Wisconsin Groundwater Coordinating Council

REPORT TO THE LEGISLATURE

August 2003

CELEBRATE WISCONSIN'S YEAR OF WATER • 2003

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State of Wisconsin \ GROUNDWATER COORDINATING COUNCIL

GROUNDWATER
Wisconsin's
buried treasure

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August, 2003

To: The Citizens of Wisconsin
The Honorable Governor Jim Doyle
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Assembly Committee on Natural Resources
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Secretary Cory L. Nettles - Department of Commerce
Secretary Rod Nilsestuen- Department of Agriculture, Trade & Consumer Protection
Secretary Helene Nelson - Department of Health and Family Services
Secretary Scott Hassett - Department of Natural Resources
President Katharine Lyall - University of Wisconsin System
State Geologist James Robertson - Geological and Natural History Survey

The Groundwater Coordinating Council (GCC) is pleased to release its 2003 Report to the Legislature. The GCC was formed in 1984 to help state agencies coordinate non-regulatory activities and exchange information on groundwater. The GCC has served as a model for interagency coordination and cooperation among state government officials, the Governor, local government and the federal government. 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 03 (July 1, 2002 to June 30, 2003) 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*. This report is available online at *http://www.dnr.state.wi.us/org/water/dwg/gcc/index.html*.

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

- *Maintain adequate funding for groundwater monitoring and research.* The GCC encourages its member agencies and the legislature to give high priority to groundwater monitoring and research to address important water issues facing the state of Wisconsin.
- *Continue implementation of Groundwater Summit and Waters of Wisconsin findings*. The GCC endorses the efforts of Waters of Wisconsin (WOW) and will continue to actively support implementation of groundwater protection and management efforts resulting from WOW and the Groundwater Summit.
- *Address groundwater quantity management issues at both statewide and regional levels*. The GCC will continue to facilitate dialogue among all parties on potential approaches and solutions to groundwater quantity management.
- *Support development of a Statewide Groundwater Monitoring Strategy***.** The GCC supports development of a coordinated monitoring strategy for Wisconsin that documents ambient groundwater quality, quantity, and use; promotes better understanding of groundwater hydrology; and involves citizens in protection of the resource.

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://www.dnr.state.wi.us/org/water/dwg/GCC/).

EXECUTIVE SUMMARY

This is 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 Groundwater Coordinating Council's activities for fiscal year (FY) 2003.

In 1984, the Legislature enacted 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://www.dnr.state.wi.us/org/water/gcc/index.htm*).

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

GROUNDWATER COORDINATION

The Groundwater Coordinating Council, its Subcommittees, and member agencies worked together to address groundwater management issues and coordinate groundwater activities in FY 03. Examples include:

1. *The GCC released a set of findings and recommendations from the 2001 Groundwater Summit*. During the past year, the GCC and its Subcommittees continued to address recommendations and strategies suggested by this gathering of industry, agriculture, water utilities, conservation groups, researchers, educators, and government agencies. Findings are contained in the document *Sharing Our Buried Treasure* available online at *http://www.dnr.state.wi.us/org/water/dwg/gcc/SOBT.pdf.* A number of other products and follow-up activities resulted from the Groundwater Summit, which are summarized on the following web page (*http://www.dnr.state.wi.us/org/water/dwg/gcc/GCC-GWSUMMIT.HTM*.)

2. *The GCC was actively involved in several components of the Waters of Wisconsin (WOW) Initiative that was facilitated by the Wisconsin Academy of Sciences, Arts and Letters over the past 2 years* (*http://www.wisconsinacademy.org/wow/index.html*). Several GCC members and Subcommittee members were members of the WOW steering committee or advisory network, and assisted with the planning for the WOW Forum in October 2002. GCC staff organized a groundwater session at WOW Forum as follow up to the Groundwater Summit and contributed information from the Summit to the final WOW report.

3. *The DNR, the Central Wisconsin Groundwater Center (CWGC) and the Wisconsin Geological and Natural History Survey (WGNHS) co-sponsored three groundwater workshops for teachers.* 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-eight teachers took part in the workshops held in Dodgeville and Waukesha. 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.

4. *The "First Annual Groundwater Festival" was held in Stevens Point on May 9 -10, 2003*. The Groundwater

Guardian Coordinator and the Groundwater Center at UW Stevens Point organized this event, with planning and participation from many state agencies, the USGS, and UW Extension. The first day of the event attracted over 600 students and teachers from around the State, and offered a host of hands-on learning activities about various groundwater topics. The second day was targeted at the general public, and consisted of seminars, workshops, and activities around themes of water conservation, groundwater and surface water connections, preventing groundwater pollution, and energy solutions. Based on the success of this event, a second annual festival is planned for southeastern Wisconsin in 2004.

5. *The GCC Monitoring and Data Management Subcommittee worked with DNR Groundwater Section staff and interested groups to outline a unified groundwater monitoring strategy.* This effort was initiated from recommendations made at the Groundwater Summit and Waters of Wisconsin meetings. The expanded group listed four general goals of monitoring: documenting the status and trends of groundwater quality and quantity; gaining a better understanding of groundwater hydrology; guiding policy and management decisions; and educational benefits. Specific monitoring objectives include water budgets, groundwater levels, and water quality. The group also identified implementation, data coordination, access, and other needs for consideration in the strategy. The strategy will be finalized by August 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 04 solicitation for groundwater research and monitoring proposals, which was sent out in September 2002 (see *Appendix B*). A total of 31 project proposals were received. A comprehensive review process resulted in the selection of 13 new projects for funding for FY 04. The GCC unanimously approved the proposed UWS groundwater research plan as required by s. 160.50(1m), Wis. Stats. The FY 04 groundwater monitoring and research projects are listed by funding agency in Table 2, including projects that were carried over from FY 03.

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 03:

1. *Several revisions to groundwater standards contained in ch. NR 140, Wis. Adm. Code, were initiated or completed.*
    - Rule changes related to the application of trihalomethane groundwater quality standards at aquifer storage & recovery (ASR) system sites have recently been promulgated. These revisions establish a "point of standards application," in accordance with s. 160.257, Wis. Stats., for several groundwater quality standards. They also define ASR terminology in the code, and establish an ASR system "design management zone" compliance boundary. These NR 140 revisions became effective July 1, 2003.
    - 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.
    - Revisions are also proposed to NR 140 to revise the existing state groundwater quality standards for arsenic. Arsenic is a known human carcinogen, and the federal drinking water maximum contaminant level (MCL) for the substance was recently lowered from 50 µg/L to 10 µg/L. A similar change is proposed for the NR 140 arsenic enforcement standard and the state drinking water standard in NR 809. The Natural Resources Board authorized public hearings for this code change at its June 2003 meeting.

2. *DNR staff created a table listing NR 140 groundwater quality standards, NR 809 state drinking water standards, and established health advisory levels (HALs) for substances in water*. 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 resolving groundwater contamination and remediation cases. It is available on the Internet at: *http://www.dnr.state.wi.us/org/water/dwg/health/hal.htm*.

3. *DNR completed source water assessments for Wisconsin's 19 drinking water systems that use surface water*. DNR staff also implemented a Source Water Assessment Program (SWAP) assessment form and mapping application. 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, wellhead protection, and other 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 towards integrating spatial and tabular data. *http://www.dnr.state.wi.us/org/water/dwg/swap/index.htm*.

4. *Administrative rules to address the control of polluted runoff from urban and rural land use activities went into effect October 1, 2002*. The rules outline statewide performance standards for agricultural facilities and practices, construction site erosion control, post-construction stormwater management, and transportation projects. The eight DNR rules (summarized in NR 151) and DATCP's ATCP 50 are the products of a multi-year effort involving a diverse advisory committee, state agencies and their local and federal partners, and other citizens. While intended to protect surface water quality, the practices and prohibitions outlined in the rules have the potential to protect groundwater quality and promote infiltration and recharge of shallow aquifer systems.

5. *The DNR's Remediation and Redevelopment program began a new grant program that funds environmental remediation at brownfield properties*. The Brownfields Green Space and Public Facilities Grant is a program that helps local governments clean up brownfield sites that will have a long-term public benefit, including the preservation of green space, the development of recreational areas or the use of a property by a local government. These grants could be used for remediation of soil and groundwater at a property.

6. *In May, COMM 82 of the plumbing code was revised to include standards for graywater reuse and stormwater use*. While NR 151 allows use of stormwater within a plumbing system as equivalent to designed stormwater infiltration, the plumbing code now specifies the plumbing system treatment performance standards to accomplish that goal. Also within the plumbing code are the requirements for graywater (lavatory, shower, etc.) treatment and reuse. These options for stormwater use and graywater reuse will provide additional avenues for designers to address water related problems, encourage Wisconsin citizens to learn more about water conservation issues, and maintain high standards for safety and health.

7. *The WGNHS, SEWRPC, and the USGS completed a regional groundwater flow model for southeast Wisconsin*. This project was the culmination of a 3-year effort involving multiple partners and funding sources, including the Southeastern Wisconsin Regional Planning Commission (SEWRPC), USGS, DNR's Source Water Assessment Program, UW Milwaukee, and UW Extension. The prime motivation for the model was the growing recognition that the declining water levels in the sandstone aquifer, increased demands for water, and deteriorating water quality in some wells are not sustainable over the long term. The model was also developed to delineate zones of contribution to all municipal wells in the SEWRPC region. Major findings include:
   - At present rates, pumping will increase 40% over the next 20 years, adding 100 ft of drawdown.
   - With the advent of major pumping centers in Waukesha County, the regional cone of depression has moved 8 miles westward from Milwaukee to Elm Grove, as has the groundwater divide.
   - Flow directions have been altered with the increase in pumping, such that water is now being pulled in from Lake Michigan and toward the Illinois border.
   - Significant amounts of recharge to the aquifer come from Western Waukesha County, suggesting areas to be protected from development.

   Next steps for the project are to simulate various water management scenarios proposed by SEWRPC and the participating water utilities and to develop refined sub-models for areas of interest. The final report will be submitted to SEWRPC's Groundwater Technical Advisory Committee and published by SEWRPC and WGNHS separately.

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. Alachlor ESA and metolachlor ESA were the most commonly detected herbicide compounds at 27.8 and 25.2%, respectively. However, the survey also showed a significant decline in parent atrazine concentrations between 1994 and 2001.

3. *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 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 (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. 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.

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. Approximately 23% of private well water samples statewide test positive for total coliform bacteria, an indicator species of other biological agents. Approximately 3% of private well water samples test positive for *E. coli*, an indicator of water borne disease that originates in the mammalian intestinal tract. Viruses may affect anywhere from 4 to 12% of private water supplies. 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.

5. *Arsenic*: Naturally occurring arsenic has been detected in wells throughout the State of Wisconsin. DNR historic data show that 3,386 public wells and 1,821 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. 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.

6. *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. The effects of groundwater withdrawals are well documented on a regional scale in the Lower Fox River Valley, southeastern Wisconsin, and Dane County. Groundwater use grew from 570 to 804 million gallons per day (Mgal/d) from 1985 to 2000. The majority of this water is used for public water supplies (330 Mgal/d), which is primarily used for drinking water, 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.

BENEFITS OF MONITORING AND RESEARCH PROJECTS

The following recently published studies illustrate the benefits of groundwater projects supported by the Wisconsin Groundwater Research and Monitoring Program:

1. *Investigating geochemical controls on arsenic in groundwater*. In 2002 the WGNHS completed field experiments in the Fox River Valley that evaluated mechanisms of arsenic release to groundwater from domestic wells, including studies of arsenic exposure to residents in the area and the effects of well chlorination on arsenic levels. Findings support the hypothesis that high levels of arsenic in groundwater occur where arsenic-bearing formations are oxidized in well boreholes. However, two distinct geochemical mechanisms appear to contribute low to moderate arsenic concentrations to well water in this aquifer. Typical domestic water use patterns may contribute to this phenomenon, because increasing groundwater residence time in wells correlates to the onset of strongly reducing conditions and higher 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.

   ***Reference*: Gotkowitz, M. B., J. A. Simo, and M. Schrieber. 2003. Geologic and geochemical controls on arsenic in groundwater in northeastern Wisconsin. Wisconsin Geological and Natural History Survey (WGNHS) Open-File Report 2003-01.**

2. *Developing methods for detecting microbial agents in groundwater*. A recent WSLH study developed a culture method for detecting *Helicobacter pylori* from a heterogeneous microbial population in water, and then used this method to establish a database for its occurrence in Wisconsin groundwater. 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. 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.

   ***Reference*: Degnan, A. J., W. C. Sonzogni, and J. H. Standridge. 2003. Development of a plating medium for selection of *Helicobacter pylori* from water samples. Applied and Environmental Microbiology, Vol. 69, No. 5, p. 2914-2918.**

3. *Documenting the occurrence of viruses in groundwater*. 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. 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.

   ***Reference:* 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, Vol. 69, No. 2, p. 1172-1180.**

FUTURE DIRECTIONS FOR GROUNDWATER PROTECTION

The Groundwater Coordinating Council 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 of groundwater research and monitoring projects that were funded in the past two fiscal years. DNR's funding for projects has been cut by over two-thirds since FY 02 (see Table 3 in Chapter 2). The UWS budget was cut by 10% in FY 04. DATCP and Commerce have been unable to fund new projects in the last two fiscal years. These cuts will hamper the State's ability to address critical groundwater monitoring and research needs in the future. The Groundwater Coordinating Council 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. *Continue implementation of Groundwater Summit and Waters of Wisconsin findings*. The GCC played an important role in facilitating a discussion between industry, agriculture, water utilities, conservation groups, researchers, educators, and government agencies on Wisconsin's groundwater management challenges through the 2001 Groundwater Summit. This discussion continued with the Waters of Wisconsin project, which placed groundwater management issues into the larger context of statewide water policy, education, and monitoring needs. The GCC endorses the efforts of Waters of Wisconsin and will continue to actively support implementation of groundwater protection and management efforts resulting from WOW and the Groundwater Summit.

3. *Address groundwater quantity management issues at both statewide and regional levels*. Groundwater quantity was an important topic at the 2001 Groundwater Summit, as well as the Waters of Wisconsin Forum. 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. In recognition of the importance of this issue the GCC formed a Groundwater Quantity Subcommittee in July 2003 to provide a resource for addressing scientific and technical questions related to groundwater quantity. The GCC will continue to be active on this issue and facilitate further dialogue among all parties on potential approaches and solutions.

