsin. However, the problem is especially prevalent in northeastern Wisconsin where increased water use has likely mobilized arsenic into the groundwater (**Figure 4.5**). In Outagamie, Winnebago, and Brown Counties approximately 45% of private drinking water wells sampled have detectable levels of arsenic (exceeding 3 µg/L). These findings led to the establishment of an "Arsenic Advisory Area" in the early 1990s. This area includes the strip of land five miles either side of the bedrock subcrop of the St. Peter Sandstone, extending in a northeasterly trend, from a location just southwest of Oshkosh, to a location just west of Green Bay. For this area, DNR developed special well construction specifications to increase the likelihood of installing a well free of arsenic.

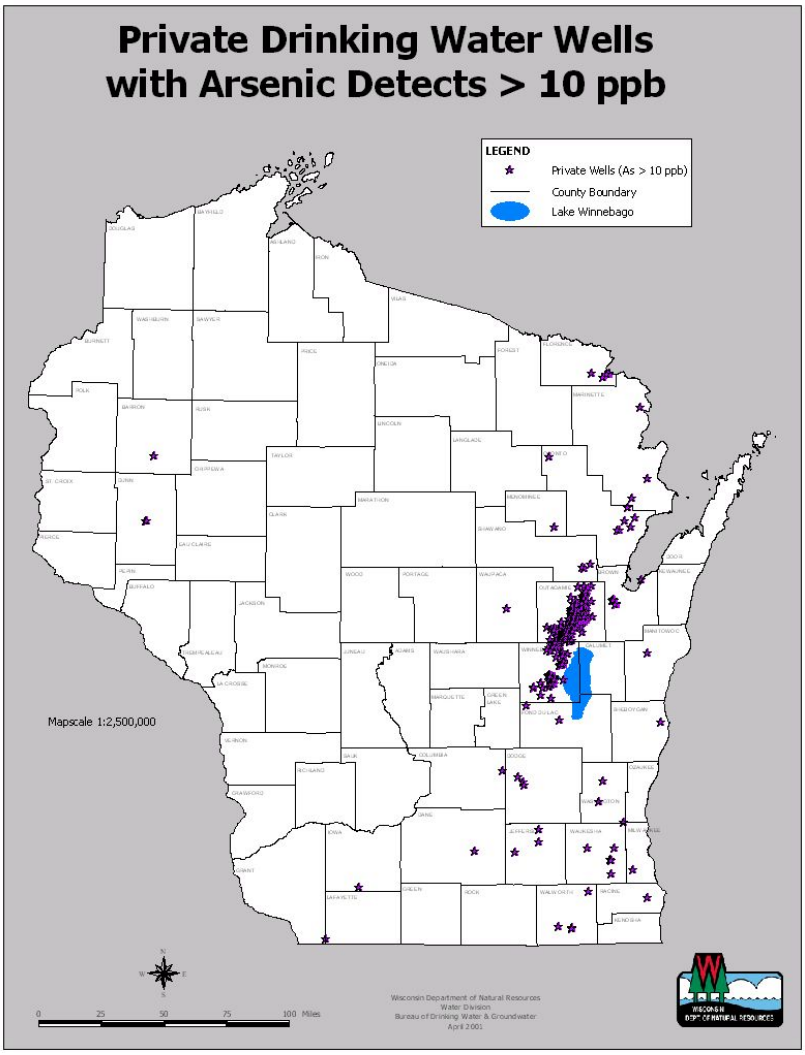

Figure 4.5 Private wells tested for arsenic in Wisconsin that have historically exceeded 10 µg/L (ppb). Source: WDNR

Arsenic bearing geologic units exist across the state. It is found in the igneous rocks of the Precambrian shield, the Paleozoic sedimentary rock, and within glacial deposits. The highest concentrations are present in the sedimentary

bedrock. Results from several DNR studies indicate the geochemical reactions causing the elevated levels of arsenic in groundwater of the northeastern part of the state are associated with oxidation of sulfide-mineralized zones within the bedrock aquifers. The main zone of mineralization extends some ten feet below the base of the Platteville Dolomite, which is part of the main upper bedrock formation of this region. If the St. Peter Sandstone is present within the geologic sequence, it lies directly below the Platteville Dolomite and the arsenic-rich mineralized zone then extends about ten feet into this sandstone. Although it is certain that this is the main mineralized zone, experts believe that there are other lateral and vertical occurrences of arsenic-rich strata.

Recent information has raised questions about the St. Peter Sandstone – Sinnipee Dolomite contact being the only location where high arsenic concentrations are found. A renewed effort is currently underway to reexamine this problem. In addition, there is evidence to suggest that increased levels of arsenic in this region may be related to increased groundwater consumption[1]. In many areas, increasing concentrations of arsenic may be a result of the water table dropping to levels at or just below the sulfide rich mineralized zone and then fluctuating up and down across this layer. This fluctuation can allow oxygen in the air to come in contact with and oxidize the sulfide minerals in this layer. This initial oxidation can then trigger a complex set of geochemical reactions that can eventually release arsenic into the groundwater. Once this reaction has been initiated it is likely to continue.

Recent findings from the WGNHS (Gotkowitz et al. 2003) support the hypothesis that high levels of arsenic in groundwater occur where mineralization is oxidized in well boreholes. However, two distinct geochemical mechanisms appear to contribute low to moderate arsenic concentrations to well water in this aquifer. 1) Oxidation of sulfide minerals may release arsenic to groundwater in confined portions of the aquifer; oxidation may have occurred at some time in the geologic past, or current levels of oxygen dissolved in the groundwater may be sufficient to permit slow oxidation to occur. 2) Reductive dissolution of arsenic-bearing iron oxides also seems to contribute low to moderate levels of arsenic to groundwater when the geochemical environment becomes sufficiently reducing. This occurs under typical domestic water use patterns, because increasing groundwater residence time in wells correlates to the onset of strongly reducing conditions and higher arsenic concentrations. The well borehole is a microbiologically active environment, and biogeochemical reactions likely contribute to the observed increase in arsenic concentrations. Reducing the volume of well bore storage relative to water use may help to limit arsenic concentrations in well water.

On October 31, 2001 EPA announced that the Federal Drinking Water Standard for arsenic would be lowered from 50 parts per billion (µg/L) for public water systems to 10 µg/L. The new standard became effective in February 2002 and compliance must be reached by 2006 (The state groundwater quality standards for arsenic have already been revised to reflect the lower threshold at the federal level, effective March 1, 2004.)The arsenic rule affects municipally owned water systems and those that serve an average of at least 25 people daily for six months of the year, among them schools, mobile home parks, apartment buildings, day care centers, and factories. Raw water samples submitted as part of a DNR and State Laboratory of Hygiene study indicated that approximately 80 public water systems contain arsenic levels exceeding 10 µg/L. However, some of those systems are already reducing arsenic to the federal health standard when they treat their raw water for other contaminants, such as iron.

The new standard also raises questions for private water supplies, particularly in regards to health risks associated with drinking water with moderate levels of arsenic (between the old and new standards). Historical data indicates that 20% of the wells in the 4-county area affected by arsenic exceed the new standard of 10 µg/L. In August 2002, the DHFS released the results of a follow-up investigation on the relationship between exposure to inorganic arsenic in water and health outcomes (Knobeloch 2002). As part of this research effort, local health departments, DNR staff, town clerks and others conducted well sampling campaigns in 19 townships in the affected counties. Several other towns offered similar well testing programs.

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[1] Since the 1950s, groundwater consumption in northeastern Wisconsin has risen significantly due to an increase in population and per capita water use. Thousands of new private wells have been constructed in this region. Municipal and industrial groundwater use has increased. As a result, regional groundwater levels in the sedimentary bedrock aquifers of northeastern Wisconsin have shown a steady long-term decline. The decline has averaged as much as three to four feet per year in the Green Bay area and as much as two to three feet per year in the Fox Cities area surrounding the City of Appleton.

2233 households submitted samples and returned health surveys, providing health and exposure information for 6669 individuals. Approximately 20% of the water supplies contained arsenic levels above 10 µg/L. Slightly more than 10% of the families consumed water that had an arsenic level greater than 20 µg/L. People over the age of 50 were more likely to report a diagnosis of skin cancer if they had consumed water that had an arsenic concentration greater than 5 µg/L for 10 years or more. Cigarette use was also associated with higher skin cancer rates: residents who both smoked and consumed arsenic-contaminated water reported the highest skin cancer prevalence rate. No association was seen between exposure to arsenic-contaminated water and the incidence of other types of cancer. However, findings from this study were consistent with previously reported associations between arsenic exposure and the prevalence of adult onset diabetes and cardiovascular disease.

References cited:

Knobeloch, L. 2002. Health Effects of Arsenic Contaminated Drinking Water. Final report submitted to the Wisconsin Department of Natural Resources. Wisconsin Department of Health and Family Services

Gotkowitz, M.B., J. A. Simo, and M. Schrieber. 2003. Geologic and geochemical controls on arsenic in groundwater in northeastern Wisconsin. Final report submitted to the Wisconsin Department of Natural Resources. WGNHS Open File Report 2003-01

More information related to arsenic can be found on the DNR Arsenic Web Page:
http://dnr.wi.gov/org/water/dwg/arsenic/index.htm

GROUNDWATER QUANTITY

Despite a general abundance of groundwater in Wisconsin, there is a growing concern about the overall availability of good quality groundwater for municipal, industrial, agricultural, and domestic use and for adequate baseflow to our lakes, streams, and wetlands. Groundwater quantity problems have occurred naturally and from human activities.

In a 1997 report titled “Status of Groundwater Quantity in Wisconsin," the GCC concluded that a coordinated effort is needed to determine appropriate management options for addressing groundwater withdrawals, to prioritize information needs, and to implement information and education programs (WDNR 1997). The report also called for funding for additional data collection and research to address groundwater quantity management issues. Though funding has been scarce some progress on these objectives has been made.

Water Use

As part of the National Water-Use Information Program, the U.S. Geological Survey (USGS) stores water-use data in standardized format for different categories of water use. Information about amounts of water withdrawn, sources of water, how the water was used, and how much water was returned, is available to those involved in establishing water-resource policy and to those managing water resources. In 1978, the USGS entered into a cooperative program with the Wisconsin DNR to inventory water use in Wisconsin. Since that time, five reports have been periodically published summarizing water use in Wisconsin.

Groundwater use statewide grew from 570 to 804 million gallons per day (Mgal/d) from 1985 to 2000 (Ellefson and others, 2002). The majority of this water is used for public water supplies (330 Mgal/d), which is primarily used for domestic use, but also supplies water for some industrial and commercial purposes. Agriculture and irrigation uses are a close second (295 Mgal/d). The remainder provides water for self-supplied domestic, commercial and industrial uses.

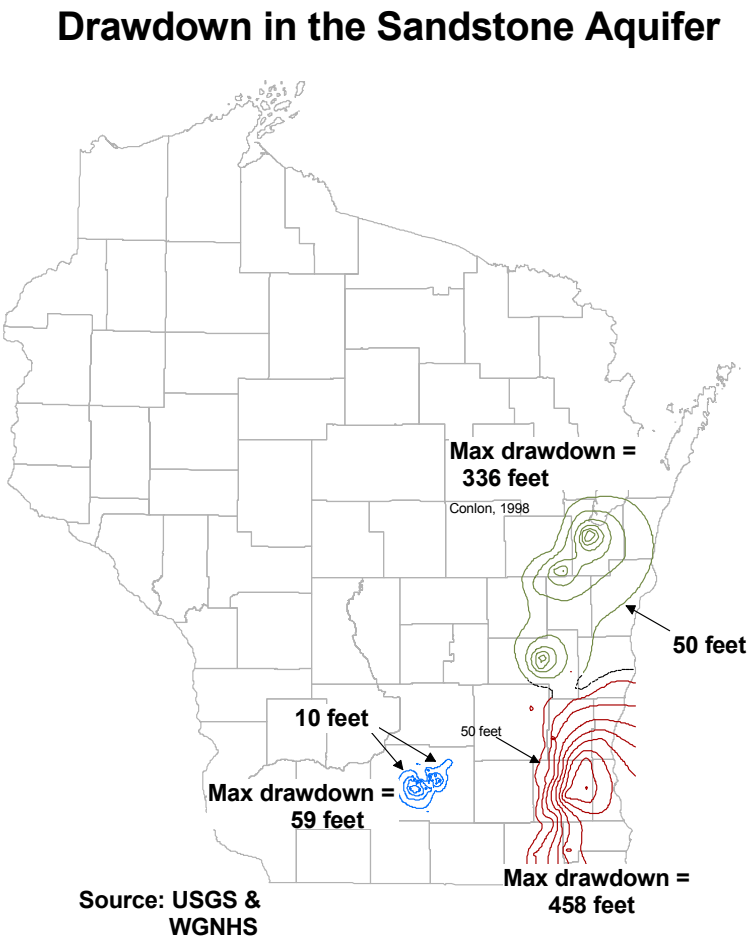

Figure 4.6 Simulated drawdown in the sandstone aquifer as of 1998-2000. Contour intervals represent levels of equal hydraulic head and are 50 feet in eastern Wisconsin and 10 feet in Dane County. Sources: USGS and WGNHS

Regional Drawdowns

The effects of groundwater withdrawals are well documented on a regional scale in the Lower Fox River Valley, southeastern Wisconsin, and Dane County. There are substantial declines in groundwater levels in these three areas (**Figure 4.6**).

The best-documented regional water quantity problem is in the Southeast part of the State. A recent study by the Wisconsin Geological and Natural History Survey and the U.S. Geological Survey shows that in the last 60 years well water withdrawals throughout southeastern Wisconsin, Illinois and Michigan were substantial enough to slow and reverse groundwater flow in some areas (Feinstein and others, 2004). In the region between Milwaukee and Waukesha County, groundwater models show that pumping water from the deep aquifers has begun to alter groundwater flow patterns extending to Lake Michigan, the Illinois border and western Waukesha County. Indeed,

about 7.5 percent of the groundwater that used to flow toward Lake Michigan never reaches the coast; it's drawn into wells. Most of that water eventually reaches Lake Michigan through storm sewers and as treated wastewater, "but the location, timing and quality of the return flow is different than what it was under natural conditions," the USGS report concludes.

Quantity and Quality

An example of how reduced quantity can bring about quality concerns is seen in Southeast Wisconsin where many communities that use deep wells now have a problem with naturally occurring radionuclides present in the deep aquifer. Wells in the deep aquifer have drawn water levels down hundreds of feet. In recent years the concentrations of radionuclides and other elements have increased in many of these wells. There appear to be correlations between large drawdowns and radionuclide concentrations, but the scientific relationships between the two are not yet completely understood. This is a very serious problem as radionuclides are carcinogenic and very costly to treat for. Several communities facing a December 2006 deadline for reducing radium levels in their drinking water are being forced to look for alternative sources. However, the alternative of drilling shallow wells is problematic in that it may impact surface waters or other shallow wells, and shallow wells are vulnerable to contamination from near-surface sources. Fortunately several communities voluntarily went beyond what state law requires to protect surface waters and other water users in siting their wells and managing their water use.

Another example that illustrates the potential that reduced groundwater quantity has to cause groundwater quality problems is in the Lower Fox River Valley where over-pumping has resulted in increased detections of arsenic in private well water in recent years (also described above in the Groundwater Quality Section of this Chapter). Some of the arsenic concentrations found in groundwater have been quite high, with 20% of private wells sampled over the new standard of 10 µg/L. Investigations in the affected area indicate that most of the arsenic is coming from a highly mineralized zone at the top of the St. Peter Sandstone. It appears that over-pumping in the Lower Fox River Valley has drawn down the bedrock aquifer to such an extent that the mineralized zone is exposed to the atmosphere and becomes oxidized, releasing arsenic.

Alternative Sources

Other developments have also highlighted the importance of groundwater quantity. Two communities, Green Bay and Oak Creek, have proposed aquifer storage and recovery as a method for addressing water shortages. Aquifer storage and recovery (ASR) involves injecting treated water into the aquifer during times of less groundwater use and pumping that water out when water demand is high, typically during the summer. Both communities are working with the WDNR on pilot studies to determine if this is feasible in Wisconsin. In addition, the communities around Green Bay have agreed to purchase water from Manitowoc where the water is withdrawn from Lake Michigan and treated.

For some communities tapping the Great Lakes is a potential solution to quantity problems. But, for some, there are bottlenecks. Governors from the eight states and premiers from the two Canadian provinces bordering the Great Lakes signed a Great Lakes Charter in 1985 setting guidelines and principles for managing Great Lakes water. A key provision of the Charter aimed to regulate large water withdrawals and diversions from metropolitan centers bordering the lakes. A supplementary agreement called Annex 2001 includes proposed provisions clarifying how, where and when water can be removed or diverted from the lakes or from groundwater that feeds them. In general it is difficult to receive permission from Great Lakes charter members to divert lake water outside of the basin which extends only some tens of miles from the Lakes in some areas. Those provisions have been released for public comment this summer.

Surface Water Impacts

Localized effects from groundwater withdrawals are not as well documented as the regional effects. Cases exist around the state where wells, springs, and wetlands have gone dry; lake levels have dropped; streamflow has been reduced; and contamination has prevented installation of new wells. The availability of groundwater may also be affected by groundwater quality, both due to naturally-occurring substances in groundwater and human-caused contamination.

Other groundwater quantity issues are more local in nature. In 2000, Perrier (Nestle Waters North America) proposed installing one or more wells in the Big Springs area in southeastern Adams County to pump groundwater

to be bottled and sold as spring water. Many local residents opposed the Perrier proposal because of concern about potential impacts to the spring. The WDNR issued an approval with conditions to protect the aquifer. The proposal highlighted the issue that, for high capacity wells, the WDNR only had authority to deny a high capacity well application if it determined that the new well would interfere with a municipal water supply well.

Solutions

Focusing on the state's limited authority to protect groundwater quantity the UW-Madison Department of Urban and Regional Planning issued a report reviewing Wisconsin's high capacity well law and made recommendations for its improvement (Born and others, 2000). The report discusses the potential impacts of high capacity wells on the environment, summarizes the existing law for managing groundwater in Wisconsin, reviews programs in selected states, and discusses issues and strategies for improving groundwater quantity management in Wisconsin. Some of the key recommendations included:

- Expand the public trust doctrine to groundwater
- Enforce existing statutory language regarding groundwater
- Explicitly recognize hydraulic continuity between groundwater and surface water in legislation
- Expand criteria for review and permitting of high capacity wells to consider effects on interconnected surface waters and ecological resources (springs, wetlands, rivers and streams, lakes, fish and wildlife)
- Enforce monitoring and reporting requirements for high capacity well permits
- Encourage voluntary reporting of water use information from other groundwater users
- Address cumulative impacts of wells by ensuring consistency with local or regional water management plans

Likewise, common themes reported in the GCC's summary of the 2001 Groundwater Summit, *Sharing our Buried Treasure*, included the need for a statewide management plan for water quantity, water conservation, high capacity well reform, reevaluation of water pricing structures and regional approaches to water quantity issues (GCC 2002). A large majority of Summit participants agreed that there is a need for a statewide groundwater quantity strategy in Wisconsin and that we are not doing enough to protect groundwater quantity in the state.

In 2002 and 2003, various groups proposed solutions to address groundwater quantity concerns in Wisconsin. Stakeholders from agricultural, environmental, industrial, and public utility interests worked together under the leadership of Senator Kedzie and Representative Johnsrud to produce groundwater legislation. On Earth Day, April 22, 2004, Governor Doyle signed a new groundwater protection law, 2003 Wisconsin Act 310, that expands the State's authority to consider environmental impacts of high capacity wells and institutes a framework for addressing water quantity issues in rapidly growing areas of the state. The Act recognizes the link between surface water and groundwater, and that all wells have an impact on groundwater quality and quantity. The law applies principles of adaptive management, allowing for changes in the regulation of high capacity wells as relevant information becomes available or groundwater conditions change.

Specifically, Act 310 sets new standards and conditions for approval of high capacity wells by the DNR, and creates Groundwater Management Areas to address regional drawdowns in the sandstone aquifer underlying large portions of Southeastern Wisconsin and the Lower Fox River Valley. In addition, the law creates more oversight of well construction activities, institutes a fee system for new construction, and establishes a Groundwater Advisory Committee to recommend strategies for groundwater management and future legislation. The law represents an important first step towards managing groundwater quantity at the State level.

The law also represents an opportunity to gain a much better understanding of groundwater quantity issues in the State. Collection of accurate high-capacity well construction and pumping information and detailed reviews of potential problem areas will provide a new understanding of water use and it's impacts. Activities within the groundwater management areas to encourage coordinated management strategies should lead to a new level of cooperation among the state, local government units, regional planning commissions, and public and private users of groundwater.

References cited:

Born, S., and others, 2000. Modernizing Wisconsin Groundwater Management: Reforming the High Capacity Well Laws, Urban and Regional Planning, UW-Madison/Extension Report Series, 2000-1, August 2000, 60 p. (Also available at *http://www.wisc.edu/urpl/people/born/index.html* under "Projects.")

Ellefson, B. R., G. D. Mueller, and C. A. Buchwald. 2002. Water Use in Wisconsin, 2000. U.S. Geological Survey Open File Report 02-356, Atlas.

Feinstein, D.T., D. J. Hart, T. T. Eaton, J. T. Krohelski, and K. R. Bradbury, 2004**.** Simulation of regional ground water flow in southeastern Wisconsin**.** Wisconsin Geological and Natural History Survey (WGNHS) Open-File Report 2004-01 (Also see *http://wi.water.usgs.gov/glpf/*)

GCC. 2002. Sharing our Buried Treasure: Directions for the Protection and Management of Wisconsin's Groundwater. A Summary of the 2001 Groundwater Summit. Wisconsin Groundwater Coordinating Council, September 2002. 17 p.

WDNR. 1997. Status of Groundwater Quantity in Wisconsin. Wisconsin Department of Natural Resources PUBL-DG-043-97. 53 p. (Also available at *http://dnr.wi.gov/org/water/dwg/gw/pubdnld.htm*)

A number of other resources related to groundwater quantity are listed on the GCC website.

Chapter 5 -- BENEFITS FROM MONITORING AND RESEARCH PROJECTS

The State of Wisconsin has funded over 320 groundwater-related monitoring and research projects since enactment of Wisconsin's comprehensive groundwater protection legislation (1983 Wisconsin Act 410) in 1984 (see *Appendix C*). Those agencies that have funded projects are the DNR, DATCP, DILHR/Commerce, and the UW System.

This chapter highlights some of the areas that have been the focus of research and monitoring projects and illustrates how agencies have used the project results to improve the management of the state's groundwater resources. Many projects have contributed to our understanding of subsurface hydrology, surface water and groundwater interactions, and geology. Some have helped to evaluate existing regulatory programs and determine if there is a need for additional regulations. Numerous studies have increased the knowledge of the movement of contaminants in the subsurface. Others have developed new methods for groundwater evaluation and protection.

Citations refer to the projects listed in the table in *Appendix C*.

THE ATRAZINE RULE

The development of the Atrazine Rule (ATCP 30, Wis. Adm. Code) illustrates how the benefits of state-funded research and monitoring can build on one another. In the mid-1980s the corn herbicide atrazine was first detected in monitoring wells and private drinking water wells in Wisconsin. The first systematic well sampling program to characterize atrazine contamination on a statewide basis was the 1988 DATCP Grade A Dairy Farm Well Water Quality Survey (LeMasters, 1989). This state-funded well survey estimated that atrazine was present in 12% of the Grade A Dairy Farm Wells in the State.

This study left unanswered many questions regarding the sources, groundwater susceptibility, and the presence of pesticides other than atrazine. Without better information on these and other questions, it was challenging for DATCP, the agency charged with groundwater protection related to agricultural chemicals, to develop a plan of action. It was obvious that a concerted information gathering program was needed. Over the next several years, before and during the development of the DATCP atrazine rule, the Wisconsin Groundwater and Pesticide Research Program played an essential role in providing the needed information. Research and monitoring were conducted on several topics that played a direct role in the evolution of the atrazine rule.

