Fiscal Year 2001 Groundwater Quality Monitoring Plan

Wisconsin Department of Natural Resources
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For more information on this plan, please call the Bureau of Drinking Water and Groundwater (608-266-0821).

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ACCP	Agricultural Chemical Cleanup Program
BMP	Best Management Practice
BTEX	Benzene, Toluene, Ethyl Benzene, and Xylene
CDC	Centers for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COMM	Department of Commerce
CWGC	Central Wisconsin Groundwater Center - Stevens Point
DATCP	Department of Agriculture, Trade and Consumer Protection
DG	Bureau of Drinking Water and Groundwater - DNR
DHFS	Department of Health and Family Services
DILHR	Department of Industry, Labor and Human Relations (now COMM)
DNR	Department of Natural Resources
DOT	Department of Transportation
EPA	Environmental Protection Agency
ES	Enforcement Standard
ESA	Ethane Sulfonic Acid - Alachlor Metabolite
FY	Fiscal Year
GCC	Groundwater Coordinating Council
GEMS	Groundwater and Environmental Monitoring System
GRN	Groundwater Retrieval Network.
LUST	Leaking Underground Storage Tank
mg/L	Milligrams per Liter
Nitrate	Term Representing Nitrate (NO_3) + Nitrite (NO_2) Nitrogen
NPM	Nutrient and Pesticide Management
OA	Oxanillic acid
PAL	Preventive Action Limit
pCi/L	Picocurries per Liter
ppb	Parts per Billion
PECFA	Petroleum Environmental Cleanup Fund Award
RR	Bureau for Remediation and Redevelopment - DNR
SEWRPC	Southeastern Wisconsin Regional Planning Commission
SLOH	State Laboratory of Hygiene - Wisconsin
SMPs	State Management Plans
µg/L	Micrograms per Liter
USGS	United States Geological Survey
UWS	University of Wisconsin System
VOC	Volatile Organic Compound
WA	Bureau of Waste Management - DNR
WGNHS	Wisconsin Geological and Natural History Survey
WPDES	Wisconsin Permit Discharge Elimination System

GLOSSARY OF ACRONYMS AND ABBREVIATIONS - Cont.

WRI	Water Resources Institute - University of Wisconsin-Madison
WT	Bureau of Watershed Management - DNR

I. INTRODUCTION

Each year since 1989 the Wisconsin Department of Natural Resources (DNR) has written a monitoring plan to identify and document the activities and priorities of its groundwater quality monitoring program.

In preparing this plan, the DNR has worked with the Groundwater Coordinating Council (GCC) and other state agencies in evaluating existing monitoring information, available resources, and monitoring needs for the 2001 fiscal year. The GCC joint solicitation process has been a valuable tool to identify and fund groundwater monitoring and research needs important to groundwater management.

Wisconsin Act 410 requires the DNR, in cooperation with other state agencies, to develop and operate a system for monitoring and sampling groundwater to determine what substances are in groundwater and whether groundwater standards are being exceeded (s. 160.27(1), Wis. Stats.). The groundwater law identifies five groundwater monitoring categories (s. 160.27(2), Wis. Stats.): management-practice monitoring, problem-assessment monitoring, at-risk monitoring, regulatory monitoring, and a monitoring plan. These are defined below.

Management-Practice Monitoring

Management-practice monitoring is groundwater monitoring or support activities associated with monitoring, such as laboratory technique development or geological resource description, that will directly lead to improved groundwater management capabilities by federal, state, local governments, or the private sector. The primary goal is to fund monitoring activities that evaluate management practices or provide solutions to groundwater quality problems.

Problem-Assessment Monitoring

Problem-assessment monitoring is intended to define the nature and extent of groundwater problems in Wisconsin. Generally, existing private drinking water supply wells are sampled. Construction and sampling of monitoring wells is left to regulatory monitoring and management-practice monitoring where more resources can be focused on a particular site, facility, or practice.

At-Risk Monitoring

At-risk monitoring is intended to define and sample at-risk potable wells in areas where substances have been detected in groundwater. Because at-risk monitoring and problem-assessment monitoring focus on drinking water wells, it is difficult to determine when problem-assessment monitoring ends and at-risk monitoring begins. One obligation of the DNR's groundwater monitoring program is to provide resources for sampling private domestic wells where there

is a legitimate, demonstrated concern that a well is “at-risk”. This monitoring is used to determine if the contamination is significant enough to warrant either Superfund or Environmental Repair Fund investigations and, where possible, to trace the contamination back to the source.

Regulatory Monitoring

Regulatory monitoring is used to determine if groundwater standards are exceeded and to obtain information necessary to respond at specific sites. Regulatory monitoring requires facility owners to monitor the impact their facility may be having on groundwater quality. Many monitoring requirements are contained in permits or administrative rules and apply to solid waste sites, hazardous waste sites and wastewater disposal facilities. Regulatory monitoring is dictated by the permits or administrative rules that apply to the site and the regulatory requirements of specific programs, and therefore, is not covered under this monitoring plan.

Monitoring Planning

Monitoring planning is the process of preparing this plan for the collection, management, and coordination of monitoring activities and exchange of information among other regulatory agencies.

This plan evaluates current efforts, needs, and available resources pertaining to management-practice monitoring (Section III), problem-assessment monitoring, and at-risk monitoring (Section IV). In addition, monitoring activities of various federal, state, and local agencies are summarized (Section V). Finally, the current status of groundwater quality is discussed, with a focus on the primary contaminants of concern (human-caused and natural) for Wisconsin's groundwater (Section VI).

II. GROUNDWATER MANAGEMENT AND PROTECTION

Wisconsin residents rely heavily on groundwater. Three quarters of Wisconsin's population depend on groundwater as their source of drinking water. Groundwater is also used extensively by agriculture and industry.

Because of our dependence on groundwater, Wisconsin has a long tradition of groundwater protection. Wisconsin adopted the nation's first water well-drilling code in 1936. For many years, Wisconsin has regulated landfills and other potential sources of groundwater contamination. Groundwater monitoring has been an important part of the DNR's regulatory programs. For example, in the solid waste program, groundwater monitoring around landfills has been required since the early 1970s.

In 1984, the Wisconsin Legislature adopted comprehensive groundwater legislation, 1983 Wisconsin Act 410, which was designed to improve Wisconsin's ability to protect its valuable groundwater resource. This legislation:

- Established numerical groundwater standards.
- Created a laboratory certification program.
- Established a water well replacement program to compensate owners of contaminated water wells.
- Established an environmental repair fund to pay for clean up of abandoned landfills and other sources of groundwater contamination.
- Increased groundwater monitoring.
- Created the GCC.

Act 410 authorized funding to implement the Groundwater Fund. This fund is supported by permit and registration fees paid from a variety of land use activities known to contaminate groundwater. Moneys from the fund and general-purpose revenue are used to implement the requirements of the legislation, including increased groundwater monitoring. In 1987, the Groundwater Fund's name was changed to the Groundwater Account of the Environmental Fund.

Act 410 also created chapter 160, Wis. Stats., which required the DNR, in conjunction with the Department of Health and Social Services, to adopt numerical groundwater standards. The standards consist of an enforcement standard (ES) and a preventive action limit (PAL) for each regulated substance. These standards are contained in ch. NR 140, Wis. Adm. Code.

Chapter 160, Wis. Stats., also requires the DNR, in cooperation with other state agencies, to develop and operate a system for monitoring and sampling groundwater to determine what substances are in groundwater and whether standards are being exceeded. The DNR is also required to coordinate the collection of groundwater quality data and the exchange of information among agencies. In response to these requirements, the DNR designed a computer system in the late 1980's for groundwater quality data. The current system, the Groundwater Retrieval Network (GRN), is now available as a world wide web based interface of access and retrieval. Through the Monitoring and Data Management Subcommittee of the GCC, the DNR and other agencies continue to investigate ways to improve the utility and accessibility of the GRN system.

In response to the requirements and concerns about the quality of Wisconsin's groundwater, the DNR and other agencies have increased their levels of groundwater monitoring since the early 1980s. These efforts have improved the understanding of groundwater quality in Wisconsin.

III. MANAGEMENT-PRACTICE MONITORING PLAN

The DNR's Groundwater Section has the lead responsibility for designing and implementing the DNR's groundwater management practice monitoring plan. The purpose of the program is to support the development of new or improved groundwater management practices or evaluation techniques. Since 1984, the DNR has funded 159 monitoring projects aimed at answering critical questions related to groundwater resource management and protection (Appendix A). Two summary publications, titled, "Wisconsin Groundwater Management Practice Monitoring Project Summaries, 1990" and "Wisconsin Groundwater Research and Monitoring Project Summaries, 1995," are available from the U.W. Water Resources Institute (WRI). The 1990 publication summarizes 55 DNR-funded groundwater projects. The 1995 publication summarizes 72 groundwater projects, 45 of which were funded by DNR. Summaries of more recent projects will be available in FY 01 on the WRI world wide web site at **http://www.wri.wisc.edu.**

Monitoring and research projects are requested through a joint solicitation process involving the Groundwater Coordinating Council (GCC) and two of its subcommittees. The process involves soliciting proposals, ranking proposals received, and coordinating funding among participating agencies. Participants in the process include representatives from the UWS, the United States Geological Survey (USGS), a representative of the Governor, and six state agencies. While the solicitation is coordinated jointly, the DNR develops its own list of priority monitoring topics (Appendix B) and administers the grants independently.

The UWS, DNR, DATCP, and Commerce each have funds available for research or monitoring related to groundwater or pesticides. Approximately $9.7 million has been spent through FY 00 on 259 different projects dealing with groundwater or related topics. In FY 2001 the four state agencies have approximately $710,000 available. Each of the four monitoring/research programs is summarized as follows:

DNR Management Practice Monitoring

The DNR has had approximately $300,000 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). Through FY 00, the DNR has spent approximately $4.7 million on 163 monitoring projects. Several of these projects have been co-funded with DATCP, Commerce and/or UWS. In FY01, DNR is spending $337,000 on 10 monitoring projects.