4. *Support development of a Statewide Groundwater Monitoring Strategy***.** Chapter 160 of the Wisconsin Statutes requires the Department of Natural Resources to work with other agencies and the Groundwater Coordinating Council to develop and operate a system for monitoring and sampling groundwater to determine whether harmful substances are present (s. 160.27, Wis. Stats.). Currently, groundwater is monitored by several agencies. While this monitoring meets the diverse needs of the various groundwater protection programs, there is no coordinated monitoring strategy that looks at long-term, statewide trends and provides enough data on which to base sound land and water use decisions. The GCC supports development of a coordinated monitoring strategy for Wisconsin that documents ambient groundwater quality, quantity, and use; promotes better understanding of groundwater hydrology; and involves citizens in protection of the resource.

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Chapter 1 -- INTRODUCTION

PURPOSE OF THE REPORT

The Groundwater Coordinating Council 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 2003 (FY 03).

The activities of the Groundwater Coordinating 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 03. *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

Wisconsin has a long history of groundwater protection. The culmination of 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. The Groundwater Protection Act created 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 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 Groundwater Coordinating Council was created to advise and assist state agencies in the coordination of non-regulatory programs and the exchange of information related to groundwater. The Coordinating 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.

The following report is intended to update the Legislature and Governor on the status of the state's groundwater program and the activities of the Groundwater Coordinating Council.

Chapter 2 -- GROUNDWATER COORDINATION

The Groundwater Coordinating Council 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 03, 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 UWS. The GCC has created five 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.

During FY 03, the GCC experienced a transition in membership along with the election of a new administration in the Governor's office. Long-time Governor's representative Jack Metcalf of Dodgeville resigned after 15 years in that position. Todd Ambs, DNR Water Division Administrator became the new Council Chair in February. DOT and Commerce also appointed new representatives (Dan Scudder and Berni Mattsson, respectively). The Governor is expected to appoint a new representative by fall 2003.

The GCC took an active role many groundwater issues and activities during FY 03, several of which are highlighted and summarized here.

Identification of Long-Term Groundwater Management Needs

Implementing findings from the Groundwater Summit. 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.

In September of 2002, the GCC released a set of findings and recommendations from the Summit, which are contained in the document *Sharing Our Buried Treasure: A Summary of the 2001 Groundwater Summit* available online at *http://www.dnr.state.wi.us/org/water/dwg/gcc/SOBT.pdf.* A number of other products and follow-up activities resulted from the Groundwater Summit, which are summarized on the GCC Summit web page (*http://www.dnr.state.wi.us/org/water/dwg/gcc/GCC-GWSUMMIT.HTM*.)

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 considered expanding its membership to include a broader base of people involved in groundwater education, including non-profit groups, consultants, well drillers, and water utilities. The Monitoring and Data Management Subcommittee began a process to evaluate the state's long term groundwater monitoring strategy. The Planning and Mapping Subcommittee began compiling information on GIS data layers to assist communities with land use planning activities. The GCC began discussing its role in groundwater quantity issues, and participated in the Waters of Wisconsin initiative. Several research priorities identified at the Summit were incorporated into the FY 04 Solicitation for Proposals, particularly those related to groundwater/surface water interactions. The GCC will continue to follow up on the findings of the Groundwater Summit in the next fiscal year, and will continue to be engaged with the implementation of the Waters of Wisconsin recommendations.

Waters of Wisconsin Initiative/Year of Water. The GCC has been actively involved in several components of the Waters of Wisconsin (WOW) Initiative that was facilitated by the Wisconsin Academy of Sciences, Arts and Letters over the past 2 years (*http://www.wisconsinacademy.org/wow/index.html*). Several GCC members and Subcommittee members were members of the WOW steering committee or advisory network, and assisted with the planning for the Waters of Wisconsin Forum in October 2002. GCC staff organized a Groundwater session at WOW Forum as follow up to the Groundwater Summit. The GCC contributed information from the Groundwater Summit to the final WOW report and ensured that Groundwater Summit themes were addressed. The GCC Education Subcommittee has been actively involved in Year of Water activities, and continues to share information about water-related events among agencies. WOW organizers have been regularly involved in GCC Subcommittee meetings and have provided updates to the GCC at its quarterly meetings.

GCC Information and Outreach Activities

Report to the Legislature Highlights brochure. In March 2003, the GCC released a one-page summary of information from the 2002 Report to the Legislature, which was mailed to every state legislator. The purpose of the brochure was to provide a concise synopsis of the GCC's purpose and responsibilities and to give an overview of the information contained in the full report. The GCC is required to prepare the Report to the Legislature every year, but is constantly trying to find ways to streamline the report and make it more accessible, while still providing a comprehensive compilation of groundwater management activities and issues. As the Report continues to evolve toward a primarily electronic document, the 1-page brochure will serve as a useful notice of the report's release and availability.

GCC displays at Geology Day and "Where the Waters Meet". The GCC participated in two events geared toward citizens and legislators in spring 2003. On March 19, the American Institute of Professional Geologists (AIPG) hosted a "Geology Day" at the State Capitol to raise awareness about issues and activities related to the geology

profession. Many of the exhibitors and displays focused on groundwater and hydrogeology issues that AIPG members are involved with around the state. On April 11, several water-related citizen groups, including the Wisconsin Association of Lakes, the Wisconsin Groundwater Association, the Wisconsin Wetlands Association, and the River Alliance of Wisconsin held a joint conference titled "Where the Waters Meet" to explore water-related issues affecting the state. The GCC provided an exhibit at both events in order to highlight the involvement of the State in monitoring, research, and education related to groundwater through the coordination of the GCC.

Website updates. Several updates to the GCC website have been made in the past year (*http://www.dnr.state.wi.us/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 and the UWS Groundwater Research Advisory Council (GRAC) continued coordination of the annual solicitation for groundwater research and monitoring proposals among state agencies. (Details are found in the section on *Wisconsin's Groundwater Research and Monitoring Program*). The GCC approved the FY 04 Solicitation for Proposals in August of 2002 (see *Appendix B*). 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. At its March 13, 2003 meeting the GCC unanimously approved the proposed UWS groundwater research plan as required by s. 160.50(1m), Wis. Stats.

On November 15, 2002, the GCC unanimously approved a revised Memorandum of Understanding (MOU) between the UW System, the Groundwater Research Advisory Council (GRAC), and the GCC regarding the coordination of the UW System's groundwater research program (see *Appendix C*). 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. 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. The revised MOU better reflects the current procedure for reviewing and ranking proposals, and clarifies the intent of the monitoring and research funds in light of potential limited budgets in the future.

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 A*. In addition to the activities listed above, the GCC received briefings and heard presentations on:

- Subcommittee activities (see below)
- 2002 GCC Report to the Legislature
- UWS FY 04 Groundwater Research Plan
- State Budget updates and effects on agency groundwater programs
- Source Water Assessment Program (SWAP) mapping applications
- DATCP Balance Pro hearings
- NR 140 Groundwater Standards update
- Mapping the sandstone aquifer of eastern Wisconsin using time domain electromagnetic induction soundings
- GCC involvement in groundwater quantity issues
- Development of statewide environmental and human health tracking network

- Health effects of arsenic contaminated drinking water
- Removal of arsenic in contaminated groundwater
- Aquifer Storage and Recovery rule status and pilot project update
- Elevated radium and salinity in the deep sandstone aquifer of eastern Wisconsin-
- Regional groundwater flow model of southeastern Wisconsin

The GCC also acknowledged the contributions of several active subcommittee members who retired or resigned during the last year through resolutions of appreciation. Ron Hennings, of the WGNHS, retired in September 2002 after 20 years of service to the GCC and its Subcommittees. Chris Mechenich, of the Groundwater Center at UW Stevens Point, resigned as chair of the Education Subcommittee in June 2003 after 12 years in that role. Both provided strong leadership to the Council and dedication to groundwater education and protection activities.

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 03:

- The "First Annual Groundwater Festival" was held in Stevens Point on May 9 -10, 2003. The Groundwater Guardian Coordinator and the Central Wisconsin Groundwater Center organized this event, with planning and participation from many state agencies, the USGS, and UW Extension. The first day of the event attracted over 600 students and teachers from around the State, and offered a host of hands-on learning activities about various groundwater topics. The second day was targeted at the general public, and consisted of seminars, workshops, and activities around themes of water conservation, groundwater and surface water connections, preventing groundwater pollution, and energy solutions. Based on the success of this event, a second annual festival is planned for southeastern Wisconsin in 2004.

- Several subcommittees have followed up on the Groundwater Summit recommendations, particularly related to groundwater quantity. The Education Subcommittee and the Local Government Subcommittee in particular have discussed groundwater quantity issues and 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. Staff added a list of Groundwater Quantity Resources to the GCC's Groundwater Summit web page, with plans to develop a Groundwater Quantity Web Page in FY 04.

- The Education Subcommittee looked into the accuracy of kits sold for testing drinking water at home. Through the efforts of UWEX, WSLH, DATCP, and DNR, several test kits were obtained and tested at the WSLH and UW-Stevens Point's Water and Environmental Analysis Lab. The results demonstrated that caution should be used in interpreting the results of these kits, and that homeowners should continue to use certified laboratories to be certain of their well water quality. A press release was prepared and distributed through UWEX as part of Drinking Water Week in May.

- At Farm Technology Days, groundwater-related booths sponsored by UW-Extension, WGNHS, CWGC, DNR, DHFS, Commerce, and DATCP were located in one tent for the second consecutive year. Exhibits provided drinking water screening for nitrate and information on drinking water quality, drinking water treatment and backflow prevention, healthy homes, proper disposal of agricultural chemicals, and proper sealing of abandoned wells.

- DNR and DATCP staff associated with the Education Subcommittee worked together to produce a Spanish translation of DNR's Nitrate in Drinking Water brochure (DNR publication DG-032-2003).

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. For example, an important research and monitoring well located in the vicinity of a proposed highway expansion project was preserved due to alert attention and communication between staff at WGNHS and DOT. This well is the only one available to WGNHS, USGS, DNR, and UW System researchers on the groundwater divide between the Yahara and Wisconsin River watersheds. 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 04. The revised priorities were included in the joint solicitation for proposals that was distributed by the UWS, DNR, Commerce, and DATCP in September 2002.

The subcommittee met with the Monitoring and Data Management Subcommittee in January 2003 to review 31 proposals that were submitted in response to the FY 04 solicitation. Subcommittee members made recommendations that were used by the three agencies and the UWS in deciding which groundwater-related proposals to fund for FY 04. The projects to be funded in FY 04 are listed in Table 2.

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 03:

- The MDMS reviewed the priorities for the DNR's groundwater management practice monitoring program for FY 04. The subcommittee met with the Research Subcommittee in January to review 31 research and monitoring proposals that were submitted in response to the FY 04 solicitation. Subcommittee members made recommendations that were used by the three agencies and the UWS in deciding which groundwater-related proposals to fund for FY 04.
- The subcommittee worked with DNR Groundwater Section staff and interested groups to outline a unified groundwater monitoring strategy. This effort was initiated from recommendations made at the Groundwater Summit and Waters of Wisconsin meetings. The expanded group listed four general goals of monitoring: documenting groundwater quality and quantity status and trends; gaining a better understanding of groundwater hydrology; guiding policy and management decisions; and educational benefits. Specific monitoring objectives identified include water budgets, groundwater levels, and water quality. The group also addressed implementation, data coordination, access, and other considerations. The subcommittee will continue to be involved in this effort that will be coordinated by DNR Groundwater Section staff.
- Well construction and geologic information management were at the forefront of the various data management issues addressed by the subcommittee in FY 03. Subcommittee members coordinated or commented on: 1) WGNHS updates to the well construction report scanned image index, which is heavily used by DNR source water assessment staff; 2) storage options for paper copies of well construction reports; 3) DNR's use of geologic, well construction, monitoring, and mapped potential contaminant source data in its source water assessments; and 4) the WGNHS geologic database now under development.

A continuing goal for the subcommittee is for members 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 03 the subcommittee met three times to track important monitoring and data management issues.

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). During this reporting period the subcommittee held meetings on September 9, 2002 (Joint meeting with the Monitoring and Data Management Subcommittee); December 11, 2002; and April 23, 2003.

Pursuant to s. 16.967 (6), Wis. Stats., eleven State Agencies are required to annually submit Plans to Integrate Land Information to the Wisconsin Land Information Board. These plans were due March 31, 2002 and they are intended to enable such information to be readily translatable, retrievable and geographically referenced for use by any state, local government or public utility. The current focus of the subcommittee is to continue reviewing these plans to determine if there is a subset of groundwater specific land information that can be compiled into a reference index catalog to be updated annually for use by groundwater practitioners. Over the next couple meetings the subcommittee will also interview staff from regional planning commissions to learn their mapping needs and priorities.

A key activity 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. For example, DOT continues to assist the DNR source water protection program with locating salt storage facilities. DOT is able to obtain GPS coordinates for salt storage facilities as part of their routine salt storage inspections. The geographic location of approximately 1,193 salt storage facilities is shared with DNR. In return DNR provides a quality control check and creates a GIS data layer that both agencies are able to use.

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.

The subcommittee worked throughout the year on trying to verify the accuracy of tests sold in home improvement and discount stores for testing drinking water at home. One company provided a sample kit; others were purchased by DNR and tested by the WSLH. Some testing was also done at the UWSP Water and Environmental Analysis Lab. Home tests for some contaminants were more accurate than for others. The subcommittee prepared a press release that was distributed by UWEX during Drinking Water Week.

The subcommittee developed a one-page fact sheet on the accomplishments of the GCC to complement the annual Report to the Legislature. DNR and UWEX legislative liaisons gave input. The fact sheet was distributed at "Geology Day" at the State Capitol on March 19, and to all legislators by mail.

The subcommittee discussed education recommendations from the Groundwater Summit and the Waters of Wisconsin Report. As a result, it decided to continue promoting groundwater quantity education. Small groups also began examining two new ideas: expanding the membership of the subcommittee, and developing a PowerPoint presentation giving a historical perspective on groundwater quantity.

The subcommittee continued to coordinate agency activities for large events such as National Drinking Water Awareness Week and Wisconsin Farm Technology Days, and to provide input into revisions to publications.

The Education Subcommittee regretfully accepted the resignations of three long-time members, Ron Hennings of the WGNHS, who retired after nearly 20 years of service to the GCC and its subcommittees, Lynda Knobeloch of DHFS, and Chris Mechenich of the Groundwater Center at UW Stevens Point. Chris had faithfully served as chairperson since 1991. It welcomed Dave Hart of WGNHS and Rob Thiboldeaux of DHFS as new members.

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 communicating local government issues and concerns about groundwater protection to the state agencies that make up the GCC, as well as to allow the GCC and its subcommittees to share information and get input about documents and publications.