The state research and monitoring program funded several key projects to better understand the sources of atrazine contamination. When atrazine was first found in groundwater, an argument had been made that this was the result of point sources such as spills and mishandling. One of the most important findings that allowed DATCP to begin developing the atrazine rule was that normal agricultural applications of atrazine could lead to groundwater contamination. The DATCP groundwater monitoring project for pesticides (Postle, 1986-96) used monitoring wells located next to agricultural fields to study groundwater contamination by atrazine and other pesticides. This study showed that atrazine from field use on sandy soils could cause contamination, often above the 3 µg/L ES. The UW Water Resources Center conducted a detailed hydrogeologic study (Chesters, 1990-91) at a farm in Dane County and showed conclusively that atrazine contamination could result from both field applications and mixing/loading practices. With the knowledge that nonpoint contamination of groundwater by atrazine was indeed occurring, DATCP could develop ways to reduce this contamination.

State-funded research was essential in showing that atrazine contamination did not follow simplistic notions of groundwater contamination susceptibility. One of the most important findings was that the Central Sands and the Lower Wisconsin River Valley (LWRV), two areas that appear similar in soils and agricultural practices, had significantly different susceptibility to contamination. These differences were pointed out in several research projects conducted by the UW Soil Science Department (Daniel, 1991; Lowery, 1991; McSweeney, 1991; Lowery, 1992-3). This information had a direct influence on the atrazine rule in that there is now a use prohibition in the

LWRV and managed use in the Central Sands.

Another key finding related to the susceptibility of groundwater to atrazine contamination was that many of the areas with high frequency of detections had medium textured (loamy) soils. It had previously been thought that these areas were less susceptible to leaching and groundwater contamination than areas with sandy soils. State-funded research and monitoring efforts, however, showed that the intensity of atrazine use, in addition to soil and geologic conditions, played an important role in the contamination. This finding helped to explain why many areas in south central Wisconsin, with medium textured soil and high corn production, had many wells contaminated with atrazine. This knowledge allowed DATCP to adopt management strategies for reducing atrazine contamination in these areas.

When atrazine was first discovered in Wisconsin's groundwater in the mid-1980s, DATCP was interested in managing its use based on predictive modeling of contamination processes. Modeling activities funded by the state research program, however, indicated that the behavior of atrazine and other contaminants in the environment was complex and could not be reliably predicted by modeling. In response to this finding, DATCP adopted a more empirical approach to identifying management areas. Actual well results were plotted on maps and, together with an analysis of soils and geology, management areas were delineated.

When monitoring and rule making efforts for atrazine first started, parent atrazine was the only compound that was considered. As more research was conducted, however, it was discovered that three metabolites (breakdown products) of atrazine were present in groundwater and were of health concern (Chesters, 1990-91; LeMasters, 1990; Cowell, 1990; Cates, 1991). State-funded sampling programs showed that due to the presence of atrazine metabolites, the groundwater problems were more serious than previously considered. This knowledge allowed DNR to strengthen the groundwater standard for atrazine in 1992 and allowed DATCP to strengthen the atrazine rule in 1993 and extend required use reductions to the entire state.

It is interesting to try to envision how DATCP's atrazine rule would look if it did not have the benefit of the intensive research and monitoring efforts. It is safe to say that it would not have been developed on as good an understanding of the behavior of atrazine in the environment or the geographic patterns of contamination. It is possible that without the intensive monitoring efforts, the full extent of the problem would not have been discovered and atrazine use would not have been reduced. On the other hand, it is possible that with inadequate knowledge a "broad brush" approach would have been taken. This could have resulted in unfair regulations that were not tailored to the different geographic areas of the state.

Two important aspects of environmental regulation that promote its acceptance are that it is based on science and that it is fair. Good research is necessary to achieve these two characteristics. The Atrazine Rule has experienced a relatively high degree of acceptance due to the effort that was put into its development.

GROUNDWATER MONITORING AT SOLID WASTE DISPOSAL SITES

The DNR's Waste Management (WA) program received project funding ten times from 1985 to 2003 through the joint solicitation process. These projects have benefited the program in many ways, primarily impacting regulations and monitoring practices.

The first two studies (Friedman, 1985-87; Battista, 1988-89) revealed for the first time that groundwater around many Wisconsin landfills was contaminated by VOCs. The studies also showed that VOC contamination of groundwater was more common at unlined municipal solid waste landfills than at other types of landfills. A follow-up VOC study (Connelly 1993-94) showed that VOC levels have decreased at most of the unlined landfills, though at many of the sites VOC levels do not show continued decline. There was no VOC contamination definitely attributable to leachate migration at any of the older, engineered landfills that confirmed that these sites are performing as WA program staff had hoped. The results of the three VOC studies have been used to establish requirements for VOC sampling at new and existing landfills. These studies have also indicated that inorganic compounds could be useful in predicting VOC contamination at landfills. Therefore, until recent EPA rules

required VOC monitoring, the WA program allowed sites to sample for inorganic parameters as part of routine monitoring and not sample VOCs until inorganics were elevated. The VOC studies provided valuable data that was used to convince EPA to reduce the number of VOCs required for monitoring at municipal solid waste landfills in Wisconsin. This reduction in monitoring (the use of inorganics and the reduced number of VOCs when they are required) allowed landfill owners considerable cost savings while maintaining equivalent environmental protection. Additionally, the VOC data was used to require responsible parties to define the degree and extent of contamination and remediate groundwater contamination at their landfills.

Research on methods of assessing groundwater quality data and data quality control completed in the third VOC study has been helpful to WA program staff and consultants in interpreting groundwater quality data from landfills and other facilities. This study also showed the need to require laboratories to report data between the limit of detection and the limit of quantitation.

An assessment of Wisconsin's Groundwater Monitoring Plan program (Pugh, 1992) for active non-approved landfills provided the documentation of a set procedure for selecting monitoring sites. This information has been useful in recent meetings with municipalities held to convince municipalities that they have not been singled out for further evaluation of groundwater contamination and to demonstrate that the process used for selecting landfills for monitoring is objective.

Three studies from 1991 to 1994 on the potential groundwater impacts at deer pits, yard waste sites, and construction and demolition landfills (Pugh, 1992-3; Pugh, 1994) were conducted because little or no data existed on the potential impact to groundwater from these sites. Research has provided the information necessary to revise rules and establish policy regarding monitoring and siting of construction and demolition (C/D) landfills, deer pits, and yard waste sites in Wisconsin. The groundwater study of deer pits showed that impacts were minimal and helped the WA program to decide not to require liners and to loosen some construction and reporting requirements. Similarly, the yard waste site study showed only minor groundwater impacts, which led the WA program to encourage active management of these sites rather than stiffen regulations. The study of construction and demolition landfills showed some groundwater impacts at large sites but little or no impacts at smaller sites. These findings led to new regulations (effective June 1996) allowing lined intermediate size C/D landfills, which can provide the economic benefits of a large site without the potential negative impacts of very large sites. Based on the research, the regulations were written to require groundwater monitoring of inorganic parameters at small size C/D landfills but only require VOC sampling when establishing background. Since these studies have been conducted, many states and the EPA have contacted the WA program about the information collected.

Another study undertaken by the WA program (Connelly, 1994) was a comparison of groundwater sampling methods for collecting metals samples at monitoring wells. The study was in response to EPA's October 1991 ban on field filtering of groundwater samples that became effective in October 1994. The WA program opposed this ban because many Wisconsin monitoring wells produce very turbid water which can lead to false positive results for metals if samples are not filtered. Additionally, the new EPA-recommended procedure, low-flow pumping, requires a significant amount of additional equipment. The study showed that the low-flow pumping method was appropriate in many circumstances but could not be used to sample slowly recovering wells. The results showed that turbidity was the best indicator that a well has been sufficiently purged. The results of the investigation are being used to revise groundwater sampling procedures required by the WA program. Additionally, the study helped establish Wisconsin as one of two leading states playing a major role in advising EPA on revisions to their groundwater sampling requirements at municipal solid waste landfills.

A follow up study by the WA program (Svavarsson, 1995) compared low flow pumping and bailing for VOC groundwater sampling at landfills. The study indicated that, in contrast to what some were claiming, there was very little difference in the results when using the two different methods. These findings were incorporated into the new groundwater sampling code and allowed the use of either method for sampling VOCs. This reduced the cost that landfill owners would otherwise have had to bear to purchase and operate low flow pumping equipment.

A joint project between the Bureau and UW Stevens Point evaluated the effectiveness of chemical oxygen demand (COD) as an indicator parameter at landfills (Connelly and Stephens, 2000). One reason for evaluating COD is that

mercury waste is generated when COD is analyzed in the laboratory. The DNR's overall goal was to reduce amount of mercury that gets into the environment. Eliminating COD sampling at the 400+ landfills that currently sample for it would help the agency meet that goal. Findings from the first year of the study indicated that there are potential to eliminate COD monitoring at some types of landfills. The second year of the study evaluated possible alternatives to sampling for COD. Dissolved organic carbon (DOC) appears to be an acceptable alternative in certain circumstances.

Between July 2000 and July 2001 the Bureau studied 31 landfills accepting municipal solid waste, to try to determine whether VOC contamination in groundwater at these landfills is increasing, decreasing or remaining stable (Connelly 2001). Investigators chose sites with 10 years of data and summarized the trends over this period of time. One purpose of this study was to determine whether natural attenuation is occurring in groundwater near leaking landfills. The study showed that natural attenuation processes were occurring at most of the landfills as evidenced by the large number of stable or decreasing concentration trends. However, the concentrations took longer to stabilize and stabilized at higher levels than at other types of VOC contamination sites described in the literature.

ARSENIC MONITORING AND RESEARCH IN NORTHEASTERN WISCONSIN

Wisconsin is also a leader in groundwater monitoring for naturally occurring compounds. Two projects in the DNR Lake Michigan District (Stoll, 1992; 1994) identified the existence of lead and arsenic contamination in groundwater. Homeowners were alerted through direct mailings, public meetings and mass media news releases. Over 72,000 people were unaware of their exposure to the substances in their drinking water. In one case, the sources of metals in these drinking water supplies were given priority for removal (Door County Lead Arsenate Mixing Sites).

The DNR coordinated with the DHFS to conduct health surveys on individuals consuming locally contaminated water supplies and made appropriate health recommendations. Local County Health Departments in affected areas are also actively monitoring groundwater quality and are providing assistance to homeowners. In 2001 and 2002, DHFS staff received additional funding to conduct a follow-up investigation on the relationship between exposure to inorganic arsenic in water and health outcomes (Knobeloch 2001). As part of this research effort, local health departments, DNR staff, town clerks and others have conducted well sampling campaigns in townships in the affected counties.

2233 households submitted samples and returned health surveys, providing health and exposure information for 6669 individuals. Approximately 20% of the water supplies contained arsenic levels above 10 µg/L. Slightly more than 10% of the families consumed water that had an arsenic level greater than 20 µg/L. People over the age of 50 were more likely to report a diagnosis of skin cancer if they had consumed water that had an arsenic concentration greater than 5 µg/L for 10 years or more. Cigarette use was also associated with higher skin cancer rates: residents who both smoked and consumed arsenic-contaminated water reported the highest skin cancer prevalence rate. No association was seen between exposure to arsenic-contaminated water and the incidence of other types of cancer. However, findings from this study were consistent with previously reported associations between arsenic exposure and the prevalence of adult onset diabetes and cardiovascular disease.

As part of this study, DHFS conducted a survey of households in selected areas of northeastern Wisconsin affected by arsenic in groundwater. The goal of this survey was to assess residents' understanding of their laboratory results, learn what actions people have taken in response to their results, and to identify barriers to increased participation in well sampling campaigns. The survey revealed that more than 80% of those who perceived their well water to be unsafe had taken action to reduce their exposure to arsenic, usually by installing a treatment system or by drinking bottled water. Among those who had not sampled their wells for arsenic, confidence in the safety of their well and lack of information about how to have their water tested were the most commonly cited reasons. Many of those who had not had their wells tested had reported that they had only recently moved into their homes or into the area.

Studies conducted by DNR of the extent of the arsenic contaminated area led to the establishment of an "Arsenic Advisory Area" in the early 1990s. This area includes the strip of land five miles either side of the bedrock subcrop of the St. Peter Sandstone, extending in a northeasterly trend, from a location just southwest of Oshkosh, to a location just west of Green Bay. For this area, DNR developed special well construction specifications, more stringent than the minimum Private Well Code requirements. DNR guidance recommends the installation of 80 feet of casing through the sandstone contact for drinking water wells in the AAA. These specifications were recommended, but not required, for new wells constructed within the "Arsenic Advisory Area". The specifications, when followed, will increase the likelihood of installing a well free of arsenic. A special casing and construction area has been established for the Town of Algoma in Winnebago County. In this area, all wells must be drilled with mud/wash rotary methods with a 10-inch upper enlarged drillhole, Bradenhead grout methods and cased to the Cambrian sandstone aquifer.

In 2002 the WGNHS completed field experiments in the Fox River Valley that evaluated mechanisms of arsenic release to groundwater from domestic wells completed in the St. Peter sandstone aquifer, including studies of arsenic exposure to residents in the area and the effects of well chlorination on arsenic levels (Gotkowitz 2001). Findings support the hypothesis that high levels of arsenic in groundwater occur where mineralization is oxidized in well boreholes. However, two distinct geochemical mechanisms appear to contribute low to moderate arsenic concentrations to well water in this aquifer. 1) Oxidation of sulfide minerals may release arsenic to groundwater in confined portions of the aquifer; oxidation may have occurred at some time in the geologic past, or current levels of oxygen dissolved in the groundwater may be sufficient to permit slow oxidation to occur. 2) Reductive dissolution of arsenic-bearing iron oxides also seems to contribute low to moderate levels of arsenic to groundwater when the geochemical environment becomes sufficiently reducing. This occurs under typical domestic water use patterns, because increasing groundwater residence time in wells correlates to the onset of strongly reducing conditions and higher arsenic concentrations. The well borehole is a microbiologically active environment, and biogeochemical reactions likely contribute to the observed increase in arsenic concentrations. Reducing the volume of well bore storage relative to water use may help to limit arsenic concentrations in well water. Results of this study were presented to DNR Drinking Water and Groundwater Program staff and used by the DNR to develop well construction guidelines for the Towns of Algoma and Omro.

Several other ongoing projects addressing arsenic issues include a study refining analytical methods for detection of arsenic compounds (Aldstadt 2001), a study of the role of chlorination in releasing arsenic (Sonzogni 2002), three projects investigating treatment methodologies for both private and public water supplies (Anderson 2001, Park 2002, McGinley 2002), and a project investigating the occurrence of arsenic in southeastern Wisconsin aquifers (Bahr and Gotkowitz 2003). These studies will help provide needed information about the occurrence, health risks, and remediation of arsenic in drinking water supplies. Results will be made available as final reports are completed.

GROUNDWATER MOVEMENT IN FRACTURED DOLOMITE

Door County has been the site of five research projects by the WGNHS to develop a framework for studying the complex groundwater flow regime in fractured rock found in many parts of the state. The first project (Bradbury, 1986-90) started as a nonpoint source watershed project investigating the hydrogeology and groundwater geochemistry in the shallow fractured dolomite aquifer in Door County. Groundwater quality was found to vary widely over time with bacteriological contamination common. The second study (Bradbury, 1992) showed that modeling results obtained from a discrete fracture model varied considerably from results produced by a continuum model for groundwater movement. The discrete fracture model estimated capture zones, groundwater flow paths, and groundwater travel times by using mathematical representations of fractures digitized from aerial photos. The third study (Bradbury, 1993-94) used a tracer for characterization of groundwater movement and contaminant transport. It revealed that hydraulic conductivity can vary widely in the same well depending on what depth interval is tested.

A fourth study applied the discrete fracture flow model above to wellhead protection at the City of Sturgeon Bay (Bradbury 1996). Municipal wells at Sturgeon Bay draw groundwater from a series of horizontal fracture planes in Door County's dolomite aquifer, and delineating wellhead protection areas in such environments is extremely

challenging. This complex project has relied upon hydrogeologic information and analytical tools developed through the three research projects described above which targeted processes and models for groundwater movement in fractured rocks. Without the knowledge and experience gained through these previous projects the Sturgeon Bay Wellhead Protection Project could not have been accomplished.

During 1999, Bradbury and others began a follow-up project to attempt to verify the results of the Sturgeon Bay wellhead protection project using natural groundwater tracers (Bradbury 2000). This research is measuring the natural seasonal variations in temperature, electrical conductivity, and oxygen and hydrogen isotopes of groundwater and precipitation in order to verify the sources and velocities of groundwater moving toward Sturgeon Bay's wells. The use of such tracers is attractive because they are naturally present in the environment.

DEVELOPING NEW TOOLS FOR GROUNDWATER PROTECTION

Applications of a wide variety of tools for gathering and working with hydrogeologic and groundwater quality data have been funded. Projects involving Geographic Information Systems (GIS) and sophisticated groundwater modeling applications have been funded in the many areas of the state. The funding agencies hope to continue to develop improved methodologies to make groundwater quality, quantity and contaminant source data more readily available.

Previous support of county-wide groundwater inventory studies and of modeling methodologies (Potter, 1992-93; Anderson, 1997) has given WGNHS and USGS personnel the hydrogeologic databases and analytical tools needed for the construction of regional groundwater models such as the recently completed Dane County groundwater model. This computer model, which covers all of Dane County, simulates current and future groundwater conditions and is being used to evaluate how current and future groundwater pumping affects regional water levels and also how groundwater use affects shallow lakes, streams, and wetlands. In addition, this model has been used to delineate groundwater capture zones for all municipal wells in Dane County (Bradbury 1996).

The Dane County model, which provides a modern hydrogeologic framework for groundwater movement in Dane County, has stimulated a number of significant research projects by other investigators (Mickelson 1994-95; Bradbury et al., 2000). These investigators are using the model as a starting point for more detailed flow models of specific problems or areas of the county. One of the most significant of these is the award of a multi-year USEPA STAR grant to a team of DNR, UW-Madison, USGS, and WGNHS investigators who are investigating the water-resources impact of different land-use strategies on Madison's urban fringe. This research will support several graduate students and is will provide an integrated assessment of the hydrological, ecological, and institutional impacts of urbanization and land-use change. This research is focused on the Pheasant Branch watershed just west of Madison. Other research projects are investigating the sources of groundwater supplying important springs in the Nine Springs and Token Creek watersheds, with the goal of determining how nearby development and groundwater use could affect the springs.

The Dane County model has now become a prototype for regional groundwater models in other parts of Wisconsin. In 2003, the WGNHS, USGS, and SEWRPC finalized a cooperative project to develop a similar model for the entire seven-county SEWRPC area of southeast Wisconsin. Other modeling projects are taking place in Sauk, Rock, and La Crosse Counties. Such models are critical tools in the planning process, and allow water managers to evaluate the impacts of various future water management and land use alternatives in order to make well-informed land-use decisions.

PREVENTION AND REMEDIATION OF GROUNDWATER CONTAMINATION

The State of Wisconsin (through the UWS Water Resources Institute) has supported many research projects emphasizing new technologies for prevention or remediation of groundwater contamination. Final reports and studies in progress provide information or products that will be important for future efforts aimed at controlling or attenuating groundwater contamination in Wisconsin. The findings cover a wide range of technologies including:

- New and enhanced physicochemical or biological methods to renovate waters contaminated by pesticides and

volatile organic carbon compounds (Collins, 1997-2002), (Li, 2000), (Benson and Eykholt, 2000), (Benson, 1997-2000), (Hoopes, 1997-99), (Park, 1997-98), (Bahr, 1996-98), (Hickey, 1994-96), (Anderson, 1994-95), (Chesters and Harkin, 1991), (Harris and Hickey, 1991-92);

- Enhancements in the ability to control, monitor, and predict the movement of landfill and mine waste contaminants to groundwater (Edil and Benson, 2000), (Edil 1997), (Benson, 1995-96), (Edil and Park, 1992-93);
- Improvements in the predictability of pump-and-treat remediation applications to contaminated aquifers (Bahr, 1994-95);
- Innovative agricultural practices designed to reduce groundwater contamination by pesticides and nitrate (DeVita and Dawson, 2001-04), (Norman, 2000-03), (Bundy, 1993-94, 1997-98), (Shinners, 1995-96), (Newenhouse, 1995), (Harrison, 1992-93), (Bahr, 1991-92); and
- Development of new technologies for evaluating the integrity of water supply well and exploration borehole seals (Edil, 1996, 1998-99), (Edil and Benson, 1997-98).

DETECTION AND MONITORING OF MICROBIOLOGICAL CONTAMINANTS

The GCC has solicited research projects during the last several years that attempt to improve understanding of microbiological aspects of groundwater contamination.

Several projects have focused on developing new techniques for detecting, quantifying, and monitoring microorganisms in groundwater and soils. Researchers at the UW-Madison Soil Science Department, developed a rapid molecular method using the polymerase chain reaction (PCR) to assay soils for the presence of specific sewage-borne pathogens (Hickey 1997). PCR-based methods eliminate the need to culture organisms for detection, and remedy shortcomings of traditional techniques by allowing rapid, sensitive, and specific identification of the pathogens of concern rather than indicator organisms. The PCR protocol Hickey developed was designed to detect DNA originating from *Escherichia coli,* which is one of the major species of bacteria associated with human waste. With this method he could distinguish *E. coli* DNA from that of its closest relative, *Shigella*. The method allowed the detection of DNA equivalent to about 20 cells. Currently, he is testing the PCR method for tracking of *E. coli* in the environment.

Because they have the capacity to co-metabolize a wide variety of organic chemicals, including halogenated compounds, methanotrophic bacteria have significant potential for bioremediation. The UW-Milwaukee Department of Biological Sciences has developed methods for quantification of methanotrophs in groundwater (Collins 1997, 1999). These methods, that include competitive PCR and direct PCR, provide approaches to monitoring bioremediation and natural attenuation. In addition, this work has provided the basis of another study that applied direct PCR to the detection of pathogens in groundwater (Collins 2001).

A recently completed study by the Wisconsin State Laboratory of Hygiene (WSLH) investigated storage and handling requirements for water samples submitted for coliform and *E. coli* analysis (Sonzogni and others, 2002). Currently the USEPA has no guidelines for sample holding times and shipping temperatures for drinking water samples submitted for *E. coli* testing. The study provided evidence to expand the allowable storage time of water samples submitted for *E. coli* analysis beyond the current eight hour limit as well as supporting a single preservation protocol for both surface waters and drinking water samples. A change to a maximum holding time of chilled samples for up to 30 hours could easily be supported by the data presented in this study. The data also called into question the current practice of allowing up to 48 hours for submitting drinking water samples with no attempt to cool them. A reduction in the time period to 30 hours, or a requirement to ship the samples at less than 10 degrees C, could be supported by the data.

Another recent WSLH study developed a culture method for detecting *Helicobacter pylori* from a heterogeneous microbial population in water, and then use this method to establish a data base for its occurrence in Wisconsin groundwater (Sonzogni and others 2002). Prior to this study, there were no reliable methods for detecting viable *H. pylori* in environmental samples (water, manure, vegetables, etc.). *H. pylori* is recognized by the World Health Organization to be the primary cause of peptic ulcers, chronic gastritis and stomach cancer. About 50% of the U.S.

population are thought to be symptomatic or asymptomatic carriers, even though the source of human infection is not well understood. The efforts of this study resulted in the development of a high quality plating media for selecting viable *H. pylori* from mixed microbial populations. Samples from over 400 private wells were *H. pylori*-absent, including wells used by infected residents. These results suggest that the route of *H. pylori* to humans in Wisconsin probably does not involve private well water.

The Marshfield Clinic Research Foundation has investigated the association of pathogenic viruses and bacteria in private wells with incidences of infectious diarrhea and indicators of well water contamination (Borchardt 1997, 1999). In general, infectious diarrhea was not associated with drinking from private wells, nor was it associated with drinking from wells positive for total coliform. However, wells positive for enterococci were associated with children having diarrhea of unknown etiology, which was likely caused by Norwalk-like viruses. Final results indicate that the incidence of virus contamination in private wells may affect 4-12% of private wells. Of concern to drinking water regulators is the seasonal variability of the virus occurrences and lack of correspondence between viral presence and common microbial indicators.

In another recently completed study with the US Geological Survey, Marshfield researchers found that 50% of water samples collected from four La Crosse municipal wells were positive for enteric viruses, including enteroviruses, rotavirus, hepatitis A virus, and Norwalk-like virus (Hunt and Borchardt, 2002). As with the private well study, there was no correspondence to common indicators of sanitary quality. More surprising, there was no relationship between presence of surface water in the well water samples as determined by isotope analysis and virus occurrence. These findings suggest that viruses may be more common than expected in drinking water samples, although they do not indicate whether the viruses are viable, are inactivated through disinfection processes, or result in illness in the community. Research into the link between virus occurrence and human health is needed to answer these questions.