UWS Groundwater Research

The UWS, through its UW-Madison Water Resources Institute (WRI), has received funding since FY 90 for groundwater research. Through FY 00, the UWS has spent $3.2 million on 87 groundwater research projects. Several projects have been co-funded with DNR, Commerce and/or DATCP and two were co-funded with WRI through the US Geological Survey. In FY 01, the UWS is spending about $306,000 on 13 groundwater research projects.

DATCP Pesticide Research

Since 1989, DATCP has had approximately $125,000 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 00, DATCP has spent about $1.4 million on 30 pesticide projects. Several of these projects have been co-funded with DNR and/or UWS. In FY 01, DATCP is spending about $79,000 on four pesticide projects.

Department of Commerce Private Sewage System 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 private sewage system technology. In 1994, when the appropriation expired, $75,000 generated through plan review and licensing fees became available each year for research on private sewage systems. Through FY 00, DILHR/Commerce has spent approximately $550,000 on seven projects. Two projects were co-funded with DNR and UWS. In FY 01, Commerce is spending $58,000 on one private sewage system research project.

The joint solicitation process provides consistency and coordination among state agencies in funding groundwater monitoring and research to meet state agency needs. As a result of the joint solicitation process, the DNR has two continuing and eight new management practice monitoring projects selected for funding in FY 2001 (Appendix C).

IV. AT-RISK/PROBLEM-ASSESSMENT MONITORING

Groundwater sampling conducted by the DNR's Drinking Water and Groundwater program has been primarily problem-assessment and at-risk monitoring. The focus of this monitoring has been to sample drinking water wells at locations deemed to be at greatest risk because of susceptible conditions or proximity to contamination sources. This process has resulted in the identification of hundreds of drinking water wells containing substances in excess of drinking water standards or health advisory levels.

Sampling is primarily targeted at volatile organic chemicals (VOCs) and pesticides. VOCs are associated with industrial processes, fuel storage tanks, and waste disposal sites. Pesticides are associated with pesticide storage and handling facilities and field application sites. Monitoring has also been conducted for nitrate and many naturally occurring substances including; arsenic, radon, and radium.

In addition to sampling drinking water wells, the process can incorporate project ideas developed by persons outside the program. It also allows for the investigation of specific geographic areas, specific contaminants, or specific facilities. The process requires the development of a project objective and provides a project summary with results and evaluation at project completion.

V. CURRENT GROUNDWATER MONITORING ACTIVITIES

Many federal, state and local agencies monitor groundwater in Wisconsin. Agencies either collect the samples with their own staff or require that monitoring be done by others pursuant to regulation or contract. The following is a summary of public agencies that monitor groundwater in Wisconsin and the types of monitoring they do. This is not intended to be a complete listing of all monitoring done in the state.

A. Federal

1. United States Geological Survey (USGS)

The USGS conducts basic groundwater research in Wisconsin. The Wisconsin District is currently conducting cooperative projects with the DNR, Wisconsin Geological and Natural History Survey, Southeast Wisconsin Regional Planning Commission, La Crosse, Dane and Sauk Counties, the Menominee Tribe of Wisconsin, and the Bad River Band of Lake Superior Chippewa. Projects are also being conducted in cooperation with EPA-Region V and the USGS – Biological Services Division. Projects include: the National Water Quality Assessment; Southeast Wisconsin Hydrologic Study; delineating well zones of contribution for several Menominee towns; the Crandon Mine Project; watershed studies such as the Pheasant Branch Groundwater Study; and groundwater/surface water interaction studies for Pool 8 of the Upper Mississippi River.

USGS, in conjunction with the Wisconsin Geological and Natural History Survey, also monitors water levels routinely from a statewide network of about 145 wells. Data from approximately 30 wells is published annually by water year in the "Water Resources Data for Wisconsin." The USGS world wide web site (**http://www.usgs.gov**) publishes historical water level data from about 170 wells and water level data for about 15 water-table wells updated monthly.

2. United States Environmental Protection Agency (EPA)

EPA monitors groundwater associated with investigation of sites listed on the National Priorities List. The EPA also conducts groundwater-sampling surveys such as the National Pesticide Survey, which look at national groundwater contamination issues.

B. State

1. Department of Natural Resources (DNR)

a. Bureau of Drinking Water and Groundwater (DG) - Monitors public water systems for bacteriological, chemical and radiological groundwater quality

problems. Staff conduct special projects to monitor private drinking water supply wells for the presence of chemical or radiological groundwater quality problems. Staff collect samples near regulated facilities to define problem areas and advise well owners of any consumption risks. These activities fall into the "problem-assessment" and "at-risk" categories of groundwater monitoring.

This year DG is funding 10 "management-practice" monitoring projects conducted by DNR staff, other agencies, and UW researchers. Studies are designed to establish or improve groundwater management practices necessary to meet state groundwater quality standards (Appendix C).

The bureau operates several computer systems for the storage and management of data for well construction and public and private well water quality monitoring sample analytical data. Most of the information contained in these systems is available on the world wide web.

b. Bureau of Waste Management (WA) - Requires regulatory monitoring of groundwater quality at proposed, active, and inactive solid waste sites. This monitoring includes organic and inorganic sampling and analysis to establish baseline groundwater quality conditions and to assess increases over baseline levels. Monitoring at inactive and active sites with known groundwater impacts includes sampling and analysis to determine the degree and extent of groundwater contamination and to determine the need for remedial action.

The bureau operates a computer system for the storage and management of data related to groundwater monitoring at landfills. Data related to mining and recycling is also available.

c. Bureau for Remediation and Redevelopment (RR) - Monitors groundwater or requires groundwater monitoring at Superfund, Leaking Underground Storage Tank (LUST), Environmental Repair, Brownfield, spill, landfill, and hazardous waste sites. Monitoring is intended to define the degree and extent of contamination (“problem- assessment” monitoring) or to assess the effectiveness of remedial measures (“regulatory” monitoring). Private individuals or corporations conducting remediation activities generate the vast majority of groundwater data associated with the RR program. Monitoring occurs at plating facilities, landfills, dry cleaners, wood treaters, manufactured gas plants, abandoned industrial facilities, and bulk and retail gasoline facilities. The program spends an average of $5 million per year from the Environmental Fund to monitor contamination sites.

The bureau operates a computer system that tracks the status of properties with groundwater contamination in Wisconsin, and provides access to the public for informational purposes. A registry of closed remediation sites is also scheduled

to be available through a web-based mapping system this fiscal year.

d. Bureau of Watershed Management (WT) - Issues Wisconsin Pollutant Discharge Elimination System (WPDES) permits and requires permittees to monitor groundwater quality (primarily nitrate and chloride) adjacent to all land treatment systems receiving more than 15,000 gallons per day of wastewater. WPDES permits are also issued for livestock operations with more than 1000 animal units. WPDES permits require management plans and include PALs and ESs for the appropriate groundwater parameters. Monitoring is typically required quarterly throughout a year.

The bureau works with unsewered communities in their efforts to construct centralized wastewater treatment facilities. WT also provides cost sharing to farmers and municipalities for mitigation of nonpoint source pollution. Work also continues on new proposed Commerce design regulations for on-site systems and jurisdictional concerns. The bureau also cooperates with RR at LUST, Environmental Response and Repair, and Superfund Cleanup sites, by issuing WPDES permits for the discharge of contaminated groundwater.

The bureau operates a computer system which records and monitors the treatment and use of municipal sludge, septage, and industrial land application activities, including an inventory and history of all sites used for land application. The system also includes monitoring well and sample analytical results data from site related monitoring.

2. Department of Agriculture, Trade and Consumer Protection (DATCP)

DATCP conducts groundwater monitoring for a number of agrichemical management programs, manages pesticide and fertilizer cleanup activities, and coordinates Wisconsin's "generic" and "pesticide-specific" state pesticide management plans (PMPs).

a. Bureau of Agrichemical Management - Conducts management- practice monitoring at highly susceptible sites across the state to determine which pesticides have the potential to enter groundwater using legal application rates. Groundwater is monitored on a project-specific basis to determine the impacts of agrichemicals (e.g., pesticides and fertilizers) on groundwater quality. Recent "problem-assessment" and "at-risk" monitoring efforts include the "Exceedence Survey: Resampling Wells that Previously Exceeded a Pesticide Enforcement Standard" and a study "Chloroacetanilide Herbicide Metabolites in Wisconsin Groundwater." A project currently underway is a third statewide random sampling of 350 private wells. This project is similar in design to the past "Atrazine Rule Evaluation Surveys" and will be statistically comparable. The bureau also funds pesticide and fertilizer research that includes groundwater monitoring.

b. Division of Food Safety - Conducts routine sampling of wells serving regulated activities such as Grade A dairy farms and bottled water producers.

3. Department of Transportation (DOT)

DOT conducts potable well sampling at approximately 150 public waysides and rest areas across the state. DOT also conducts additional groundwater management and protection activities as part of design, construction, and maintenance of state and federal highways. Since 1970, DOT has investigated potential road salt impacts to surface water runoff, vegetation, soils, and groundwater. In the last few years DOT has limited investigations to impacts on groundwater using 1 or 2 monitoring wells per site. Monitoring is generally on a quarterly basis for a period of 5 years. To date, approximately 20 sites throughout the state have been monitored as part of ongoing studies of road salt impacts. Approximately 5 sites are currently monitored, and future groundwater monitoring plans are being evaluated.

As part of the road construction program, an estimated 25 to 75 environmental assessments are conducted annually along right-of-ways where potential sources of petroleum or hazardous waste contamination may occur. Assessments consist of standard environmental audits of properties adjacent to highways and environmental drilling and sampling to identify or delineate the extent of soil and groundwater contamination.

DOT has several ongoing wetland monitoring projects which evaluate wetland hydrology, water quality and biotic response to constructed mitigation sites. The DOT is also working on standards for erosion control and storm water management and is currently participating in a project to investigate methods for treating highway runoff flowing into karst sinkholes. DOT is also monitoring several sites to evaluate the effectiveness of natural attenuation for petroleum contaminated groundwater.

4. Department of Health and Family Services (DHFS)

Recommends health-based enforcement standards for substances found in groundwater, investigates cases of water-borne illness and studies health impacts of contaminated drinking water. Recent studies include the health effects of arsenic contaminated water in northeastern Wisconsin, and health impacts of nitrate-contaminated groundwater. DHFS also monitors groundwater for bacteriological quality at facilities regulated by the hotel/restaurant program. Staff have been involved in studies conducted on natural radiological contaminants and monitoring done at migrant worker camps. Grants are also provided to counties for "at-risk" monitoring. DHFS staff acts as the primary resource for information about the health risks posed by contaminated drinking water, and prepares and distributes a wide variety of informational materials.