The subcommittee met by conference call on May 1, 2002 to provide updates on current activities and get input from subcommittee members on several issues. Some new members and additional persons were invited to participate in the call. Subcommittee members agreed to meet in the fall of 2002 and focus on ways the LGS could be involved in promoting discussion of groundwater quantity issues and options for regionalization of water management.

The LGS met in Waukesha in September to learn more about groundwater quantity issues and concerns in the state. Attendees heard presentations about Dane County, southeast Wisconsin, the Lower Fox River Valley, the Central Sands and the crystalline bedrock in central Wisconsin. The subcommittee discussed potential groundwater legislation currently being circulated for review and considered what role the LGS or the GCC might play. The LGS decided it wanted to follow the groundwater quantity issue and planned to meet as appropriate to evaluate groundwater quantity initiatives and determine what they might be able to contribute.

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. Four state agencies have made up to $750,000 available each year for groundwater-related monitoring or research. Approximately $11.9 million has been spent through FY 03 on 298 different projects dealing with groundwater or related topics (see *Appendix D* for a complete listing). The sources of money and purposes of monitoring or research 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 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). Additional funds have been available in recent years through various Federal and State sources, enabling the DNR to fund additional projects. However, these funds were reallocated to other priorities in FY 03 and FY 04. 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.

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 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.

3. DATCP Pesticide Research - Since 1989, DATCP has had approximately $135,000 available annually as a result of the pesticide law to fund research on pesticide issues of regulatory importance. The money comes from fees paid by pesticide manufacturers to sell their products in Wisconsin. Through FY 03, 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. Through FY 03, 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 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. 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. This MOU was reviewed and updated in FY 03 to reflect current practices and clarify the intent of the monitoring and research funds in light of potential limited budgets in the future. The revised MOU is included in *Appendix C*.

FY 03 Proposal Solicitation. The Solicitation for Proposals (SFP) for FY 03 was distributed in September 2001. A total of 38 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 2001 to review and rank the projects that were submitted for funding. As a result of the subcommittee meeting, the GRAC meeting in February, and review of the proposals by agency staff, 7 new projects were selected for funding in FY 03. Thirteen on-going projects were carried over into FY 03. A total of 20 projects were funded through the joint solicitation at a cost of approximately $492,000 (see Table 1).

FY 04 Proposal Solicitation. The SFP was distributed in September 2002 for funding in FY 04. 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 B*). The deadline for proposals was November 18, 2002.

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 31 proposals were submitted, representing 9 institutions or campuses and requesting over $1 million 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.

Thirteen of the 31 proposals will be funded in full or in part by the University of Wisconsin and the DNR. Neither DATCP nor Commerce will fund new projects in FY 04. With the assistance of Federal (USGS) dollars leveraged through the Water Resources Institute, all of the continuing UWS projects that began in FY 03 will be funded through FY 04. The projects to be funded in FY 04 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 FY 03 and FY 04. 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. DATCP and Commerce have been unable to fund new projects in the last two fiscal years. These cuts will hamper the State's ability to address critical groundwater monitoring and research needs in the future. The Groundwater Coordinating Council 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.

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.

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 100 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.

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 03

Agency	*Title*	*Author(s)*	*Affiliation*	*FY 03 Budget*
DATCP				
	*Chloroacetanilide and Atrazine Residue Penetration and Accumulation in Two Wisconsin Groundwater Basins	W. DeVita, P. McGinley, and G. Kraft	UW-Stevens Point	$31,067
	*Agrochemical Leaching from Sub-optimal, Optimal, and Excessive Manure-N Fertilization of Corn	J. Norman and K. Brye	UW-Madison	$35,409

No new projects were funded by DATCP through the FY 03 solicitation for proposals.

The total cost for all projects funded by DATCP in FY 03, including the co-funded project below is $80,000

DNR				
	*Nitrate Loading History, Fate, and Origin for Two Wisconsin Groundwater Basins	G. Kraft	UW-Stevens Point	$31,722
	*Monitoring Contaminant Flux from a Stormwater Infiltration Facility to Groundwater	C. Dunning and R. Bannerman	USGS & WDNR	$35,000
	*Importance of Disinfection on Arsenic Release from Wells	W. Sonzogni, G. Bowman, J. Standridge, and A. Clary	WSLH	$15,000
	Evaluation of Enzyme Linked Immunosorbent Assay for Analysis of Di Amino Atrazine in Wisconsin Groundwater in Comparison to Chromatography	J. Strauss and W. Sonzogni	WSLH	$11,932
DNR/DATCP				
	*Occurrence of Antibiotics in Wastewater Effluents and their Mobility in Soils: A Case Study from Wisconsin	K. G. Karthikeyan and W. Bleam	UW-Madison	DNR $28,476 DATCP $13,524

The total cost for all new projects funded by DNR through the FY 03 solicitation for proposals, including the co-funded project below is $17,864.

The total cost for all projects funded by DNR in FY 03, including the co-funded projects is $128,062.

UWS				
	*Co-occurrence and Removal of Arsenic and Iron in Groundwater	P. McGinley	UW-Stevens Point	$17,054
	*Field Evaluation of Raingardens as a Method for Enhancing Groundwater Recharge	K. Potter	UW-Madison	$19,039#
	*Impacts of Land Use and Groundwater Flow on the Temperature of Wisconsin Trout Streams	S. Gaffield and L. Wang	WGNHS & WDNR	$31,816
	*Impacts of Privately-Sewered Subdivisions on Groundwater Quality in Dane County, WI	K. Bradbury	WGNHS	$17,733
	*Monitoring and Scaling of Water Quality in the Tomorrow-Waupaca Watershed	B. Browne	UW-Stevens Point	$33,387
	*Removal of Heavy Metals and Radionuclides from Soils Using Cationic Surfactant Flushing	C. Evans and Z. Li	UW-Parkside	$21,049
	*Removal of Arsenic in Groundwater Using Novel Mesoporous Sorbent	J. Park	UW-Madison	$28,299#
	Role of the Hyporheic Zone in Methylmercury Production and Transport to Lake Superior	D. Armstrong and C. Babiarz	UW-Madison	$31,620

Determination of Aquitard and Crystalline Bedrock Depth Using Time Domain Electromagnetics	D. Hart and D. Alumbaugh	UW Extension	$30,330
Monitoring the Effectiveness of Phytoremediation and Hydrogeologic Response at an Agricultural Chemical Facility	W. DeVita and M. Dawson	UW- Stevens Point	$14,910
F Test for Natural Attenuation in Groundwater: Application on Benzene	F. Evangelista and A. Pelayo	UW-Whitewater	$12,950
Photocatalytic Adsorption Media and Processes for Enhanced Removal of Arsenic from Groundwaters	M. Anderson	UW-Madison	$31,116

UWS/DNR

Arsenic Contamination in Southeast Wisconsin: Sources of Arsenic and Mechanisms of Arsenic Release	J. Bahr and M. Gotkowitz	UW-Madison & WGNHS	UWS $41,831 DNR $5,932

The total cost for all new projects funded by the UWS through the FY 03 solicitation for proposals, including the co-funded project above is $162,757.

The total cost for all projects funded by the UWS in FY 03 including the co-funded project above is $303,525 (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 02

Table 2: Groundwater Research and Monitoring Projects to be 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	$13,960
	Design and Evaluation of Rain Gardens for Enhancement of Groundwater Recharge	K. Potter	UW-Madison	$18,630
	Fate Of Representative Fluoroquinolone, Macrolide, Sulfonamide and Tetracycline Antibiotics in Subsurface Environments	K. Karthikeyan and J. Pedersen	UW-Madison	$41,860
	Evaluation of Contamination of Groundwater around Landfills	T. Edil, C. Benson and J. Connelly	UW-Madison & WDNR	$20,380
	An Assessment of Aquifer Storage Recovery for Selected Generic Hydrogeologic Settings in Wisconsin	Mary Anderson	UW-Madison	$19,230
	What Happens When the Confined Cambrian-Ordovician Aquifer in SE Wisconsin is "Dewatered"?	T. Eaton	WGNHS	$15,769
	Coupled Modeling of Gravity and Aeromagnetic Data For Analysis of the Waukesha Fault, Southeastern Wisconsin	J. Skalbeck	UW-Parkside	$19,150
	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	$31,068
	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	$46,648

The total cost for all new projects funded by the UWS through the FY 04 solicitation for proposals is $223,340.

The total cost for all projects funded by the UWS in FY 04 is $270,000 (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 3: Groundwater Research and Monitoring Projects Funded from FY 1999 through FY 2003

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
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
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**

[1]2001 DNR figures do not include 71K from Federal 106 funds applied toward FY02 projects
[2]2001-2003 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 03. 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. The DNR also has specific groundwater-related regulatory programs.

DNR regulatory programs to protect groundwater are the responsibility of four Bureaus:

1. Bureau of Drinking Water and Groundwater – Regulates public water systems, private drinking water supply wells, well abandonment and high capacity wells. The Bureau also educates well drillers, pump installers, and water system operators and publishes materials to educate well owners. The Bureau's Groundwater Section coordinates groundwater activities of the DNR, as well as other state agencies. In particular, the Groundwater Section is responsible for adoption and implementation of groundwater standards contained in ch. NR 140, Wis. Adm. Code. *http://www.dnr.state.wi.us/org/water/dwg/index.htm*

2. Bureau of Waste Management - Regulates and monitors groundwater at proposed, active, and inactive solid waste facilities and landfills. The Bureau reviews investigations of groundwater contamination and implementation of remedial actions at active solid waste facilities and landfills. The Bureau 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://www.dnr.state.wi.us/org/aw/wm/index.htm*

3. Bureau for Remediation and Redevelopment - Oversees response actions at spills, hazardous substance release sites, abandoned containers, 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 Bureau's work relates to groundwater contamination. *http://www.dnr.state.wi.us/org/aw/rr/index.htm*

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

Bureau of Drinking Water and Groundwater

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.

Revisions to ch. NR 140 related to the application of trihalomethane groundwater quality standards at aquifer storage & recovery (ASR) system sites have recently been promulgated. These revisions establish ASR well site NR 140 "point of standards application", in accordance with s. 160.257, Stats., for chloroform, bromodichloromethane, dibromochloromethane and bromoform groundwater quality standards. They also define ASR terminology in the code, and establish an ASR system "design management zone" compliance boundary. These NR 140 revisions became effective July 1, 2003.

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 submittal of results of a recently completed alachlor ESA toxicological study by Monsanto, the manufacturer of alachlor.

Revisions are also proposed to NR 140 to revise the existing state groundwater quality standards for arsenic. Arsenic is a known human carcinogen, and the federal drinking water maximum contaminant level (MCL) for the substance was recently lowered from 50 µg/L to 10 µg/L. A similar change is proposed for the NR 140 arsenic enforcement standard and the state drinking water standard in NR 809. The Natural Resources Board authorized public hearings for this code change at its June 2003 meeting.

Bureau staff have recently created a table listing NR 140 groundwater quality standards, NR 809 state drinking water standards, and established health advisory levels (HALs) for substances in water. 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 Department staff involved with groundwater contamination and remediation cases. It is available on the Internet at: *http://www.dnr.state.wi.us/org/water/dwg/health/hal.htm*. Links in this table allow users to obtain additional toxicological and health related information on many of the substances listed.

Groundwater Section staff serve on the Bureau for Remediation and Redevelopment's Standards and Streamlining Team. This team identifies policy issues, develops guidance, and provides 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. The team is also responsible for developing additional NR 720 soil standards, supporting groundwater standards development and streamlining the cleanup process.

Groundwater staff also serve on the NR 700 Implementation Team. This team evaluates and makes recommendations promoting consistency for statewide issues affecting the Bureau for Remediation and Redevelopment, such as site investigations, soil and groundwater remediation, and general case closure decisions. The team's function is critical in obtaining statewide consistency on how the DNR evaluates, addresses and closes soil and groundwater contamination sites.

Groundwater monitoring and research. DNR continues to administer funds for management practice monitoring projects. During FY 03, $128,000 was spent on 6 projects selected during the joint solicitation process described under *Wisconsin's Groundwater Research and Monitoring Program* in this report. Two additional projects were funded from separate sources. Topics addressed include:

- Monitoring contaminant flux from a stormwater infiltration facility to groundwater
- Occurrence of antibiotics in wastewater effluents and their mobility in soils
- Nitrate loading history, fate, and origin for two Wisconsin groundwater basins
- Importance of disinfection on arsenic release from wells
- Sources of arsenic and mechanisms of arsenic release in southeast Wisconsin
- Evaluation of Enzyme Linked Immunosorbent Assay (ELISA) for analysis of di-amino atrazine in groundwater in comparison to chromatography
- An experimental and mathematical study of the alpha-particle activity of groundwater with high gross alpha
- Additional laboratory work for determining susceptibility of La Crosse municipal wells to enteric virus contamination

Approximately $125,000 was awarded to 4 projects for management practice monitoring during FY 04. These projects are new studies selected during this year's joint solicitation for proposals (see Tables 1 and 2 in Chapter 2). More details on the DNR's Groundwater Monitoring and Research program can be found at *http://www.dnr.state.wi.us/org/water/dwg/gw/research.htm*.

Final reports received by the DNR in FY 03 include:

Aldstadt, J. 2002. Development of analytical methods for comprehensive chemical and physical speciation of arsenicals in groundwater

Collins, M. L. P. 2002. New approaches to the assessment of microbes in groundwater: application to monitoring bioremediation and detection of pathogens

Degnan, A. J., and J. Standridge. 2002. Development and application of a plating media for detection of *Helicobacter pylori* in water

Gotkowitz, M. B., J. A. Simo, and M. Schrieber. 2003. Geologic and geochemical controls on arsenic in groundwater in northeastern Wisconsin

Grundl, T. and L. Schmidt. 2002. Delineation of high salinity conditions in the Cambro-Ordovician aquifer of eastern Wisconsin.

Hunt, R., and M. Borchardt. 2003. Susceptibility of La Crosse municipal wells to enteric virus contamination from surface water contributions

Jansen, J. and R. Taylor. 2002. Time domain electromagnetic induction survey of the sandstone aquifer in the Lake Winnebago area.

Knobeloch, L. 2002. Public health impacts of arsenic contaminated drinking water

Sonzogni, W. C., J. Standridge, and M. Bussen. 2002. Preservation and survival of *E. coli* in well water samples submitted for routine analyses

Zuniga, D. 2002. VOC trend analysis of WI solid waste landfill monitoring data: A preliminary analysis of the natural attenuation process

Under direction of the GCC, the UW Water Resources Institute (WRI) and the Groundwater Section continue to distribute the findings of groundwater monitoring and research funded through the Wisconsin Groundwater Research and Monitoring Program. Final reports and 2-page research summaries are available for most projects. Almost 100 summaries are available electronically on the following WRI web page (*http://www.wri.wisc.edu/wgrmp/wgrmp.htm*).