GROUNDWATER DRAWDOWNS

Large-scale withdrawals of groundwater are adversely affecting the environment, economy and public health in large areas of Wisconsin. These drawdowns can cause the water level in wells, streams and wetlands to drop or cause them to dry up entirely. Drawdowns can also cause the levels of arsenic, radium (the precursor to radon) and salinity in drinking water to increase.

State-supported research is using groundwater information and groundwater flow models developed at a regional scale and adapting it for use at the local level. In Washington County, researchers are working with the city of Richfield to develop a protocol for quantifying its groundwater budget (Cherkauer, 2003). That information will be coupled with projected changes in land use and pumping demand to define the effects of several development scenarios on the community's water supply. Once developed, this protocol will enable other communities to decide how to best protect vital groundwater recharge areas, local streams, lakes and wetlands.

Another project is investigating the sources of high salinity and radium in the deep sandstone aquifer that supplies water to residents of eastern Wisconsin (Grundl and Bradbury, 2003). This project is examining in detail the chemistry of the groundwater and the rock formations of this complex aquifer and determining whether high pumping rates are raising salinity and radium levels. This will help city planners and water utility directors better understand the relationship between well operations and water quality in this region, and evaluate effects of urban growth on water supplies.

Other State-supported research is investigating the viability of aquifer storage and recovery (ASR) for Wisconsin, a technology already accepted in other parts of the country, where excess water is stored in aquifers when demand is low and withdrawn for use when demand increases (Anderson, 2003). Computer models of groundwater flow and transport in ASR systems are being developed for three representative groundwater systems in Wisconsin. A better understanding of pumping rates, storage times and other factors that affect recovery efficiency of ASR systems will help guide future decision-making about using these systems in Wisconsin.

Chapter 6 -- FUTURE DIRECTIONS FOR GROUNDWATER PROTECTION

The Groundwater Coordinating Council (GCC) is directed by statute to include in its annual report a "list and description of current and anticipated groundwater problems" and to "set forth the recommendations of the Council" (s. 15.347(13)(g), Wis. Stats.). The purpose of this Chapter is to call attention to statewide priorities in the area of research, monitoring, policy, planning, and coordination related to groundwater and to provide direction to the GCC and its Subcommittees. In addition, this Chapter sets forth the Council's recommendations for future groundwater protection and management needs to state agencies, the Governor, the Legislature, and the citizens of Wisconsin.

PRIORITY RESEARCH & MONITORING NEEDS

- **Maintain adequate funding for groundwater monitoring and research**: State budget cuts have severely limited the number and scope of groundwater research and monitoring projects that were funded in the past three fiscal years (see Table 3 in Chapter 2). DNR's funding for projects has been cut by over two-thirds since FY 02 and has been forced to use Federal dollars with high overhead costs. The UWS budget was cut by 10% in FY 04 and FY 05. DATCP and Commerce have been unable to fund new projects in the last three fiscal years. Continued cuts will hamper the State's ability to address critical groundwater monitoring and research needs in the future. The GCC encourages its member agencies and the legislature to maintain adequate resources for groundwater monitoring and research and to seek partnerships to leverage additional funds.

- **Investigate adverse impacts from groundwater withdrawals:** Recent headlines about high capacity wells, long term water supplies in the Fox River Valley, and severe drawdowns in southeastern Wisconsin have generated many questions about the effects of groundwater withdrawals on surface waters and long-term groundwater availability. There is a need to further quantify hydrographic relationships of surface and groundwater, as well as to develop tools to evaluate the impacts of withdrawals on surface waters. The GCC should continue to encourage research efforts that will provide information useful in addressing this issue.

- **Investigate extent and causes of naturally occurring substances in groundwater:** Continued problems of elevated arsenic, low pH, and other water quality problems in domestic wells exist over large areas of northeast Wisconsin. Additionally elevated sulfate, total dissolved solids, and radium have been found in some new deep municipal wells in the Lower Fox River Valley making the wells unusable. In some other existing deep wells as far south as Milwaukee the total dissolved solids have been steadily increasing over the years. These sulfate and TDS levels pose a problem for local water managers, and the origin of the dissolved solids is not completely understood. The State needs more information about the extent and causes of these problems in order to give advice to homeowners, municipalities, and well drilling contractors. The GCC should continue to encourage research efforts that will provide information useful in addressing these issues.

- **Evaluate occurrence of recently discovered groundwater contaminants:** Recent research conducted in Europe and the U.S. indicates that traces of pharmaceuticals (including antibiotics and hormones) and pesticide breakdown products are common contaminants found in groundwater and surface water. In addition, studies have found evidence of viruses and other microbial agents in both municipal water supplies and domestic wells. Research is needed to determine whether these substances pose a threat to Wisconsin's groundwater resource, and also to human health.

- **Research land use management and its impact on the groundwater resource:** Additional research is needed on the effect of various land uses (e.g. urbanization and agriculture) on groundwater quality and quantity. For example, recently enacted stormwater infiltration rules help reduce runoff in urban areas, but the effects on groundwater quality are largely unknown. Similarly, agricultural nonpoint source rules require nutrient

management plans that protect surface water quality, but may also improve groundwater quality. Projects must be managed in such a way as to maximize their relevance to state land use problems. This issue crosses agency lines and promises to be an important issue for years to come.

- **Identify potential groundwater quality issues associated with innovative water management tools.** Aquifer Storage and Recovery (ASR) and Enhanced Aquifer Recharge are two techniques that are being explored in Wisconsin and other parts of the world to address long-term water supply needs in water-limited areas. These tools may help communities meet water demands during peak use periods or help mitigate adverse effects of long-term water withdrawals. However, the long-term effects on water quality and aquifer geochemistry are relatively unknown, especially in areas with existing water quality issues (e.g. arsenic and radium). Research is needed on a variety of levels in order to evaluate whether these tools are appropriate for Wisconsin.

PRIORITY POLICY & PLANNING NEEDS

- **Address groundwater quantity management issues at both statewide and regional levels:** Groundwater quantity issues came to the forefront of public discussion in FY 04, with the development and passage of landmark groundwater quantity legislation, 2003 Wisconsin Act 310. This legislation has the potential to address needs identified by two recent forums, the 2001 Groundwater Summit and the Waters of Wisconsin Initiative. Common themes included the need for a statewide management plan for water quantity, water conservation, high capacity well reform, reevaluation of water pricing structures and regional approaches to water quantity issues. The GCC will continue to serve as a resource for addressing scientific and technical questions related to groundwater quantity and facilitate further dialogue among all parties on potential approaches and solutions.

- **Provide resources to local governments for Smart Growth/Comprehensive Planning activities**. Recent legislation has required local units of government to develop a comprehensive plan by 2010 in order to undertake land use activities. This plan must address nine elements, including natural and agricultural resources, housing, utilities, and land use. This planning process presents a unique opportunity to address and implement groundwater protection at the local level. Through the Local Government Subcommittee, the GCC will seek ways to assist local communities in their planning efforts to encourage groundwater protection.

- **Find solutions to groundwater nonpoint pollution problems**: A 2002 DATCP report indicates that 37.7% of wells contain a detectable level of at least one herbicide or herbicide metabolite and 11.1% of Wisconsin's wells still contain detectable atrazine residues. In addition, 14% exceed the nitrate standard. These rates are substantially higher in agricultural areas. More work is needed to determine how far Wisconsin groundwater will deteriorate without a substantial change in farming practices, and what practices will sustain both agriculture and groundwater quality. The GCC will support the agencies and the UWS in obtaining information pertinent to the human health implications of consuming nitrate and pesticide contaminated groundwater and the effect of discharge of this groundwater on surface waters and their ecosystems.

PRIORITY COORDINATION NEEDS

- **Support implementation of a Statewide Groundwater Monitoring Strategy:** Chapter 160 of the Wisconsin Statutes requires the DNR to work with other agencies and the GCC to develop and operate a system for monitoring and sampling groundwater to determine whether harmful substances are present (s. 160.27, Wis. Stats.). In FY 04, several agencies worked together to develop a Statewide Groundwater Monitoring Strategy to guide agency monitoring efforts for the next ten years. The GCC encourages agencies, the university, and federal and local partners to implement the various components of the strategy and to seek funding to support its implementation.

- **Coordinate and facilitate consistent messages on groundwater related issues:** The public has benefited

from the consistent educational messages that have been endorsed by the GCC. Through the Education Subcommittee, the GCC will continue to provide its leadership and assistance to state agencies that provide educational materials to the public. In 2004, the Subcommittee will launch a "Groundwater Information Network" with non-governmental organizations to further its mission of promoting consistent messages regarding groundwater protection. Priorities include promoting water stewardship and awareness of water quantity issues, finding innovative ways to encourage testing of private water supplies, and providing materials for local communities to support comprehensive planning activities.

- **Promote consistency between the agencies on data management issues:** Through the DNR's groundwater data system (GRN) and the GCC's Directory of Groundwater Databases, state and local government agencies now have more convenient access to groundwater data. This effort must be maintained by continuing to identify data needs and ways to make data easily accessible. Data consistency must be promoted by use of common geographical locators and minimum data elements for use in a GIS environment. The GCC will continue to provide leadership and communication on data management through its subcommittees. This continued effort displays the GCC's commitment to management of the resource through sound scientific methods.

Ensure access to findings of groundwater research and monitoring projects: More than 120 summaries of groundwater-related monitoring and research projects funded through the Wisconsin Groundwater Research and Monitoring Program are now available online. In FY 04, the WRI Water Resources Library digitized and put online the full text of most WRI and selected DNR project final reports. To maintain and enhance this resource it will be important to add new summaries and reports as they become available, create a more visually appealing set of front-end pages for the site, and publicize the web site location and content more widely. Another WRI initiative is the development of topical fact sheets to summarize research and monitoring findings relative to important groundwater issues in the state. The GCC supports development of these fact sheets and resources and will continue to promote ways to translate sound science into effective groundwater management strategies.

Appendix A :

Statutory Language Relating to the Groundwater Coordinating Council

Chapter 15, Wis. Stats., "Structure of the Executive Branch"

15.347 (13) Groundwater Coordinating Council.

(a) *Creation*. There is created a groundwater coordinating council, attached to the department of natural resources under s. 15.03. The council shall perform the functions specified under s. 160.50.

(b) *Members.* The groundwater coordinating council shall consist of the following members:
1. The secretary of natural resources.
2. The secretary of commerce.
3. The secretary of agriculture, trade and consumer protection.
4. The secretary of health and family services.
5. The secretary of transportation.
6. The president of the University of Wisconsin System.
7. The state geologist.
8. One person to represent the governor.

(c) *Designees*. Under par. (b), agency heads may appoint designees to serve on the council, if the designee is an employe or appointive officer of the agency who has sufficient authority to deploy agency resources and directly influence agency decision making.

(d) *Terms*. Members appointed under par. (b) 8 shall be appointed to 4-year terms.

(e) *Staff*. The state agencies with membership on the council and its subcommittees shall provide adequate staff to conduct the functions of the council.

(f) *Meetings*. The council shall meet at least twice each year and may meet at other times on the call of 3 of its members. Section 15.09 (3) does not apply to meetings of the council.

(g) *Annual report*. In August of each year, the council shall submit to the head of each agency with membership on the council, the governor and the chief clerk of each house of the legislature, for distribution to the appropriate standing committees under s. 13.172 (3), a report which summarizes the operations and activities of the council during the fiscal year concluded on the preceding June 30, describes the state of the groundwater resource and its management and sets forth the recommendations of the council. The annual report shall include a description of the current groundwater quality in the state, an assessment of groundwater management programs, information on the implementation of ch. 160 and a list and description of current and anticipated groundwater problems. In each annual report, the council shall include the dissents of any council member to the activities and recommendations of the council.

Chapter 160, Wis. Stats., "Groundwater Protection Standards"

160.27 Substances in groundwater; monitoring.

(1) The department [of natural resources], with the advice and cooperation of other agencies *and the groundwater coordinating council*, shall develop and operate a system for monitoring and sampling groundwater to determine whether substances identified under s. 160.05 (1) are in the groundwater or whether preventive action limits or enforcement standards are attained or exceeded at points of standards application.

160.50 Groundwater coordinating council.

(1) GENERAL FUNCTIONS. The groundwater coordinating council shall serve as a means of increasing the efficiency and facilitating the effective functioning of state agencies in activities related to groundwater management. The groundwater coordinating council shall advise and assist state agencies in the coordination of nonregulatory programs and the exchange of information related to groundwater, including, but not limited to, agency budgets for groundwater programs, groundwater monitoring, data management, public information and education, laboratory analysis and facilities, research activities and the appropriation and allocation of state funds for research.

(1m)FUNDING FOR GROUNDWATER RESEARCH**.** The groundwater coordinating council shall advise the secretary of administration on the allocation of funds appropriated to the board of regents of the University of Wisconsin System under s. 20.285 (1) (a) for groundwater research.

(2) SUBCOMMITTEES. The groundwater coordinating council may create subcommittees to assist in its work. The subcommittee members may include members of the council, employes of the agencies with members on the council, employes of other state agencies, representatives of counties and municipalities and public members. The council shall consider the need for subcommittees on the subjects within the scope of its general duties under sub. (1) and other subjects deemed appropriate by the council.

(3) REPORT. The groundwater coordinating council shall review the provisions of 1983 Wisconsin Act 410 and report to the chief clerk of each house of the legislature, for distribution to the legislature under s. 13.172 (2), concerning the implementation of the act by January 1, 1989.

Chapter 281.34, Wis. Stats., "Groundwater Withdrawals"

(10) Research and monitoring. To aid in the administration of this section the department [of natural resources] shall, *with the advice of the groundwater coordinating council*, conduct monitoring and research related to all of the following:

(a) Interaction of groundwater and surface water.

(b) Characterization of groundwater resources.

(c) Strategies for managing water.

Appendix B : Meeting Minutes

WISCONSIN GROUNDWATER COORDINATING COUNCIL
DRAFT MEETING MINUTES – AUGUST 15, 2003
WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Members Present: Todd Ambs (DNR), Nick Neher (DATCP), Dan Scudder (DOT), Fran Garb (UW-System), Jamie Robertson (WGNHS), Berni Mattsson (Commerce) and Henry Anderson (DHFS)

Others Present: Tim Asplund and Mike Lemcke (DNR), Randy Zogbaum (DATCP), Anders Andren and Jim Hurley (UW Aquatic Sciences Center), George Kraft (UW Stevens Point), Ken Bradbury (WGNHS), Randy Hunt (USGS), Mark Borchardt (Marshfield Clinic Research Foundation), Ed Morse (Wisconsin Rural Water Association)

The meeting began at 10:00 AM.

1. **General Business** – Introductions were made. No repairs were made to the agenda. Meeting minutes from May 16th were approved as written.

2. **Education Subcommittee Report -**Randy Zogbaum highlighted several ongoing activities of the Education Subcommittee.
   - Historical information related to groundwater quantity - As one way to help citizens understand groundwater quantity issues, Dave Hart from the WGNHS and Chuck Dunning from USGS have been compiling old reports, records, and anecdotes of springs in Dane County and elsewhere. The Education Subcommittee hopes to use these reports and anecdotes to develop materials that illustrate alterations to the hydrologic cycle due to population growth and urban expansion and the resulting demand for water. Ideas being considered include a brochure, fact sheets, or web pages.
   - Home water testing kits - Randy noted that the Subcommittee was continuing to follow up on issues related to the accuracy and usefulness of water testing kits that are sold in home improvement stores. The State Lab of Hygiene completed a study of one such kit for pesticides, and found that while it performed as advertised, there were a number of concerns related to the interpretation of the results. Randy and Nick Neher recently met with the Consumer Protection group at DATCP to discuss the possibility of a "buyer beware" press release to caution consumers about using these kits. The Subcommittee will formally report their findings and recommendations to the GCC at its November meeting.
   - Coordination of water testing efforts - The Subcommittee will continue to promote private well testing as part of Drinking Water Awareness Week, but will also work more closely with the public health community and laboratories to conduct campaigns as part of Public Health is Everywhere week in April of each year.

   Finally, Randy noted the departure of two long time members of the Education Subcommittee, Lynda Knobeloch, of DHFS, and Chris Mechenich of the Groundwater Center at UW Stevens Point (see next item). Rob Thiboldeaux will be taking Lynda's place as DHFS rep on the Subcommittee. A new chair will be chosen at the September meeting of the Subcommittee.

3. **Resolution of Appreciation for Chris Mechenich** - Todd Ambs noted that Chris Mechenich, Groundwater Educator with UW Extension, had decided to move on to other pursuits after 17 years in that position. He listed a number of contributions to groundwater education that Chris has made during her tenure, including:
   - Chairing the Education Subcommittee since 1991
   - Organizing and leading groundwater workshops for teachers
   - Supporting the GW Guardian program since its inception in the mid-1990s

- Planning and implementing the First Groundwater Festival held in May in Stevens Point
- Organizing a private well testing booth at Farm Progress Days for several years (10+)
- Conducting Drinking Water Education Programs to educate private well owners and those at the local level about groundwater quality
- Serving as the UW Stevens Point's representative on the UW-System Groundwater Research Advisory Council
- Assisting with planning, facilitating, and follow-up to the Groundwater Summit and Waters of Wisconsin Forum

The GCC endorsed a Resolution of Appreciation for Chris that will be presented to her at a celebration in Stevens Point on October 2nd.

4. **Monitoring Strategy Workgroup** - Tim Asplund reported that a work group had been formed to assist the DNR's Groundwater Section and the Monitoring and Data Management Subcommittee (MDMS) in developing a statewide groundwater monitoring strategy. This group first met in July and plans to meet monthly for the period of one year. Tasks for the work group include identifying goals for the strategy, reviewing and evaluating existing monitoring programs, identifying gaps and needs, and making recommendations on ways to enhance and maintain the state's groundwater monitoring capacity. Tim noted that this effort would focus on monitoring groundwater quantity as well as quality. He also stressed that the purpose of developing a strategy was to provide consistent framework for agency specific monitoring efforts, not necessarily to create a new monitoring program. Nick Neher noted that another important element of the strategy should be to eliminate redundancy among state programs. He also mentioned that the land and water conservation program at DATCP was working on ways to integrate water quality monitoring at the county level and that it would be good to involve them in this effort.

5. **EPA's Evaluation of State Monitoring Councils** – Tim Asplund reported that the GCC had been asked to participate in a survey of state and regional water-related monitoring councils to assist the EPA in identifying ways to strengthen water quality monitoring programs in the nation. While the GCC is not a water monitoring council per se, it does have the institutional structure and longevity that the EPA is interested in promoting as a model for other states. Tim noted that he had participated in a detailed interview with the EPA's consultant, and that a draft report had been prepared. Some of the initial findings for ensuring success of a monitoring council included the need for dedicated staff, a statutory mandate, and support among participating agencies. Tim will provide the GCC with the final report when it becomes available. Jamie Robertson noted that if the EPA was serious about promoting state councils such as the GCC, it should make funding available to keep them going. He encouraged everyone to be alert to Federal funding opportunities along these lines, especially in a time of dwindling state funds.

6. **Groundwater Quantity Subcommittee Report** - Tim Asplund provided some brief background on the formation of this group, which includes at least one representative from each agency in addition to several experts from the UW system and local partners. The primary purpose of the group is to provide scientific and technical expertise on questions and issues related to groundwater quantity. The first meeting of the group was spent defining terms and concepts, discussing the role of the Subcommittee, and identifying potential areas that need to be addressed. In particular, one major issue is the kinds of investments (staff, time, data, resources) needed to adequately manage groundwater quantity. Tim noted that the group will likely meet relatively frequently in the coming months, but that the GCC may wish to evaluate the need or role for the Subcommittee at some future date. Todd Ambs expressed his appreciation to the GCC for agreeing to form the Subcommittee, and noted that it was imperative to have a good cross section of scientists to weigh in on the concepts that are being proposed as part of groundwater quantity legislation. Nick Neher also noted his support for

the Subcommittee as a means of promoting consistent messages and terminology across groups, as well as generating discussions among agencies. Nick also pointed out that the real decisions regarding water quantity are being made at the community level, and that these issues needed to be addressed as part of the comprehensive planning process.

7. **Conceptualizing Wisconsin's Groundwater Quantity Challenges** - George Kraft presented an overview of key concepts and definitions related to groundwater quantity. In general, resource concerns can be categorized in terms of: 1) surface water depletions, such as effects on streams, wetlands, and springs; 2) large regional drawdowns, such as in major urban areas in the state; and 3) reductions in water quality, related to arsenic, total dissolved solids (TDS), and radioactivity. George then went on to characterize pumping impacts as either: 1) *acute*, which is when pumping of a well immediately impacts a surface water resource or another well; or 2) *chronic*, which represents longer term, cumulative impacts of water withdrawals on a regional scale, not tied to any single well. George noted that either of these impacts must be evaluated in terms of rate, fate (consumed, put back, or transferred), duration, and location (other users, proximity to surface water, and local and regional hydrology).

   George then noted that in a management framework, there are locations in the state where wells can be evaluated on a case-by-case basis (acute impacts), and other areas where well densities are high and/or regional drawdown occurs (chronic impacts). These differences suggest three tiers for management based upon geography or hydrologic unit:
   1) low density groundwater extraction areas, with low intensity of management and evaluations made well by well
   2) higher density groundwater extraction areas, with intermediate levels of management (potential regionalization, monitoring, modeling, voluntary limits to pumping)
   3) high drawdown regions, with immediate and mandated regional groundwater planning, management, and remedial measures

   George then concluded his presentation with a number of areas that need to be addressed, including public trust and ownership issues, standards or thresholds for surface water protection, adaptive management concepts, and funding.

   A general discussion then ensued on a number of these issues. Ken Bradbury noted that it would be helpful to have an overall philosophy to guide management approaches, similar to the public trust doctrine for surface waters, or ensuring a potable water supply for groundwater quality. George noted that there are a number of standards for surface waters (public trust, navigability, fishable/swimable) but that people were struggling with appropriate standards for groundwater withdrawals. Other states use criteria such as maintaining minimum flows, or no wells within quarter mile of stream, but these are relatively arbitrary and only apply to surface water depletions. Todd noted that there needed to be something concrete and easy to apply, yet based on science. Currently the idea being discussed is "no significant adverse environmental impact." Another approach might be weighing the public interest in a particular water body against the economic value of a water project. Jamie noted that people and legislators want numbers, even if it is not adequate scientifically. Nick Neher suggested that another concept is mitigation, or putting water back to compensate for what is withdrawn. Jamie agreed, noting that the overarching goal should be to minimize the disruption of the water cycle, or to keep water local. All agreed that this discussion was important toward developing a "groundwater ethic."

8. **Groundwater Quantity Legislation** - Todd Ambs thanked everyone for their ideas and input and stated that it would be helpful if actual legislation could be introduced for people to begin reacting to, especially beyond the groundwater community. One critical message that needs to be communicated is that there are places where we will be out of water in the near future if nothing is done. Todd emphasized that it was critical to get the issues out on the table and have a discussion, and that there

needed to be a conscious choice to deal with these issue proactively or not. The alternative is to allow a crisis or circumstances beyond our control dictate how we manage water.

Todd then outlined several key elements that are likely to be incorporated into groundwater legislation. Key among these are:

- a general permitting process for all wells, with an associated one-time fee;
- the idea of "no significant adverse environmental impact" on water bodies as the criteria for evaluating potential impacts of a high capacity well;
- the creation of "groundwater management regions" to help the state deal with long term, chronic impacts of groundwater extraction in certain hydrologic settings;
- the idea of limited-term (10-year), renewable permits to allow for adaptive management and to address future water needs.

He noted that there appears to be a lot of interest in the legislature, with bipartisan support, and that he hoped that a draft for discussion purposes would be made available this fall.