5. Department of Commerce

Commerce regulates private and commercial sewage systems and monitors groundwater at underground fuel storage tanks. Commerce continues to fund research on alternative on-site disposal systems, which may include groundwater monitoring. Regulation and inventory tracking of petroleum storage tanks and the administration of the Petroleum Environmental Cleanup Fund Award (PECFA) are also charges within the department.

Commerce maintains a database inventory of petroleum product tanks regulated under COMM 10. Tank inventory records currently exceed 173,500 as tanks continue to become registered.

The department has revised their private sewage system code (COMM 83), which went into effect July 1, 2000. Commerce is working with private consultants to develop database and monitoring systems to assist counties with their maintenance tracking programs. These systems will provide maintenance schedules and reporting of maintenance events over the life of the system.

6. Wisconsin Geological and Natural History Survey (WGNHS)

WGNHS conducts basic and applied groundwater research and provides technical assistance, maps, and other information and education to aid in the management of groundwater resources. WGNHS staff are currently preparing groundwater related maps (water table or aquifer maps) for Dane, Polk, Greek Lake, and Buffalo counties. Work also continues on a large hydrogeologic study of seven southeastern Wisconsin counties in cooperation with the Southeastern Wisconsin Regional Planning Commission.

About 18,000 well construction records (drinking water and monitoring wells) are reviewed, sorted, and cataloged each year. A massive project initiated in FY 00 involves scanning and entering selected fields into a database for the approximately 350,000 drinking water well construction logs on file since 1936. This project will be completed during FY 01. Work is continuing on development of a statewide database for approximately 36,000 geologic logs and drill holes that have more complete lithologic information. In addition, a new karst feature repository will be initiated in FY 01.

In cooperation with the USGS, groundwater levels are measured monthly from a statewide network of approximately 145 monitoring wells. Geologic samples from about 300 wells per year are collected and described, and about 300 groundwater samples per year are analyzed for nitrate, chloride, and several other basic parameters. The WGNHS is also involved in wellhead protection and groundwater modeling projects around the state, in addition to research on the sources and geochemical characteristics of arsenic contamination in water-supply wells in northeastern and

southeastern Wisconsin.

7. Central Wisconsin Groundwater Center (CWGC)

CWGC provides groundwater education and technical assistance to the citizens of Wisconsin. The center conducts homeowner water quality sampling programs and collects samples in cooperation with county Extension agents and the UW - Stevens Point Environmental Task Force Lab, for bacteriological quality, nitrate, chlorides, pH, alkalinity, hardness, corrosivity, and occasionally pesticides. In 1999, the Center assisted 3,950 households in having their water tested. The CWGC also assists local communities with wellhead protection planning and investigating groundwater contamination problems.

8. University of Wisconsin System (UWS)

The UWS conducts a wide-range of groundwater research including short and long-term studies covering both fundamental and applied research topics through the GCC joint solicitation. Seven new and seven continuing groundwater-related projects are being funded this fiscal year at 4 different university campuses. Many educational programs for all ages are conducted across the state, including the national "Give Water a Hand" program at the UW Environmental Resources Center. The UW Nutrient and Pesticide Management (NPM) program engages in on-farm demonstration and field day activities to disseminate information on agricultural best management practices (BMP) around the state, focus on critical areas, and publish materials for farmers and other agricultural professionals. The UWS cooperates with other state agencies involved in the Non-point Source Water Pollution Abatement program.

Five groundwater-focused projects coordinated through UW-Extension and the Multi-Agency Land and Water Education Grant Program ran between July 1, 1999, and June 30, 2000. These projects 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.

The university system offers many groundwater related courses, focusing on a wide range of topics. Programs cover K-12 education for teachers, undergraduate and graduate level, continuing education, and outreach programs.

C. Local Government

1. Counties

Many counties, either through grants provided by DHFS or with their own funds, monitor

for bacteriological or chemical water quality. Pesticide manufactures have also funded county groundwater monitoring activities. Counties that operate waste disposal sites are required to monitor groundwater in the vicinity of those sites. Counties often provide money to sample private wells providing drinking water for infants. The well sampling generally includes bacteria, nitrate, and fluoride analyses. Counties can regulate (under DNR supervision) well construction and pump installation for certain private wells. Counties can adopt ordinances regulating disposal of septage on land (consistent with DNR requirements).

2. City, Village and Towns

Many local government units monitor groundwater in the vicinity of public waste disposal sites. They also monitor public water supply wells. Larger cities may have their own health departments, which sample for bacteriological or chemical water quality. Under the Groundwater Protection Act, zoning authority for cities, villages, towns, and counties was expanded to “encourage the protection of groundwater.” Many communities are involved in developing wellhead protection plans for their drinking water supply wells.

VI. GROUNDWATER QUALITY

Groundwater quality varies greatly throughout Wisconsin. Groundwater monitoring by state agencies is intended to help determine the extent of groundwater contamination in the state and identify the sources of contamination. The primary human-caused contaminants of concern are VOCs, nitrate, and pesticides. Natural constituents which may present health concerns commonly found in Wisconsin groundwater include iron, manganese, sulfate, arsenic, and radium. Microbial contaminants (viruses, bacteria, and parasites) are also increasingly becoming a concern.

A. Volatile Organic Chemicals

Gasoline and industrial solvents, paints, paint thinners, drain cleaners, air fresheners, and household products (such as spot and stain removers) are examples of VOCs. Long term exposure to VOCs may cause cancer. Short-term health effects of VOC exposure include nausea, dizziness, tremors, and other health problems.

The DNR has sampled thousands of wells for VOCs. Over 80 different VOCs have been found in Wisconsin drinking water supply wells. Thirty different VOCs have been found to exceed the ES, affecting more than 770 drinking water supply wells. Figure 1 represents VOC detects at over 2,450 public and private drinking water supply wells in Wisconsin. Trichloroethylene is the most commonly found VOC in Wisconsin's groundwater.

Figure 1. VOC Detects at Public and Private Drinking Water Supply Wells

Sources of VOCs include landfills, underground storage tanks, and hazardous substance spills. The DNR's Bureau of Remediation and Redevelopment does problem-assessment and at-risk monitoring at state Environmental Repair Fund sites, abandoned facilities, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA - superfund), LUST, and spill sites. The bureau currently tracks:

- More than 17,800 LUST sites.
- 4,000 waste disposal facilities.
- 1,400 high priority Environmental Repair sites.

Many of these sites act as sources of VOCs.

1. Landfills

Wisconsin has 90 active, licensed solid waste landfills. All are required to monitor groundwater. Two studies conducted over a four-year period on 51 industrial and municipal landfills revealed the following:

- 27 of 45 (60%) unlined landfills had VOC contaminated groundwater;
- VOCs were not detected at 6 landfills with liner and leachate collection systems;
- VOC contaminated groundwater was detected at 21 (81%) of the 26 unlined municipal solid waste landfills;
- 20 different VOCs were detected overall;
- 1,1-Dichloroethane was the most commonly detected VOC.

Two DNR publications: "Volatile Organic Compounds in Groundwater and Leachate at Wisconsin Landfills (1988)", and "VOC Contamination at Selected Landfills - Sampling Results and Policy Implications (1989)", further describe the research results. In a follow-up VOC study conducted from 1992 to1994, the department reviewed historical data and sampled groundwater at 11 closed, unlined landfills and at six older, lined landfills. VOC levels decreased following closure at all but two of the unlined landfills, though at many sites VOC levels stabilized and remained high. No VOC contamination was attributable to leachate migration at any of the six older, lined landfills.

Over the past few years, increasing numbers of residential developments have been located close to old, closed landfills. Several of these landfills are impacting groundwater. In 1998 and 1999, DHFS sampled private wells downgradient of 19 small, closed landfills in one county. Several of the private wells had results above maximum contaminant levels. This research showed that there might be many 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 studying 16 old, closed landfills from five regions across the state. Private wells around each of the landfills were sampled and significant levels of contamination were found. Of the 113 wells that were sampled, 31 had detects of VOCs. Fourteen homes had levels exceeding drinking water standards and were given health advisories not to drink their water.

2. Storage Tanks

Wisconsin requires underground storage tanks with a capacity of 60 gallons or greater to be registered with the Department of Commerce. This registration program has

identified:

- 173,552 tanks as of June 28, 2000;
- 78,011 tanks regulated by the Federal underground storage tank program;
- 13,544 regulated tanks currently in use.

A federally regulated tank is any tank is over 110 gallons in size that 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 June 1, 2000, DNR records indicate:

- 6,900 active underground storage tank contamination cleanups;
- 10,900 inactive sites;
- the most commonly found contaminants are benzene, toluene, ethyl benzene, and xylene (BTEX compounds);
- More than 5,000 LUST sites have BTEX groundwater standard exceedances;
- Wells at more than 300 households have been contaminated by leaks from underground storage tanks.

3. Hazardous Waste

Hazardous waste treatment storage and disposal facilities and generators improperly managing hazardous waste are additional sources of VOC contamination. The DNR's Bureau for Remediation and Redevelopment is investigating or remediating contamination at 27 sites. Approximately 140 sites statewide are subject to corrective action authorities.. Groundwater monitoring is performed when necessary to delineate the extent of contamination.

The following are summary statistics on spills in Wisconsin:

- Approximately 1000 discharges are reported annually;
- Approximately 65% of the 1000 discharges are petroleum related;
- Another 15% of the 1000 discharges are agrichemicals.

B. Pesticides

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

1. DATCP Studies

The following are DATCP pesticide related studies conducted within the last two years, or as part of ongoing research.

a. 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 had been prohibited since 1993. DATCP is gathering data to see if renewed atrazine use will cause groundwater contamination. DATCP is monitoring groundwater quarterly under 17 fields, 10-40 acres in size, for 5 years. Growers choose the tillage and pesticide application methods best suited for their operations. Fourteen of the sites currently have two years of data. Of these, eight show a statistically significant upward trend in atrazine levels. The atrazine enforcement standard was exceeded at least one time in 9 of the sites. The nitrate enforcement standard has been exceeded at all of the sites.

b. 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 (sandy soils, less than 25 ft. to groundwater) to moderately susceptible (loamy soils, 15 to 50 ft. to groundwater) sites. As many as 50 different field sites have been sampled. Currently 25 sites are being monitored across the state.