Groundwater monitoring well requirements, as specified under NR 141, are administered by Groundwater 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 department 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.

Groundwater 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 on the Bureau of Drinking Water and Groundwater's web page at *http://www.dnr.state.wi.us/org/water/dwg/gw/sample.htm*. They are among the most downloaded documents on the Bureau's web page.

Groundwater data management. Groundwater data from the Department's consolidated Groundwater Retrieval Network (GRN) system is available on the Bureau of Drinking Water and Groundwater's website at *http://www.dnr.state.wi.us/org/water/dwg/*. GRN accesses groundwater data from three program database systems in the bureaus of Waste Management and Drinking Water and Groundwater 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. Data from the Bureau of Watershed Management's database system will be added in the near future to include data from monitoring wells associated with wastewater discharge permits.

Software developed by the DNR for electronic management of eight (8) paper forms related to well construction continues to be available on the Bureau of Drinking Water and Groundwater's website at *http://www.dnr.state.wi.us/org/water/dwg/gw/software.htm*. The DNR Well Forms program allows users to enter data, print paper copies, export and import records and search selected fields. Forms available within the program include the following:

- Monitoring Well Construction Form 4400-113A
- Monitoring Well Development Form 4400-113B
- Well/Drillhole/Borehole Abandonment Form 3300-5B
- Soil Boring Log Information Form 4400-122 and 122A
- Groundwater Monitoring Well Information Form 4400-89
- Groundwater Monitoring Inventory Form 3300-67
- First Water Quality Report Form (3300-77)
- Drinking Water Well Construction Report Form (3300-77A)

Data from the DNR Well Forms program can now be uploaded and made available for retrieval in the GRN system. This could potentially save wells drillers, consultants and Department staff time now spent filling out paper forms and entering data.

Through the State's Source Water Assessment Program (SWAP), the DNR continued to make progress on several groundwater-related data initiatives in FY 03. The DNR's Drinking Water and Groundwater program coordinated efforts to improve the Department's data on public water supply wells and significant potential sources of contamination that may threaten these wells. Cooperative projects with the Remediation and Redevelopment,

Waste Management, and Watershed Management programs are improving existing locational information and collecting new information for known groundwater contamination sites, large landfills, large confined animal feedlot operations and other potential threats. 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). DNR staff use these reports to help determine the susceptibility of public water systems to contamination and for many other purposes.

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. To achieve this goal the DNR, working with other state and federal agencies and extensive citizen input, developed a two-part state WHP Program that was approved by the USEPA in 1993. A WHP plan must be developed for any new municipal water supply well constructed since May 1, 1992. The plan must be approved by the DNR's Public Water Systems Section. 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 existing wells.

The DNR continues a statewide public information effort aimed at encouraging water utilities to protect their water supplies from potential sources of contamination through wellhead protection planning. Wellhead protection activities are coordinated through a Wellhead Protection Standing Team created in January of 1998. Among the activities undertaken this past year were:

- *Teacher training*. For the third year in a row, Department staff worked with the Central Wisconsin Groundwater Center (CWGC) and the Wisconsin Geological and Natural History Survey (WGNHS) to sponsor three groundwater workshops for teachers in January and February. 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-eight teachers took part in the workshops held in Dodgeville and Waukesha. 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.

- *Working with local communities on WHP planning*. Groundwater Section staff assist communities with WHP planning, whether it be providing information, reviewing documents or making presentations to promote the WHP program. The DNR also works with the Wisconsin Rural Water Association in providing assistance. Information is shared with local communities through a spring and fall wellhead protection newsletter.

- *WHP publications*. The DNR makes publications available to assist communities in their wellhead protection efforts.

- *Upgrading the DNR's WHP web pages*. The Department continues to update its WHP web pages (*http://www.dnr.state.wi.us/org/water/dwg/gw/whp.htm*) as new information becomes available. It currently includes general information on WHP, an annotated bibliography, a list of contacts for more information, a list of available publications, example WHP ordinances, and past and present issues of the Wisconsin Wellhead Protection News. Several DNR publications have been added to the web page in viewable and downloadable formats.

- *Keeping track of wellhead protection activity*. The Department has developed a database to keep track of communities working on wellhead protection planning, whether required or voluntary. The Department is also working to incorporate a tracking system for both wellhead protection and source water assessment activities into the Department's Drinking Water System database. The DNR uses this information to report annually to EPA on WHP and source water assessment progress.

- *Promoting the Groundwater Guardian Program*. The Department contracted with the Central Wisconsin Groundwater Center (CWGC) in 2001 to hire a person to promote the Groundwater Guardian program

statewide. The contract expired in the fall of 2002, but additional funds allowed the position to be funded through June 2003. The person prepared materials, made presentations to encourage local governments to become Groundwater Guardian communities, worked with existing Groundwater Guardian communities and organized the first 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.* The WHP Team continues to work closely with the Source Water Protection Team to provide consistency and continuity between the two programs. One area where the teams are working together is promoting advanced WHP Area delineations. In order to provide the most accurate information available to assist in WHP planning, the DNR has funded or is funding 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 will provide delineations of the 5, 50 and 100-year capture zones for each of the municipal wells in these areas. Communities can use these delineations in their WHP planning process.

Since source water assessment set-aside funds are no longer available from EPA, the Department 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. Groundwater Section staff provided wellhead protection training to regional Department staff who will be giving the source water assessments to municipal water supply systems and encouraging communities to adopt protection plans.

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. When completed, the program will have: 1) delineated source water protection 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. 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.

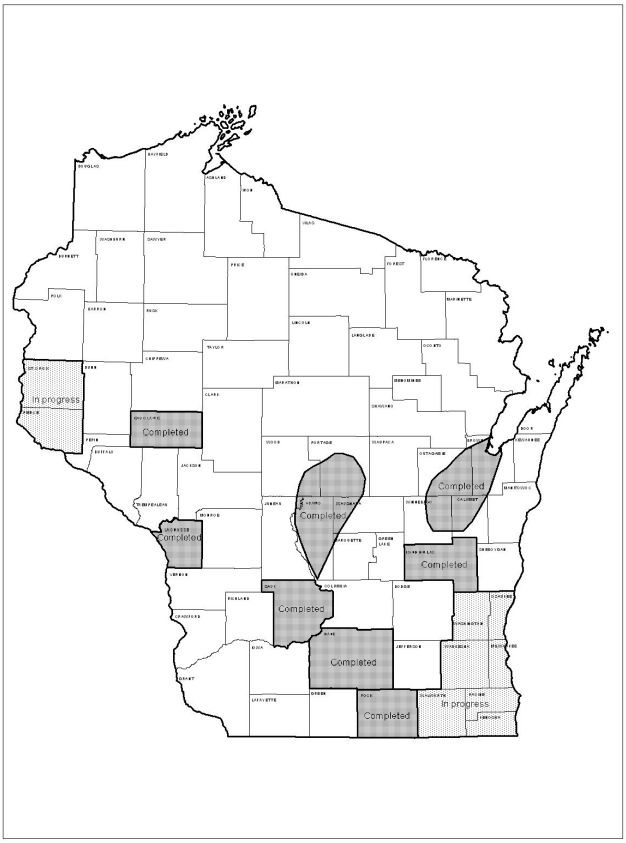

Figure 3.1 Areas where regional groundwater modeling studies are delineating source water areas for municipal systems using groundwater. Source: WDNR

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 are 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 well construction, hydrologic, geologic, and other information to determine each system's susceptibility to contamination. SWAP staff will hand deliver assessments to municipal systems. For other systems, the results of the assessments will be available on request by drinking water systems and made available on the Internet. The goal of Wisconsin's SWAP is to provide information that will assist communities in preparing WHP plans.

Source water assessments for Wisconsin's 19 drinking water systems that use surface water were completed in 2003 and are all available on the Internet at *http://www.dnr.state.wi.us/org/water/dwg/swap/index.htm*.

The SWAP assessment form and mapping application were implemented in FY 03. 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, wellhead protection, and other Department needs. The Assessment Form uses the mapped potential contaminant sources along with well construction, monitoring, and geologic information to help Department 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.

Coordination of groundwater components of basin plans. Groundwater Section 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. For example, the Rock River Coalition Groundwater Issues Team has focused on cataloging data and resources, identifying contaminant sources and karst features, developed an award-winning karst brochure and promoted well abandonment demonstrations.

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 Department staff and partnership groups, are responsible for setting priorities in each basin. The plans identify geographic priorities for the nonpoint source program and will be used to help rank projects eligible for nonpoint source grant funds. The Groundwater Section is involved in integrated planning by providing basic data on groundwater for each basin and more detailed information as is needed. The Section is uniquely suited to highlight areas in need of management based on groundwater issues and nonpoint source priority areas related to groundwater.

New Runoff Management rules with performance standards for stormwater infiltration were promulgated in October 2002. Groundwater Section staff worked with Runoff Management staff to ensure compliance with chapter NR 140, Wis. Adm. Code. The Section 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.

Arsenic in groundwater. The Bureau of Drinking Water and Groundwater continues to address groundwater concerns related to elevated levels of naturally occurring arsenic, particularly in northeastern Wisconsin. DNR historic data show that 3,386 public wells and 1,821 private wells have detectable levels of arsenic. In a portion of Outagamie, Shawano, Winnebago, and Brown Counties approximately one out of three private drinking water wells sampled have arsenic detects.

On October 31, 2001 EPA announced that the Federal Drinking Water Standard for arsenic would be lowered from 50 parts per billion for public water systems to 10 parts per billion. The new standard became effective in February 2002 and compliance must be reached by 2006. Hearings to determine if the State's groundwater standard (NR 140) and drinking water standard (NR 809) should match the Federal standard will be held in August 2003.

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. The Bureau will work with affected water systems to determine what this new standard means for them and what their options are. The Bureau is tracking current and new technologies for treating arsenic that may be possibilities for small water systems in Wisconsin. The DNR will continue to urge EPA to make funding available specifically for arsenic treatment for small systems that will have trouble covering the cost of treatment systems.

The department continues to advise drillers on well construction and has implemented two Special Casing Depth Areas, one in the Towns of Algoma and Omro in Winnebago Co. and the other in the Towns of Grand Chute and Center in Outagamie Co. The special casing area in the Town of Algoma has led to discussions about creating a new public water supply system.

Over the past three years, the Department has funded several studies through its Management Practice Monitoring Program to address various aspects of the arsenic issue. Several of these studies were completed in FY 03, and Department staff are using the findings to better understand the problem and develop effective solutions. See *Appendix D* for a listing of projects.

More information on the arsenic issue can be found in the Chapter 5, *Condition of the Groundwater Resource,* and Chapter 6, *Benefits from Monitoring and Research Projects*. In addition, a web page has been developed to provide DNR staff and public with information and updated recommendations (*http://www.dnr.state.wi.us/org/water/dwg/arsenic/index.htm*).

Underground Injection Control program. The purpose of the Underground Injection Control (UIC) program is to ensure that any aquifer that meets the definition of an underground source of drinking water (USDW) is protected from contamination that may result from the use of injection wells.

Federal regulations promulgated in response to Part C of the Safe Drinking Act of 1974 mandate the development of a UIC program in each state along with the identification of aquifers considered to be USDWs. The United States Environmental Protection Agency (EPA) is required to directly implement the UIC program in any state that chooses not to establish its own regulatory program. Since 1983, EPA has recognized the Department of Natural Resources (DNR) as the lead enforcement authority for Wisconsin's UIC program. All aquifers of the state are considered to be USDWs.

When the original state-federal UIC primacy agreement was signed it was believed that state administrative rules prohibited the use of injection wells in Wisconsin. However, various changes in the federal UIC regulations over the past two decades have modified the scope of the federal UIC program to the point where state regulators may no longer claim that all underground injection practices are prohibited. In response to the changes in federal UIC program requirements, the Department had proposed to create ch. NR 815, Wis. Adm. Code. The proposed chapter was to serve as a template for demonstrating that underground injection practices were being adequately regulated through various state programs; however, the Wisconsin State Legislature returned the proposed rules to the DNR with instructions for revision in 2001.

DNR staff have been working with EPA throughout 2002 to respond to the concerns expressed by the State Legislature and anticipate that a revised injection well rule package and federal-state primacy agreement will be in place within the next two years. Failure to execute a new UIC primacy agreement may result in the direct enforcement of federal injection well regulations by the EPA. Activities or practices that would be affected by the loss of state UIC program primacy include the following:

- discharge of domestic wastewater to large-capacity septic systems.
- subsurface discharge or infiltration of storm water runoff.
- in-situ remediation of contaminated soils or groundwater.
- discharge of industrial or municipal wastewater to subsurface land treatment systems.
- use of aquifer storage recovery wells[1] by municipal drinking water systems.

Efforts to develop aquifer storage recovery (ASR)[1] wells in Oak Creek and Green Bay are also continuing:

- The Oak Creek ASR well continues to store and produce potable water. The DNR has allowed the water to be reintroduced into the municipal water distribution system; however, increasingly elevated concentrations of manganese have been detected after each of the injection-storage-recovery cycles. This indicates that the geochemistry of the receiving aquifer has been altered and has not stabilized.

- During a recently completed test, the Green Bay ASR well failed to recover water meeting the new federal drinking water standard of 10 µg/L for arsenic until five times the volume of the originally injected water was retrieved from the ASR well. Currently, the Green Bay Water Utility is reconstructing the casing of the ASR well and has requested approval to conduct a second test in order to evaluate whether or not the changes will enable the ASR well to be operated in a manner that complies with state and federal requirements.

High capacity wells. The Department of Natural Resources 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 Department 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.

Groundwater quantity and water withdrawal issues have received more than usual attention in recent years, prompted by the interest of a major water bottling company in locating a high capacity well near two spring sites. The Department is continuing to address the potential impacts of the proposed wells through the review and approval process. This project highlighted the limited authority that the state has in regulating groundwater withdrawals that may affect surface water resources.

Drinking Water and Groundwater web site. In June 2003, the Bureau launched an improved Drinking Water and Groundwater web site (*http://www.dnr.state.wi.us/org/water/dwg/index.htm*). The site is designed to ease navigation and provide easy access to information for consumers, well drillers and pump installers, and water system owners and operators. Special programs include capacity development, the plan review process for community water systems, groundwater information, operator certification information, underground injection well information, and links to DNR Drinking Water & Groundwater staff and Administrative Codes. Four online databases are also accessible through the Water Quality Database links. In addition, many of the Bureau's Drinking Water contaminant brochures and well owner publications have been made available in PDF format.