9. **2003 Report to the Legislature** - Tim Asplund noted that copies of the 2003 report had been distributed with the agenda, along with a one-page description of the major changes or updates since last year. He also noted that the "Directions for Future Groundwater Protection" chapter had not been updated and that he would appreciate any suggestions or feedback from the GCC on what to include in this chapter as a means of recommendations. Jamie Robertson asked if there was a reason that the title of this chapter focused on protection, and not management or just groundwater. Tim noted that this was partly driven by the statutory requirements for the report, but that it could be renamed if so desired. Jamie also suggested that an item be added under Research and Monitoring Priorities regarding issues related to aquifer storage and recovery and "enhanced aquifer recharge," especially looking at the effects of infiltration of treated wastewater on groundwater quality. Jamie also suggested adding a reference to Chris Mechenich's contributions somewhere in the report. Nick Neher suggested adding a bullet item to emphasize the continued need for research and monitoring funds, especially in the context of being able to take on the increased workload associated with groundwater quantity issues in the future. Tim agreed to make these changes, and noted that he would be putting the final touches on the report and making it available to the legislature by the end of August. In addition, he reported that a new website was being created to provide more accessibility to the report (http://www.dnr.state.wi.us/org/water/dwg/gcc/rtl/gccreport.htm). Nick Neher moved and Henry Anderson seconded a motion to approve the 2003 Report to the Legislature as presented with staff making appropriate modifications. The motion passed unanimously.

10. **FY05 Joint Solicitation -** Jim Hurley noted that the UW System expected to have very limited funds for new groundwater projects in FY05 due to expected commitments to the second year of continuing projects. As a result, Jim stated that the Groundwater Research Advisory Council (GRAC), with new chair Randy Hunt of USGS, would be seriously reviewing the UW System research priorities in putting together the solicitation package for this year. Tim Asplund noted that DNR, DATCP and Commerce all expected to have very limited funds as well, primarily due to budget cuts. Tim noted that the solicitation package would be provided to the GCC in early September for its review, and that he and Jim hoped to make it available to potential investigators by the end of September.

11. **Miscellaneous Agency Updates**:
    - Jim Hurley noted that the Water Resources Institute was developing a research fact sheet series to highlight different topics that are being addressed through the joint solicitation process. The first fact sheet will be on arsenic. He noted that this fact sheet series would be a good complement to the research summaries of each project that are currently online. He also noted that WRI was in the process of making some final reports available online as well.

- Anders Andren reported that WRI was working with Steve Born's "Water Resources Institutions and Policy" class and Shaili Pfeiffer of the Waters of Wisconsin project, to develop a website that would serve as a database of Wisconsin water policy and laws. This effort should be completed by December.
- Nick Neher noted that a recent 9th Circuit Court ruling requires that a NPDES permit be issued for application of pesticides near water. This could have wide impact on EPA and state enforcement and oversight of pesticide applications. States are waiting for an interpretation from EPA to see if legislation is needed to fix this situation.

12. **Technical Presentation: Susceptibility of La Crosse Municipal Wells to Enteric Virus Contamination** - Randy Hunt, of the US Geological Survey and Mark Borchardt, of the Marshfield Clinic Research Foundation, presented findings from their recently completed DNR-funded project. The objectives of the study were to quantify the surface water contributions to several municipal wells in La Crosse and ultimately to relate the amount of surface water to the presence and frequency of virus occurrence. Randy noted that several ongoing hydrologic studies in the La Crosse area presented a good opportunity to conduct this investigation, due to the unique geologic and hydrologic setting of the La Crosse area. Four wells, two with surface water contributions and two without, and one river water site were sampled monthly for one year for several gastrointestinal viruses and other indicators of water sanitary quality. Viruses were analyzed using state of the art molecular techniques (reverse transcription-polymerase chain reaction (RT-PCR)). In addition, stable isotopes of oxygen and hydrogen were used to quantify the amount of surface water and also the time of travel. Randy noted that the stable isotope work not only confirmed that surface waters were reaching 2 of the 4 wells, but also that the travel times were adequate for virus survival (ranging from 2 to 9 months, depending upon flow rates in the river).

    Mark reported that of the 48 well water samples, viruses were detected in half of them. Surprisingly, none of the well water samples (0 of 48) had any incidence of common microbial indicators (total coliform, *E. coli*, fecal enterococci, or coliphages). In addition, there was no correspondence between virus occurrence and surface water contributions, nor was there any temporal trend. These results suggest that there was an additional fecal source, such as leaking sewer lines, which may be impacting the wells. Follow up work showed that the well samples contained a much more diverse array of viruses than the river water, including several common human enteroviruses, further indication of a different source. Importantly, none of the 24 RT-PCR positive samples contained culturable viruses. However, Mark noted that the culture techniques are less sensitive than the molecular techniques, and are not as specific. Thus it is not known whether viable or infectious viruses are reaching well water, and ultimately whether there is a threat to public health. Mark stated that he intended to have a paper ready for publication this fall, and that he had submitted a proposal to the EPA to conduct a more thorough investigation of the link between virus occurrence in municipal water supplies and illness rates. A discussion then ensued on the public information aspects of this study, with an agreement made to coordinate the release of information in tandem with the completion of the manuscript.

13. **The meeting was adjourned.** The next meeting is scheduled for 12 noon, Friday, November 14th, 2003, at the Department of Agriculture, Trade and Consumer Protection, 2811 Agriculture Drive in Madison.

Respectfully submitted,

Tim Asplund, Water Resources Specialist
Department of Natural Resources

WISCONSIN GROUNDWATER COORDINATING COUNCIL
MEETING MINUTES – NOVEMBER 14, 2003
WISCONSIN DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION

Members Present: Mike Lemcke for Todd Ambs (DNR), Nick Neher (DATCP), Dan Scudder (DOT), Anders Andren for Fran Garb (UW-System), Jamie Robertson (WGNHS), Berni Mattsson (Commerce) and Henry Anderson (DHFS)

Others Present: Tim Asplund and Jeff Helmuth (DNR), Randy Zogbaum and Jim Vanden Brook (DATCP), Jim Hurley (UW Aquatic Sciences Center), Bob Pearson (DOT), Jon Heberer and Lynita Docken (Commerce), and Tom Braun (independent consultant)

The meeting began at 12:00 noon.

1. **General Business** – Introductions were made. No repairs were made to the agenda. Meeting minutes from August 15th were approved as written.

2. **Education Subcommittee Report -**Randy Zogbaum highlighted two ongoing activities of the Education Subcommittee.
   - Home water testing kits - A memo was provided to the GCC summarizing the activities to date in regards to evaluating a home test kit designed to detect pesticides in tap water. The kit seemed to perform as advertised, but the Subcommittee noted some potential problems, including the limited number of pesticides that the kit actually tests for, and the inability to detect atrazine breakdown products, which are included in Wisconsin's groundwater enforcement standard. The Subcommittee asked for GCC's approval to distribute the findings more widely, both within state agencies, and to the public. Nick Neher noted that only one type of kit was evaluated in the study and suggested that other available kits be evaluated before releasing the information more widely. He also offered DATCP staff and laboratory resources to perform these additional tests. The Subcommittee will report these findings to the GCC in February.
   - Education Advisory Group memo - One of the recommendations from the Groundwater Summit held in 2001 was to expand the membership of the Education Subcommittee to include other groups involved in groundwater education, such as nonprofit groups, well drillers, and private laboratories. The Subcommittee decided that expanding the Subcommittee could become unmanageable and settled on creating an electronic "Groundwater Education Advisory Group" instead. The idea would be to invite representatives of groups not currently represented on the Subcommittee to keep abreast of Subcommittee activities via email. This group could be asked to provide feedback on Subcommittee activities, or to suggest topics or other items for the Subcommittee to discuss. Attendance at Subcommittee meetings would be welcome, but not required. The GCC gave its approval to proceed with the creation of this group and suggested potential groups and individuals to invite.

   Tim Asplund noted that Randy Zogbaum had agreed to chair the Subcommittee, at least in the short term, and that the new Groundwater Educator at UW Stevens Point would likely be taking some leadership role in the future as well.

3. **Planning and Mapping Subcommittee Report** - Bob Pearson reported on a joint meeting with the Local Government Subcommittee that was held in October at the Wisconsin Rural Water Association office in Plover. Three representatives from various regional planning commissions also attended. The purpose of the meeting was to initiate a dialogue on groundwater information needs at the local and regional level, and to get feedback on the Subcommittee's Groundwater GIS Index. The meeting also included presentations by Madeline Gotkowitz of WGNHS and Andy Selk of DNR demonstrating recently developed groundwater information and mapping resources. Bob noted that

the meeting generated some good discussion and exchange of information, and gave the Subcommittee some feedback on which to go forward with the GIS index project. In addition, it helped identify some additional datasets that the Subcommittee was not previously aware of. Bob noted that Andy Selk's demonstration of the Source Water Assessment Program (SWAP) tools generated a lot of interest and discussion of how to balance security concerns with the ability to get data into the hands of those who can most benefit from it. Another theme of the meeting was being able to get information out to the right people, especially in the context of comprehensive planning. Tim noted that the Local Government Subcommittee would be focusing its efforts on how to ensure that existing Smart Growth planning networks are used to their fullest potential in distributing groundwater information. Jamie Robertson noted that the transfer of information from state and university domain out to citizens and local decision-makers was a key role of the GCC and that he was glad to see these activities occurring.

4. **Monitoring and Data Management Subcommittee report** - Jeff Helmuth reported on the following topics recently discussed by the Monitoring and Data Management Subcommittee:
   - Joint Solicitation Reviews - Because of the tight budget times, the Subcommittee may revisit its review procedures, both to minimize time spent on proposal review, and to focus the review efforts on the proposals most likely to be funded. One scenario might be to pre-screen the proposals if the number of submittals is high. [Note: Only 15 proposals were received as of the November 24th deadline (compared to 31 in 2002), so no pre-screening was necessary.]
   - SWAP mapping applications and security - Jeff noted that he was looking into developing a password-protected method of providing access to SWAP assessments and databases for state and local partners. He noted that the security concerns were not trivial, but that there was also a strong push to get the information out to those who can use it. Mike Lemcke noted that Wisconsin was not alone in terms of being cautious with access and releasing information. He also noted that much of the data and tools are just reaching the point of being ready to be shared anyway, so the discussion of accessibility is as much a technical and quality control issue as it is a security issue. Jeff noted that because SWAP was winding down, it was important to consider ways to partner with others to make use of the information.
   - Monitoring Strategy Work Group - The work group has been meeting monthly since July, and has finished reviewing existing monitoring programs. The next steps are to investigate other states' monitoring strategies and to start identifying where the gaps are in Wisconsin's monitoring capacity. The group hopes to have a draft ready for review by spring 2004.
   - Encouraging use of Unique Well Numbers - One element of the discussion of a monitoring strategy is the need to improve the ability of sharing data among state agencies and university and local partners. The key to this sharing is using unique well numbers (WUWN). Efforts have been made at the agency level to use these numbers, but there is also a need for more education of well owners to provide the WUWN when they submit water samples. The Subcommittee recommended that the Education Subcommittee explore this idea further. The GCC directed the chairs of the two subcommittees to communicate with each other on this issue.

5. **Groundwater Quantity Update and Subcommittee Report** – Mike Lemcke reported that draft groundwater quantity legislation had been put together by the Legislative Reference Bureau, and released jointly by Senator Kedzie and Representative Johnsrud on September 24th. Sen. Kedzie had noted in a recent speech at a Waters of Wisconsin forum (Nov. 3rd), that this was not just a reform of the high capacity well laws, but an attempt at broader groundwater quantity management. Mike noted that the Governor's Office was also developing another draft, and that these two drafts would be circulated for comment among various interests in an attempt to identify areas of agreement and disagreement. Tim Asplund noted that the Quantity Subcommittee had not met since late August, but that it was scheduled to meet in December to discuss the two draft proposals. In the meantime, he

and Jeff Helmuth have been providing the Subcommittee with more information about current practices in regards to the regulation of surface water diversions, high capacity well approvals, and reporting water use, in addition to identifying potential costs of gathering data and developing tools to implement a quantity management program.

6. **FY05 Joint Solicitation for Groundwater Proposals** – Jim Hurley noted that this year's solicitation would be fairly competitive due to limited funds that would be available, both because of a large number of continuing projects and because of state agency budget cuts. He noted that the UW System priorities were unchanged for the most part. The solicitation went out on time in mid-September and the WRI website was ready for submissions at the end of October. Jim stated that he did not have a sense for how many proposals would be submitted by the November 24th deadline, but that he and Tim had been getting just as many calls and inquiries as in the past, despite the limited funding. Jim observed that the pool might be limited this year because many familiar PI's are currently being funded on 2-year projects. Jim also reported that the UW System Library Fund was supporting an effort to get all past UW System funded groundwater research reports scanned and online in a searchable format.

7. **Request for Pre-approval of UW System Continuing Projects** – Jim Hurley noted that the WRI receives $80 – 85K annually from the US Geological Survey as part of its base budget and that it must be matched 2:1 with non-federal funds. In the past, the WRI has used proposals funded through the Joint Solicitation to provide this match. However, because of the timing of the budget proposal to the USGS, it is necessary to "lock in" projects that will be funded in FY05 before the final selection process for this year's solicitation. In order to do this, the WRI has requested the GCC to "pre-approve" the second year funding of continuing projects, continent upon satisfactory progress of these projects. Jim asked for a similar pre-approval for this year. Henry Anderson made a motion to this effect, Mike Lemcke seconded it, and the motion carried unanimously.

8. **Water Quality Monitoring at the Department of Agriculture, Trade and Consumer Protection -** Jim Vanden Brook provided a comprehensive summary of DATCP's water quality monitoring activities, as recently reported to the ATCP Board. He began with a chronology of Wisconsin's regulation of water quality and ag chemicals, noting that the Department was now dealing with nutrient management issues (nitrate and phosphorus) in addition to pesticides. Jim noted that a new ATCP 31 rule package was recently approved by the Board, which would move the beginning of the timing restriction to April 1 from April 15, and included one additional atrazine prohibition area (PA). ATCP 50 was recently promulgated dealing with nutrient management. Some elements of this rule include adoption of NRCS's Standard 590 and requiring every field in the state to have a nutrient management plan by 2008. DATCP's responsibilities to implement this rule include outreach, education, incentives, and compliance provisions.

   Jim then summarized recent findings of various water quality sampling and research studies:
   - Municipal wells: In a 2000 survey, 24 wells exceeded the 10 mg/L nitrate enforcement standard (ES). Half of these also had detects of a pesticide or a metabolite.
   - Private wells: DATCP's database currently contains about 30,000 wells, compiled from DATCP, DNR, UW, and private labs. These records are perused annually to identify wells that exceed an ES and that may lead to the establishment of a PA for atrazine. Over 3500 wells statewide exceed the nitrate ES of 10 mg/L.
   - Exceedance survey: 148 private wells located in PA's have been sampled annually for a number of years. Atrazine concentrations have gone down in 78% of these wells. Of the 150 original wells, 17 are now below 1.5 ppb, while 28 remain above the ES of 3.0 ppb.

- Re-use of atrazine in former PA's: 17 sites with mid-field monitoring wells are being monitored for atrazine, though this evaluation is ending in fall 2003. When grouped by soil texture, slight increases have been seen in median TCR atrazine in coarse soils and larger increases in medium soils over time.
- 2001 statewide survey of private wells: A random stratified survey of 350+ private wells showed significant decrease in the number of wells with detectable levels of atrazine between 1994 (11.1%) and 2001 (5.1%). Only 1.1% now exceed the ES for atrazine. However, 37.7% contain a detectable level of a pesticide or a metabolite.
- Pioneer Farm water quality monitoring: Eight flumes have been set up to monitor runoff under different management regimes. The terrain is proving difficult to measure during storm events. For example, manure applied to frozen ground at one site resulted in a huge plume of nitrate showing up in one snowmelt sample from February 2003.
- Nitrate leaching study: Professor John Norman has been monitoring field scale leaching of nitrate from different manure management regimes. Even at optimal rates of manure application, concentrations in leachate are approaching 10 mg/L. These results demonstrate that different fertility approaches and practices do affect nitrate concentrations in wells.

Jim closed his presentation noting that one of the big questions right now is whether the new nutrient management standards are protective of groundwater. This is likely to become a focus for future monitoring efforts. Other goals for the future include continued tracking of atrazine trends and identifying and characterizing new pesticide contaminants. Nick Neher noted that the efforts of the Wisconsin Agriculture Stewardship Initiative (WASI), a partnership of the DNR, DATCP and the agricultural community, are critical to changing practices on the part of the producer. This partnership, which developed the Pioneer Farm idea, is at the cutting edge in terms of cooperative efforts at the state level.

9. **Stormwater Infiltration, Water Re-use and Groundwater -** Lynita Docken and Tom Braun provided an overview of recent plumbing code changes administered by the Department of Commerce that have implications for water quality and quantity. Lynita noted that people typically do not look at the plumbing code in the context of water resources management, but that the links have been there for a long time, starting with a typhoid outbreak in Ashland and an inadequate water distribution system. Tom then discussed the water re-use concept, noting that only a small percentage of water delivered to households is actually used for drinking water and that some wastewater could be used for other purposes, playing a role in water conservation. Lynita noted that currently all plumbing fixtures in Wisconsin are required to be supplied with water that meets Federal drinking water standards, but that recent code changes have allowed for different levels of water quality for certain uses, such as toilet flushing and irrigation. She then discussed planned changes in stormwater infiltration rules for commercial buildings to comply with NR151, noting that some of the provisions have implications for groundwater quality. Jamie Robertson mentioned that sustainable water supplies for human uses was identified as a major issue for the 21st century at the recent Geological Society of America meeting, and that inefficiencies in water use, as in the volume of water required to move waste around, was one of the culprits. Making these kind of options available now for preservation of future water supplies seems to be prudent before it becomes necessary or required. Bob Pearson noted that it was interesting to see how groundwater and surface water interactions have played out in the context of stormwater infiltration and NR 151, forcing the water cycle connections to be made in an institutional framework.

10. **Miscellaneous Agency Updates**:
    - WGNHS: Jamie Robertson noted an effort to digitize existing county water table maps, as well as compiling information to develop a new understanding and possible re-naming of the hydro-stratigraphy of different water bearing geologic units, to assist with groundwater modeling.

- DNR: Mike Lemcke noted that the Watershed Management Bureau Director position was in open recruitment, and encouraged everyone to apply. He also noted that the revised drinking water standard for arsenic (but not the corresponding groundwater ES) was to receive a hearing in the legislature in the next week.
- DOT: Dan Scudder noted a minor reorganization at the Bureau level within DOT, but that the environmental work and staff remain the same. Bob Pearson noted that TRANS 277 relating to salt storage initiated DOT's groundwater research and monitoring efforts, but that stromwater rules and monitoring of runoff have also been increasingly important. Both of these programs may offer land around the state that could be used for installing wells as part of a monitoring strategy, as well as lend candidate wells to the effort.
- UWS: Anders Andren noted that the federal funding for the Water Resources Institute actually increased by 8-9% this year, partially offsetting the cuts in the state allocation for groundwater research. He also noted that new WRI and Sea Grant brochures contain some interesting tidbits of information about water in the state, and would be worth checking out. He mentioned that WRI was beginning to work with UWEX more closely on several outreach initiatives, including a possible water quality outreach office on campus. Other partners would be welcome!
- DHFS: Henry Anderson reported that DHFS was losing funding and FTE's in the groundwater toxicology area in the state budget. On the positive side, he noted that the federal grant for developing an Environmental Health Tracking network was underway, and that DHFS would be working closely with DNR and DATCP on this project.
- Commerce: Berni Mattsson noted that rules for the administration of the Petroleum Environmental Remediation Fund were to undergo revision in the spring to be consistent with statutes. She also mentioned that a joint study with the DNR and the EPA investigating closure protocol for natural attenuation sites was underway and a draft may be available for GCC to review by the May meeting.
- DATCP: Nick Neher reported that cost share amounts have been reduced for clean-up sites, due to funds being tapped for balancing the state budget. He also noted that the DNR's urban clean sweep program has been merged with DATCP's rural program. Finally, Nick noted that a committee had recently provided some recommendations about how to give some leeway to local governments to regulate siting of livestock facilities, but to implement statewide standards to ensure consistency in regulating air and water quality. Likely an expert panel would be convened to offer guidance on standards, along with an advisory board attached to DATCP to review specific cases to ensure fairness of local decisions. It is hoped that this process would provide protections to farmers as well as protect water and air quality.

11. **The meeting was adjourned.** The next meeting is scheduled for 12 noon, Friday, February 20th, 2004, at the Water Resources Institute (UW Aquatic Sciences Center), 1975 Willow Drive in Madison. Meeting dates, times, and locations will be set for the rest of the year.

Respectfully submitted,

Tim Asplund, Water Resources Specialist
Department of Natural Resources

WISCONSIN GROUNDWATER COORDINATING COUNCIL
MEETING MINUTES – FEBRUARY 20, 2004
UW AQUATIC SCIENCES CENTER

Members Present: Todd Ambs (DNR), Nick Neher (DATCP), Fran Garb (UW-System), Jamie Robertson (WGNHS), Berni Mattsson (Commerce), Dan Scudder (DOT), and Henry Anderson (DHFS)

Others Present: Tim Asplund, Jeff Helmuth, and Mike Lemcke (DNR), Randy Zogbaum (DATCP), Jim Hurley and Anders Andren (UW Aquatic Sciences Center), Randy Hunt and Paul Juckem (USGS), Kevin Masarik (UWSP Groundwater Center)

The meeting began at 12:00 noon.

1. **General business** – Introductions were made. The GCC welcomed Kevin Masarik, new UW Extension Groundwater Educator based at UW Stevens Point. No repairs were made to the agenda. Meeting minutes from November 14th were approved as written.

2. **Education Subcommittee report -**Randy Zogbaum highlighted several ongoing activities of the Education Subcommittee.
   - Home water testing kits - The Subcommittee is checking on the availability of pesticide test kits from other manufacturers and getting feedback from field staff before proceeding with a memo to agencies cautioning the use of these kits.
   - Education Advisory Group - The Subcommittee plans to finalize its list of potential groups and individuals to invite to participate in an email-based advisory group by the next GCC meeting.
   - Groundwater Quantity Resources - The Subcommittee continues to gather resources and develop messages related to groundwater quantity. One resource that recently became available was a USGS website on groundwater resources in the Great Lakes Basin, with a case study on southeast Wisconsin (http://wi.water.usgs.gov/glpf/). A June Wisconsin Natural Resources magazine article on quantity is also in the works.
   - Supplying unique well numbers (WUWN) - Members of the Monitoring & Data Management (MDMS) and Education Subcommittees met to discuss ways to encourage home owners to provide their WUWN when they submit a water sample for analysis. The Groundwater Center and State Lab of Hygiene staff are considering changes to their lab submittal forms to explain what the WUWN is and explain why its important. DNR will also be making changes to its water sampling brochures.
   - 2nd Annual Groundwater Festival - Members of the Subcommittee will be assisting and presenting at this festival, sponsored by the Wisconsin Groundwater Guardians, to be held in Waukesha on April 23, 2004. The event is targeted at 5-6th grade students and their teachers.

3. **FY05 Joint Solicitation update** - Jim Hurley welcomed everyone to the UW Aquatic Sciences Center, and then provided a summary of the annual solicitation for groundwater monitoring and research proposals. He noted that it was a comparatively "light" year, with only 15 proposals submitted asking for a total of $410,000 for the first year (as compared to the year before with 31 proposals and over $900,000 requested). Proposal budgets ranged from $5500 to $41,000, with an average request of $27,000. The lower number of proposals and smaller budgets were an acknowledgment of the reduced amount of funding available for FY05, with only $100 - $125K from the UW System expected to be available for new projects. Jim reported that the GCC subcommittees had met and provided their review scores, and that all of the external peer reviews had been compiled. He noted that the next step was the Groundwater Research Advisory Council (GRAC) meeting on March 19th, and that he expected to have materials ready by the end of February.

4. **WRI Fact Sheets** - Jim Hurley handed out examples of a new fact sheet series highlighting water-related research going on in the state and tying into current hot topics, such as arsenic, drawdowns, and PCBs in sediments of Green Bay. The first audience for these fact sheets would be the Wisconsin congressional delegation, and more technical audiences, such as AWRA. The fact sheets follow a standard 1-page back-to-back format, and include a map of Wisconsin illustrating the issue or where work is being done. Future plans are to make these more generally available through the WRI website, and to cover other topics such as radium.