   In 1999, DATCP collected 32 groundwater samples from monitoring wells near 24 agricultural fields and analyzed them for pesticides. The table below summarizes data from 1992 to 1999.

   In 1999, a total of thirteen compounds were detected in groundwater. Four of these compounds (atrazine, alachlor, metribuzin and nitrate) were found at levels above an ES. Alachlor ESA, a break down product of alachlor, was detected in

40 percent of the samples. Cyanazine amide, a metabolite of cyanazine first detected in 1997, was found in 12 percent of the samples in 1999.

Year	Sites	Wells	Samples
1992	40	120	400
1993	30	100	300
1994	30	99	265
1995	30	99	132
1996	30	99	50
1997	30	99	50
1998	26	83	79
1999	26	83	32

c. Atrazine Rule Evaluation Survey - In 1994 and 1996 DATCP conducted surveys to evaluate the restrictions on the use of atrazine in Wisconsin. The original survey was designed to determine how levels of atrazine and its metabolites in groundwater were changing three and five years after the atrazine rule went into effect. A similar survey began in 2000 and will be completed in early 2001. The 2001 results will be statistically comparable to the first two surveys. A total of seven common herbicides, ten degradates and nitrate will be analyzed. Results to date show:

- A significant decline in atrazine concentrations between 1994 and 1996;
- Average atrazine plus metabolite concentration in wells with detections declined from 0.96 to 0.54 parts per billion (ppb) in the two year period, a 44% decrease;
- The total percent of contaminated wells did not show a significant decline.

d. Chloroacetanilide Herbicide Metabolites 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.

e. Other Sampling Efforts - DATCP continues to collect groundwater samples from private wells associated with pesticide investigations. Most of these investigations are initiated based on an exceedance of a pesticide ES in groundwater. These data help DATCP identify probable sources of pesticides in groundwater, provide background water quality information, and assist in the development of regulatory actions such as Atrazine Rule amendments.

A significant problem was identified during two surveys of groundwater quality at pesticide storage and handling facilities. The Agricultural Chemical Cleanup Program (ACCP), administered by DATCP, was created primarily to address point source contamination at these facilities and in nearby wells. Point source contamination on farms is also handled by the ACCP. To date, approximately 300 cases involving soil or groundwater remediation related to spills, misuse, improper storage and other point sources have been identified at facilities and farms. Monitoring groundwater from adjacent private wells and/or installation of monitoring wells is often associated with these cases. ACCP funds are used to reimburse responsible parties for private well sampling and analysis, as well as installation of monitoring wells around contamination sites.

2. Triazine Screen Sampling

In 1991, the Wisconsin State Laboratory of Hygiene (SLOH) began a public testing program using an immunoassay screening test for triazine-based compounds. The triazine immunoassay screen uses specific antibodies designed to selectively bind to target compounds that are present at low concentrations. This screening test is available to the public via an 800 telephone number and an analysis fee. DNR funds a part time staff position to assist in the quality control process for data collection and well location verification.

DNR groundwater databases contain more than 14,000 triazine screen results:

- 42% of the samples had a detection for a triazine based compound;
- 13% exceeded the PAL for atrazine of 0.3 ppb;
- 1.6% exceeded the ES for atrazine of 3.0 ppb.

Figure 2 shows the distribution of triazine screen detections from drinking water supply wells (public and private).

Figure 2. Triazine Screen Detects in Wisconsin

Currently the immunoassay triazine analysis detects atrazine and eleven other compounds, but does not detect two of the three atrazine metabolites included in the groundwater standard. While there is no ES for the triazine screen, comparing the triazine results to the ES and PAL for atrazine provides a reference for possible contamination. Atrazine has been so heavily used in Wisconsin that there have been relatively few detects of other triazine-based compounds in groundwater.

In 1993, DATCP completed a study, in cooperation with CIBA-GEIGY, where split samples were analyzed using both the triazine screen and gas chromatography. Results confirmed low triazine detects (i.e. the triazine screen was not producing false positives) and that the triazine screen overestimates parent atrazine and underestimates total chlorinated residues.

In 1997, DATCP further investigated differences between the triazine screen and gas chromatography results. DATCP, with support from DNR, collected 49 split samples for analysis by the SLOH and DATCP laboratories. Results of this study showed that 33% of the wells that were below the 3 ppb ES for atrazine based on a triazine screen were above the ES level when analyzed by gas chromatography. As a result, the SLOH now advises homeowners that the triazine screen results should be taken with caution and used for initial screening purposes only.

C. Nitrate

Nitrate-nitrogen is the most commonly found groundwater contaminant in Wisconsin and exceeds 10 mg/L in approximately 10% of the state's wells. Nitrate can induce a condition in babies known as methemoglobinemia or "blue baby syndrome," in which red blood cell hemoglobin is unable to carry oxygen to the body's tissues. All infants are at risk, but those suffering gastrointestinal illness appear to be more sensitive than healthy infants.

Nitrate enters groundwater from many sources, including nitrogen-based fertilizers, animal waste storage and feedlots, municipal and industrial wastewater and sludge disposal, refuse disposal areas, and private septic systems. Nitrate ES exceedance rates vary widely across the state, with the heavy agricultural areas accounting for most exceedances. Up to 50% of rural wells in specific agricultural areas of southern Wisconsin exceed the ES. Most of the differences across the state can be attributed to variations in nitrogen loading, differences in

soil type, geology, and depth to groundwater.

A 1993 study conducted by the U.S. Centers for Disease Control (CDC) and a follow-up study by the WGNHS and the DHFS titled “Wisconsin Private Well Water Quality Data Summary Report,” show that from 6.5% to 14% of the state's domestic wells exceed the nitrate ES of 10 mg/L. However, these numbers vary widely by county and database. Roughly 80,000 of Wisconsin's 800,000 private drinking water supply wells are expected to exceed the ES of 10 mg/L for nitrate. Figure 3 shows nitrate detections for public and private wells with concentrations at or above the PAL of 2 mg/L.

Figure 3. Drinking Water Supply Wells with Nitrate >= 2 mg/L

A joint pamphlet developed by DHFS and DNR, titled “Nitrate in Drinking Water,” recommends that all newly constructed private wells, and wells that have not been tested during the past 5 years, be tested for nitrate. Testing is also recommended for wells used by pregnant women and infants less than six months old.

In 1997, DHFS and the UW Dept. of Preventive Medicine studied the economic and health impacts of nitrate-contaminated groundwater. 1500 surveys were sent to families whose wells had been tested for nitrate during 1994-1996. Families were grouped into two categories: low exposure (nitrate-N levels < 2 mg/L) and high exposure (>12.9 mg/L). 562 surveys were completed and returned for analysis. Study results showed:

- Families with nitrate contaminated wells were slightly older in age, had lower household incomes, were more likely to live on a farm, and had lived in their homes longer than families in the low exposure group.

- Few in the high exposure group took action to reduce their exposure to nitrate. Of those who took action, most purchased bottled water for use by an infant or pregnant woman.

- Residents of homes with nitrate contaminated water supplies reported a higher incidence of thyroid disorders, arthritis, and fibromyalgia than others.

- Health differences were not statistically significant after adjusting for the residents’ ages.

- Compliance with the drinking water advisory for pregnant women was very high.

There were two recent cases from southern Wisconsin where infants showed symptoms of methemoglobinemia, including one who required hospitalization. DHFS staff summarized these cases in a report published in the July 2000 issue of Environmental Health Perspectives (Knobeloch, L., B. Salna, A. Hogan, J. Postle and

H. Anderson. Blue babies and nitrate-contaminated well water. *Environmental Health Perspectives*, vol. 108, no. 7, July 2000). Many health issues and other information related to nitrate in groundwater are discussed in a publication titled "Nitrate in Wisconsin Groundwater: Sources and Concerns," available from Extension Publications at the UW-Madison.

D. Arsenic

Arsenic, a naturally occurring element, is becoming an issue of increasing concern in Wisconsin groundwater. Exposure can occur through three main pathways. It may be ingested through food or water consumption, absorbed through contact with the skin, or inhaled through the air. Depending on the exposure pathway and concentration, high arsenic levels can cause a variety of symptoms including nausea, diarrhea, vomiting, headaches, delirium, muscle spasms, numbness and tingling in the arms and legs, thickening and discoloration of the skin, decreased production of blood cells, abnormal heart rhythm, blood vessel damage, and in extreme cases, death. Long term ingestion of contaminated water has been found to increase the risk of skin cancer and increase tumors of the kidney, bladder, liver and lungs. The current PAL and ES are 5 μg/L and 50 μg/L, respectively.

Elevated arsenic concentrations were first detected in northeastern Wisconsin in 1987. In 1992 and 1993, DNR staff sampled 1943 private wells throughout northeastern Wisconsin, primarily in Winnebago and Outagamie counties. Arsenic levels of 5 μg/L or greater were found in 622 of the 1943 wells. Sixty-eight of the wells (3.5%) exceeded the ES.

Several recent studies have focused on sampling for arsenic. In 1994, the CDC Study added arsenic sampling as a component in the Northeast District (now Region). Staff sampled 113 private water supply wells for arsenic. Arsenic was detected in 75 wells, and 11 wells were greater than 5 μg/L. None exceeded the ES of 50 μg/L.

In 1994, staff from the Southern District office sampled 119 private water supply wells. Results indicated that 51 wells (43%) had an arsenic detection between 1 and 5 μg/L. Five (4%) had detects between 5 and 10 μg/L. Seven (6%) had detects between 10 and 20 μg/L, and 4 (3%) had detects above 20 μg/L. The four highest detects were found in four different counties (Columbia, Dodge, Fond du Lac, and Jefferson.)

Figure 4 illustrates the statewide distribution of drinking water wells (both public and private) that have had arsenic concentrations that exceeded 5.0 µg/L at least once during routine sampling. Note that while arsenic detections are clustered in the Fox River Valley, arsenic has been found in other areas of the state as well.