Bureau of Waste Management

The Bureau of Waste Management regulates and monitors groundwater at proposed, active, and inactive solid waste facilities and landfills. The Bureau also reviews investigations of groundwater contamination and implementation of remedial actions at active solid waste facilities and landfills.

As of July 1, 2002, the Bureau 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. The Bureau is continuing to look at options to provide a web interface to allow facilities to upload environmental monitoring data into the Groundwater and Environmental Monitoring System (GEMS) database and review the data currently in GEMS.

The Bureau 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

[1] Aquifer storage recovery wells inject treated drinking water into a suitable aquifer for storage. During a high demand event the stored water is recovered through the same well and reintroduced into the water distribution system with little need for additional treatment to remove potential drinking water contaminants.

do a rough screening of old, closed town, city and village landfills with monitoring wells. In February 2000 and July 2003 we sent the screening reports, identifying landfills that need further attention to each of the regions for follow-up evaluations.

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. 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.

The Bureau 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 Department'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

The Bureau 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 not be available until spring 2004.

Bureau for Remediation and Redevelopment

The Bureau for Remediation and Redevelopment (RR) is primarily responsible 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 and at closed landfills. All cleanups are conducted according to WI Administrative Rules NR 700-750, Investigation and Remediation of Environmental Contamination, and NR 140, Groundwater Quality. Persons responsible under the laws, or those persons or groups involved in the redevelopment of potentially contaminated properties, do the majority of cleanups. Program staff provide assistance on cleanups conducted by consultants at responsible parties direction, and contract with and direct consultants on state-funded cleanups.

<u>Cleanup of groundwater contamination</u>. 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 Department 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.

<u>Brownfields program</u>. The DNR Remediation and Redevelopment program coordinates several efforts to encourage local governments and private businesses to cleanup and redevelop brownfield properties. 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. Many brownfields have groundwater contamination. The RR program provides technical assistance, helps to clarify legal liability, provides financial assistance and provides technical project oversight of cleanup projects.

One of the financial assistance programs implemented by the DNR is the Brownfields Site Assessment Grant (SAG) program. 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. The SAG program benefits groundwater by serving as a funding source for (1) 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. The SAG program does not fund remediation activities but 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 addition, the RR program began a new grant program in FY 03 that funds environmental remediation at brownfield properties. The Brownfields Green Space and Public Facilities Grant is a program that helps local governments clean up brownfield sites that will have a long-term public benefit, including the preservation of green space, the development of recreational areas or the use of a property by a local government. These grants could be used for remediation of soil and groundwater at a property.

The RR program continues to provide redevelopment assistance at brownfield sites with groundwater contamination. RR staff assist local governments and private businesses with the cleanup and redevelopment of brownfields. In many cases these properties have groundwater contamination or contamination that poses a threat to groundwater. Also, the RR program continues to provide a number of different assurance letters related to properties with groundwater contamination. General Liability Clarification Letters provide assurances to parties involved with voluntary cleanup sites so that they can buy or redevelop brownfield properties without concern about liability. “Off site” letters are provided to owners of property who demonstrate that the contamination under their properties did not originate on the property. These letters facilitate development of the property while the Department provides oversight of the cleanup being conducted by the person responsible for the contamination. In addition, lease letters are provided to lessees who rent properties overlying contaminated groundwater. These letters clarify the activities that lessees may undertake in order to remain free of liability for the contamination. Other assurance letters are also provided to lenders and local governments.

The RR program also continues to 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 Department 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.

Summary of FY 03 Accomplishments:

- Site Assessment Grants. In FY 03 announced that it will fund 54 Site Assessment Grants. Approximately $1.7 million was awarded to 38 communities across the state. Small grants of up to $30,000 make up 49 of the awards, while 5 are large grants of between $30,000 and $100,000. In FY 03, the DNR received 85 applications totaling approximately $3.5 million in requests, nearly twice as much money as was available to be awarded. These grants will fund the removal of approximately 50 aboveground and underground storage tanks and 126 abandoned drums and other containers of hazardous substances. These grants will also be used to fund 55 environmental site investigations. To date, 162 grants have been awarded to properties around the state representing around 554 acres of land.

- Brownfields Green Space and Public Facilities Grant. In FY 03 the DNR promulgated ch. NR 173 which describes the rules and requirements for the new Brownfields Green Space and Public Facilities Grant program. The emergency rule was adopted by the Natural Resources Board in August of 2002 and the permanent rule took effect in December of 2002. The DNR developed application materials and a scoring system that 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. In January

of 2003, the Department received applications for funding for the first round of grants. Eighteen applications requesting a total of $1.9 million for environmental remediation were received. On February 27 Governor Doyle signed into law the budget repair bill for fiscal year 2002-2003 (2003 Wisconsin Act 1), reducing funds for investigation and clean up of contaminated sites, including brownfields redevelopment. The law eliminated all funding ($1 million) for DNR's Green Space and Public Facilities grants and moves this money into the state's general fund. As a result, the DNR was unable to fund any of the Green Space grant applications received in January. The DNR may be able to fund some of these applications in the 04-05 biennium depending on the funding available in the budget.

- Voluntary Party Liability Exemption and Liability Clarification Letters. In FY 03, there were 3 completed cleanups where the Department issued a Certificate of Completion and 13 new sites that began the voluntary cleanup process. In addition, 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 58 sites throughout the state in FY 03.

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 groundwater use restrictions at the County Register of Deeds Office. This database is to be used with well construction requirements for private wells, and with a setback distance for new municipal wells. These revisions went into effect in November 2001, along with a corresponding database on the Internet (*http://gomapout.dnr.state.wi.us/org/at/et/geo/gwur/index.htm*). 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 Department works with Diggers' Hotline to make the GIS Registry information available to well drillers. Before drilling, well drillers contact Diggers' Hotline, which then informs the Department if a well is proposed for a property listed on the Registry. The Department will then contact the driller and advise them that special well construction features may be necessary, and that they must contact the Bureau of Drinking Water and Groundwater prior to any well construction activities.

Starting in fall 2002 the GIS Registry expanded to include sites closed with residual soil contamination, including those sites closed with soil deed restrictions after August 1, 2002. The same type of locational and site specific information is included for these sites as is currently included for sites with residual groundwater contamination.

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 contamination.

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://www.dnr.state.wi.us/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.

Bureau of Watershed Management

The Bureau of Watershed Management is responsible for statewide implementation of DNR's Groundwater Standards Program 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 Bureau. Integrated basin planning carried out in the field under guidelines developed by the Bureau, 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. The Bureau of Watershed Management 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.

The Bureau of Watershed Management 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.

The Bureau of Watershed Management 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 Department 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).

Septage and sludge management - The Bureau of Watershed Management 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. The Bureau 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.

The Bureau 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 (81% dairy; 9% poultry; 9% 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 Department'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 it is expected that the revised rules will be promulgated in 2004 in time for the construction season. Federal Storm Water Phase 2 regulations will 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 Department has developed performance standards (i.e. 80% sediment control, infiltration, peak flow, buffer requirements, etc.) that became effective in October 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 for implementation of the storm water management performance standards.

Nutrient management plans – One of the performance standards included as part of the Redesign effort which became effective in October 2002 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/exception 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://www.dnr.state.wi.us) 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, 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 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 03 approximately $200,000 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 2002, DATCP provided $406,215 to fund Clean Sweep projects in 41 counties for collection and disposal of waste pesticides and containers. Approximately 279,714 pounds of waste were collected, reducing the potential for inadvertent environmental damage. Approximately $400,000 will be available during 2003 for these projects.

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. 2003 will be the third 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 that 350 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 1995-2002 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 2002, 36 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 2002, this study entered its 17th program year. Over the years, as many as 50 different field sites have been sampled. Currently 22 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 5 years. In 2002, 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

DATCP funded three continuing pesticide research projects during FY 03 with a total commitment of $80,000. These two-year projects were 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. DATCP's research fund, which is based on fees paid by pesticide manufacturers, provides approximately $135,000 annually to meet pesticide related research needs of the Department.

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 37,000 wells and over 217,000 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 that addresses Private Onsite Wastewater Treatment Systems is part of the state plumbing code, 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, was revised effective May 1, 2003 and additional revisions are under consideration. 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. While the Department of Natural Resources, Chapter NR 151 included a gallon-for-gallon trade-off, where the use of stormwater within a plumbing system is considered equivalent to designed stormwater infiltration, the plumbing code now specifies the plumbing system treatment performance standards to accomplish that goal. Also within the plumbing code are the requirements for graywater (lavatory, shower, etc.) treatment and reuse. These options for stormwater use and graywater reuse will not only provide additional avenues for designers to address water related problems; they will also provide the impetus for Wisconsin citizens to learn more about water conservation issues while maintaining high safety and health standards.

Currently the Plumbing Advisory Code Council and Commerce staff are in the process of revising the stormwater section of the plumbing code. 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 by that date, also.

Private Onsite Wastewater Treatment Systems (POWTS). A revised private onsite wastewater treatment systems (POWTS) code, Comm 83, was implemented on July 1, 2000. Ongoing audits of the county onsite sewage system programs indicate that even with the availability of additional onsite treatment options, based on plan review and permit activities, most property owners continue to choose the same types of onsite systems that were available under the previous code. Nine manuals for standard system designs are referenced in the code. The majority of the

designs are being selected from the conventional, mound, pressure distribution, at-grade, and holding tank component manuals. The quality of written management and contingency plans that are now required for each onsite system design continues to improve. These plans are intended to alert the owners of onsite systems to the need for regular inspection, servicing and/or maintenance. These plans provide for mandatory system maintenance schedules and reporting of maintenance events over the life of the system. To help insure that the maintenance is properly performed, training classes and workshops for "POWTS Maintainers" continue to be offered by private vendors and the University of Wisconsin – Extension. The number of registered POWTS Maintainers continues to increase. This will help insure that the maintenance requirements are met. The Department has completed work on a "fix-up" Comm 83 code package that is intended to correct errors and clarify certain provisions in the current code. A code council that was formed met several times to discuss issues and offered several recommendations to the Department. Revisions to the Comm 83 code will be implemented early in 2004. The Department continues to communicate with the Department of Natural Resources regarding mutual issues such as large onsite sewage systems.

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 and emergency generator tanks. Comm 10 is currently under revision to update adopted standards and technical requirements to address current day needs and technology.

Since 1991 the database inventory of petroleum product tanks regulated under Comm 10 has increased from 143,681 to 176,827 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 June 6, 2003 the database reflects 79,120 federally regulated tanks with only 12,664 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 at a strong pace 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. The 2001 aboveground storage tank upgrade requirement reduced the number of bulk plants by approximately 30%. There was no apparent impact on users as operators consolidated tank storage and moved to larger tanks.

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)

The PECFA program from August 1989 through June of 2003 has reimbursed petroleum storage tank system owners approximately $1.3 billion for investigation and remediation of petroleum contamination in both soil and

groundwater. The program, in addition to auditing owner invoices and authorizing payments, performs technical reviews of site investigations, remedial options, and grants closures for the majority of the State's leaking underground storage tank (LUST) sites.

The budget bill passed in late August 2001 increased the bonding authority by $72 million to a total of $342 million. The proceeds from the sale of revenue bonds have been used to "pay down" the backlog of audited claims awaiting payment. The debt service that resulted from the original bond sales reduced the annual spending authority to $75 million in FY 02 and $68 million in FY 03. In FY 03, PECFA reimbursed close to 2,400 claimants a total of over $130 million. Currently PECFA is making reimbursement payments approximately 6 months after the claim is received. The petroleum inspection fee supports PECFA's spending authority.

The Department 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 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 400 sites. The Department is currently reviewing existing sites that have been reimbursed more than $200,000, and a continual interagency effort is conducted to evaluate the status of these sites. Many of these sites are expected to be at the point of requesting closure, hereby halting the continued exhaustion of PECFA resources.

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 continues to study whether Sanitary Permit information collected by the governmental units (counties) may be integrated with information on onsite system servicing, maintenance and inspection activities that are required to be reported and tracked. 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. The Department continues to participate in discussions with county code administrators, service providers and other interested parties relative to tracking and recording of inspection, maintenance and servicing events for onsite sewage systems.

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 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 03

The Natural Resources Board approved five proposed groundwater enforcement standards for public hearing in June of 2002. Since that time, DHFS staff have reviewed comments from stakeholders and preliminary data from a new study on the toxicity of the ethane sulfonic acid metabolite of alachlor (i.e. alachlor ESA). Once these reviews are complete, DHFS will forward final recommendations to the DNR for consideration by the Natural Resources Board. In May of 2003, DHFS submitted a supplemental recommendation to reduce the groundwater enforcement standard for arsenic from 50 µg/L to 10 µg/L, consistent with new Federal regulations.

In the fall of 2002, DHFS staff worked with representatives of the Centers for Disease Control to assist in a study designed to determine whether methyl-t-butyl ether (MTBE) can be detected in the blood of residents exposed to low levels (1–5 µg/L) in public water systems. MTBE is a motor fuel additive designed to reduce air pollution that has become a persistent and problematic groundwater contaminant in many parts of the United States. Preliminary findings suggest that MTBE can be detected in the blood of people who consume water with low-level MTBE contamination, and there appears to be a background level of MTBE exposure from sources such as motor vehicle use that is low but detectable in residents of rural Wisconsin. These findings were presented at a meeting of the National Groundwater Association in June of 2003.

During 2002-2003, DHFS staff worked with state and federal environmental health agencies to develop concepts and methods for the investigation of organic vapor intrusion into residences and commercial buildings. Vapor intrusion describes a hydrogeological scenario where petroleum or solvents dissolved in contaminated groundwater vaporize, move upward through spaces between soil particles, and ultimately enter buildings through spaces in the foundation. Investigating the health threat from this exposure pathway is a rapidly emerging area of environmental science. During 2002-03, DHFS staff presented training lectures on this topic to each DNR regional office, the Department of Commerce, and several environmental consulting firms. In the spring of 2003, DHFS staff organized a nationally-attended workshop discussing vapor intrusion issues, and produced written guidance for environmental professionals involved in investigating and remediating sites with vapor intrusion concerns.