5. **Research Subcommittee report** - Tim Asplund noted that the Research Subcommittee had met jointly with the MDMS to review the joint solicitation groundwater proposals. At the end of the meeting, the Subcommittee brainstormed ideas for disseminating the results of the groundwater projects more widely and ensuring that final reports are read and used. Ideas included having an annual "report review" meeting of the subcommittee to highlight and discuss significant research that has been done; adding a requirement to the proposal solicitation to include references to any previously funded joint solicitation projects on a similar subject; and asking PIs to submit metadata (data about the data) with their final reports. Tim noted that he would follow up with Ken Bradbury, chair of the Research Subcommittee on these ideas. Jamie Robertson suggested that it might be useful to obtain a set of index maps showing state and Federal legislative districts, and to be able to notify legislators when a project has been completed within their district. This might also be useful for the map showing the locations of joint solicitation funded projects in the Report to the Legislature.

6. **Groundwater Monitoring Strategy** - Mike Lemcke provided a brief overview of the progress made on developing a statewide groundwater monitoring strategy. He noted that this effort started as a way to take a fresh look at the yearly DNR Groundwater Monitoring Plan, which had become more of an annual report on monitoring activities. Several factors, including groundwater quantity issues, EPA monitoring requirements, and Waters of Wisconsin also gave impetus to this effort. In general the goals of the strategy are 1) to document the status and trends of groundwater quality, quantity and use; 2) to characterize groundwater resources; and 3) to make information available and accessible. A work group has been reviewing current monitoring programs and identifying gaps to be addressed by the strategy. The strategy addresses several components, including data mining, water level monitoring, water quality assessment, streamflow monitoring, and water use reporting. Several implementation phases will be suggested, along with estimated costs. Mike noted that the intention of the strategy is to provide a framework for putting phases and components into place as resources become available, rather than suggesting an entirely new program in need of funding. Nick Neher noted that counties often struggle with what to include in the monitoring component of their land and water conservation plans, and that having this strategy in place may assist them in their efforts.

7. **Groundwater Quantity Subcommittee report** – Jeff Helmuth provided a summary of major topics of discussion that the Quantity Subcommittee had taken up in several meetings between December and February, in conjunction with ongoing efforts at crafting legislation.
   - Groundwater Management Areas - These have been conceptualized as large regions with significant drawdowns (SE Wisconsin, Lower Fox River valley) where there is a need for coordinated water management. The Subcommittee has noted some limitations of this concept, including cumulative impacts of smaller wells in urban fringe or other high-density areas. Also the Subcommittee has noted that the drawdown maps that were used for discussion purposes will need to be refined with actual monitoring data if to be used for regulatory purposes.
   - Significant Adverse Environmental Impacts - The Subcommittee came up with a list of sensitive resources that might be impacted by water withdrawals, noting that there was no uniform or specific distance that is applicable for all surface waters in terms of a buffer zone or trigger for review. However, the Subcommittee noted that having some sort of buffer was useful, and that 1200 feet was consistent with other groundwater protection provisions.

- Water use reporting - The Subcommittee generally supported the idea of requiring pumpage reporting for all high capacity wells, noting that the optimal frequency of reporting would vary depending upon the nature of the well. Deeper wells in confined aquifers could get by with an annual report, while shallow wells near a critical surface water resource would need more frequent monitoring, if not reporting.

Jeff noted that the subcommittee was generally supportive of the legislative efforts and excited about the prospects of the legislation. The meetings were well attended and captured a lot of positive ideas and energy. Jamie Robertson cautioned that we need to be careful not to spend all of the time and attention on "red zones" and ignore places that could become a critical management area if nothing is done. Dan Scudder asked if there was some way to institute a PAL/ES concept as applied to groundwater quantity, with a mechanism to trigger some level of review if an area was approaching a critical state. Jeff noted that the draft legislation did have some mechanisms and flexibility in place to address future problems.

8. **Groundwater Quantity Management Legislation update** - Todd Ambs provided a status report on the discussions to date, noting that it had been a very open and transparent process, with much of the discussion and materials regularly posted on Senator Kedzie's website. Todd noted that the recognition that quantity was an important issue to be addressed was a huge positive step, and that "doing nothing" was no longer on the table. The main question at this point was if anything could be done before the end of the legislative session in early March. Todd then summarized the key aspects of the legislation that seemed to have broad agreement, and some of the remaining sticking points. He noted that the GCC would likely have a role in advising the DNR about allocations of resources for monitoring and research. He also noted that the Quantity Subcommittee may be asked to provide some further input on the groundwater management area concept, either as it comes out in the legislation or as draft proposals are re-worked for the next session.

9. **Technical Presentation: Hydrogeology of the Coon Creek Watershed: Insights on Driftless Area Hydrology -** Randy Hunt provided a brief overview of USGS activities in the Coon Creek watershed and La Crosse County in general, noting that much of the background hydrogeological work was supported by Source Water Assessment Program (SWAP) funds. The particular project in the Coon Creek watershed was supported by the UW System through the WRI and constituted Paul Juckem's masters' project. Paul then gave a presentation on the major objectives and findings of his work. He noted that the objectives of the study were to gain a better understanding of the influence of hydrostratigraphy on groundwater flow and to document the spatial patterns and temporal trends of recharge in the watershed. He noted that the Upper Coon Creek watershed was characterized by unglaciated steep hillslopes with intensified recharge cycles. Researchers in the early 1980's noted increased baseflows and decreased storm peaks over the previous 50 years, which was attributed to changes in land management and improved erosion control practices in the watershed.

   Paul then launched into a description of the modeling approach taken to address the three objectives and summarized his major findings. First, he found that individual hydrostratigraphic units make a difference in modeling recharge rates. Some layers act as minor confining layers, while other layers act as unique aquifer systems, with perched water tables. Second, recharge rates appear to vary spatially, with most recharge occurring on hillslopes, rather than ridgetops and valleys. These two findings point to the importance of scale for modeling recharge. On a larger regional level, uniform recharge rates and simple geologic stratification are adequate. On a smaller, subwatershed scale more detail is needed. This could have implications for communities and patterns of rural development within the watershed. The third objective was to document temporal trends. Recharge as a percentage of annual precipitation was found to increase from 19% in the 1930's to 28% in the early 1980's, but remaining relatively stable since then, suggesting that land management practices have stabilized recharge efficiency. However, storm flows have continued to decline for unknown reasons.

10. **Miscellaneous Agency Updates**:
    - DATCP: Nick Neher reported that a hearing was to occur the following week on recommendations for siting large livestock operations. The recommendations keep intact local control through zoning processes, but implement statewide standards to ensure consistency in regulating air and water quality and put into place some timelines on decision-making processes to protect farmers from being treated unfairly. Nick noted that this was similar to the groundwater legislation, in that it was trying to address problems before they occur.
    - UWS: Anders Andren noted that the Water Resources Institute program was again zeroed out in the Federal budget and that he and Jim Hurley would be traveling to Washington DC to try to get it restored. Anders noted that almost all of Wisconsin's funding through the program was being used to match joint solicitation projects. Jim noted that the national call for proposals through the National Water Resources Institute program was closing on March 1st, and that he thought the chances were pretty good this year due to the fact that water use and water quantity was the only topic identified in the RFP.
    - WGNHS: Jamie Robertson reported that Federal funding had been obtained to continue bedrock mapping in Outagamie and Winnebago counties, which will be useful information for well siting and arsenic issues. Other mapping is continuing in Pierce and St. Croix counties, where development pressures have given increased attention to availability of groundwater resources.
    - DNR: Mike Lemcke noted that new state arsenic groundwater standards would go into effect on March 1st (10 µg/L for the ES and 2 µg/L for the PAL). Todd Ambs reported that he had been involved in discussions of Annex 2001 of the Great Lakes Charter, and that a plan would likely be presented to the Great Lakes governors and premiers in May, with the intention of releasing for public comment in early summer. He also noted that Governor Doyle was becoming Chair of the Council of Great Lakes governors on July 1st, likely resulting in increased attention to Great Lakes issues in Wisconsin. Todd also noted an effort in the legislature to allow flow weighted averaging by water utilities to deal with radium compliance issues, which would result in some households drinking water above health standards. He noted that the Governor would likely veto the measure if it reached his desk.
    - Commerce: Extracts from the PECFA Tracker database have been added to the Commerce website for public viewing. The link is http://apps.commerce.state.wi.us/ER_Tracker/GetSites. The information allows the viewer to see the current status of a site, including what expenses have been approved or denied and what actions Commerce staff has taken.
    - USGS - Randy Hunt expanded on the new USGS web page devoted to groundwater in the Great Lakes basin and the southeastern Wisconsin groundwater flow modeling efforts. He noted that significant findings were that a considerable amount of water which would normally flow to Lake Michigan was being intercepted by groundwater pumping within the basin, and that groundwater flow directions had been altered within the deep sandstone aquifer.

11. **Remaining meetings for the rest of the year -**
    - May 14, 2004: 12 - 3:00 PM, WGNHS, 3817 Mineral Point Road, Madison
    - August 20, 2004: **10 AM - 12:30 PM**, DOT, 4802 Sheboygan Avenue, Madison
    - November 12, 2004: 12 - 3:00 PM, DATCP, 2811 Agriculture Drive, Madison

12. **The meeting was adjourned at 3:00 PM.**

Respectfully submitted,

Tim Asplund, Water Resources Specialist
Department of Natural Resources

WISCONSIN GROUNDWATER COORDINATING COUNCIL
DRAFT MEETING MINUTES – MAY 14, 2004
WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

Members Present: Todd Ambs (DNR), Nick Neher (DATCP), Anders Andren for Fran Garb (UW-System), Jamie Robertson (WGNHS), Dan Scudder (DOT), and Lynda Knobeloch for Henry Anderson (DHFS)

Others Present: Tim Asplund, Terry Evanson, and Mike Lemcke (DNR), Randy Zogbaum (DATCP), Jim Hurley (UW Aquatic Sciences Center), Ken Bradbury and Dave Hart (WGNHS), Nancy Quirk (WWA), Ed Morse (WRWA), Jennifer Skinner (Commerce), and Kathleen Standen (We Energies)

The meeting began at 12:00 noon.

1. **General business** – Introductions were made. Meeting minutes from February 20th were approved as written. Tim Asplund noted that he had a few miscellaneous items to add to the agenda.

2. **Miscellaneous updates** - Tim Asplund briefed the GCC on the following items:
   - 20th anniversary of the original groundwater law: Tim noted that May 11, 2004 marked the 20th anniversary of the implementation of 1983 Wisconsin Act 410, which put into place Chapter 160 of the Wisconsin Statutes (Groundwater Protection Standards) and created the GCC. He circulated a press release that went out to statewide media outlets with the May 11 DNR News and Outdoor Report highlighting this anniversary. Nick Neher provided some quotes for the article, along with Mike Lemcke and Steve Born.
   - FY05 Joint Solicitation: Tim noted that the GCC had reviewed and unanimously concurred with the FY05 UW System Groundwater Research Plan via email, and that a letter to this effect had been mailed to the UW System office and the Department of Administration on April 13, 2004.
   - POWTS report from Commerce: A report summarizing the Department of Commerce's Private Onsite Wastewater Treatment System (POWTS) Performance Monitoring Activities for calendar year 2003, as required by Comm 83.71(7) Wis. Adm. Code, was received by Todd Ambs on May 6th. Tim passed around copies of the report. The report indicated that limited funds were available to undertake new monitoring activities. Todd suggested that if the GCC had specific needs or concerns on this topic, it should be sure to communicate them to Commerce in the future.
   - *Straddling the Divide* Symposium: Ken Bradbury reported that a symposium was being planned for February 15-16, 2005 in Chicago to address water supply issues in the Lake Michigan region. The symposium is especially geared towards local and regional planning agencies in areas experiencing water shortages, and would contain both policy and technical tracks to enhance understanding about regional-scale planning and decision-making for water resources. For more information, contact Doug Walker of the Illinois State Water Survey (ddwalker@uiuc.edu).

3. **Education Subcommittee report -**Randy Zogbaum highlighted several ongoing activities of the Education Subcommittee.
   - DNR brochure revisions - Several DNR brochures were revised and updated recently with input and review by the Education Subcommittee. Several of the revisions were a result of Education Subcommittee actions and discussion items, such as encouraging submittal of unique well numbers along with water samples, cautionary language about using do-it-yourself test kits, and more inclusive information about who to contact with questions.
   - 2nd Annual Groundwater Festival - Members of the Subcommittee assisted and made presentations at this festival, sponsored by the Wisconsin Groundwater Guardians, held in Waukesha on April 23, 2004. The event attracted 5-600 5 and 6th grade students and their

teachers, and featured a keynote address by state Senator Neil Kedzie.

- Groundwater Information Directory - Kevin Masarik of UW Stevens Point Center for Watershed Science and Education is currently putting together a "who-does-what" directory of groundwater information and resources to take the place of the outdated Groundwater Education Resource Directory. This will be modeled on a similar Minnesota publication and made available initially as an electronic resource on the GCC website. It will be finalized by the end of August.

4. **Local Government Subcommittee report** - Tim Asplund handed out a summary of the most recent meeting of the Subcommittee, which was held on May 5th, 2004. The main focus of the meeting was to continue discussion of comprehensive planning tools and the recently enacted groundwater quantity legislation. Attendees heard about the Changing Landscapes effort by the DNR's Land Use Team to identify computer tools that could be used by local governments to make land use decisions and to provide training in use of these tools around the state. The Subcommittee also provided input on a proposal to develop guidance for incorporating groundwater information into comprehensive plans and heard a summary of the recently enacted groundwater quantity legislation signed by Governor Doyle on Earth Day.

5. **2004 Report to the Legislature** - Tim Asplund provided a handout summarizing plans for producing the annual GCC report to the Legislature, due in August, along with a proposed outline/table of contents. He reminded everyone that the report serves both as a means of summarizing groundwater related activities that occurred in the past fiscal year, as well as a comprehensive reference on agency groundwater programs. He noted that this year's report would likely highlight issues and activities surrounding groundwater quantity and the recently passed legislation, as well as the efforts to put together a State groundwater monitoring strategy. He noted that the full report itself would have limited distribution, but that more effort would be spent making the report available online and through widespread distribution of the Executive Summary and/or a one-page "Report Card."

   Tim then asked if anyone had suggestions for other items to highlight or feedback on the proposed outline. The following items were suggested:
   - Highlight sections on arsenic and radium, especially since new standards are either in place or on the horizon
   - Add some information on the recent USGS report on Groundwater in the Great Lakes Basin
   - Add applicable sections on groundwater quantity where needed (subcommittee reports, summary of groundwater legislation, Condition of the Resource) and consider developing a new section where progress in implementing the new legislation can be tracked and updated in future reports
   - Start charting dollars spent on groundwater research and monitoring by state agencies, or other ways to document how funding is being diminished over time.

6. **Status of funding for arsenic monitoring and education** - Lynda Knobeloch raised the question of whether we were doing enough as state agencies to address the arsenic problem in Wisconsin, especially in terms of accessing Federal funds for well testing campaigns and advising people of the health risks associated with drinking arsenic contaminated water. Lynda noted that Wisconsin is often overlooked at the national level, even though significant numbers of people are potentially affected by the new health standards. Anders Andren noted that the Wisconsin congressional delegation was very aware of the problem and often asked about it during his annual visits to their offices. The discussion then turned to potential funding sources, and the need for agencies to work together to document health risks and frame an argument about what needs to be done. Todd Ambs brought the discussion to an end, noting two issues for further discussion - is there adequate education, and how to be more proactive about seeking funds for monitoring and well testing.
7. **Groundwater Monitoring Strategy** - Mike Lemcke provided a brief overview of the progress made

on developing a statewide groundwater monitoring strategy. He reviewed the overall goals of the strategy, as presented at the February GCC meeting, noting that the intention was to develop a framework for agencies to use in implementing their groundwater monitoring activities over the next 10 years. A draft strategy was currently undergoing review by agency representatives on the Work Group, and would then be provided to the Monitoring and Data Management Subcommittee. A second draft should be available for the full GCC and other subcommittees by the August GCC meeting. Todd Ambs noted that the DNR Water Division was also developing a coordinated statewide water quality monitoring strategy, incorporating both baseline and targeted monitoring activities. He stated that the groundwater strategy should be incorporated into this effort as appropriate. Part of the impetus for doing this was to meet EPA requirements for state water quality monitoring programs, but also to improve internal coordination and to be able to establish baseline data for evaluating effectiveness of management practices and regulatory activities.

8. **State of Wisconsin Closure Protocol Study** – Terry Evanson, of the DNR's Remediation and Redevelopment Program, gave a presentation on an EPA-funded study to evaluate closure protocols used in remediation cases, particularly those involving cleanups of contaminants from leaking underground storage tanks (USTs). Partners on this project include the Department of Commerce and UW Madison. The objectives of the study are 1) to evaluate if information submitted as part of a site closure is sufficient to assess if natural attenuation is occurring on a plume; 2) to determine if forecasts made at closure are correct; 3) to assess the effectiveness of the decision-making process; and 4) to identify site characteristics where additional monitoring is needed. The study has two phases: a desktop analysis of data from closed sites to develop a database of site characteristics; and a field study of 10 closed UST sites to track changes in groundwater quality that have occurred since closure. Work has started on the database inventory and two pilot field studies are planned for this summer. A number of pitfalls and potential limitations were discussed, such as comparing data from new wells to those collected from previous wells, and obtaining permission to re-visit closed sites.

9. **Groundwater Quantity Management Legislation** - Todd Ambs provided an overview of the recently enacted Groundwater Protection Act, 2003 Wisconsin Act 310. Todd noted that the legislation represented a first step in comprehensive groundwater management, but that it was significant that there was broad recognition of a problem needing to be addressed. He also noted that the entire process was open and informed by science, in contrast to many other legislative proposals. Some of the key aspects of the legislation in this regard include recognition of the water cycle, an opportunity for adaptive management, water use reporting requirements, and maintaining the status quo for the vast majority of groundwater withdrawals.

   Todd then went into some of the details of the legislation, noting that the Groundwater Advisory Committee (GAC) was key to future progress on groundwater quantity management. Some of the topics this Committee will be asked to address include the "1201" problem - wells located outside the 1200 foot Groundwater Protection Areas, better defining springs, other water bodies in need of protection, and other parts of the state that should be designated as groundwater management areas. Todd noted that DNR had sent a letter to the legislature laying out the charge for the Committee and suggesting the creation of a science advisory group and a water policy group to provide technical assistance. Todd closed by stating that the DNR was currently seeking appropriations and positions to implement the legislation.

   Todd was asked if the GCC had a role in the implementation of the legislation. Todd remarked that the GCC was mentioned specifically as an advisor to the DNR on research and monitoring needs. Most of the provisions were deferred to the DNR for implementation, but since there was a lot of overlap in staff the GCC would likely play an active role. Subcommittees may also wish to continue with efforts in education, data management, and monitoring related to groundwater quantity.

10. **Great Lakes Annex and draft agreement on water withdrawals -** Todd Ambs reported that after 3 years of intense discussion, a draft agreement governing water diversions and withdrawals from the Great Lakes was ready to go to all of the governors and premiers within the Basin for their review and authorization to release it to the public for comment. Todd noted that this agreement represented an unprecedented attempt to develop a comprehensive water management strategy for the Great Lakes Basin. The agreement sets up a science-based process for approving water withdrawals and diversions by a regional authority and contains some controversial concepts, such as requiring conservation measures, returning flows to the Basin, and an improvement standard. How these concepts are implemented is the substance of the agreement and the main subject for public comment. In terms of process, Todd anticipated that if the governors and premiers gave authorization for public comment, it would be released in mid-summer, with a 90-day comment period. [Materials can be accessed at http://www.cglg.org/. The comment period closes on Oct. 18, 2004.] There will also be at least 2 regional hearings and several state-by-state public meetings to solicit input. Todd noted that the public comments were critical and would be listened to. He noted that there were still disagreements among the states and provinces on many of the provisions, and that public input may help resolve some of the issues. However, there was a strong sense among all of the parties that it was critical to reach an agreement due to the vulnerability of the current system. Implementation is still a long ways off, as the final agreement would need to go to Governors and premiers, state and provincial legislatures, Congress and Parliament for approval.

11. **Technical Presentation: Geophysical Tools at the WGNHS -** Dave Hart, of the Wisconsin Geological and Natural History Survey (WGNHS), provided an overview of geophysical techniques being used at WGNHS to help answer various hydrogeologic questions and improve understanding of Wisconsin aquifer systems. He defined geophysics as the measurement of physical phenomena that are sensitive to subsurface properties as a surrogate for measuring the properties themselves. He noted that these indirect methods are usually cheaper, non-invasive, and allow more spatial coverage than direct techniques. Dave then highlighted several of these geophysical tools and their application:
    - Time-domain electromagnetic method (TEM): Uses electromagnetic signals to determine conductance of soils and rock layers. Currently being used to map the location and extent of the Eau Claire shale aquitard at the local scale.
    - Ground penetrating radar: Useful for identifying direction and thicknesses of bedrock materials, strata, locating manmade structures and buried geologic features. It can also help interpret water quality data.
    - Natural gamma logs: Helpful for determining lithography within a borehole, and may be useful in locating radium hotspots.
    - Optical logs: Visual interpretation of a borehole, precludes needing a rock core from every well.

    Dave concluded by describing other tools that may be used in the future such as seismics and spectral logs. Jamie Robertson noted that these techniques provide a lot of information for little cost, and that the WGNHS was actively developing many unique and creative approaches and uses for the tools.

12. **The meeting was adjourned at 3:00 PM.** The next meeting is schedules for August 20, 2004: **10 AM - 12:30 PM**, DOT, 4802 Sheboygan Avenue, Madison.