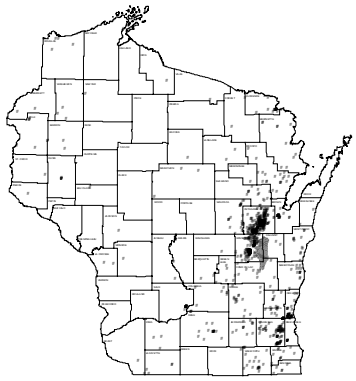

Figure 4. Drinking Water Wells Tested with Arsenic Levels > 5.0 µg/L

In addition to past DG staff sampling programs, two projects were funded in recent years through the GCC Joint Solicitation process, titled "A Study of Well Construction Guidance for Arsenic Contamination in Northeast Wisconsin" and "Stratigraphic Controls on the Mobilization and Transport of Naturally Occurring Arsenic in Groundwater: Implication for Wellhead Protection in Northeastern Wisconsin." These studies concluded that the primary source of arsenic is a mineralized zone at the top of the St. Peter Sandstone at the geologic contact within the overlying Sinnipee Dolomite. As a result of these studies a special well construction casing guidance was issued for an area within 5 miles of the St. Peter subcrop in Winnebago and Outagamie counties, known as the Arsenic Advisory Area (AAA).

Ongoing research indicates that casing off the upper parts of the St. Peter Sandstone is usually effective in eliminating or reducing the presence of arsenic in drinking water. DNR guidance recommends the installation of 80 feet of casing through the sandstone contact for drinking water wells in the AAA. However, over the last several years some wells that were not constructed according to guidance have exhibited increasing arsenic concentrations and have required replacement or reconstruction. In addition, follow-up testing on 50 replacement wells found that arsenic levels are exceeding standards in at least 5 cases where initially they had been below the ES. Additional sampling of replacement wells will occur over the next 2 fiscal years to test whether current guidelines are adequate at lowering arsenic concentrations.

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. 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.

In May 2000, EPA proposed lowering the Federal drinking water standard for arsenic from 50 µg/L to 5 µg/L. This proposed revision is under review, but will likely take effect in FY 01. A sampling effort of 3,300 public water supply systems (Municipal, Other than Municipal, and Non-transient Non-community wells) was undertaken in the summer of 2000. Out of 2784 samples, only 2 had arsenic levels above the current ES of 50 µg/L, while 185 (6.6%) had levels that exceeded 5 µg/L. Historical data indicates that 11% of Wisconsin's public supply wells have exceeded 5 µg/L at least once. Thus the proposed standard could have a significant impact on the ability of many public water supply systems to comply with Federal Safe Drinking Water Act standards.

The proposed 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). In FY 01, the DHFS received funding to conduct a follow-up investigation on the relationship between exposure to inorganic arsenic in water and health outcomes. As part of this research effort, local health departments, DNR staff, town clerks and others have conducted well sampling campaigns in 3 townships in the affected counties. Several other towns have offered similar well testing programs. Over 550 households have submitted samples and returned health surveys, providing health and exposure information for about 1600 individuals. Historical data indicates that 37% of the wells in the 4-county area affected by arsenic exceed the 5 µg/L standard. In two of the townships, almost 50% of the samples tested in the current campaign exceed 5 µg/L.

Including the two studies mentioned above, a total of five GCC-funded projects will address issues related to arsenic in FY 01. Additional studies include an analysis of the geologic and geochemical controls on arsenic in groundwater and two studies related to analytical methods for detection and remediation of arsenic compounds. These studies will help provide needed information about the occurrence, health risks, and treatment of arsenic in drinking water supplies.

E. 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 south eastern parts of the state. Nearly 90 public water systems either exceed or are nearing the drinking water standard of 15 pCi/l for gross alpha activity.

Two studies have been initiated to address concerns about radioactive compounds in groundwater. The first titled "Identification and Quantitation of Alpha Emitting Radiochemicals in Drinking Water", began in FY 2000. Staff will collect samples from about 100 community and nontransient noncommunity public water wells. Each sample

will be analyzed for several alpha emitting radiochemicals in an attempt to identify and quantify the relative contribution of each chemical to the total gross alpha activity in the samples. SLOH will analyze for total Uranium (U-238, U-234, U-235) alpha activity, total Thorium (Th-228, Th-230, Th-232) alpha activity, Radium 226, and Polonium 210 alpha activities. 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.

A second study is looking at radon in drinking water supplies. Staff from the DNR will sample about 340 noncommunity, nontransient and other than municipal water systems per year. Project results will help determine the impact of expected new EPA standards for radon in drinking water. 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.

F. Biological Hazards

The DNR is aware of several areas in Wisconsin where biological contamination of the aquifer is common. Biological 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. Biological agents include bacteria, viruses, and parasites. These agents can cause acute illness, which could result in serious illness or death for some groups of people.

Results from 537 wells tested statewide in a 1993 CDC Private Well Water Quality Survey indicated that 23.3% of the wells tested positive for total coliform bacteria, an indicator species of possible fecal contamination. 2.4% of the wells tested positive for *E. coli* bacteria .

In an effort to address concerns arising from possible airborne bacteriological contamination of wells, the Private Drinking Water Supply program initiated a study in 1998 with the SLOH titled “A Study of the Role of Air-borne Particulates as the Cause of Unexplained Coliform Contamination in Drilled Wells.” 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.

Mark Borchardt, of the Marshfield Medical 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 a series of studies from 1997-2000. 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 (origin), which was likely caused by calciviruses. Preliminary results indicate that the incidence of virus contamination in private wells is similar to or lower than that of community wells.

VII. GROUNDWATER DATA

The Department's groundwater data systems receive thousands of samples each year. The tables that follow provide an example of the substances tested for and data stored in various department databases and retrievable through the Groundwater Retrieval Network (GRN): **http://oraweb.dnr.state.wi.us/inter1/plsql/grn$.startup**. The data originates from the SLOH or other outside laboratories and is entered into one of three Department program database systems: the Groundwater and Environmental Monitoring System (GEMS), the Public Water Supply System, and the Private Water Supply/Groundwater Section System. Data from other DNR systems or program databases are not included in these summary tables.

Table 1 lists groundwater sampling data available from GRN for January to December 1999. Parameters are listed only if detected in at least one well. Rows are sorted alphabetically by parameter description.

Table 2 lists similar information for substances that have ESs and PALs only. Rows are sorted by number of wells that exceed the ES.

TABLE 1: Groundwater Sampling Data from January - December 1999 - Detects

Storet Code	Parameter Description	Total Wells Sampled	Wells With Detects	Enforcement Standard (ES)	Preventive Action Limit (PAL)	Units	# Wells Exceeding ES	# Wells Exceeding PAL
39730	2,4-D	765	6	NONE	NONE	UG/L		
34205	ACENAPHTHENE	281	3	NONE	NONE	UG/L		
81552	ACETONE	1125	80	1000	200		8	9
81553	ACETOPHENONE	17	1	NONE	NONE	UG/L		
46317	ALACHLOR	771	4	2	0.2	UG/L	0	4
39330	ALDRIN	91	2	NONE	NONE	UG/L		
410	ALKALILITY TOTAL CACO3	1896	1859	NONE	NONE	MG/L		
425	ALKALINITY BICARBONATE AS CACO3	33	15	NONE	NONE	MG/L		
430	ALKALINITY CARBONATE AS CACO3	73	58	NONE	NONE	MG/L		
39036	ALKALINITY DISS	3313	3279	NONE	NONE			
39337	ALPHA BHC	112	26	NONE	NONE			
34361	ALPHA ENDOSULFAN	120	8	NONE	NONE			
39348	ALPHA-CHLORDANE	326	7	NONE	NONE	UG/L		
1105	ALUMINUM DIG ICP	1180	259	NONE	NONE	UG/L		
1106	ALUMINUM DISS	65	37	NONE	NONE	UG/L		
34220	ANTHRACENE	281	1	3000	600	UG/L	0	0
1097	ANTIMONY AA FURNACE	1302	46	6	1.2	UG/L	3	5
1095	ANTIMONY DISS AA FURN LOW LVL	133	13	6	1.2	UG/L	5	13
70	AROMATICS, HYDROXYLATED (MG/L)	1	1	NONE	NONE	MG/L		
1000	ARSENIC DISS	833	274	50	5	UG/L	9	164
1002	ARSENIC ICP	1469	381	50	5		11	57
978	ARSENIC ICP-MS TOTAL RECOVERABL	2	2	50	5	UG/L	1	2
34225	ASBESTOS	7	1	7	0.7		0	0
30	ASH, TOTAL (MG/L)	2	2	NONE	NONE	MG/L		
39033	ATRAZINE	780	51	3	0.3	UG/L	0	15
31855	BACTERIA SULFATE REDUCING	4	1	NONE	NONE	#/ML		
47006	BACTERIA TOTAL PLATE CNT	1	1	NONE	NONE	#/ML		
1005	BARIUM DISS	693	677	2	0.4	UG/L	676	677
1007	BARIUM ICP	1377	1312	2	0.4		332	342
1009	BARIUM ICP TOTAL RECOVERABLE	2	2	2	0.4	UG/L	2	2
34030	BENZENE	3200	273	5	0.5	UG/L	37	192
78124	BENZENE IN WATER (UG/L)	1052	171	5	0.5	UG/L	47	124
39120	BENZIDINE	190	1	NONE	NONE	UG/L		
34526	BENZO (A) ANTHRACENE	281	1	NONE	NONE	UG/L		
34247	BENZO (A) PYRENE	543	3	0.2	0.02	UG/L	3	3
34242	BENZO (K) FLUORANTHENE	281	1	NONE	NONE	UG/L		
77247	BENZOIC ACID	155	7	NONE	NONE	UG/L		
77147	BENZYL ALCOHOL	160	1	NONE	NONE	UG/L		
1012	BERYLLIUM DIG ICP	1289	116	4	0.4	UG/L	3	11
1010	BERYLLIUM DISS	102	28	4	0.4		0	14
39338	BETA BHC	110	31	NONE	NONE			
34356	BETA ENDOSULFAN	111	10	NONE	NONE			
39340	BHC GAMMA (LINDANE)	838	2	0.2	0.02	UG/L	0	1
39341	BHC GAMMA (LINDANE) - DISSOLVED	23	11	0.2	0.02	UG/L	6	10
34273	BIS (2-CHLOROETHYL) ETHER	254	2	NONE	NONE			
39100	BIS (2-ETHYLHEXYL) PHTHALATE	272	126	6	0.6	UG/L	61	126
310	BOD 5 DAY	11	8	NONE	NONE	MG/L		
1022	BORON DIG ICP	84	57	960	190	UG/L	0	0
1020	BORON DISS ICP	792	708	960	190	UG/L	0	0