DHFS staff have been active in research and outreach activities relating to naturally-occurring arsenic in groundwater in Winnebago, Outagamie and Brown Counties. Long-term exposure to arsenic in drinking water has been shown to contribute to increased risk of skin, lung and bladder cancers, as well as a number of cardiovascular and dermatological problems. Other conditions that may be related to arsenic exposure include diabetes and adverse reproductive outcomes. In FY 03 DHFS staff completed a follow-up investigation of the relationship between exposure to inorganic arsenic in water and health outcomes. As part of this research effort, local health departments, DNR and DHFS staff, town clerks and others carried out township-based well sampling campaigns throughout Winnebago and Outagamie counties. More than 2200 families completed questionnaires aimed at assessing arsenic exposure and related health outcomes. The study found that 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. Since the first round of sampling efforts, several townships have begun to conduct follow-up well testing campaigns on an annual basis, and some have expanded the scope of the sampling to include nitrate, bacteria and other contaminants of concern. Awareness of arsenic as a public health concern well water should continue to grow in northeastern Wisconsin as a result of these ongoing efforts.

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 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 03, 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 "re-discovering" the same information over time.

Groundwater Level 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/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 03 the Survey carried out the following county-based groundwater studies:

Dane County:	Continued updates of the regional groundwater flow model; continued model simulations for local municipalities and industries; completed a two-year study on the effects of new rural subdivisions on groundwater; assisted with University-based research projects on springs and wetlands in the county. Assisted with impact studies for the proposed UW/MGE West Campus Cogeneration power plant facility.
Calumet County:	Developed a database of hydrogeologic information that will be used to compile a 1:100,000-scale water-table elevation map and hydrogeologic cross sections depicting the extent and thickness of the primary aquifers.
Fond du Lac County:	Developed (with D. Cherkauer, UW-Milwaukee) a preliminary groundwater flow model of the county for use in the DNR source water assessment (SWAP) programs. The Survey also initiated new bedrock mapping in the county.
La Crosse County:	Completed a report on the geology 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 a report on contributing areas for municipal wells. Staff are continuing work on detailed studies of the hydrogeology beneath bedrock ridges.

Sauk County: Converted the depth to bedrock and water table maps, completed in the previous year, to fully digital products available to the public on CD-ROM.

Waukesha County: Based on findings from the regional model of southeastern Wisconsin (see below), the Survey proposed, and was awarded funding for, a project to investigate deep groundwater quality in Waukesha County. This project is being carried out in cooperation with UW-Milwaukee and the USGS and will be conducted during FY 04 and 05.

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 03, the WGNHS, SEWRPC, and the USGS completed a regional groundwater flow model for southeast Wisconsin and prepared reports on model construction and use. During FY 04 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 SWAP 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 04 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. 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 2002 the project team developed a bibliography and state-of-the-science report on aquitard hydrogeology. During 2003 the team will investigate aquitards at field sites in Dane, Waukesha, and Adams Counties.

Arsenic in groundwater. The WGNHS, with DNR support, is carrying out research on the source(s) and geochemical characteristics of arsenic contamination in water-supply wells in northeastern and southeastern Wisconsin. In FY 03 the WGNHS completed a project in the Fox River Valley that evaluated mechanisms of arsenic release to groundwater from domestic wells completed in the St. Peter sandstone aquifer, including the effects of well chlorination on arsenic levels. The results of this research, conducted cooperatively with the USGS and with J. Antonio Simo of the UW-Madison Department of Geology and Geophysics, were presented to DNR Drinking Water and Groundwater Program staff. DNR staff are using the information to develop well construction guidelines for affected areas within Outagamie and Winnebago Counties.

In FY 03, the WGNHS completed the first 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. The second year of the project will focus on identifying the geochemical conditions that release this arsenic to groundwater.

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 GIS techniques with basic landscape data and rainfall-runoff modeling and is being tested in Dane County. This project was completed in FY 03 and should result in a publication during the next year.

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 involved the linking of the recharge model described above with groundwater-flow and stream-temperature models, and focused on Rowan Creek, in southern Columbia County.

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. In April 2003, an article describing the Survey's fractured-rock work in Door County was featured in *Geotimes*, the nation's newsmagazine of earth sciences. This article is available online at <*http://www.agiweb.org/geotimes/apr03/feature_wisconsin.html*>.

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. WGNHS 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 03 the WGNHS will continue to provide data and consultation on karst issues as requested by various units of government and the public.

Crandon Mine. The WGNHS has also been actively assisting the DNR in its review of the proposed massive sulfide mine near Crandon, Wisconsin. This review includes 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.

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.

Research projects completed this year or in progress include:

1. Hydrogeology of Sauk County
2. Hydrogeology of La Crosse County
3. Methods of assessing aquitard integrity
4. Hydrogeology and temperature of Wisconsin trout streams
5. Geophysical investigation of the Eau Claire Formation
6. Regional groundwater flow model of southeastern Wisconsin
7. Hydrogeology of Dane County
8. Investigation of arsenic contamination of groundwater in northeastern Wisconsin
9. Development of new methods for determining groundwater recharge rates
10. Review of material submitted regarding proposed mine near Crandon, Wisconsin
11. Investigation of the effects of rural subdivisions on groundwater quality
12. Source-water protection for Fond du Lac County
13. Water-table map for Calumet County
14. Geophysical investigations of the Eau Claire Formation
15. Source-water protection for the SEWRPC counties

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 March, 2003 two WGNHS staff members (Robertson and Bradbury), at the request of Senator Russ Feingold's office, presented a briefing on Wisconsin groundwater issues to members of Wisconsin's congressional delegation in Washington, D.C.

In FY 04 WGNHS staff members plan to participate 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 04. 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 04. 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 geographic information systems (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 at the WGNHS. Another high priority is to make high quality, accurate digital datasets available to state agencies and the public. In FY 03, the WGNHS developed a version of the primary geologic database for distribution to the general public in digital format. This database, called WiscLith, contains lithologic and stratigraphic descriptions of geologic samples collected from across the state. The database is searchable by location, stratigraphy, and lithology. The database will be published on CD-ROM and will be available in the first quarter of FY 04.

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.

Recent WGNHS Publications

Bulletin 101: Geology of La Crosse County, Wisconsin. 2003. T.J. Evans. 33 p. plus 1 color plate.

Educational Series 42: Wisconsin in Geologic Time, 2003 [WGNHS calendar; educational text focused on groundwater and its flow.] 2002. (1 poster).

Miscellaneous Map 54-DI: Depth to bedrock map of Sauk County, Wisconsin: Digital information. 2003. M.B. Gotkowitz and K.K. Zeiler. (1 CD-ROM).

Miscellaneous Map 55: Water-table elevation of Sauk County, Wisconsin. 2002. M.B. Gotkowitz and K.K. Zeiler. (Scale 1:100,000).

Miscellaneous Map 55-DI: Water-table elevation of Sauk County, Wisconsin: Digital information. 2003. M.B. Gotkowitz and K.K. Zeiler. (1 CD-ROM).

Open-File Report 2001-02: Scanned images of Wisconsin Well Constructor's Reports. 2002. (Available by county on 77 CD-ROMs).

Open-File Report 2002-05: Delineation of zones of contribution for municipal wells in Sauk County, Wisconsin: Final report. 2002. M. Gotkowitz, K. Zeiler, C. Dunning, and J. Thompson, 74 p. plus 2 color plates.

Open-File Report 2003-01: Geologic and geochemical controls on arsenic in groundwater in northeastern Wisconsin: Final report. 2003. M.B. Gotkowitz, J.A. Simo, and M. Schreiber. (1 CD-ROM; files on CD are in PDF format.)

Bradbury, K.R. 2003. A circuitous path: Protecting groundwater in Wisconsin. *Geotimes*, V 48, no. 4, p 18–22.

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

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 102 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) - Bureau of Environment
- Hazardous Waste - Division of Business Management (Risk & Safety Management Section)
- Wetlands - Bureau of Environment
- Erosion Control and Storm Water Management - Bureau of Environment
- 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 1,193 salt storage sites listed in the database and 2,294 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 new 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 56 separate locations along major highway routes are used to help determine the timing and method of sand and salt application rates. Annual training for proper snowplowing and salt spreading techniques is provided for county snowplow operators.

Salt 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 (1 or 2 shallow monitoring wells per site). To date approximately 20 sites throughout the state have been studied. In general, each site is 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 future groundwater monitoring plans are being evaluated. 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). The next progress report is due in 2003.

For more information, visit the following web site (http://www.dot.state.wi.us) or contact Mr. Robert Pearson, Hydrogeologist, Bureau of Environment, Room 451, P. O. Box 7965, Madison, Wisconsin 53707-7965; phone: 608-266-7980, or e-mail robert.pearson@dot.state.wi.us.

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. 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 03 included studies of the behavior of mercury in the aquatic environment and investigations into the presence of arsenic in drinking water supplies – including release mechanisms and evaluations of various methods for its removal.

Research. During FY 03, the WRI directed a wide-ranging program of priority groundwater research consisting of 13 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:

- Examination of the influence of groundwater on summer water temperatures in trout streams;
- 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;
- Determination of whether a convenient mapping technique, based on the electrical conductivity of subsurface layers of shale and sandstone, is suitable for southern Wisconsin;
- Examination of how subdivisions constructed without private sewers may contaminate groundwater;
- Investigation into the feasibility of removing heavy metals from contaminated soils using cationic surfactant;
- Examination of methods of removing iron from groundwater and assessing the potential for using these methods to simultaneously remove arsenic;
- Evaluation of the effectiveness of natural attenuation in the source-zones of petroleum-contaminated soils;

- Determination of the influence of trees on groundwater levels and contaminant concentrations;
- Determination of whether stream water during baseflow conditions can be used to monitor groundwater quality in a watershed;
- Investigation into the use of UV light and nanoparticulate oxide adsorbents to remove arsenic from groundwater;
- Testing the use of "rain gardens" for receiving runoff and recharging local aquifers;
- Development of thin-film microporous absorbents to remove arsenic from contaminated groundwater.

These 13 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-Extension and UW-Parkside.

The UWS selected nine new groundwater research projects from this year's Solicitation for Proposals for support during FY 04 (July 1, 2003–June 30, 2004) (see Table 2). Three projects, selected from the previous year's solicitation, will receive continuation support during FY 04. The new projects are based at UW-Madison, UW-Extension, UW-Stevens Point and UW-Whitewater. The WRI also provided 50% support for a full-time "Waters of Wisconsin Forum" staff position at the Wisconsin Academy of Sciences, Arts & Letters and is helping coordinate the 2003 "Wisconsin Year of Water" observance.

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 04 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**.** 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 groundwater research results to a wider audience through its Web site at *http://www.wri.wisc.edu/*. Staff members maintain a complete list of publications resulting from UWS-funded projects at *http://www.wri.wisc.edu/Publications/66-00pubs.html*. The Water Resources Library makes copies of the publications available to the public.

WRI also assists in disseminating information about DNR, DATCP and Commerce projects funded through the Wisconsin Groundwater Research and Monitoring Program. WRI established and continues to maintain a Groundwater Research and Monitoring Project Web page at *http://www.wri.wisc.edu/wgrmp/wgrmp.htm*. This site presents summaries of the results of more than 100 completed groundwater research/monitoring projects funded since 1989, and is updated as projects are completed. The Water Resources Library lends copies of the complete final project reports to the public.

WRI staff has begun redesigning the Groundwater Research and Monitoring Project Web page to make it easier to use and more visually appealing. Plans for the redesign include an expanded search capability and the availability of complete final reports in PDF format. Site improvements should make it even more popular and effective in disseminating groundwater-related research results.

The Online Directory of Water Expertise and the Water Resources Library offer other avenues for the dissemination of groundwater-related research information. First put online in 2000, the database contains more than 800 water experts, including groundwater professionals, and can be searched by area of expertise, research interests or name. The database can be found at *http://www.wri.wisc.edu/wriexpertise/index.asp*. Users with an interest in water issues can contact the experts by phone, fax or email. Water professionals can sign up or update their entries online.

Water Resources Library**.** The Water Resources Library maintains a specialized collection of more than 25,000 water-related publications, 30 journals and 100 newsletters. The collection covers all major topics in water resources, but is particularly strong in groundwater-related publications. A popular service is the K–12 water-related curricula collection. All materials are included in MadCat, the UW-Madison online library catalog, and can be searched at *http://madcat.library.wisc.edu*.

Because the library is located on the UW-Madison campus, the library collection is supplemented by the university's major research collection, numerous online databases and full-text resources. The Water Resources Library also maintains a Web site (*http://wri.wisc.edu/library*), which serves as a gateway to water-related information on the Web as well as a guide to the library. Web users can pose questions to AskWater, the library's online reference service. The library's monthly publication, "Recent Acquisitions and Web Sites of Interest," frequently emphasizes groundwater-related publications and Web sites, and is distributed widely among university personnel, state agency staff, researchers, consultants, libraries, private organizations and interested citizens.

In addition, in celebration of Wisconsin's Year of Water (2003), the library is expanding its reach by establishing Wisconsin's Water Library, an online water information resource especially for the people of Wisconsin. The Web site was created in partnership with the Wisconsin Academy of Sciences, Arts & Letters; the UW Sea Grant Institute, and UW-Madison Libraries. The online library will loan books to all Wisconsin residents, offer lists of water-related books and Web sites by topic, and provide virtual reference-desk service. It is scheduled to go online in July 2003 at *http://aqua.wisc.edu/waterlibrary*.

Media relations**.** The Aquatic Sciences Center has a media relations professional on staff, who distributes news releases, media advisories and other information regarding groundwater-related research on behalf of the WRI. A news release distributed in July 2002 regarding new FY 03 groundwater projects garnered the interest of several media outlets across the state, most notably WXPR in Rhinelander.

Conferences, meetings, and presentations**.** The Wisconsin WRI co-sponsored the American Water Resources Association-Wisconsin Section annual meeting during Feb. 27-28, 2003, in Lac du Flambeau, Wis. The title of this year's event was "Gathering of the Waters." Conference speakers discussed the threats to water supply and quality resulting from increased urbanization, agricultural expansion, climate change and population growth. More than 40 contributed papers or posters, covering a range of topics regarding Wisconsin's water resources, were presented. The meeting is unique in that it especially encourages students to present papers or posters describing their original research. Students funded through the Wisconsin Groundwater Research and Monitoring Program are asked to present results of their research at this forum.

In addition, the WRI played an active role as a sponsor and participant in the Waters of Wisconsin Forum—a statewide initiative spearheaded by the independent, nonprofit Wisconsin Academy of Sciences, Arts and Letters—that is examined how to best to use and conserve the state's aquatic resources.