Respectfully submitted,

Tim Asplund, Water Resources Specialist
Department of Natural Resources

Appendix C : WI Groundwater Research & Monitoring Projects 1986-2004

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
1986				
Hydrogeological Investigation of VOC Contaminated Private Wells Near Hudson, Wisconsin	Anklam	1986	DNR	31b
Treatment of Cheese Processing Wastewater by Ridge and Furrow Disposal - Nitrogen Transformations	Boyle	1986	DNR	23
A Case Study of Nitrogen Transformations at a Rapid Infiltration System Used for the Disposal of Food Processing Wastewater	Boyle, Hoopes	1986	DNR	17b
Volatile Organic Compounds in Small Community Wastewater Disposal Systems Using Soil Absorption	Boyle, Sonzogni	1986	DNR	5
Investigation of Hydrogeology and Groundwater Geochemistry in the Shallow Fractured Dolomite Aquifer in Door County, Wisconsin	Bradbury	1986-90	DNR	12
Hydrogeology of the Wisconsin River Valley in Marathon County, Wisconsin	Bradbury	1986	DNR	22
The Prediction of Nitrate Contamination Potential Using Known Hydrogeologic Properties	Cherkauer	1986-87	DNR	10
The Effect of Construction, Installation and Development Techniques on the performance of Monitoring Wells in Fine-Grained Glacial Tills	Cherkauer, Palmer	1986	DNR	16
Volatile Organic Compounds in Groundwater and Leachate at Wisconsin Landfills	Friedman	1985-87	DNR	4a
Barron County Nitrate Study	Hanson	1986-87	DNR	37
Field Investigation of Groundwater Impacts from Absorption Pond Systems Used for Wastewater Disposal	Hoopes	1985-86	DNR	17a
A Simple Stochastic Model Predicting Conservative Mass Transport Through the Unsaturated Zone into Groundwater	Hoopes	1986	DNR	1
The Use of Groundwater Models to Predict Groundwater Mounding Beneath Proposed Groundwater Gradient Control Systems for Sanitary Landfill Designs	Hoopes	1986	DNR	6
Evaluation Techniques for Groundwater Transport Models	Hoopes	1986	DNR	7
The Occurrence of Volatile Organic Compounds in Wastewater, Sludges and Groundwater at Selected Wastewater Treatment Plants in Wisconsin	Hunger	1985-90	DNR	18

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Groundwater Quality Monitoring - Long Term Effects of Intensive Farming and Sprinkler Irrigation on Groundwater Quality	Kammerer	1986	DNR	15
Fate of Aldicarb Residues in A Groundwater Basin near Plover, Wisconsin	Kraft	1986-87	DNR	3
Monitoring of Volatile Organic Compounds in Tomah, Wisconsin	Krohn	1986, 1989	DNR	31a
Fate and Mobility of Radium-226 in Municipal Wastewater Sludge Following Agricultural Landspreading	Portle	1986	DNR	19
Groundwater Monitoring for Pesticides	Postle	1986-97	DNR	2
Graphical and Statistical Methods to Assess the Effect of Landfills on Groundwater Quality	Potter	1986-87	DNR	14a
Groundwater Quality and Laundromat Wastewater: Summit Lake, Wisconsin	Saltes	1986-88	DNR	29
Filtration Preservation Study of Groundwater Samples	Sauer	1984	DNR	21a
West Bend Road Salt Use and Storage Study	Sucht	1986-91	DNR	8
Environmental Investigation of the City of Two Rivers Landfills, Manitowoc County, Wisconsin	Van Biersel	1986-87	DNR	24
Volatile Organic Compound Contamination of Private Water Supplies Adjacent to Abandoned Landfills in Marathon County	Wittkopf	1986-89	DNR	41
1987				
Plover Area Nitrate Study	Bailey	1987-88	DNR	48
Characterization of Groundwater Impacts at an Above Ground Petroleum Storage Terminal	Becker, Ham	1987	DNR	43
Research and Data Analysis of Groundwater Contamination from Municipal Rapid Infiltration Land Disposal Systems	Boyle, Hoopes, Potter	1987-88	DNR	56
Downward Movement of Water Below Barnyard Grass Filter Strips - Case Studies	Bubenzer, Converse	1987-89	DNR	39
1987 Volatile Organic Compound Testing Project in Rock County, Wisconsin	Holman	1987	DNR	40
Flambeau Paper Sulfite Lagoon Site Contamination Study	Lantz	1987	DNR	30

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Groundwater Survey of Bacterial Contamination Near Rapid Infiltration Wastewater Treatment System	Norenberg, Standridge	1987	DNR	21b
Investigation of Large Scale Subsurface Soil Absorption Systems	Peerenboom	1987	DNR	42
Hydrogeologic Investigation and Groundwater Quality Assessment (Havenswood Landfill)	Singh	1987	DNR	28
Nitrate Contamination in West-Central Wisconsin with Emphasis on Mill Run First Edition Subdivision	Tinker	1987-90	DNR	11
Lead Migration from Contaminated Sites - Door County, Wisconsin	Wiersma, Stieglitz	1987-88	DNR	13
1988				
A Ground Penetrating Radar Study of Water Table Elevation in a Portion of Wisconsin's Central Sand Plain	Anderson (Mary), Bentley	1988	DNR	50
VOC Contamination at Selected Wisconsin Landfills - Sampling Results and Policy Implications	Battista	1988-89	DNR	4b
Assessment of Geologic Controls on Groundwater Flow and Distribution in Precambrian Bedrock, Central Wisconsin, Using Remote Sensing and Geophysical	Brown, Davidson Jr.	1988	DNR	49
Digital Simulation of Solute Transport to Green Bay and Lake Michigan by Groundwater from Door County, Wisconsin	Cherkauer	1988-91	DNR	57
Degradation of Atrazine, Alachlor, Metolachlor in Soils and Aquifer Materials	Chesters	1988-90	DNR	52
Radionuclides in Drinking Water of North central Wisconsin	Dobbins, Fitzgerald	1988-89	DNR	54
Sealing Characteristics of Sodium Bentonite Slurries for Water Wells	Edil	1988	DNR	34
Mutagenic Effects of Selected Toxicants Found in Wisconsin's Groundwater	Meisner, Belluck	1988-89	DNR	38
Mineralogical and Geophysical Monitoring Naturally Occurring Radioactive Elements in Selected Wisconsin Aquifers	Morsky, Taylor	1988	DNR	51
Evaluation of the Effect of Stormwater Disposal on Groundwater	Nienke, Shaw	1988-89	DNR	53
Methods for Determining Compliance with Groundwater Quality Regulations at Waste Disposal Facilities	Potter	1988-89	DNR	14b

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Analytical Determination of Atrazine Alachlor and Their Selected Degradation Products in Contaminated Groundwater: Implication for Wisconsin Groundwater	Sonzogni	1988-89	DNR	47
Lead Contamination Study of Door County	Stoll	1988	DNR	44
Freedman Creek Hydrogeologic Baseline Report	Wilson	1988-89	DNR	45
1989				
Effect of Soil Type on Atrazine and Alachlor Movement Through Unsaturated Zone	Daniel	1989	DATCP/ DNR	62
Effects of Volatile Organic Compounds on Clay Landfill Liner Performance	Edil, Berthouex, Park, Sandstrom	1989	DNR	61
Grade A Dairy Farm Water Well Quality Survey	LeMasters, Doyle	1989	DNR	58
Groundwater Quality Investigation of Selected Townships in Jefferson County, Wisconsin	Madison	1989	DNR	60
Designs for Wellhead Protection in Central Wisconsin	Osborne, Sorenson, Knaak, Mechenich	1989	DNR	63
Pesticide Migration Study	Shaw	1989-90	DNR	55
Optimum Manure Application Rate - Corn Fertility Management and Nitrate Leaching to Groundwater in Sandy Soils	Shaw	1989-90	DNR	71
Subdivision Impacts on Groundwater Quality	Shaw, Ameson, VanRyswyk	1989	DNR	67
Demo of Low Input Strategies for Potato/Vegetable Production in Irrigated Sands	Shaw, Curwen, Kraft, Osborne	1989-90	DNR	59
1990				
A Field Evaluation of Drainage Ditches as Barriers to Contaminant Migration	Bahr, Chambers	1990-91	DNR	75
Incorporation of County Groundwater Inventory Data into the DNR Groundwater Information Network (GIN)	Bohn	1990	DNR	68
Atrazine Contamination of Groundwater in Dane County, Wisconsin	Bradbury, McGrath	1990-91	DATCP/ DNR	64
Sources and Extent of Atrazine Contamination of Groundwater at a Grade A Dairy Farm in Dane County, Wisconsin	Chesters, Levy	1990-91	DATCP/ UWS/DNR	65
Follow Up to the Grade A Dairy Farm Well Water Quality Survey	Cowell, LeMasters	1990	DATCP/ DNR	70

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Report on Bacteriological Water Quality Monitoring of Door County Variance and Special Casing Approval Wells	Hutchinson	1990-91	DNR	72
DNR and DATCP Rural Well Survey	LeMasters	1990	DATCP/ DNR	69
Variation in Hydraulic Conductivity in Sandy Glacial Till: Site Variation Versus Methodology	Mickelson, Bradbury, Rayne	1990-92	DNR/UWS	74
Analytical Determination of Pesticide Metabolites and Carrier Chemicals in Wisconsin Wells	Sonzogni, Eldan, Lawrence	1990	DNR	77
Nitrogen Isotope Monitoring at Unsewered Subdivisions	Tinker	1990	DNR	76
Volatile Organic Chemical Attenuation in Unsaturated Soil Above and Below an Onsite Wastewater Infiltration System	Tyler, Peterson, Sauer	1990-91	DNR/UWS	73
1991				
Integrated Decision Support for Wellhead Protection	Adams, Bensen	1991	UWS	
Role of Mobile Colloids in the Transport of Chemical Contaminants in Groundwaters	Armstrong, Shafer	1991-93	UWS	
On-site Nitrogen Removal Systems Research Demonstration Project: Phase I	Ayres & Assoc.	1991	DILHR	
Evaluation of Potential Phytotoxicity and Crop Residues when Using Sprayer Rinsate as a Portion of the Diluent in Pesticide Spray Mixtures	Binning	1991	DATCP	
To Expand Groundwater Sampling in the Lower Wisconsin River Valley	Cates, Madison, Postle	1991	DNR	78
Renovation of Pesticide Contaminated Rinse Waters	Chesters, Harkin	1991	UWS	
In-situ Removal of Fe, Mn, and Ra from Groundwater	Christensen, Cherkauer	1991	UWS	
Reactions of Chlorohydrocarbons on Clay Surfaces	Fripiat	1991	UWS	
The Biological Impact of Landfill Leachate on Nearby Surface Waters	Geis, Sonzogni, Standridge	1991	DNR	83
Chemical Transport Across a Sediment-Water Interface	Green	1991-92	UWS	
Adsorptive Behavior of Atrazine and Alachlor in Organic-Poor Sediments	Grundl	1991	UWS	
Effect of Complex Mixtures of Leachate on the Transport of Pollutants in Groundwater	Grundl, Cherkauer	1991-92	UWS	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Bioremediation of Herbicide-Contaminated Soil and Water	Harris, Armstrong	1991	UWS	
Near-Source Transport of Contaminants in Heterogeneous Media	Hoopes	1991-92	UWS	
Design of a Small Scale Transportable Mixing/Loading System	Kammel	1991	DATCP	
Municipal Wastewater Project	Kopecky	1991	DNR	85
Dependence of Aldicarb Residue Degradation Rates on Groundwater Chemistry in the Wisconsin Central Sands	Kraft, Helmke	1991-92	DNR	84
Using Ground Penetrating Radar to Predict Preferential Solute Movement and Improve Contaminant Monitoring in Sandy Soils	Kung, Madison	1991	UWS	
Nitrate Movement Through the Unsaturated Zone of a Sandy Soil in the Lower Wisconsin River Valley	Lowery, Kussow	1991-93	UWS	
Effect of Soil Type, Selected BMPs, and Tillage on Atrazine and Alachlor Movement Through the Unsaturated Zone	Lowery, McSweeny	1991	DATCP/ DNR	66
A Study of the Response of Nitrate and Pesticide Concentrations to Agricultural BMPs in Sandy Corn Fields	Madison, Cates	1991-94	DNR	81
Facility Plan Amendment for Wastewater Collection for Green Lake Sanitary District, Green Lake, WI	McMahon & Assoc.	1991	DILHR	
Contamination Attenuation Indices for Sandy Soils: Tools for Information Transfer	McSweeney, Madison	1991	UWS	
Tracking Contaminant Pathways in Groundwater Using a Geologically Based Computer Code for Outwash	Mickelson, Anderson	1991-92	UWS	
A Tracer Technique for Measuring Regional Groundwater Velocities from a Single Borehole	Monkmeyer	1991	UWS	
The Economic Effects of Groundwater Contamination on Real Estate	Page	1991	UWS	
Prediction of Organic Chemical Leachate Concentrations from Soil Samples	Park	1991	UWS	
Crop Rotations Effects on Leaching Potential and Groundwater Quality	Posner, Bubenzer, Madison	1991-92	DNR	80
Barnyard Management Practices: Effect on Movement of Nitrogen Through Soils and Impact on Groundwater Quality	Shaw	1991-92	DNR	9

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
A Comparative Study of Nitrate-N Loading to Groundwater from Mound, In Ground Pressure and at Grade Septic Systems	Shaw, Turyk	1991-92	DNR	82
Waupaca County Groundwater Project: Towns of St. Lawrence and Little Wolf	Wilson, Blonde	1991	DNR	79a
1992				
Effects of Transient Cross-Stratification Flow on Contaminant Dispersion	Bahr	1992-93	UWS	
Geographical Information System for Subsurface Characterization	Bosscher, Adams	1992-93	UWS	
Distribution of Radionuclides in Wisconsin Groundwater	Bradbury, Mudrey	1992	DNR	91
Evaluation of NURE Hydrogeochemical Groundwater Data for Use in Wisconsin Groundwater Studies	Bradbury, Mudrey, Shrawder	1992	DNR	90
Preliminary Comparison of a Discrete Fracture Model with a Continuum Model for Groundwater Movement in Fractured Dolomite	Bradbury, Muldoon	1992	DNR	89
GIS Mapping of Groundwater Contaminant Sources, Quality and Contamination Susceptibility for Door County	Carlson, Stoll, Hronek	1992-93	DNR	93
Distribution, Transport and Fate of Major Herbicides and Their Metabolites	Chesters	1992-93	UWS/DATCP	
Dane County Atrazine/Land Management Project	Conners, Bohn, Madison, Muldoon, Richardson	1992	DATCP/ DNR	99
Use of Tire Chips to Attenuate VOCs	Edil, Park	1992-93	UWS	
Municipal Wastewater Absorption Pond Renovation for Enhanced Nitrogen Removal	Gilbert	1992-93	DNR	97
Living Mulch Systems for Nitrate Trapping in Vegetable Production	Harrison	1992-93	UWS	
Remediation of Soils Contaminated by Leaking Underground Storage Tanks by Vapor Extraction and In-situ Biostimulation	Hickey, Jacobsen, Bubenzer	1992-93	DNR	96
Herbicide and Nitrate Movement in a Sandy Soil in the Lower Wisconsin River Valley	Lowery, McSweeney	1992-93	UWS/DATCP	
Spatial Attributes of the Soil-Landscape-Groundwater System of the Lower Wisconsin River Valley	McSweeney, Madison, Attig, Bohn, Falk	1992-93	DNR	88

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Nitrogen Removal from Domestic Wastewater in Unsewered Areas	Otis, Converse	1992-96	DILHR	
New Approaches to Measuring Biologic Effects of Groundwater Contaminants	Porter	1992	UWS	
Estimating the Spatial Distribution of Groundwater Recharge Rates Using Hydrologic, Hydrogeologic and Geochemical Methods	Potter	1992-93	UWS/DATCP	
Investigation of Potential Groundwater Impacts at Demolition Landfills and Deer Pits	Pugh, Connelly	1992-93	DNR	98a
Assessment of Wisconsin's Groundwater Monitoring Plan Program for Active Non-Approved Landfills (1985-1990)	Pugh, Gear	1992	DNR	92
Evaluation of Denitrification Systems for Improving Groundwater from On-Site Waste Disposal Systems	Shaw	1992-93	DNR	95a
Arsenic as a Naturally Elevated Parameter in Water Supply Wells in Eastern Winnebago and Outagamie Counties	Stoll	1992	DNR	87
Waupaca County: Towns of Lebanon and Scandinavia	Wilson, Blonde	1992	DNR	79b
1993				
Urban Stormwater Infiltration: Assessment and Enhancement of Pollutant Removal	Armstrong	1993-94	DNR	102
Trace Metal Transport Affected by Groundwater Stream Interactions	Bahr	1993-94	UWS	
Tracer Study for Characterization of Groundwater Movement and Contaminant Transport in Fractured Dolomite	Bradbury, Muldoon	1993-94	DNR	101
Evaluation of Five Groundwater Susceptibility Assessments in Dane County, Wisconsin	Bridson, Bohn	1993-94	DNR	100
Management of Sweet Corn Processing Wastes to Protect Groundwater Quality	Bundy	1993-94	UWS	
Impact of Tunnel Dewatering on Surface Water Bodies in Milwaukee County	Cherkauer	1993-94	UWS	
A Further Study of Organics at Wisconsin Municipal Solid Waste Landfills	Connelly	1993-94	DNR	104
Ultrasonic Verification Technique for Evaluating Well Seals	Edil	1993-94	UWS	
Long-Term Transformation and Fate of Nitrogen with Mound Type Soil Absorption Systems for Septic Tank Effluent	Harkin	1993-94	DNR	103

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Field Evaluation of Near Source Transport of Contaminants in Heterogeneous Media	Hoopes	1993-94	UWS	
Variability of Hydraulic Conductivity in Supraglacial Sediments	Mickelson	1993-94	UWS	
The Impact of Atrazine Management Areas Designation on Weed Control Strategies in Wisconsin Corn Production	Nowak	1993	DATCP	
1994				
Photocatalytic degradation of volatile organic carbon	Anderson (Marc)	1994-95	UWS	94REM2B2
Improved design of pump and treat systems for heterogeneous aquifers	Bahr	1994-95	UWS	94REM3B2
Herbicide contamination of soil and groundwater at a mixing and loading site	Chesters	1994-95	UWS/ DATCP	94PES2B2
An Investigation of Field-Filtering and Low-Flow Pumping When Sampling for Metals	Connelly	1994	DNR	106
Mineral phase sorption of selected agrichemicals to Wisconsin Soils	Grundl	1994-95	UWS	94PES1B2
Stratigraphy, sedimentology, and porosity distribution of the Silurian rocks of the Door Peninsula, Wisconsin	Harris	1994-95	UWS	94HGE2B2
Using 'PREDICT' to reduce herbicide usage and improve groundwater quality	Harvey	1994-95	UWS	94PES6B2
Comparative evaluation of biostimulation approaches for enhancing in situ TCE degradation in contaminated aquifers	Hickey	1994-95	UWS	94REM6B2
Leaching Potential of Imazethapyr and Nicosulfuron in Sparta Sand	Lowery	1994	DATCP	
Cover Crops to Limit Herbicide Use on Sweet Corn	Newenhouse	1994	DATCP	
Groundwater Hydrogeology of an Agricultural Watershed	Potter	1994-95	DATCP/ DNR	109
Investigation of Potential Groundwater Impacts at Yard Waste Sites	Pugh, Connelly	1994	DNR	98b
Optimization of Two Recirculating Sand Filters for Nitrogen and Organic Chemical Removal from Domestic Wastewater	Shaw	1994	DNR	95b
Factors Affecting the Determination of Radon in Groundwater	Sonzogni	1994	DNR	111

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Integrated Computerized Mapping of Point Source Contaminants and Physical Environmental Characteristics to Protect and Manage Groundwater Quality	Stoll	1994	DNR	105
The Further Incidence of Native Arsenic in Eastern Wisconsin Water Supply Wells; Marinette, Oconto, Shawano and Brown Counties	Stoll	1994	DNR	110
Groundwater Survey of Alachlor and ESA its Polar Metabolite in Southern Wisconsin	Vanden Brook, Postle	1994	DATCP/ DNR	112
The Use of Peat as an Absorptive Medium	Wiersma, Stieglitz	1994	DATCP	
1995				
Evaluating the Effectiveness of Landfill Liners	Benson	1995-96	UWS	
Tracer Study for Characterization of Groundwater Movement and Contaminant Transport in Fractured Dolomite	Bradbury	1995-96	UWS	
Application of a Discrete Fracture Flow Model for Wellhead Protection at Sturgeon Bay, Wisconsin	Bradbury, Muldoon	1995-96	DNR	113
Direct and Residual Effects of Land-applied Sweet Corn Processing Wastes on Nitrate Loss to Groundwater	Bundy	1995-96	DNR	120
Integration of Hydraulics and Geology into a Hydrostratigraphic Model for the Paleozoic Aquifer of Eastern Dane County, Wisconsin	Cherkauer	1995	UWS	
A Comparison of Low Flow Pumping and Bailing for VOC Sampling	Connelly	1995	DNR	114
A Low-Input Crop Management Plan for Wisconsin Fresh-Market Vegetable Growers	Delahaut	1995	DATCP	
Use of Heavy Nitrogen to Study Nitrate Flux from Septic Systems	Harkin	1995-96	UWS/Comm	
Agrichemical Impacts to Groundwater Under Irrigated Vegetables in the Central Sand Plain	Kraft	1995-96	DNR	116
Vertical and Horizontal Variability of Hydrogeologic Properties in Glaciated Landscapes	Mickelson	1995	DNR	119
Synergistic Effects of Endocrine Disrupters in Drinking Water	Porter	1995-96	UWS	
Development and Demonstration of an Accurate Manure Spreading System to Protect Water Quality, Improve Waste Management and Farm Profitability	Shinners	1995-96	UWS	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Geologic Constraints on Arsenic in Groundwater with Applications to Groundwater Modeling	Simo	1995	UWS	
Characterization of E. Coli and Total Coliform Organisms Isolated from Wisconsin Groundwater and Reassessment of their Public Health Significance	Sonzogni	1995	DNR	117
Evaluation of Enzyme-linked Immunosorbent Assay for Herbicide Analysis of Wisconsin Soil in Comparison to Gas Chromatography	Sonzogni	1995	UWS	
An Evaluation of Long-term Trends and a Mineralogical Interpretation of Naturally Occurring Metals Contamination and Acidification of the	Weissbach	1995-96	DNR	115
Collection of Hydraulic and Geologic Data to Improve the Quality of the Wisconsin Groundwater Monitoring Network	Zaporozec	1995-96	DNR	118
1996				
Bioremediation of Hydrocarbons Influenced by Air Sparging: A Multi-model Approach to Assess Contaminant Mass Removal	Bahr	1996	UWS	
Delineation of Capture Zones for Municipal Wells in Dane County, Wisconsin	Bradbury	1996	DNR	121
Responses of Biological Toxicity Tests to Mixtures of Pesticides and Metabolites	Chesters	1996-97	UWS	
Evaluation of Well Seals Using an Ultrasonic Probe	Edil	1996	UWS	
Iron-based Abiotic Destruction of Chlorinated Solvents and Pesticides in Groundwater	Eykholt	1996	DATCP	
Biostimulation of Trichloroethylene Degradation in Contaminated Aquifers	Hickey	1996	UWS	
Optimum Management of Ground-water Resources in the Lower Fox River Valley	Krohelski	1996-97	DNR	122
Variability of Nitrate Loading and Determination of Monitoring Frequency for a Shallow Sandy Aquifer, Arena, Wisconsin	Madison	1996-97	DNR	123
Characterization of the Role of Evapotranspiration on Groundwater Movement and Solute Chemistry in Groundwater-fed Wetlands	Potter	1996-97	UWS	
Ground-water Recharge and Contamination in Wisconsin's Driftless Area	Potter	1996	DATCP	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Land Use Effects on Groundwater and Streamwater Quality in the Little Plover River Watershed	Shaw	1996-97	DATCP	
Stratigraphic Controls on the Mobilization and Transport of Naturally Occurring Arsenic in Groundwater: Implication for Wellhead Protection in	Simo	1996	UWS	
Evaluation of Shallow-soil Absorption Fields Associated with Advanced On-site Disposal System	Stieglitz	1996-97	DNR/UWS Comm	125
GIS as a Tool to Prioritize Environmental Releases, Integrate their Management, and Alleviate their Public Threat	Stoll	1996-97	DNR	126
The Use of Azimuthal Resistivity & Self Potential Measurements to Delineate Groundwater Flow Direction in Fractured Media	Taylor	1996	UWS	
An Integrated Approach to the Management of Insects in Sweet Corn Grown for Fresh Market	Wedberg	1996-97	DATCP	
1997				
Improved Estimation of Groundwater Recharge Rates	Anderson (Mary)	1997	UWS	
Hydrogeochemical and Microbiological Studies for Enhanced Ground Water Bioremediation	Bahr	1997-98	UWS	
In situ Air Sparging: Air Plume Characterization and Removal Effectiveness	Benson	1997-98	UWS	
Groundwater Protection by Application of Modern Portfolio Theory to Microbiotesting Strategies	Blondin	1997	UWS	
Holding Tank Effluent and Fecal-Contaminated Groundwater: Sources of Infectious Diarrhea in Central Wisconsin?	Borchardt	1997-98	Comm	
Development of a Variable Rate Nitrogen Application Approach for Corn	Bundy	1997-98	UWS	
Groundwater Bioremediation: Monitoring with MMO Probes	Collins	1997-98	UWS	
Experimental Verification of Models Used to Evaluate Landfill Liner Effectiveness	Edil	1997	UWS	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Stratigraphy, sedimentology, and Porosity Distribution of the Silurian Aquifer of Ozaukee County, Wisconsin	Harris	1997	UWS	
Molecular Techniques for Detection and Identification of Sewage-Borne Human Pathogens in Soils	Hickey	1997-98	Comm	
Nitrate-Contaminated Drinking Water Followback Study	Kanarek	1997	DNR	131
Fate of Nicosulfuron in Sparta Sand	Lowery	1997	DATCP	
Treatment of Groundwater Contaminated with Chlorinated Aliphatics Using a Silicone Tubing Supported Methanotrophic Biofilm Reactor	Park	1997-98	UWS	
Evaluation of the Use of DUMPSTAT to Detect the Impact of Landfills on Groundwater Quality	Potter	1997	DNR	130
Stratigraphic Controls on Distribution of Hydraulic Conductivity in Carbonate Aquifers	Simo	1997-98	DNR	129
Improved Detection Limits for Ground Water Monitoring	Sonzogni	1997	DNR/UWS	128
Determining Compatibility Between Herbicide Release and Habitat for Karner Blue Butterfly in Red Pine Plantations	Sucoff	1997	DATCP	
A Study of Well Construction Guidance for Arsenic Contamination in Northeast Wisconsin	Weissbach	1997-98	DNR	127
1998				
Assessment of Impacts on Groundwater/Lake and Wetland Systems	Anderson (Mary)	1998	UWS	
Groundwater-Surface Water Interactions in the Nine Springs Watershed	Bahr	1998-99	DNR	137
Evaluation of the Confining Properties of the Maquoketa Formation in the SEWRPC Region of Southeastern Wisconsin	Bradbury	1998	DNR	138
Watershed-Scale Nitrate Contamination and Chloroflurocarbon Ages in the Little Plover Basin: A Study at the Groundwater/Surface Water Interface	Browne	1998-99	UWS	
Determining Ground-Water Recharge Rates in Southern Washington County	Cherkauer	1998-99	UWS	
Characterization of the Hydrostratigraphy of the Deep Sandstone Aquifer in Southeastern Wisconsin	Eaton	1998-99	DNR	134