Storet Code	Parameter Description	Total Wells Sampled	Wells With Detects	Enforcement Standard (ES)	Preventive Action Limit (PAL)	Units	# Wells Exceeding ES	# Wells Exceeding PAL
82198	BROMACIL	32	15	NONE	NONE	UG/L		
81555	BROMOBENZENE	3094	6	NONE	NONE	UG/L		
77297	BROMOCHLOROMETHANE	2250	2	NONE	NONE	UG/L		
32101	BROMODICHLOROMETHANE	3813	116	0.6	0.06	UG/L	56	115
32104	BROMOFORM	3730	74	4.4	0.44	UG/L	0	43
34413	BROMOMETHANE	3729	23	10	1	UG/L	4	16
34292	BUTYL BENZYL PHTHALATE	254	4	NONE	NONE	UG/L		
77350	BUTYLBENZENE SEC	2231	78	NONE	NONE			
77353	BUTYLBENZENE TERT	2215	30	NONE	NONE			
1027	CADIUM ICP-MS A ELEMENTS	1339	126	5	0.5	UG/L	4	17
1025	CADMIUM ICP-MS DISSOLVED	758	196	5	0.5	UG/L	4	90
46385	CADMIUM TCLP	3	3	NONE	NONE	MG/L		
916	CALCIUM	1277	1275	NONE	NONE	MG/L		
915	CALCIUM DISS	410	409	NONE	NONE	MG/L		
918	CALCIUM ICP TOTAL RECOVERABLE	2	2	NONE	NONE	MG/L		
77000	CARBON DIOXIDE	39	39	NONE	NONE	UG/L		
85544	CARBON DIOXIDE GAS	31	31	NONE	NONE	%		
77041	CARBON DISULFIDE	1019	94	1000	200	UG/L	24	25
32102	CARBON TETRACHLORIDE	4075	75	5	0.5	UG/L	27	64
81957	CARBON TOT ORGANIC(TOC)-WATER	2	2	NONE	NONE	MG/L		
680	CARBON TOTAL ORGANIC	46	46	NONE	NONE	MG/L		
39810	CHLORDANE GAMMA	326	7	NONE	NONE	UG/L		
940	CHLORIDE	4797	4348	250	125	MG/L	204	422
941	CHLORIDE DISS	816	665	250	125	MG/L	36	75
34301	CHLOROBENZENE	4055	176	100	20	UG/L	2	6
34311	CHLOROETHANE	3821	241	400	80	UG/L	10	20
34576	2-CHLOROETHYL VINYL ETHER	562	1	NONE	NONE	UG/L		
32106	CHLOROFORM	3822	267	6	0.6	UG/L	10	137
34418	CHLOROMETHANE	3832	256	3	0.3	UG/L	51	174
34452	4-CHLORO-3-METHYLPHENOL	272	2	NONE	NONE	UG/L		
1034	CHROMIUM AA FURN COMPLEX MATRIX	1380	450	100	10	UG/L	3	21
1030	CHROMIUM DISS	725	409	100	10	UG/L	0	19
34320	CHRYSENE	281	3	0.2	0.02	UG/L	3	3
1035	COBALT DISS	105	75	NONE	NONE	UG/L		
1037	COBALT ICP	43	31	40	8		6	15
341	COD DISS	3429	2910	NONE	NONE	MG/L		
340	COD HI LEVEL	735	508	NONE	NONE	MG/L		
99060	COLIFORM TOTAL COLILERT	919	88	0	0	#/100 ML	88	88
80	COLOR	10	3	15	7.5	CATCH-ALL	1	1
94	CONDUCTIVITY - FIELD	4510	4504	NONE	NONE	CATCH-ALL		
95	CONDUCTIVITY AT 25C	264	256	NONE	NONE	CATCH-ALL		
1040	COPPER DISS	335	164	1300	130	UG/L	0	2
1042	COPPER ICP-MS A ELEMENTS	114	90	1300	130	UG/L	1	8
38695	CRENOTHRIX	34	15	NONE	NONE	#/ML		
45058	CRESOL	27	8	NONE	NONE	UG/L		
77151	CRESOL M	14	5	NONE	NONE	UG/L		
77152	CRESOL O	258	9	NONE	NONE	UG/L		
77146	CRESOL P	240	8	NONE	NONE	UG/L		
77780	CYANAZINE	34	11	1	0.1	UG/L	0	7
720	CYANIDE	213	23	200	40	MG/L	0	0
723	CYANIDE DISS	6	1	200	40	UG/L	0	0
38432	DALAPON	753	4	NONE	NONE	UG/L		

Storet Code	Parameter Description	Total Wells Sampled	Wells With Detects	Enforcement Standard (ES)	Preventive Action Limit (PAL)	Units	# Wells Exceeding ES	# Wells Exceeding PAL
39360	DDD WHL SMPL	86	6	NONE	NONE	UG/L		
39370	DDT WHL SMPL	86	6	70	7	UG/L	2	2
46373	DEETHYLATRAZINE	34	15	3	0.3	UG/L	0	4
46374	DEISOPROPYLATRAZINE	34	14	3	0.3	UG/L	0	7
4442	DIAMINOATRAZINE	6	5	NONE	NONE	UG/L		
39570	DIAZINON	20	9	NONE	NONE	UG/L		
32105	DIBROMOCHLOROMETHANE	2625	90	60	6	UG/L	0	0
34306	DIBROMOCHLOROMETHANE IN WHOLE WATER SAMPLE (UG/L)	1334	3	60	6	UG/L	0	0
38437	1,2-DIBROMO-3-CHLOROPROPANE	2826	1	0.2	0.02	UG/L	0	0
77596	DIBROMOMETHANE	3290	1	NONE	NONE	UG/L		
82052	DICAMBA	541	1	300	60	UG/L	0	0
34536	1,2-DICHLOROBENZENE	4022	96	600	60	UG/L	0	1
34566	1,3-DICHLOROBENZENE	3787	22	1250	125	UG/L	0	0
34571	1,4-DICHLOROBENZENE	4022	247	75	15	UG/L	0	7
34668	DICHLORODIFLUOROMETHANE	2643	368	1000	200	UG/L	0	0
34496	1,1-DICHLOROETHANE	3844	522	850	85	UG/L	9	31
34531	1,2-DICHLOROETHANE	1305	14	5	0.5	UG/L	0	2
32103	1,2-DICHLOROETHANE IN WHOLE WATER SAMPLE (UG/L)	2761	101	5	0.5	UG/L	15	71
45617	1,2-DICHLOROETHENE	20	20	NONE	NONE	UG/L		
34501	1,1-DICHLOROETHYLENE	4048	106	7	0.7	UG/L	29	80
34546	1,2-DICHLOROETHYLENE	3981	112	100	20	UG/L	1	4
77093	1,2-DICHLOROETHYLENE CIS	3974	540	70	7		54	159
34423	DICHLOROMETHANE	4033	657	5	0.5	UG/L	61	477
34601	2,4-DICHLOROPHENOL	267	1	NONE	NONE	UG/L		
34541	1,2-DICHLOROPROPANE	4009	146	5	0.5		5	85
77173	1,3-DICHLOROPROPANE	3085	2	NONE	NONE	UG/L		
77170	2,2-DICHLOROPROPANE	3095	2	NONE	NONE	UG/L		
77168	1,1-DICHLOROPROPENE	2994	1	NONE	NONE	UG/L		
77161	1,2-DICHLOROPROPENE TRANS	27	1	NONE	NONE	UG/L		
34699	1,3-DICHLOROPROPENE-TRANS	2946	2	0.2	0.02	UG/L	0	1
39380	DIELDRIN	651	9	NONE	NONE	UG/L		
4585	DIESEL RANGE ORGANICS WATER	3	3	NONE	NONE	UG/L		
34336	DIETHYL PHTHALATE	254	79	NONE	NONE	UG/L		
81577	DIISOPROPYL ETHER	1143	14	NONE	NONE	UG/L		
99121	DIMETHENAMID	17	1	NONE	NONE	UG/L		
34606	2,4-DIMETHYLPHENOL	272	18	NONE	NONE	UG/L		
34341	DIMETHYL PHTHALATE	257	2	NONE	NONE	UG/L		
39110	DI-N-BUTYL PHTHALATE	254	68	100	20	UG/L	0	0
34596	DI-N-OCTYL PHTHALATE	255	3	NONE	NONE			
77624	2,3-DINITROTOLUENE	98	15	NONE	NONE	UG/L		
34611	2,4-DINITROTOLUENE	232	17	0.05	0.005	UG/L	9	17
34626	2,6-DINITROTOLUENE	232	26	0.05	0.005	UG/L	12	26
82388	1,4-DIOXANE	9	1	NONE	NONE	MG/L		
300	DISSOLVED OXYGEN	1	1	NONE	NONE	MG/L		
299	DISSOLVED OXYGEN PROBE	216	214	NONE	NONE	MG/L		
70295	DISSOLVED SOLIDS TOTAL	421	420	NONE	NONE	MG/L		
81888	DISYSTON (DISULFOTON)	36	9	NONE	NONE	UG/L		
39356	DUAL	562	5	15	1.5	UG/L	0	2
99069	E COLI MUG (COLILERT)	88	6	NONE	NONE	#/100 ML		
39390	ENDRIN	861	2	2	0.4	UG/L	0	1
81894	EPTAM (ERADICANE)	17	11	250	50	UG/L	0	0
82045	ETHANE	81	66	NONE	NONE	UG/L		
82044	ETHENE	81	80	NONE	NONE	UG/L		
34371	ETHYLBENZENE	1305	12	700	140	UG/L	0	0