***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.**

UWS Publications and Presentations Resulting from Wisconsin Groundwater Research and Monitoring Program Projects in FY 03

Anderson, M.A.; W. Zeltner, and E. Lee. 2002. Removal of As(III) and As(V) in Contaminated Groundwater with Thin-Film Microporous Oxide Adsorbents. Groundwater Research Report WRI GRR 02-05. Madison: UW Water Resources Institute.

Anderson, M.P. 2002. Groundwater-Lake Interaction: Response to Climate Change in Vilas County, Wisconsin. Groundwater Research Report WRI GRR 02-02. Madison: UW Water Resources Institute.

Browne, B.A. 2003. A Basin-Scale Denitrification Budget for a Nitrate Contaminated Wisconsin Aquifer: A Study at the Groundwater/Surface Water Interface. Groundwater Research Report WRI GRR 03-01. Madison: UW Water Resources Institute.

Cherkauer, D.S., and C.J. LaCosse. 2003. Causes of Historical Changes in Groundwater Recharge Rates in Southeastern Wisconsin. Groundwater Research Report WRI GRR 03-02. Madison: UW Water Resources Institute.

Cherkauer, D.S. 2003. Quantifying the spatial variability of groundwater recharge using GIS and a distributed-parameter model. In final review: *Ground Water*.

Cherkauer, D.S., and S.A. Ansari. 2003. Estimating the spatial and temporal distribution of groundwater recharge using topography, hydrogeology, land cover and precipitation. Manuscript in review: *Ground Water*.

Dodson, S.I. 2002. Effect of Clean and Polluted Groundwater on Reproduction and Development of *Daphnia*. Groundwater Research Report WRI GRR 02-01. Madison: UW Water Resources Institute.

Kashian, D.R., and S.I. Dodson. 2002. Evaluation of the use of *Daphnia* for toxicity testing of endocrine disruptors: Effects of vertebrate hormones on development and sex determination in *Daphnia magna.* In review: submitted to *Journal of Aquatic Ecosystem stress and recovery.*

Kashian D.R.. 2002. "Reproduction and development in *Daphnia:* The role of hormones, pesticides and detoxification." Ph.D. dissertation. University of Wisconsin-Madison.

Kashian, D.R. 2002. An investigation of xenobiotic detoxification through P-450 induction in *Daphnia magna.* To be submitted to *Environ. Toxicol. Chem.*

Kashian, D.R., and S.I . Dodson. 2002. Disruption of developmental and sexual determination processes in *Daphnia magna*: A survey of 10 agricultural chemicals. In review: submitted to *Environ. Toxicol. Chem.*

Stoor, R.W. 2002. "Groundwater contributions of methylmercury to a Lake Superior Watershed." M.S. Thesis, Environmental Chemistry and Technology Program, University of Wisconsin-Madison.

Stoor, R.W.; D.E. Armstrong, K. Rolfus, L. Cleckner, and D.P. Krabbenhoft. 2002. Importance of Groundwater in Production and Transport of Methylmercury in Lake Superior Tributaries. Groundwater Research Report WRI GRR 02-04. Madison: UW Water Resources Institute.

Turyk, N.B.; B.H. Shaw, and M.P. Russelle. 2002. Remediation of Soil and Groundwater Using Effectively and Ineffectively Nodulated Alfalfa. Groundwater Research Report WRI GRR 02-03. Madison: UW Water Resources Institute.

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, 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/*.

In 2002, the Center assisted over 3100 households in having their water tested in conjunction with county Extension offices and the Watershed Center's Water and Environmental Analysis Laboratory. Of these, 10% exceeded drinking water standards for nitrate-nitrogen. Twenty-two percent of samples were unsafe because of coliform bacteria. Eleven education programs helped nearly 900 well users in six counties understand potential remedies for these problems and the relationship of land use practices to groundwater quality.

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 nearly 374,000 individual test results for approximately 52,200 samples covering the state. Chemistry data includes pH, conductivity, alkalinity, total hardness, nitrate-nitrite, 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 25 counties are represented by 500 or more samples.

Center staff are playing pivotal roles in a number of state groundwater issues. Working with partners in the private and public sectors on groundwater quantity policy and law is a current priority for the Center. Center staff work 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.

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 conducted the highly successful First Annual Groundwater Festival. More about the 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 is coordinating interest among WDNR, 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 currently pilot-testing an EMS Guidebook for Wisconsin Farms, as well as pilot-testing on-line environmental assessments to fulfill that step of EMS development and implementation.

The Healthy Homes Partnership, an offshoot of Home*A*Syst held a Healthy Homes Satellite Videoconference in March 2003 for Healthy Homes educators, and now offers materials via CD and on the Web as well as the current print edition of Help Yourself to a Healthy Home. In another offshoot of Home*A*Syst, the Farm & Home Program has just received EPA funding to conduct social marketing research with landscape managers in the Lake Monona Watershed. Lessons will be relevant to encouraging landscape managers statewide to adopt more water pollution preventing techniques.

July 2002 – June 2003 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.

- *Drinking Water and MTBE: A Guide for Private Well Owners* (MTBE = Methyl tertiary-butyl ether). 6 page brochure. Produced jointly by The National Farm*A*Syst/Home*A*Syst Office, and the UW-Extension Solid and Hazardous Waste Education Center. Funded by a grant from the U.S. EPA Office of Ground Water and Drinking Water. May be found on the web at: *http://www.uwex.edu/farmandhome/wqpaap/products.html*

- *Healthy Home Satellite Videoconference.* 2 hour videotape. This national videoconference for Healthy Homes educators was broadcast on March 27, 2003 and featured presentations by content experts on asthma, mold, and integrated pest management. Participants had opportunities to interact with the experts through question and answer sessions. Tape available at cost of production. Information from: *www.uwex.edu/healthyhome/satvideoconf/*. Produced by the Healthy Homes Partnership and UW-Extension.

- *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 *www.uwex.edu/healthyhome*.

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

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

- *Agricultural Electrical Energy Consumption: A Focus on Energy Initiative.* Focus on Energy sponsored web tool for farm electricity conservation: *www.soils.wisc.edu/cocoon/foe/*

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 thirteen 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 02, NPM revised and distributed the *Nutrient Management Farmer Education Curriculum* that includes a discussion of nitrates in groundwater. In 2002-2003, the curriculum was taught in 15 counties with 134 producers farming more than 41,000 acres. Moving beyond crop production, NPM also worked collaboratively with the dairy systems faculty to write and publish a complementary curriculum, *Dairy Whole-Farm Nutrient Management: the Diet Connection*. The curriculum leads farmers through animal feed management aspects of whole-farm nutrient management and covers phosphorus, nitrogen, and potassium in detail.

In the field, the program staff supported formation of the Professional Nutrient Applicators Association of Wisconsin (PNAAW). NPM cooperated with these custom manure haulers, DNR, and DATCP to conduct an actual manure spill in-field demonstration and is developing subsequent educational materials emphasizing water quality protection. In Dane, Rock, and Columbia counties NPM staff and cooperating farmers completed eleven on-farm nitrogen rate and time of application comparisons. Analysis of the multi-year results showed that corn yields and economics were not improved when N rates exceeded UW recommendations. 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. More information on these efforts and many publications are available at the NPM web site (*http://ipcm.wisc.edu*).

Basin Education Program. The UWS cooperates with other state agencies involved with water resources and natural resource issues. In 1998, UW-Extension entered into a new partnership with the DNR and USDA-NRCS in Wisconsin. This new partnership provides land and water resources education in 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 Program works to support local conservation professionals such as county Extension agents, Land Conservation Department staff, and NRCS staff. In addition to other natural resource issues, the educational programs address a

broad range of groundwater-related topics, including drinking water, threats to groundwater quality, information about localized groundwater problems such as karst, and a variety of other unique water quality issues. More information can be found at *http://clean-water.uwex.edu/index.html*.

Multi-Agency Land and Water Education Grant Program (MALWEG). UW-Extension also 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. More information can be found at *http://clean-water.uwex.edu/malweg/index.htm*.

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 provide 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 have developed an interactive study guide dealing with safety, sampling, and chemistry for drinking water operators and publications related to drinking water. Staff attend and present papers at a variety of conferences and symposia and publish research finding in professional journals.

Summary of groundwater-related activities accomplished in FY 03. The state and nationally funded research projects conducted by the Drinking Water Quality program at WSLH focus on a variety of topics related to analysis and monitoring of microbiological and chemical contaminants in groundwater. Examples of research projects started or ongoing in FY 03 include:

- Importance of disinfection on arsenic release from wells (WDNR);

- Evaluation of enzyme linked immunosorbent assay for analysis of di-amino atrazine in Wisconsin groundwater in comparison to chromatography (WDNR);
- Assessment of endocrine disrupting chemicals in water reclamation systems (WERF)
- Assessment of improved methods for detecting *E. coli O157* using flow cytometry and serology (EMPACT, Environmental Monitoring for Public Access and Community Tracking, funded through the city of Madison);
- Identification of viruses in groundwater (WDNR);
- Comparison of pesticide home water testing kits with certified analytical laboratory results (WDNR).

In addition, the following report was published in a leading environmental journal resulting from a WDNR sponsored project:

Degnan, A. J., W. C. Sonzogni, and J. H. Standridge. 2003. Development of a Plating Medium for Selection of *Helicobacter pylori* from Water Samples. Applied and Environmental Microbiology, Vol. 69, No. 5, p. 2914-2918.

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 Division - Wisconsin District

The mission of the U.S. Geological Survey-Water Resources Division 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 ground water.

- Providing scientific and technical assistance in hydrologic fields to other Federal, State, and local agencies, to licensees of the Federal Energy Regulatory Commission, and to international agencies on behalf of the U.S. Department of State.

The Wisconsin District is currently conducting cooperative projects that have a significant groundwater component with the DNR, WGNHS, Southeast Wisconsin Regional Planning Commission (SEWRPC), La Crosse, 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 V, National Park Service, and USGS. On going projects that have a significant ground-water component are listed below.

Ongoing projects with state and local agencies

1. Ground-water observation well network.
2. Wisconsin water-use data file.
3. Southeast Wisconsin Hydrologic Study.
4. La Crosse County Groundwater Study
5. Susceptibility of La Crosse municipal wells to enteric virus contamination from surface water.
6. Hydrologic review of proposed zinc-copper mine near Crandon
7. Simulation of shallow groundwater flow for parts of the Menominee, Stockbridge-Munsee, Ho-Chunk Reservations.
8. Monitoring contaminant flux from a storm water infiltration facility to groundwater.
9. Groundwater and the Great Lakes WEB site development.
10. Simulation of groundwater/surface water interaction in the vicinity of the Chiwaukee Prairie.

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.

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 Jim Krohelski, USGS, 8505 Research Way, Middleton, Wisconsin, 53562-3581 (608/821-3850), jtkrohel@usgs.gov , Chuck Dunning (608-821-3827), cdunning@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 2002 (Oct. 1, 2001 to Sept. 30, 2002), 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, 23,000 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 124 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. It may also include feed management to reduce phosphorus in manure and other manure use alternatives such as biofuel production and composting.
- 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 9,500 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 491,000 acres of conservation systems was planned, including 247,800 acres of erosion reduction, 103,200 acres of wildlife habitat, and 16,700 acres of managed grazing land by 175 livestock producers.
- 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 18,700 acres of riparian buffers were installed and 15,200 acres of trees and shrubs were established.
- Dam rehabilitation pilot project: From the 1950s to 1980s, 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 9 deteriorating dams in seven western counties as part of a four state pilot project. Planning will begin on 9 more dams soon. These accomplishments resulted in the obligation of $3.2 million in federal rehabilitation funds.

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 and Practice Standard Code 595 Pest Management were both completed this fiscal year. These revisions enhance groundwater protection by promoting better nutrient and pest 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 608-276-8732 ext. 227, or Jim Kaap at 608-276-8732 ext. 266.

Chapter 4 -- CONDITION OF THE GROUNDWATER RESOURCE

The Groundwater Coordinating Council 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, and hazardous substance spills. The DNR requires monitoring at state Environmental Repair Fund sites, abandoned facilities, Comprehensive Environmental Response Compensation Liability Act (CERCLA- Superfund), leaking underground storage tank, and spill sites. 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.

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 LUST 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.

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 176,827 tanks. As of June 6, 2003 the database reflects 79,120 federally regulated tanks with only 12,664 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.

Underground storage tanks over 110 gallons have been federally regulated since 1988. As of August 1, 2002, DNR records indicate there are 3,600 active underground storage tank contamination cleanups and approximately 4,600 open sites. 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 LUST 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 4.1**). 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).

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

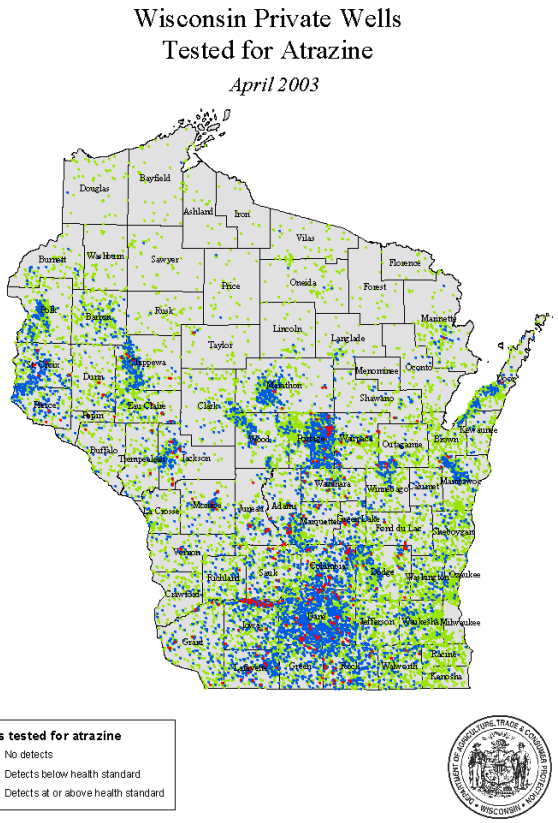

Figure 4.1 Private wells tested for atrazine in Wisconsin as of April 2003. Source: DATCP

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 are expected in late 2003.

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 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 Department of Natural Resources (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 2002, this study entered its 17th program year. In 2002, samples from monitoring wells near 17 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, 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%.

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).

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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Ward, M.H., S.D. Mark, K.P Cantor, D.D. Weisenburger, A. Correa-Villasenor, and S.H. Zahm. 1996. Drinking water nitrate and the risk of non-Hodgkin's lymphoma. Epidemiol. 7(5):465-71.