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Further Evaluation of Well Seals Using an Ultrasonic Probe	Edil	1998	DNR	136
Evaluation of Exploration Borehole Seals Using Time Domain Reflectometry (TDR)	Edil	1998-99	UWS	
Fate of Metolachlor, Alachlor, and Nitrate in Granular Iron/Soil/Water Systems,	Eykholt, Davenport, Wonsettler	1998	DATCP	
Investigation of Air Sparging: Numerical Modeling, Laboratory Verification and Design Guidelines	Hoopes	1998-99	UWS	
The Direct Effect of Agricultural Chemicals on Wisconsin's Declining and Endangered Amphibians	Karasov	1998-99	UWS/DATCP	
Relationships Between Water Quality in Stream Base Flow and Private Wells and Land use in the Tomorrow/Waupaca River Watershed	Shaw	1998-99	DNR	132
Impact of Ginseng Production on Groundwater Quality,	Shaw, De Vita	1998	DATCP	
Northeast Region Public Water Supply Location Utilizing Geographic Information Systems and Global Positioning Systems	Stoll	1998	DNR	133
Effects of Fosamine, Picloram, and Triclopyr on Reducing Aspen in Prairie Bush Clover Habitat,	West	1998	DATCP	
Evaluation of Geology and Hydraulic Performance of Wisconsin Ground-Water Monitoring Wells	Zaporozec	1998	DNR	135
1999				
On-line SFE/GC for Improved Detection of Trace Organic Pollutants in Ground Water Monitoring	Armstrong	1999	UWS/DATCP	
A Rational Design Approach for Permeable Reactive Walls	Benson	1999-2000	UWS	
Viral Contamination of Household Wells Near Disposal Sites for Human Excreta	Borchardt, Sonzogni	1999-2000	DNR	144
Groundwater Flow and Heat Transport in Wetlands: Transient Simulations and Frequency-Domain Analysis	Bravo	1999-2000	UWS	
Monitoring: Evaluation of the Abundance, Diversity, and Activity of Methanotroph Populations in Groundwater	Collins	1999-2000	UWS	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Mechanical Controls on Fracture Development in Carbonate Aquifers: Implications for Groundwater Flow Systems	Cooke	1999-2000	DNR	142
Acute and Chronic Toxicity of Nitrate to Brook Trout (Salvelinus fontinalis)	Crunkilton	1999-2000	DNR	140
Maquoketa Shale as Radium Source to the Cambro-Ordovician Aquifer System	Grundl	1999-2000	DNR	141
Sedimentology, Stratigraphy, and Porosity-Conductivity Relations of the Silurian Aquifer of Ozaukee County, Wisconsin	Harris	1999-2000	UWS	
Analysis of Microbiological and Geochemical Processes Controlling Biodegradation of Aromatic Hydrocarbons in Anaerobic Aquifers	Hickey	1999-2000	DNR	143
Assessing and Reducing Leaching of Agricultural Chemicals on Silt Loam Soils under Different Farming Systems	Kung	1999-2000	DATCP	
Using Geographic Information Systems and Soil Landscape Models to Predict Critical Sites for Nonpoint Source Pollution	Lowery	1999-2000	DATCP	
Water and Land Use: Interpretation of Existing Data to Foster Constructive Public Dialogue and Policy Formulation	Read	1999	UWS	
Natural Attenuation of Fuel and Related Groundwater Contaminants - A Measurement Method	Sonzogni	1999	UWS	
Fate of the Herbicides Atrazine, Cyanazine, and Alachlor and Selected Metabolites	Stoltenberg	1999	DATCP	
Hydraulic Conductivity and Specific Storage of Maquoketa Shale	Wang	1999	UWS	
2000				
A groundwater model for the Central Sands of Wisconsin: Assessing the environmental and economic impacts of Irrigated agriculture	Anderson (Martha), Bland, Kraft	2000	DATCP/ DNR	146
Remediating groundwater using reactive walls containing waste foundry sands	Benson, Eykholt	2000-01	DNR/UWS	147
Field verification of capture zones for municipal wells at Sturgeon Bay, Wisconsin	Bradbury, Rayne, Muldoon	2000	DNR	148
Refinement of two methods for estimation of groundwater recharge rates	Bradbury, Anderson, Potter	2000	DNR	150

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Causes of historical changes in ground-water recharge rates in southeastern Wisconsin	Cherkauer	2000-01	UWS	
Evaluating options for changing groundwater and leachate monitoring requirements for landfills to reduce mercury used by laboratories	Connelly, Stephens, Shaw	2000-01	DNR	151
Compatibility of containment systems with mine waste liquids	Edil, Benson	2000-01	UWS	
Time domain electromagnetic induction survey of eastern Waukesha County and selected locations	Jansen, Taylor	2000	UWS	
Admicelle-catalyzed reductive dechlorination of PCE by zero valent iron	Li	2000-01	UWS	
Development of neural network models for predicting nitrate concentration in well water	Lin, Shaw	2000-01	UWS	
Field monitoring of drainage and nitrate leaching from managed and unmanaged ecosystems	Norman, Brye	2000-01	UWS	
Macropore flow: A means for enhancing groundwater recharge or a potential source of groundwater contamination	Potter, Bosscher	2000-01	UWS	
Hydraulic Conductivity and Specific Storage of Maquoketa Shale	Wang	2000	UWS	
Improvement of Wisconsin groundwater monitoring network	Zaporozec	2000	DNR	149
2001				
Development of analytical methods for comprehensive chemical and physical speciation of arsenicals in groundwater	Aldstadt	2001-02	DNR	154
Removal of As(III) and As(V) in Contaminated Groundwater with Thin-Film Microporous Oxide Adsorbents	Anderson (Marc)	2001-02	UWS	
The Spatial and Temporal Variability of Groundwater Recharge	Anderson (Mary), Potter	2001	UWS	
Importance of Groundwater in Production and Transport of Methyl Mercury in Lake Superior Tributaries	Armstrong	2001-02	UWS	
A study of microbiological testing of well water quality in Door County and incidence of illness in humans	Braatz	2001	DNR	159
A Basin-Scale Denitrification Budget for a Nitrate Contaminated Wisconsin Aquifer: A Study at the Groundwater/Surface Water Interface	Browne, Kraft	2001-02	UWS	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
New approaches to the assessment of microbes in groundwater: application to monitoring bioremediation and detection of pathogens	Collins	2001-02	DNR	155
VOC trend analysis of WI solid waste landfill monitoring data: A preliminary analysis of the natural attenuation process	Connelly	2001-02	DNR	153
Evaluation of pathogen and nitrogen movement beneath on-site systems receiving domestic effluent from single pass sand filters	Converse	2001	Comm	
Effectiveness of phytoremediation and hydrogeologic response at an agricultural chemical facility in Bancroft, WI	DeVita, Dawson	2001-02	DATCP	
Effect of Clean and Polluted Groundwater on Daphnia Reproduction and Development	Dodson	2001-02	UWS	
Verification and characterization of a fracture network within the Maquoketa shale confining unit, SE Wisconsin	Eaton	2001	DNR	157
Groundwater Modeling: Semi-Analytical Approaches for Heterogeneity and Reaction Networks	Eykholt	2001	UWS	
Geologic and geochemical controls on arsenic in groundwater in northeastern Wisconsin	Gotkowitz	2001-02	DNR	152
Screening of agricultural and lawn care pesticides for developmental toxicity using the mouse embryo assay	Greenlee	2001	DATCP	
Public health impacts of arsenic contaminated drinking water	Knobeloch	2001-02	DNR	158
Pesticide and nitrate leaching in soils receiving manure	Lowery, Arriaga, Stoltenberg	2001	DATCP	
An analysis of arsenic replacement wells to determine validity of current DNR well construction guidance	O'Connor	2001-02	DNR	156
Remediation of Soil and Groundwater Using Effectively and Ineffectively Nodulated Alfalfa	Turyk, Shaw	2001-02	UWS/DATCP	
2002				
Groundwater-lake interaction: Response to climate change Vilas County, Wisconsin	Anderson (Mary)	2002	UWS	02-GSI-1
Impacts of privately-sewered subdivisions on groundwater quality in Dane County, WI	Bradbury	2002-3	UWS	02-OSW-1
Chloroacetanilide and atrazine residue penetration and accumulation in two Wisconsin groundwater basins	DeVita, McGinley, Kraft	2002-3	DATCP	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Effect of clean and polluted groundwater on reproduction and development of Daphnia	Dodson	2002	UWS	02-BEP-1
Monitoring contaminant flux from a stormwater infiltration facility to groundwater	Dunning, Bannerman	2002-3	DNR	168
Removal of heavy metals and radionuclides from soils using cationic surfactant flushing	Evans, Li	2002-3	UWS	02-REM-3
Impacts of land use and groundwater flow on the temperature of WI trout streams	Gaffield, Wang	2002-3	UWS	02-GSI-3
Delineation of high salinity conditions in the Cambro-Ordovician aquifer of eastern Wisconsin	Grundl, Taylor	2002	DNR	170
Investigation of changing hydrologic conditions of the Coon Creek watershed in the driftless area of Wisconsin	Hunt	2002	UWS	02-GSI-2
Susceptibility of La Crosse municipal wells to enteric virus contamination from surface water contributions	Hunt, Borchardt	2002	DNR	165
Occurrence of antibiotics in wastewater effluents and their mobility in soils. A case study for Wisconsin	Karthikeyan, Bleam	2002-3	DATCP/ DNR	169
Nitrate loading history, fate, and origin for two WI groundwater basins	Kraft	2002-3	DNR	171
Monitoring and Scaling of Water Quality in the Tomorrow-Waupaca Watershed	Lin, Browne	2002-3	UWS	02-SAM-1
Co-occurrence and removal of arsenic and iron in groundwater	McGinley	2002-3	UWS	02-REM-2
Agrochemical leaching from sub-optimal, optimal, and excessive manure-N fertilization of corn agroecosystems	Norman, Brye	2002-3	DATCP	
Removal of arsenic in groundwater using novel mesoporous sorbent	Park	2002-3	UWS	02-REM-5
Field evaluation of raingardens as a method for enhancing groundwater recharge	Potter	2002-3	UWS	02-BMP-1
Importance of disinfection on arsenic release from wells	Sonzogni, Bowman Standridge, Clary	2002-3	DNR	172
Preservation and survival of E. coli in well water samples submitted for routine analyses	Sonzogni, Standridge, Bussen	2002	DNR	173
Development of a culture method for detection of Helicobacter pylori in groundwater	Sonzogni, Standridge, Degnan	2002	DNR	167
Time domain electromagnetic induction survey of the sandstone aquifer in the Lake Winnebago area	Taylor, Jansen	2002	DNR	173

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
2003				
Photocatalytic Adsorption Media and Processes for Enhanced Removal of Arsenic from Groundwaters	Anderson (Marc)	2003	UWS	03-WSP-02
Role of the Hyporheic Zone in Methylmercury Production and Transport to Lake Superior	Armstrong, Babiarz	2003-4	UWS	03-CTP-02
Arsenic Contamination in Southeast Wisconsin: Sources of Arsenic and Mechanisms of Arsenic Release	Bahr, Gotkowitz	2003-4	DNR/ UWS	174/ 03-HDG-01
Monitoring the Effectiveness of Phytoremediation and Hydrogeologic Response at an Agricultural Chemical Facility	DeVita, Dawson	2003-4	UWS	03-REM-06
F Test for Natural Attenuation in Groundwater: Application on Benzene	Evangelista, Pelayo	2003	UWS	03-REM-08
Determination of Aquitard and Crystalline Bedrock Depth Using Time Domain Electromagnetics	Hart, Alumbaugh	2003	UWS	03-HDG-03
An Experimental and Mathematical Study of the Alpha-Particle Activity of Wisconsin Ground Waters with High Gross Alpha	Sonzogni, Arndt, West	2003	DNR	176
Evaluation of Enzyme Linked Immunosorbent Assay for Analysis of Di Amino Atrazine in Wisconsin Groundwater in Comparison to Chromatography	Strauss, Sonzogni	2003	DNR	175
2004				
Field and Laboratory Validation of Photoactivated Adsorption for Removal of Arsenic in Groundwaters	Anderson (Marc)	2004	DNR	179
An Assessment of Aquifer Storage Recovery for Selected Generic Hydrogeologic Settings in Wisconsin	Anderson (Mary)	2004	UWS	04-HDG-01
Development of a groundwater flow model for the Mukwonago River watershed, southeastern Wisconsin	Bahr	2004-5	DNR	180
Monitoring and predictive modeling of subdivision impacts on groundwater in Wisconsin	Bradbury, Bahr	2004-5	DNR	178
Providing communities with the groundwater information needed for comprehensive planning.	Cherkauer	2004-5	UWS	04-WSP-01
What happens when the confined Cambrian-Ordovician aquifer in SE Wisconsin is "dewatered"?	Eaton	2004	UWS	04-HDG-02
Evaluation of Contamination of Groundwater Around Landfills	Edil, Benson, Connelly	2004-5	UWS	04-CTP-04

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
A Combined Hydrogeologic/Geochemical Investigation of Groundwater Conditions in the Waukesha County area, WI	Grundl, Bradbury, Feinstein, Hart	2004-5	UWS	04-WSP-02
Fate Of Representative Fluoroquinolone, Macrolide, Sulfonamide And Tetracycline Antibiotics In Subsurface Environments	Karthikeyan, Pedersen	2004-5	UWS	04-CTP-02
Groundwater Pollutant Transfer and Export in Northern Mississippi Loess Hills Watersheds	Kraft, Browne	2004-5	DNR	181
Combination of Surfactant Solubilization with Permanganate Oxidation for Groundwater Remediation	Li	2004-5	UWS	04-REM-04
Design and Evaluation of Rain Gardens for Enhancement of Groundwater Recharge	Potter	2004-5	UWS	04-BMP-01
Coupled Modeling of Gravity and Aeromagnetic Data For Analysis of the Waukesha Fault, Southeastern Wisconsin	Skalbeck	2004	UWS	04-HDG-03

Appendix D : FY 05 Joint Solicitation for Groundwater Research and Monitoring Proposals

September 2003

The University of Wisconsin System (UWS) and the Wisconsin Departments of Natural Resources (DNR), Agriculture, Trade, and Consumer Protection (DATCP), and Commerce annually participate in a joint solicitation for research and monitoring proposals dealing with groundwater, pesticides and/or onsite wastewater treatment systems. At least $390,000 will be available for groundwater-related monitoring and research in fiscal year 2005 (FY05) for new and continuing projects. However, limited funds will be available for new projects due to state budget cuts and expected commitments to continuing projects. The four programs, which are collectively called the Wisconsin Groundwater Research and Monitoring Program, are summarized as follows:

1. UWS Groundwater Research - The UWS, through its UW-Madison Water Resources Institute (WRI), has received funding since FY 90 for groundwater research. The UWS will have $300,000 to fund research in FY 05. Through FY 03, the UWS has spent $4.1 million on 113 groundwater research projects. Several projects have been co-funded with DNR, Commerce and/or DATCP and nine were co-funded with WRI through the US Geological Survey.

2. DNR Management Practice Monitoring - The DNR has been funding groundwater management practice monitoring projects since FY 86. The DNR will have approximately $90,000 available for FY 05 to support groundwater monitoring studies that evaluate existing design and/or management practices associated with potential sources of groundwater contamination. The intent of these studies is to reduce the impacts of potential sources of contamination by changing the way land activities that may impact groundwater are conducted. The money comes from the Groundwater Account of the Environmental Fund (which is funded by various fees). Through FY 03, the DNR has spent approximately $5.5 million on 169 monitoring projects. Several of these projects have been co-funded with DATCP, Commerce and/or UWS.

3. DATCP Pesticide Research - Since 1989, the DATCP has had approximately $135,000 available annually to fund research on pesticide issues of regulatory importance. This money comes from fees paid by pesticide manufacturers to sell products in Wisconsin. Through FY 03, the DATCP has spent about $1.8 million on 42 pesticide projects. Some of these projects have been co-funded with DNR and/or UWS.

4. Department of Commerce Private Sewage System Research – The Division of Safety & Buildings (formerly in the Department of Industry, Labor, and Human Relations) received an annual appropriation of $50,000 from 1990 to 1993 to fund research on alternatives to current private sewage-system technology. In 1994, when the appropriation expired, $75,000 generated through plan review and licensing fees became available each year for research on private sewage systems. As of September 2003, Commerce has indicated that no funds will be available for research projects in FY 05. Through FY 03, the DILHR/Commerce has spent approximately $600,000 on eight projects. Two projects were co-funded with DNR and UWS.

The Wisconsin Groundwater Coordinating Council (GCC) provides consistency and coordination among the four state agencies in funding groundwater monitoring and research to meet state agency needs. The reasons for this solicitation to be made jointly are to:

- Facilitate proposal writing
- Streamline the review process

- Curtail duplication
- Improve coordination among agencies and researchers
- Enhance communication among the agencies and among principal investigators (P.I.)

Joint funding of some projects may be appropriate, but joint funding is not the purpose of this solicitation because each agency has its own designated mission and priorities. Although all proposals received will be distributed to each agency, each investigator is asked to identify the agency whose mission and priorities best match their project.

Please read the solicitation carefully; it contains a description of the priorities for each agency program and other pertinent information, including a new online proposal submission process. Capital items may not be purchased with these funds, and faculty salaries plus fringe benefits will be limited to a maximum of 10% of an individual grant (e.g., for a $20,000 grant, a maximum of $2,000 can be allotted to faculty salaries and fringe benefits).

Investigators who are new to this program are encouraged to solicit an example proposal from the agency contacts listed below

If you have questions please call the following appropriate agency contacts.

James Hurley, UW Water Resources Institute: (608) 262-0905; hurley@aqua.wisc.edu
Tim Asplund, Department of Natural Resources: (608) 267-7449; tim.asplund@dnr.state.wi.us
Jeff Postle, Department of Agriculture, Trade and Consumer Protection (608) 224-4503; jeff.postle@datcp.state.wi.us
Harold Stanlick, Department of Commerce: (262) 521-5065; hstanlick@commerce.state.wi.us

Eligibility

Please note that each agency has separate requirements for eligibility. Review the agency-specific sections carefully. In general:

UWS:	Funds are restricted for use by faculty within the UW System or by academic staff who have achieved nomination to P.I. status.
DNR & Commerce:	Funds are restricted to use by UW System and state and county agency contractors.
DATCP:	Any college or university, research foundation or individual having a demonstrated capacity in pesticide or other applicable research may submit proposals.

Investigators who are not affiliated with the state and therefore not eligible for funding by UWS, DNR, or Commerce may wish to collaborate on a proposal with a UWS investigator or state agency staff member.

A principal investigator with unfinished Groundwater Research and Monitoring Program-funded final reports that are significantly overdue (in the case of UWS by more than six months) with respect to initially specified or understood completion dates will not be eligible for new funding. The Groundwater Coordinating Council may consider extenuating circumstances on a case-by-case basis.

Online Submission of Proposals

(Complete instructions for online submission can be found at the UW Water Resources Institute Web site.)

Proposals for the Wisconsin Groundwater Research and Monitoring Program will be submitted entirely online, through the University of Wisconsin Water Resources Institute's (WRI) Web site at http://wri.wisc.edu. The Web site will be ready for principal investigator registration and proposal uploads after October 20, 2003. **The deadline for submittal of proposals is 6:00 PM Monday, November 24, 2003.**

Please note that investigators will be required to register on the Web site prior to submitting a proposal. Once an investigator has registered, he or she may begin submitting information about one or more proposals, and may update and add new information at any time prior to the proposal deadline on November 18th. Once all of the information has been provided and checked for accuracy, the investigator will be required to approve the final package for official submission. **Access to the online submission Web site will be closed after 6:00 PM (CST) on November 24, 2003.**

Investigators should be prepared to provide the following information when submitting a proposal online at the WRI Web site (see *Guidelines for Proposal Submission* on page 5 for more details):

- Title
- Investigators
- Abstract (condensed version of project summary separate from the Project Narrative)
- Location of Research
- Target agency ranking
- Adobe Acrobat file (.pdf) of proposal text
- Budget information
- Names and email addresses of three qualified reviewers of proposal, including their disciplines and specialties (at least two must be from outside of Wisconsin)

Investigators will be required to upload a .pdf version of their proposal to the WRI Web site. In order to create a .pdf file, investigators will need to either use Adobe Acrobat software or go online to Adobe's site to create a .pdf file. Adobe offers a monthly subscription for .pdf file creation or a free trial period that enables creation of 5 .pdf files at http://www.adobe.com/store/products/createpdf.html.

Proposals should be no longer than 18 pages. All pages should be 8.5" x 11". The project summary, narrative, curriculum vitae, and support pages should start on a new page, be double-spaced (except for Figure and Table legends), and use no smaller than 11-point font. All margins should be no less than 0.75 inches. The proposal must be consecutively paginated on the bottom of the page. Include literature citations in the proposal where appropriate (single-spaced within, double-spaced between). **A Word and WordPerfect template will be provided on the WRI web site. We encourage all investigators to use these pre-formatted files for their proposal text.**

Any section of a proposal that exceeds the specified maximum page limits will be grounds for returning the proposal to the author. A *Proposal Guideline Checklist* is provided on page 7 to assist proposal authors.

All proposals must be submitted online. No facsimiles of proposals and no hand-written proposals will be accepted. Special attachments (maps, brochures, etc.) will be accepted, noted, and kept on file, but will not be included in the package of materials submitted to reviewers.

Review of Proposals

All proposals received through the Wisconsin Groundwater Research and Monitoring Program joint solicitation process receive reviews from the following four groups:

1. External peer review: The UW Water Resources Institute solicits a minimum of four external peer reviews of all proposals. (As part of this peer review process, investigators should provide the names, addresses and email of three suggested reviewers with expertise in the field of the proposal.)
2. The Research and Monitoring & Data Management Subcommittees of the GCC
3. The Groundwater Research Advisory Council (GRAC)
4. Staff from the funding agencies

The two most important considerations of the reviewers are 1) whether the proposal meets agency priorities as outlined in this solicitation and 2) whether the proposal is well written and scientifically sound. Other criteria include:

- project cost
- proposed timeline
- whether the proposed project methodology meets the stated objectives
- whether the resources requested are adequate to carry out the project
- and whether the project investigators have the abilities to complete the proposed project.

Additional review criteria may be applied by individual agencies (see agency-specific sections that follow).

Funding decisions will be made in March 2004. Proposals that are not chosen for funding through this solicitation may be referred to other funding sources for their consideration with permission of the investigators. Likewise, other funding organizations may refer proposals to the funding agencies involved in this solicitation.

Administration of Projects

Proposals that are funded become the property of the granting Wisconsin state agency. Please note that each agency has separate mechanisms for administering funds, and separate requirements for reporting. However, all investigators will be asked to submit a 2-page Project Summary upon completion of the project to be posted on the Water Resources Institute web site, and to make a copy of the final report available to the Water Resources Institute Library. For more information on these requirements, please contact Tim Asplund or James Hurley.

Guidelines for Proposal Submission

(See WRI web site (http://wri.wisc.edu) for complete submission details)

I. Register online at the WRI web site anytime after October 20, 2003. (Each investigator must register.)

A. Name of investigator

B. Title/Position

C. Affiliation

D. Mailing Address

E. Phone number

F. Fax number

G. Email address

II. Enter information about each proposal.

A. Title

B. Investigators (from drop-down menu of investigators previously-registered on the site)

C. Abstract (condensed version of project summary)

D. Location of Research

E. Ranking of agencies in order of preference or relevance for funding (note that the selected order does not exclude consideration of a proposal by any of the agencies, but does assist the reviewers in evaluating the proposal)

III. Upload proposal text as Adobe Acrobat .pdf file. (Please use Word or WordPerfect templates provided on Web site to develop this section.)