Storet Code	Parameter Description	Total Wells Sampled	Wells With Detects	Enforcement Standard (ES)	Preventive Action Limit (PAL)	Units	# Wells Exceeding ES	# Wells Exceeding PAL
78113	ETHYLBENZENE IN WHOLE WATER SAMPLE (UG/L)	2773	212	700	140	UG/L	15	23
77651	ETHYLENE DIBROMIDE	2825	3	0.05	0.005		2	2
38467	FENURON	32	13	NONE	NONE	UG/L		
34376	FLUORANTHENE	281	1	NONE	NONE	UG/L		
34381	FLUORENE	281	3	400	80	UG/L	0	1
951	FLUORIDE	1579	1407	4	0.8	MG/L	7	205
950	FLUORIDE DISS	561	497	4	0.8	MG/L	1	55
99951	FLUORIDE TOTAL OPERATOR VALUE	27	24	NONE	NONE	MG/L		
38694	GALLIONELLA	34	2	NONE	NONE	#/ML		
899	HARDNESS CALC METHOD TOTAL REC	2	2	NONE	NONE	UG/L		
46570	HARDNESS CALCIUM CACO3	7	7	NONE	NONE	MG/L		
900	HARDNESS CALCULATION METHOD	1794	1784	NONE	NONE			
22413	HARDNESS TOTAL DISS	3537	3536	NONE	NONE	MG/L		
39410	HEPTACHLOR	861	9	0.4	0.04	UG/L	2	5
39420	HEPTACHLOR EPOXIDE	861	2	0.2	0.02	UG/L	0	1
34391	HEXACHLOROBUTADIENE	2441	14	NONE	NONE	UG/L		
34386	HEXACHLOROCYCLOPENTADIENE	1004	1	NONE	NONE	UG/L		
77103	2-HEXANONE	405	1	NONE	NONE			
1045	IRON	241	169	0.3	0.15	MG/L	56	89
74010	IRON	1249	1010	0.3	0.15	MG/L	451	596
1046	IRON DISS	2582	1832	0.3	0.15	UG/L	929	1069
980	IRON ICP TOTAL RECOVERABLE	5	5	0.3	0.15	MG/L	5	5
34408	ISOPHORONE	255	5	NONE	NONE	UG/L		
77223	ISOPROPYLBENZENE	2234	157	NONE	NONE	UG/L		
1052	LEAD AA FURNACE	1	1	NONE	NONE			
1051	LEAD AA FURNACE COMPLEX MATRIX	193	120	15	1.5	UG/L	22	83
1049	LEAD DISS	726	133	15	1.5	UG/L	7	80
1114	LEAD ICP-MS TOTAL RECOVERABLE	3	2	15	1.5	UG/L	0	1
38692	LEPTOTHRIX	34	11	NONE	NONE	#/ML		
567	LUBRICATING OIL	1	1	NONE	NONE	UG/L		
85795	M/P-XYLENE	2009	158	10000	1000	UG/L	0	6
927	MAGNESIUM	1229	1226	NONE	NONE	MG/L		
925	MAGNESIUM DISS	414	413	NONE	NONE	MG/L		
921	MAGNESIUM ICP TOTAL RECOVERABLE	2	2	0.05	0.025	MG/L	2	2
39530	MALATHION	20	5	NONE	NONE	UG/L		
1055	MANGANESE	1266	954	0.05	0.025	UG/L	426	558
1056	MANGANESE DISS	984	818	0.05	0.025	UG/L	812	812
1123	MANGANESE TOTAL RECOVERABLE ICP	1	1	NONE	NONE	UG/L		
71900	MERCURY AA COLD VAPOR	1322	111	2	0.2	UG/L	0	11
71890	MERCURY DISS	423	52	2	0.2	UG/L	9	20
76994	METHANE	81	79	NONE	NONE	UG/L		
85548	METHANE (CH4) IN AIR SAMPLE, % OF LEL OF METHANE	1	1	NONE	NONE	%LEL OFCH4		
85547	METHANE GAS	37	35	NONE	NONE	%		
39480	METHOXYCHLOR	861	8	40	4	UG/L	2	2
81595	METHYL ETHYL KETONE	1135	26	460	90	UG/L	8	9
78133	METHYL ISOBUTYL KETONE	526	7	500	50	UG/L	2	4
77418	1-METHYLNAPHTHALENE	4	1	NONE	NONE	UG/L		
77416	2-METHYLNAPHTHALENE	280	13	NONE	NONE	UG/L		
78032	METHYL TERT BUTYL ETHER	2163	49	60	12	UG/L	0	0

Storet Code	Parameter Description	Total Wells Sampled	Wells With Detects	Enforcement Standard (ES)	Preventive Action Limit (PAL)	Units	# Wells Exceeding ES	# Wells Exceeding PAL
79662	METHYLENE CHLORIDE	26	6	NONE	NONE			
81408	METRIBUZIN	564	4	250	50	UG/L	0	0
1060	MOLYBDENUM DISS	26	26	NONE	NONE	UG/L		
1062	MOLYBDENUM ICP DIG	5	2	NONE	NONE	UG/L		
38511	MONURON	29	17	NONE	NONE	UG/L		
34696	NAPHTHALENE	2985	194	40	8	UG/L	15	34
77342	N-BUTYLBENZENE	2241	67	NONE	NONE			
1065	NICKEL DISS	116	75	100	20	UG/L	6	14
1067	NICKEL ICP	1306	506	100	20		8	18
78142	2-NITROANILINE	254	5	NONE	NONE			
623	NITROGEN KJELDAHL DISS	145	119	NONE	NONE	MG/L		
625	NITROGEN KJELDAHL TOTAL	29	24	NONE	NONE	MG/L		
608	NITROGEN NH3-N DISS	496	275	NONE	NONE	MG/L		
610	NITROGEN NH3-N ISE	88	23	NONE	NONE	MG/L		
613	NITROGEN NO2-N DISS	882	159	1	0.2	MG/L	2	10
615	NITROGEN NO2-N TOTAL	710	169	1	0.2	MG/L	3	5
630	NITROGEN NO3+NO2	7429	4315	10	2	MG/L	229	1924
631	NITROGEN NO3+NO2 DISS	1055	798	10	2	MG/L	40	259
618	NITROGEN NO3-N DISS	2584	1394	10	2	MG/L	83	732
620	NITROGEN NO3-N TOTAL	421	258	10	2	MG/L	11	104
34438	N-NITROSODIMETHYLAMINE	199	1	NONE	NONE	UG/L		
34433	N-NITROSODIPHENYLAMINE	254	2	7	0.7	UG/L	0	2
77224	N-PROPYLBENZENE	2240	87	NONE	NONE			
77275	O-CHLOROTOLUENE	3088	39	NONE	NONE	UG/L		
90	OXIDATION REDUCTION POTENTIAL	314	314	NONE	NONE	%		
85550	OXYGEN GAS	38	38	NONE	NONE	%		
77135	O-XYLENE	1933	132	10000	1000	UG/L	0	4
34671	PCB 1016	75	1	0.03	0.003	UG/L	1	1
77277	P-CHLOROTOLUENE	3088	9	NONE	NONE	UG/L		
39032	PENTACHLOROPHENOL	1037	8	1	0.1	UG/L	4	5
403	PH - DISS	1260	1250	NONE	NONE			
400	PH - FIELD	4402	4398	NONE	NONE	pH		
34461	PHENANTHRENE	281	7	NONE	NONE	UG/L		
34694	PHENOL	272	10	6	1.2	UG/L	4	10
32723	PHENOLICS DISSOLVED	52	34	NONE	NONE			
34043	PHENOLICS TOTAL	67	39	NONE	NONE	CATCH-ALL		
46313	PHORATE (THIMET)	36	4	NONE	NONE	UG/L		
665	PHOSPHORUS TOT EPA METHOD 365.1	33	17	NONE	NONE	MG/L		
39720	PICLORAM	749	1	500	100	UG/L	0	0
77356	P-ISOPROPYLTOLUENE	2234	81	NONE	NONE			
73605	P-NITROANILINE	254	2	NONE	NONE	UG/L		
937	POTASSIUM	29	28	NONE	NONE	MG/L		
935	POTASSIUM DISS	250	242	NONE	NONE	MG/L		
32020	PROPIONIC ACID	1	1	NONE	NONE	MG/L		
34469	PYRENE	281	4	250	50	UG/L	0	1
77045	PYRIDINE	147	10	10	2	UG/L	0	0
11503	RADIUM 226 + 228 TOTAL	16	16	NONE	NONE	PC/L		
9503	RADIUM 226 DISS	16	15	NONE	NONE	PC/L		
11501	RADIUM 228	16	16	NONE	NONE	PC/L		
82303	RADON 222	274	274	NONE	NONE	PC/L		
500	RESIDUE TOTAL	1182	1168	NONE	NONE	MG/L		
1147	SELENIUM AA FURNACE	1330	124	50	10		1	1
1145	SELENIUM DISS	690	144	50	10	UG/L	1	20
1075	SILVER DISS	365	33	50	10	UG/L	0	1
1077	SILVER ICP COMPLEX MATRIX	1037	63	50	10	UG/L	0	0