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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. Approximately 23% of private well water samples statewide test positive for total coliform bacteria, an indicator species of other biological agents (Warzecha et al 1995). Approximately 3% of private well water samples test positive for *E. coli*, an indicator of water borne disease that originates in the mammalian intestinal tract. 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.

In an effort to address concerns arising from possible airborne bacteriological contamination of wells, the WSLH completed a study investigating the role of air-borne particulates as the cause of unexplained coliform contamination in drilled wells (Trest et al. 1998). Samples were collected from 165 well sites located throughout Wisconsin. 96 of these recently experienced a total coliform positive. Of the 165 wells, 51% contained viable coliform organisms. Of the wells that had previous coliform positive, 61.5% of the air samples tested coliform positive. Of the wells that had no recent coliform positive, 36% of the air samples tested total coliform positive. Wells adjacent to positive air coliform samples were 1.7 times more likely to contain coliform bacteria than wells where the air coliform samples were negative. Wells located near vegetation, barnyards, pets, or fecal material; and samples collected within three hours of a rainfall event or where the grass had been recently mowed had relatively high percentages of air coliform positive samples. The study also determined that coliform bio-aerosols experimentally created near a wellhead are capable of artificially infecting a well.

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.

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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

Trest, M. T., J. H. Standridge, S. M. Kluender, J.M. Olstadt, and W.T. Rock. 1998. A Study of the Role of Air-borne Particulates as the Cause of Unexplained Coliform Contamination in Drilled Wells. University of Wisconsin State Laboratory of Hygiene and Wisconsin Department of Natural Resources. Unpublished report.

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 Radioactivity

Naturally-occurring radioactivity in groundwater, including uranium, radium, radon, and gross alpha is becoming an increasing concern. Sampling has identified radionuclides in groundwater in north-central Wisconsin, high levels of radium in water supplies in eastern Wisconsin, and gross alpha problems in northeastern and southeastern parts of the state. Nearly 60 public water systems either exceed the drinking water standard of 15 pCi/L for gross alpha activity (**Figure 4.2**). The DNR is enforcing the revised radionuclide standard adopted into NR 809 in October 2001. All systems that do not meet the current standards for gross alpha or radium will be asked to submit treatment plans and specifications, and to return to compliance by December 2003.

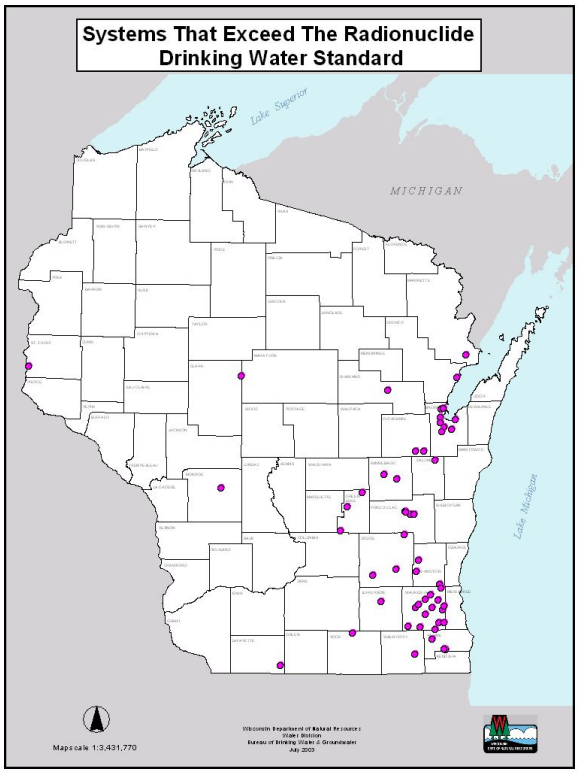

Figure 4.2 Public water systems that exceed 15 pCi/L for gross alpha activity as of July 2003. Source: WDNR

Two studies have been initiated by the DNR to address concerns about radioactive compounds in groundwater. The first titled "Identification and Quantitation of Alpha Emitting Radiochemicals in Drinking Water", began in FY 00. 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.

Preliminary results indicate 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 is currently developing models to account for the discrepancy between the total gross alpha activity and measurements of individual radionuclides.

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.

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. Department of Natural Resources historic data show that 3,386 public wells and 1,821 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 4.3**). In a portion of Outagamie, Shawano, Winnebago, and Brown Counties approximately one out of three private drinking water wells sampled have arsenic detects. 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.

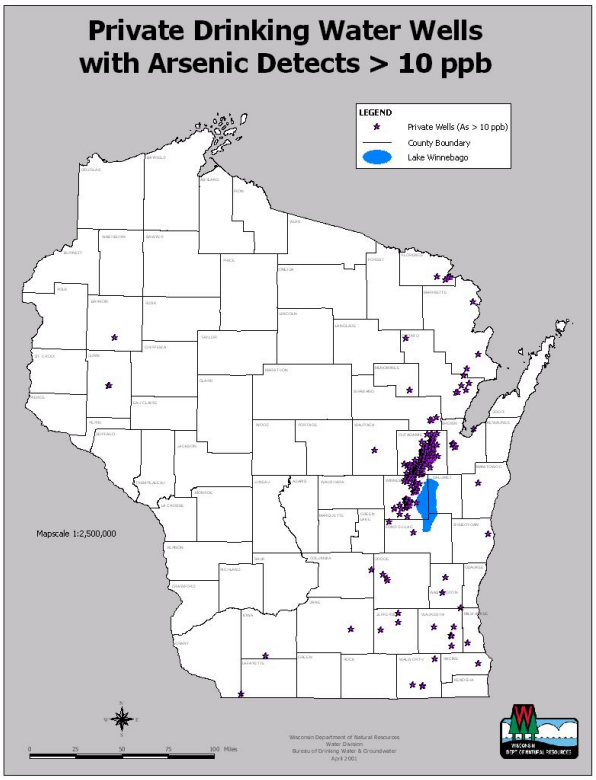

Figure 4.3 Private wells tested for arsenic in Wisconsin that exceed 10 µg/L (ppb). Source: WDNR

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[2]. 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 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.

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

[2] 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.

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 WDNR Arsenic Web Page:
http://www.dnr.state.wi.us/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. 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 4.4**).

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 drinking water, 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.

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.

In a 1997 report titled "Status of Groundwater Quantity in Wisconsin," the Wisconsin Groundwater Coordinating Council (GCC) concluded that a coordinated effort is needed to determine appropriate management options for addressing groundwater

Drawdown in the Sandstone Aquifer

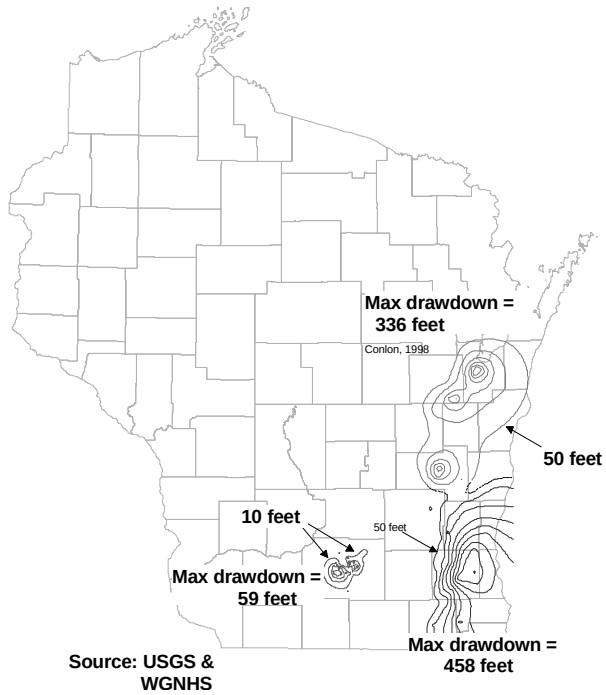

Figure 4.4 Simulated drawdown in the sandstone aquifer as of 1998-2000. Contour intervals represent levels of equal hydraulic head and are 50 feet in eastern Wisconsin and 10 feet in Dane County. Sources: USGS and WGNHS

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.

Since publication of that report, other developments have further 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 are considering whether to construct a pipeline as Green Bay has done to withdraw water from Lake Michigan.

Over-pumping in the Lower Fox River Valley has resulted in increased detections of arsenic in private well water in recent years. 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.

In 2000, Perrier proposed installing one or more wells in the Big Springs area in southeastern Adams County to pump out 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 approve a high capacity well application if it is determined that the new well will interfere with a municipal water supply well.

Recently, attention has focused on the state's limited authority to protect groundwater quantity. In August of 2000, the UW-Madison Department of Urban and Regional Planning issued a report reviewing Wisconsin's high capacity well law and making 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 include:

- 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

Groundwater quantity was an important topic at the Groundwater Summit held October 30, 2001. Common themes reported in the GCC's Summit summary, *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). At the conclusion of the Summit, 87.5% of those who filled out an evaluation form agreed that there is a need for a statewide groundwater quantity strategy in Wisconsin. 100 per cent of evaluation form respondents agreed that we are not doing enough to protect groundwater quantity in the state.

In 2002 and 2003, various groups have proposed solutions to address groundwater quantity concerns in Wisconsin. In fall of 2002, draft groundwater quantity legislation developed by the Municipal Environmental Group (MEG) and the WI Rural Water Association (WRWA) was made available for public comment. In March 2003, Rep. Spencer Black introduced a bill (AB 191) that directs the DNR to consider all waters of the state in its high

capacity well permitting decisions. In addition, a set of recommendations related to groundwater withdrawals has been put forward by a joint effort of UW-Stevens Point, the River Alliance and the Potato and Vegetable Growers Association. Further activity is anticipated during the fall 2003 legislative session.

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.

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://www.dnr.state.wi.us/org/water/dwg/gw/Pubdwnld.htm*)

A number of other resources related to groundwater quantity are listed on the Groundwater Coordinating Council web site.

Chapter 5 -- BENEFITS FROM MONITORING AND RESEARCH PROJECTS

The State of Wisconsin has funded over 300 groundwater-related monitoring and research projects since enactment of Wisconsin's comprehensive groundwater protection legislation (1983 Wisconsin Act 410) in 1984 (see *Appendix D*). 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 D*.

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.

Chapter 6 -- FUTURE DIRECTIONS FOR GROUNDWATER PROTECTION

The Groundwater Coordinating Council 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 of groundwater research and monitoring projects that were funded in the past two fiscal years. DNR's funding for projects has been cut by over two-thirds since FY 02 (see Table 3 in Chapter 2). The UWS budget was cut by 10% in FY 04. DATCP and Commerce have been unable to fund new projects in the last two fiscal years. These cuts will hamper the State's ability to address critical groundwater monitoring and research needs in the future. The Groundwater Coordinating Council encourages its member agencies and the legislature to maintain adequate resources for groundwater monitoring and research and to seek partnerships to leverage additional funds.

- **Support development of a Statewide Groundwater Monitoring Strategy:** Chapter 160 of the Wisconsin Statutes requires the Department of Natural Resources to work with other agencies and the Groundwater Coordinating Council to develop and operate a system for monitoring and sampling groundwater to determine whether harmful substances are present (s. 160.27, Wis. Stats.). Currently, groundwater is monitored by several agencies. While this monitoring meets the diverse needs of the various groundwater protection programs, there is no coordinated monitoring strategy that looks at long-term, statewide trends and provides enough data on which to base sound land and water use decisions. The GCC supports development of a coordinated monitoring strategy for Wisconsin that documents ambient groundwater quality, quantity, and use; promotes better understanding of groundwater hydrology; and involves citizens in protection of the resource.

- **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

- **Continue implementation of Groundwater Summit and Waters of Wisconsin findings**: The GCC played an important role in facilitating a discussion between industry, agriculture, water utilities, conservation groups, researchers, educators, and government agencies on Wisconsin's groundwater management challenges through the 2001 Groundwater Summit. This discussion continued with the Waters of Wisconsin project, which placed groundwater management issues into the larger context of statewide water policy, education, and monitoring needs. The GCC endorses the efforts of Waters of Wisconsin and will continue to actively support implementation of groundwater protection and management efforts resulting from WOW and the Groundwater Summit.

- **Address groundwater quantity management issues at both statewide and regional levels:** Groundwater quantity was an important topic at the 2001 Groundwater Summit, as well as the Waters of Wisconsin Forum. 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. In recognition of the importance of this issue the GCC formed a Groundwater Quantity Subcommittee in July 2003 to provide a resource for addressing scientific and technical questions related to groundwater quantity. The GCC will continue to be active on this issue 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. The GCC will seek ways to assist local communities in their planning efforts to encourage groundwater protection. The Local Government Subcommittee will play an active role in this effort.

- **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 contaminated groundwater and the effect of discharge of this groundwater on surface waters and their ecosystems. In addition, it will continue to facilitate consistent education to provide a clear message on the many causes and effects of nitrate in groundwater for urban and rural citizens.

- **Identify tools that can be used to better predict Wisconsin's groundwater susceptibility to contamination:** Studies have demonstrated the need for developing statewide data layers that would facilitate better groundwater vulnerability assessments. These data layers include land use, soils, regional groundwater flow, hydrogeologic characteristics such as aquifer materials, and potential point sources of contamination such as underground storage tanks and pesticide spills. The studies also illustrate the importance of locational data for contaminant sources. The GCC's Planning & Mapping and Monitoring & Data Management Subcommittees have prioritized, promoted, and helped facilitate the development of data layers as part of a larger data integration initiative. Through the DNR's Source Water Assessment Program, this work will continue and will result in improved predictive capabilities.

PRIORITY COORDINATION NEEDS

- **Coordinate and facilitate consistent messages on groundwater related issues:** The public has benefited from the consistent educational messages that have been endorsed by the Education Subcommittee. The Education Subcommittee will continue to provide its leadership and assistance to state agencies providing educational materials to the public. Priorities for the future 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 100 summaries of groundwater-related monitoring and research projects funded through the Wisconsin Groundwater Research and Monitoring Program are now available online. To maintain and enhance this resource it will be important to add new summaries annually 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 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.

- **Increase citizen involvement in groundwater protection**: Citizens are concerned about the protection of Wisconsin's groundwater, as evidenced by their participation in discussions of the Perrier bottling plant proposals, attendance at township-based well testing programs in arsenic affected areas, and the success of the Groundwater Festival held in May, 2003. However, citizen groups need a source of accurate unbiased technical information as well as assistance in organizing and communicating about their groundwater activities. Programs such as the National Groundwater Guardian program help citizen groups network and receive recognition for their efforts. The GCC supports Wisconsin's growing number of Groundwater Guardian communities and affiliates as a positive step toward an active and informed citizen network.