A. Title, Investigators, Affiliations of Investigators (top of first page)

B. Project Summary (begin on same page, **not to exceed 2 double-spaced pages**)

1. Specific groundwater or related problem addressed by research/monitoring proposal.
2. What will findings contribute to problem solution or understanding?
3. Project objectives.
4. Project approach to achieve objectives including methods and procedures.
5. Users of project findings.

C. Proposal Narrative (begin on new page, **not to exceed 10 double-spaced pages**)

1. Objectives

2. Background information describing prior research/monitoring relevant to objectives; references to ongoing projects and how they relate to proposed investigation; information gaps which will be filled by the proposed project.

3. Project plan outlining experimental design and schedule

4. Methods detailed enough to convince the reviewer that the investigators are up-to-date on modern techniques; a general statement alluding to techniques is not acceptable.

5. Relevance to groundwater and related problems

6. Citations

7. Training support (if any) provided by the project and information dissemination plan.

D. Curriculum vitae of Principal Investigators (begin on new page, **not to exceed 4 pages**)

   Include curriculum vitae (including recent publications) of each investigator and state the time each will spend on the project.

E. Current or pending support (begin on new page, **not to exceed 2 pages**)

IV. Enter budget information (entered online at WRI web site).

A. Salaries and wages

B. Fringe benefits (include percentage of grant to be used for faculty salaries, wages, and benefits)

C. Tuition remission charges (if applicable).

D. Supplies and publication costs: list office, laboratory, computer and field supplies separately.

E. Travel to support field operations only. Travel to meetings is excluded because of the limited funding.

F. Other costs: e.g., equipment maintenance and fabrication, subcontracts, rentals, etc.

G. Total direct costs.

V. Submit names and email addresses of three qualified reviewers, including their areas of expertise. (Two of the reviewers must be from outside Wisconsin.)

VI. Review the accuracy of the information provided and submit final proposal package. **(This step must be completed by 6:00 PM on Monday, November 24, 2003.)**

PROPOSAL GUIDELINE CHECKLIST

ITEM	GUIDELINE	THIS PROPOSAL
GENERAL PRESENTATION		
Font	Minimum of 11 point	
Margins	Minimum of 0.75”	
PAGE LIMITATIONS		
Project Summary	Maximum of 2 pages	
Narrative and supplements	Maximum of 10 pages	
Curriculum Vitae	Maximum of 4 pages total and 2 for 1 P.I.	
Current and Pending Support	Maximum of 2 pages	
Entire Proposal	Maximum of 18 pages	
PAGINATION		
Project Summary	Page 1 and 2	
Narrative and supplements	Begin on new page, paginate starting at 3	
Curriculum Vitae	Begin on new page, paginate consecutively	
Current and Pending Support	Begin on new page, paginate consecutively	
LINE SPACING		
Project Summary	Double spaced	
Narrative Body	Double spaced	
Figure Legends	Single spaced	
Tables / Titles	Single spaced	
Citations	Single within, double between	
Training and Info Transfer	Single spaced	
Curriculum Vitae	No specific guidelines	
Current and Pending Support	No specific guidelines	

UNIVERSITY OF WISCONSIN SYSTEM (UWS)
PROJECTS FUNDED
THROUGH THE GROUNDWATER RESEARCH ADVISORY COUNCIL

The UWS, through its Water Resources Institute (WRI) and its Groundwater Research Advisory Council (GRAC), seeks projects of a fundamental or applied nature on any aspect of groundwater research in the natural sciences, engineering, social sciences or law. Projects funded in the current cycle are listed on the WRI web site at http://wri.wisc.edu. The UWS has approximately $75,000 available in FY 05 to fund new projects. The remainder of the UWS groundwater research funds has been committed to ongoing projects.

Applicant Requirements: Most often the principal investigator will be a faculty member on any campus in the UWS. However, academic staff who has achieved nomination to P.I. status by endorsement of the relevant academic dean may serve in this capacity. Projects that appear to be continuations of previously funded projects with two years of UWS support and projects that have been twice rejected will not be considered. The UWS also strives to avoid funding situations where a P.I or co-P.I.'s name appears on more than two UWS projects during any given fiscal year.

Budget Considerations: Projects will not be approved in any one budget cycle for a period of more than two years and then contingent on satisfactory progress. No capital equipment (more than $5,000 per item) may be purchased. Travel for attendance at scientific meetings will not be accepted. Faculty salaries and fringe benefits to be paid from any project may not exceed 10% of the total individual grant (including fringe benefits). Overhead costs are not allowed. Supplies should not exceed 20% of individual grant.

Review of Proposals: Recent literature citations are required for all proposals seeking support from the UWS. Funding decisions are based on ratings by GCC subcommittees and reviews solicited from an international list of experts in the field of the proposed work. The GRAC, which consists of university, state agency, and public representatives, meets as a body to discuss the results of the review process and thereupon to recommend a priority list of projects that the UWS should strive to fund in accordance with budgetary resources. A suitable UWS Groundwater Research Program is then assembled by the WRI and submitted to the GCC before the Department of Administration can release UWS research funds upon passage of a State budget.

UWS Groundwater Research Priorities:
(Presented in no particular order of importance)

- Research on the development and evaluation of groundwater protection and practices.
- Chemical and biological degradation of pollutants in surface soils, subsoils, and groundwater, including identification, toxicity, and persistence of degradation products.
- Transport of pollutants in soil and groundwater, including elucidation of soil and hydrologic factors controlling movement and development or validation of predictive models.
- Impact of waste, and agricultural (including agricultural feeding operations), industrial, or municipal management practices on groundwater quality.
- Characterization of geologic factors affecting groundwater movement, contamination, and aquifer

recharge.

- Interactions of groundwater and surface water including chemical transformations in the hyporheic zone; impacts of groundwater withdrawal on surface waters; influence of groundwater discharge on water quality.

- Wetland impacts on water quality and the interaction of groundwater with wetlands.

- Investigations on the development, understanding, improvement, cost-effectiveness, or utility of innovative biological, chemical or physico-chemical technologies for remediation of contaminated soils and/or groundwater.

- Biological, ecosystem, and human health effects of common groundwater pollutants.

- Field validation of effects of new technologies for on-site wastewater and groundwater treatment on groundwater quality.

- Investigations into the best methods for optimizing groundwater use in Wisconsin, and strategies for long-term management of groundwater.

FY 05 WISCONSIN DEPARTMENT OF NATURAL RESOURCES
GROUNDWATER MANAGEMENT PRACTICE MONITORING PROGRAM

Management practice monitoring is defined as groundwater monitoring or support activities associated with groundwater monitoring, such as laboratory technique development or geologic resource description, for establishing or improving management practices necessary to meet the state groundwater quality standards of NR 140, Wis. Adm. Code. Limited funds will be available to fund new monitoring projects in FY 05 (July 1, 2004 through June 30, 2005), due to continuing commitments to ongoing projects. However, the Department will actively participate in the review of proposals and make recommendations to the other agencies participating in the solicitation to help meet Department priorities. Outstanding proposals may also be considered for funding through other sources. Contact Tim Asplund (608-267-7449) for more information if you intend to submit a proposal.

Applicant Requirements. Funds are restricted to use by UWS and state agency contractors. Others may submit proposals if they include a state-affiliated co-principal investigator. Due to limited funds, the Department encourages applicants to include a UW System eligible investigator to maximize funding options.

Budget Considerations. Monitoring proposals will be considered for a maximum of two years. Contracts will be approved on an annual basis. Projects costing less than $35,000 annually will be given greater consideration than more expensive projects. Budget items to be identified should include such things as personnel costs, supplies, equipment, necessary travel, and other appropriate items. The management practice monitoring funds cannot support indirect costs or the purchase of capital equipment.

In preparing the budget be aware of the following contractual requirements.

Contractual Requirements:

- All monitoring wells installed shall meet DNR regulations and approved procedures for installation, construction and documentation (Chap. NR 141, Wis. Adm. Code.)

- For each new monitoring well, a soil boring form (Form 4400-122), a well construction report (Form 4400-113A), and a monitoring well development form (Form 4400-113B) shall be submitted on paper or in a computer format supplied by the DNR.

- For all groundwater sample points (monitoring wells, piezometers, and private water supplies) an inventory form supplied by the Department shall be completed and submitted (available electronically in the DNR Groundwater Forms Program).

- All groundwater quality monitoring data shall be submitted to the DNR in a computer format acceptable to the Department upon completion of the final report.

- All groundwater samples shall be analyzed by a laboratory certified in Wisconsin for that purpose under Chapter NR 149, Wis. Adm. Code.

- The contractor shall request and use labels with Wisconsin Unique Well Numbers from the DNR for wells constructed and/or sampled to allow identification of wells.

- Abandonment of monitoring wells shall be the responsibility of the contractor. Wells shall be abandoned in accordance with DNR regulations (Chap. NR 141, Wis. Adm. Code) and approved

procedures upon completion of the project, unless alternative prior arrangements have been made with the DNR.

- Quarterly project status reports shall be submitted to the project manager within 30 days of the end of each quarter. A final report and a 2-page project summary shall be submitted to the project manager within 60 days of the end of the contract period. The final report must contain a thorough discussion of how the results of the project can and should be used by decision-makers. For example, results that could assist local decision-makers with integrating groundwater in Comprehensive Planning activities should be highlighted.

Review of Proposals: All proposals will be reviewed and rated by DNR staff, and the Monitoring & Data Management and Research Subcommittees of the Groundwater Coordinating Council.

Two important criteria in evaluating each proposal are: 1) whether the proposal addresses an emerging issue or a ongoing monitoring need as listed below; and 2) whether the project involves either groundwater monitoring or activities conducted to support groundwater monitoring. Support functions can include, among other things, laboratory analysis technique development, well drilling and construction methodology development, data management and definition of geologic and hydrogeologic conditions for groundwater management purposes. Proposals should contain a clear discussion of the expected practical application of the project results. This will help the reviewer understand the importance of the proposed research, and will ensure that the researcher designs the project with practical application of results in mind.

In making final funding decisions, the DNR's Groundwater Section will formulate its recommendations based on input from all project reviewers and available funds. The Director of the DNR's Bureau of Drinking Water and Groundwater will make the final funding decisions.

Management Practice Monitoring Priorities for FY 05

Proposals will be considered for funding that address one or more of the following priority issues or ongoing monitoring needs.

Priority Issues

Department staff have identified the following priority issues as being of the highest importance for groundwater monitoring and research for FY 05. Unlike the ongoing monitoring needs that follow the priority issues, these are specific ideas for projects for which state groundwater experts see an immediate need.

Groundwater Withdrawals and Connections to Surface Waters – Recent events (high capacity well permits, aquifer storage and recovery pilot programs, arsenic, and urban growth near recharge areas) have highlighted the need for continued understanding of the implications of groundwater use on groundwater quality, groundwater quantity, and surface water resources. Research is needed in the following areas:

- identification and mapping of aquatic resources (e.g. cold water streams, wetlands) that are sensitive to groundwater withdrawals and buffer areas needed to protect them;
- water quantity management issues, such as estimates of current use rates by type and loss amounts, and basin-scale groundwater budgets;
- quantification of environmental, social and economic impacts of groundwater withdrawals, including projections of groundwater use in NE and SE Wisconsin;
- assessment of and improvements to existing mechanism for determining impacts of withdrawals on

public water supplies;
- monitoring of surface and groundwater flow to determine hydrologic connections and pathways between them;
- investigation of the occurrence and causes of aquifer drawdowns that affect surface water features such as springs, streams and wetlands; and
- characterizing groundwater impacts on and contributions to surface water quality, including TMDL development.

Further information on this issue may be obtained by contacting Tim Asplund (608-267-7449).

Emerging Groundwater Contaminants - Recent research conducted in Europe and the U.S. indicates that traces of pharmaceuticals (including antibiotics and hormones) and pesticide breakdown products are common contaminants found in groundwater and surface water. In addition, studies have found evidence of viruses and other microbial agents in both municipal water supplies and domestic wells. More sophisticated analytical techniques and more stringent regulatory requirements have increased the ability and need for monitoring of these substances in groundwater and drinking water sources. Research is needed to determine whether these substances pose a threat to Wisconsin's groundwater resource, and also to human health.

- Pharmaceuticals, Endocrine Disrupters, and Other Chemicals - Research proposals should address at least one of the following questions: 1) Can commonly used pharmaceuticals or other endocrine disrupting chemicals be detected in groundwater? 2) How do these substances behave in the environment (e.g. do they leach, how quickly do they breakdown)? And 3) what are the most cost-effective analytical techniques for detecting antibiotics, hormones, and other common pharmaceuticals in water? Further information on this issue may be obtained by contacting Bill Phelps (608-267-7619) or Elisabeth Harrahy (608-264-6260).
- Microbial Pathogens –Research is needed to evaluate the health risk of microbial pathogens in groundwater and to develop more cost-effective analytical and monitoring techniques for microbial contaminants, including parasites, bacteria, viruses, and microbial indicators. In addition there is a need to characterize the incidence and identity of viruses in groundwater sources serving public water systems. Further information on this issue may be obtained by contacting Don Swailes (608-266-7093).

Ongoing Needs

The following priority topics for groundwater management practice monitoring represent ongoing needs as determined by the Research and Monitoring & Data Management Subcommittees of the Wisconsin Groundwater Coordinating Council, a number of state agency staff, and university researchers. The list of priorities is not in any specific order. Further information on any of these topics may be obtained by contacting Tim Asplund (608-267-7449).

Naturally Occurring Substances in Groundwater: Continued problems of elevated arsenic, low pH, and other water quality problems in domestic wells exist over large areas of eastern Wisconsin. Additionally elevated sulfate, total dissolved solids (TDS), and radium have been found in some new deep municipal wells in the Lower Fox River Valley making the wells unusable. In some other existing deep wells as far south as Milwaukee the total dissolved solids have been steadily increasing over the years. The Department needs more information about the extent and causes of these problems in order to give advice to homeowners, municipalities, and well drilling contractors.

- Arsenic – Further characterization of the source, extent, health effects, and treatment of naturally occurring arsenic is a continuing need. Examples: define the lateral and vertical extent of elevated arsenic and other associated metals; improve understanding of the system geochemistry, including reaction triggers and the mobility of the contaminants; find solutions to drinking water problems

such as well construction/ reconstruction options and treatment; and conduct toxicological and risk assessment studies to determine impacts on human health and the environment.

- Elevated sulfate, TDS, and radium - Research is needed to define the extent of these water-quality problems, to determine the sources of the dissolved constituents, to determine the hydrogeologic processes responsible for mobilizing the constituents, and for developing advice for the design and placement of new wells and the remediation of older wells.

Land Use Impacts on the Groundwater Resource: Research is needed on the effect of various land uses (e.g. urbanization and agriculture) on groundwater quality and quantity. For example, recently enacted stormwater infiltration rules help reduce runoff in urban areas, but the effects on groundwater quality are largely unknown. Similarly, agricultural nonpoint source rules require nutrient management plans that protect surface water quality, but may also improve groundwater quality. Projects must be managed in such a way as to maximize their relevance to state land use problems.

- Nitrate Contamination - Conduct site-specific studies to compare the NRCS 590 standard as proposed in ATCP 50 to current management practices. Evaluate the extent of impacts of nitrate contamination on groundwater quality. Examples: monitoring and evaluation of the impacts of animal operations on groundwater; evaluating the effectiveness of Best Management Practices (BMPs) in reducing nitrogen levels in groundwater; compare methods that can be used to evaluate the groundwater impacts of current farming systems as well as the economic and water quality impacts of alternative farming systems. Other potential sources of nitrate to be investigated include quarry blasting materials and onsite wastewater treatment systems.
- Infiltration of Urban Runoff - There is a need to monitor the impact of stormwater infiltration on groundwater quality including organic compounds, metals, bacteria and viruses to evaluate DNR performance standards for pretreatment and infiltration devices at residential, commercial and industrial sites. In addition, research is needed on the effects of land use on groundwater recharge and potential strategies for increasing infiltration.

Incorporating Groundwater in Comprehensive Planning - Legislation adopted in 2000 requires all communities that make land use decisions to base those decisions on a comprehensive plan by January 1, 2010. The legislation outlines nine elements that must be included in each comprehensive plan. Groundwater information or issues may be addressed in several of the nine elements. Work is needed to develop an example comprehensive plan that would show how groundwater could be adequately addressed in a comprehensive plan. This will be valuable information for local governments who typically don't have the resources to fully address groundwater issues.

Health Effects of Groundwater Contaminants - Research is needed to better characterize the impact of contaminated groundwater on public health. Proposals should focus on contaminants that are commonly encountered in public and private drinking water supplies at levels of health concern and should evaluate sources, fate, transport and risk to potable wells. Pathogenic microorganisms, radionuclides, toxic chemicals (both naturally-occurring and synthetic), and their metabolites are of interest. This includes review and evaluation of DNR groundwater databases; identification and sampling of at-risk potable wells; and correlation of land-use and hydrogeology with risk to potable wells from the substances. In addition, evaluating the synergistic impacts of contaminant mixtures is of concern to the Department.

Natural Attenuation – NR 726 allows for closure of sites above NR 140 groundwater enforcement standards if it is demonstrated that natural attenuation is effectively cleaning up groundwater. There is a need to go back and audit a sub-set of closed sites to determine whether the assumptions made at closure were appropriate. Questions include 1) Has the plume margin changed since closure and how much? 2) Have contaminant concentrations in groundwater changed since closure and how long will it take to meet enforcement standards? 3) How do contaminant type and aquifer characteristics influence the time frame

for natural attenuation? Other needs include: comparing the effectiveness of pump & treat versus natural attenuation; identifying biogeochemical parameters for cost effective evaluation of natural attenuation at petroleum contaminated sites; and determining the utility of natural attenuation for chlorinated compounds.

Wastewater Treatment/Disposal – Monitor and evaluate the extent to which current and alternative on-site wastewater (private sewage) systems comply with state groundwater quality standards. Examples: evaluate new onsite wastewater treatment performance as a function of pretreatment, soil depth, texture and structure, and other factors; research on the effect of anti-bacterial soaps on septic systems; and monitoring of nitrogen and phosphorus near lakeshore communities. Also monitor different types of wastewater land application and land spreading practices. Of particular concern to the Department is the potential for groundwater contamination from the land application of cheese and dairy wastes.

Resource Definition – Conduct studies to better describe the geologic, hydrogeologic, and geochemical conditions that affect the groundwater quality and quantity in an area of the state. Example: evaluation of groundwater flow and/or contaminant transport in karst areas.

New Technology - Develop new laboratory or field technology (or new applications of existing technologies) for determining the characteristics of groundwater and geologic formations for management purposes, including downhole monitoring techniques and rapid site assessment.

Data Management and Integration – Improve existing state methods for managing and integrating groundwater monitoring data. Examples: working with state agencies to identify existing archives of data related to groundwater quality and management practice monitoring (e.g. karst features, springs); developing a framework for a statewide karst feature database; and improving the system for reporting of water use.

DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION (DATCP) PESTICIDE RESEARCH PROGRAM

RESEARCH GRANT PROGRAM FOR FY 05 SOLICITATION OF APPLICATIONS

The DATCP Pesticide Research Program is administered by the Agricultural Resource Management Division. Applications are invited for grant awards focusing on regulatory issues associated with pesticide use and control. The DATCP may have up to $135,000 for FY 05 to fund new projects depending upon the state budget. Contact Jeff Postle (608-224-4503) for more information if you intend to submit a proposal. Investigators should note that the focus of the DATCP program is on pesticide research, which includes but is not limited to groundwater issues.

Applicant Requirements: Any college or university, research foundation or individual having a demonstrated capacity in pesticide or other applicable research may submit proposals.

Budget Considerations: The Department may award grants not to exceed three years for research projects on the program priorities outlined below.

Review of Proposals: Proposals are reviewed using the process outlined on page 4. Funding decisions are made by the DATCP Secretary based on recommendations by the Bureau of Agrichemical Management staff who receive input from GCC subcommittee members and experts in the field.

DATCP RESEARCH PRIORITIES FOR FY 05

1) **Evaluation of the Environmental Fate Investigation Strategies and Remediation Alternatives for Contaminated Soil and Water at Pesticide Spill Sites.**

   Research should investigate the degradation and movement of pesticides at spill sites, develop criteria on the need for and appropriate extent of remedial actions, and evaluate various methods for investigation and remediation of contaminated soil and water.

2) **Development of Methods for Cleaning Pesticide Mixing/Loading Pads and Disposing of Pesticide Rinsates.**

   Projects should evaluate methods of decontaminating pesticide mixing/loading pads and disposing of or treating pesticide-contaminated rinsate water.

3) **Refinement of Application Methods for Pesticides with High Drift Potential to Reduce Environmental and Public Health Problems.**

   The research should focus on how different application methods and environmental conditions affect the potential for drift of pesticides such as metam-sodium or clomazone.

4) **Evaluation of Factors Influencing the Patterns of Groundwater Contamination by Pesticides and Pesticide Metabolites in Wisconsin.**

   This topic involves examining factors which influence pesticide leaching to determine areas of the state that are susceptible to groundwater contamination by specific pesticides.

5) **Use Related Monitoring of Pesticides and Pesticide Metabolites in Groundwater.**

This project should study groundwater contamination by field application of pesticides in key environmental settings such as fractured bedrock areas.

6) **Identification of the Sources of Pesticide Contamination in Groundwater in Rural Areas.**

Methods should be developed and investigations conducted at contaminated well sites to determine if the contamination is due to field use (nonpoint source) or spills or mishandling (point source) of pesticides.

7) **Evaluation of the Economic Feasibility of Various Chemical and Non-Chemical Weed Control Practices.**

This project should develop a methodology for evaluating the economic feasibility of modifying weed control practices and apply it to examples where practices are changed to reduce impacts on groundwater.

8) **Pesticide Use Surveys.**

These projects should conduct detailed pesticide use surveys that complement other data gathering efforts, such as ground and surface water monitoring, to improve the understanding of pesticide related issues.

9) **Use Related Monitoring of Pesticides in Surface Water and the Effect of Management Practices on Contaminant Levels.**

Projects on this topic should determine the impacts of pesticide use practices on surface water quality and evaluate the ability of various management practices, such as stream setbacks, to reduce contamination.

10) **Evaluation of the Effect of Pesticide Use on Endangered Species and their Habitat.**

This topic should explore how the use of specific pesticides affects the habitat and survival of endangered species in Wisconsin and how alternative pest control methods could reduce problems.

11) **Evaluation of Health and Environmental Risks from Commonly Used Lawn Care Pesticides**

This project should evaluate the health risks following applications of lawn care pesticides such as pendimethalin, 2,4-D, dicamba, and MCPP.

12) **Development of Pest Management Techniques that Lead to Efficient Use of Pesticides and Reduce Impacts on the Environment.**

This project should look at ways of reducing pesticide use through integrated pest management, use of alternative pest control strategies, best management practices, or other techniques that promote efficient pesticide use and minimize environmental problems.

DEPARTMENT OF COMMERCE

ONSITE WASTEWATER TREATMENT RESEARCH OBJECTIVES

The Department of Commerce supports research focused on the performance of onsite sewage system designs, products, and management practices that can be incorporated into the administrative rules regulating onsite sewage systems. These designs, products, or management practices must be:

- Directed toward protecting public health, groundwater and surface water quality;
- Result in onsite sewage treatment that is consistent with the provisions of the Groundwater Protection Law;
- Be affordable by the average owner of an onsite sewage system; and
- Be practical for the climate and soils of Wisconsin.

The Department also intends to monitor on an ongoing basis, the performance of various onsite sewage system methods and technologies. The purpose of the performance monitoring is to provide additional information on the long-term performance of the various onsite sewage system methods and technologies, to confirm their reliability, to provide data for improvements and to monitor long-term compliance with the groundwater standards. As of September 2003, the Department has indicated that it will not have funds available to fund projects in FY 05. However, the Department will actively participate in the review of proposals and make recommendations to the other agencies participating in the solicitation to help meet Department priorities.

Commerce Research Priorities for FY 05

1. Developing a correlation between dry and wet unit measurements for monitoring treatment in soil absorption units - e.g. Fecal count per gram of dry soil versus Fecal count in cfu's/100ml.
2. Research on treatment efficiency of traditional septic tank/septic absorption systems.