Storet Code	Parameter Description	Total Wells Sampled	Wells With Detects	Enforcement Standard (ES)	Preventive Action Limit (PAL)	Units	# Wells Exceeding ES	# Wells Exceeding PAL
39055	SIMAZINE	773	3	4	0.4	UG/L	0	0
929	SODIUM	1312	1310	NONE	NONE	MG/L		
930	SODIUM DISS	797	797	NONE	NONE	MG/L		
923	SODIUM ICP TOTAL RECOVERABLE	1	1	NONE	NONE	MG/L		
247	SOLIDS, TOTAL (MG/L)	22	22	NONE	NONE	MG/L		
402	SPECIFIC CONDUCTANCE	243	243	NONE	NONE			
77128	STYRENE	3932	47	100	10	UG/L	1	5
946	SULFATE DISS	2213	2184	250	125	MG/L	231	462
945	SULFATE TOTAL	864	813	250	125	MG/L	47	86
746	SULFIDE DISS	45	29	NONE	NONE	MG/L		
745	SULFIDE TOTAL	24	10	NONE	NONE	MG/L		
150	SUSPENDED SOLIDS TOTAL	24	22	NONE	NONE	PRODUCTION		
45607	TEBUTHIURON	29	18	NONE	NONE	UG/L		
77562	1,1,1,2-TETRACHLOROETHANE	3015	2	70	7	UG/L	0	0
34516	1,1,2,2-TETRACHLOROETHANE	3512	2	0.2	0.02	UG/L	1	1
34475	TETRACHLOROETHYLENE	4069	399	5	0.5	UG/L	78	309
77770	2,3,4,6-TETRACHLOROPHENOL	64	6	NONE	NONE	UG/L		
77769	2,3,5,6-TETRACHLOROPHENOL	26	3	NONE	NONE			
81607	TETRAHYDROFURAN	924	133	50	10	UG/L	26	74
1059	THALLIUM AA FURNACE DIG	1288	61	2	0.4	UG/L	4	36
1057	THALLIUM DISS ICP	110	56	NONE	NONE			
982	THALLIUM TOTAL REC AA FURNACE	2	2	NONE	NONE	UG/L		
99120	THORIUM TOT REC	3	2	NONE	NONE	UG/L		
1100	TIN DISS	12	1	NONE	NONE	UG/L		
34010	TOLUENE	4064	472	1000	200	UG/L	20	26
134	TOTAL DISSOLVED SOLIDS 180 C	9	2	NONE	NONE	MG/L		
46492	TRIAZINE SCREEN	153	67	NONE	NONE	UG/L		
77613	1,2,3-TRICHLOROBENZENE	2230	15	NONE	NONE	UG/L		
34551	1,2,4-TRICHLOROBENZENE	3409	28	70	14	UG/L	0	0
34506	1,1,1-TRICHLOROETHANE	4086	319	200	40	UG/L	16	33
34511	1,1,2-TRICHLOROETHANE	4055	40	5	0.5	UG/L	12	31
39180	TRICHLOROETHYLENE	4064	539	5	0.5	UG/L	149	394
34488	TRICHLOROFLUOROMETHANE	2789	173	3490	698	UG/L	0	0
77687	2,4,5-TRICHLOROPHENOL	272	5	NONE	NONE			
34621	2,4,6-TRICHLOROPHENOL	272	1	NONE	NONE	UG/L		
77443	1,2,3-TRICHLOROPROPANE	3014	1	60	12	UG/L	0	0
81611	TRICHLOROTRIFLUOROETHANE	131	2	NONE	NONE	UG/L		
82080	TRIHALOMETHANES TOTAL	964	179	NONE	NONE	UG/L		
77221	1,2,3-TRIMETHYLBENZENE	27	7	NONE	NONE	UG/L		
77222	1,2,4-TRIMETHYLBENZENE	2245	160	NONE	NONE			
77226	1,3,5-TRIMETHYLBENZENE	2245	111	NONE	NONE			
76	TURBIDITY	6	4	NONE	NONE	CATCH-ALL		
92537	TURBIDITY (JACKSON Turbidity units)	116	116	NONE	NONE	CATCH-ALL		
28012	URANIUM NATURAL	4	3	NONE	NONE	PC/L		
1085	VANADIUM DISS	89	37	NONE	NONE	UG/L		
1087	VANADIUM ICP	28	22	30	6		9	19
39175	VINYL CHLORIDE	4073	326	0.2	0.02	UG/L	313	326
81551	XYLENE TOTAL	1196	89	10000	1000	UG/L	7	17
1090	ZINC DISS	444	321	5	2.5	UG/L	193	255
1092	ZINC EP TOX TEST ICP	1266	536	5	2.5		147	149
1094	ZINC TOT REC	1	1	5	2.5	UG/L	1	1

Table 2: Groundwater Sampling Data from January - December 1999 for substances that have an NR140 Enforcement Standard

Storet Code	Parameter Description	Total Wells Sampled	Wells With Detects	Enforcement Standard (ES)	Preventive Action Limit (PAL)	Units	# Wells Exceeding ES	# Wells Exceeding PAL
1046	IRON DISS	2582	1832	0.3	0.15	UG/L	929	1069
1056	MANGANESE DISS	984	818	0.05	0.025	UG/L	812	812
1005	BARIUM DISS	693	677	2	0.4	UG/L	676	677
74010	IRON	1249	1010	0.3	0.15	MG/L	451	596
1055	MANGANESE	1266	954	0.05	0.025	UG/L	426	558
1007	BARIUM ICP	1377	1312	2	0.4		332	342
39175	VINYL CHLORIDE	4073	326	0.2	0.02	UG/L	313	326
946	SULFATE DISS	2213	2184	250	125	MG/L	231	462
630	NITROGEN NO3+NO2	7429	4315	10	2	MG/L	229	1924
940	CHLORIDE	4797	4348	250	125	MG/L	204	422
1090	ZINC DISS	444	321	5	2.5	UG/L	193	255
39180	TRICHLOROETHYLENE	4064	539	5	0.5	UG/L	149	394
1092	ZINC EP TOX TEST ICP	1266	536	5	2.5		147	149
99060	COLIFORM TOTAL COLILERT	919	88	0	0	#/100 ML	88	88
618	NITROGEN NO3-N DISS	2584	1394	10	2	MG/L	83	732
34475	TETRACHLOROETHYLENE	4069	399	5	0.5	UG/L	78	309
34423	DICHLOROMETHANE	4033	657	5	0.5	UG/L	61	477
39100	BIS (2-ETHYLHEXYL) PHTHALATE	272	126	6	0.6	UG/L	61	126
1045	IRON	241	169	0.3	0.15	MG/L	56	89
32101	BROMODICHLOROMETHANE	3813	116	0.6	0.06	UG/L	56	115
77093	1,2-DICHLOROETHYLENe cis	3974	540	70	7		54	159
34418	CHLOROMETHANE	3832	256	3	0.3	UG/L	51	174
945	SULFATE TOTAL	864	813	250	125	MG/L	47	86
78124	BENZENE IN WATER (UG/L)	1052	171	5	0.5	UG/L	47	124
631	NITROGEN NO3+NO2 DISS	1055	798	10	2	MG/L	40	259
34030	BENZENE	3200	273	5	0.5	UG/L	37	192
941	CHLORIDE DISS	816	665	250	125	MG/L	36	75
34501	1,1-DICHLOROETHYLENE	4048	106	7	0.7	UG/L	29	80
32102	CARBON TETRACHLORIDE	4075	75	5	0.5	UG/L	27	64
81607	TETRAHYDROFURAN	924	133	50	10	UG/L	26	74
77041	CARBON DISULFIDE	1019	94	1000	200	UG/L	24	25
1051	LEAD AA FURNACE COMPLEX MATRIX	193	120	15	1.5	UG/L	22	83
34010	TOLUENE	4064	472	1000	200	UG/L	20	26
34506	1,1,1-TRICHLOROETHANE	4086	319	200	40	UG/L	16	33
78113	ETHYLBENZENE IN WHOLE WATER SAMPLE (UG/L)	2773	212	700	140	UG/L	15	23
34696	NAPHTHALENE	2985	194	40	8	UG/L	15	34
32103	1,2-DICHLOROETHANE IN WHOLE WATER SAMPLE (UG/L)	2761	101	5	0.5	UG/L	15	71
34511	1,1,2-TRICHLOROETHANE	4055	40	5	0.5	UG/L	12	31
34626	2,6-DINITROTOLUENE	232	26	0.05	0.005	UG/L	12	26
1002	ARSENIC ICP	1469	381	50	5		11	57
620	NITROGEN NO3-N TOTAL	421	258	10	2	MG/L	11	104
32106	CHLOROFORM	3822	267	6	0.6	UG/L	10	137
34311	CHLOROETHANE	3821	241	400	80	UG/L	10	20
34496	1,1-DICHLOROETHANE	3844	522	850	85	UG/L	9	31
1000	ARSENIC DISS	833	274	50	5	UG/L	9	164
71890	MERCURY DISS	423	52	2	0.2	UG/L	9	20
1087	VANADIUM ICP	28	22	30	6		9	19
34611	2,4-DINITROTOLUENE	232	17	0.05	0.005	UG/L	9	17
1067	NICKEL ICP	1306	506	100	20		8	18
81552	ACETONE	1125	80	1000	200		8	9

Storet Code	Parameter Description	Total Wells Sampled	Wells With Detects	Enforcement Standard (ES)	Preventive Action Limit (PAL)	Units	# Wells Exceeding ES	# Wells Exceeding PAL
81595	METHYL ETHYL KETONE	1135	26	460	90	UG/L	8	9
951	FLUORIDE	1579	1407	4	0.8	MG/L	7	205
1049	LEAD DISS	726	133	15	1.5	UG/L	7	80
81551	XYLENE TOTAL	1196	89	10000	1000	UG/L	7	17
1065	NICKEL DISS	116	75	100	20	UG/L	6	14
1037	COBALT ICP	43	31	40	8		6	15
39341	BHC GAMMA (LINDANE) - DISSOLVED	23	11	0.2	0.02	UG/L	6	10
34541	1,2-DICHLOROPROPANE	4009	146	5	0.5		5	85
1095	ANTIMONY DISS AA FURN LOW LVL	133	13	6	1.2	UG/L	5	13
980	IRON ICP TOTAL RECOVERABLE	5	5	0.3	0.15	MG/L	5	5
1025	CADMIUM ICP-MS DISSOLVED	758	196	5	0.5	UG/L	4	90
1027	CADIUM ICP-MS A ELEMENTS	1339	126	5	0.5	UG/L	4	17
1059	THALLIUM AA FURNACE DIG	1288	61	2	0.4	UG/L	4	36
34413	BROMOMETHANE	3729	23	10	1	UG/L	4	16
34694	PHENOL	272	10	6	1.2	UG/L	4	10
39032	PENTACHLOROPHENOL	1037	8	1	0.1	UG/L	4	5
1034	CHROMIUM AA FURN COMPLEX MATRIX	1380	450	100	10	UG/L	3	21
615	NITROGEN NO2-N TOTAL	710	169	1	0.2	MG/L	3	5
1012	BERYLLIUM DIG ICP	1289	116	4	0.4	UG/L	3	11
1097	ANTIMONY AA FURNACE	1302	46	6	1.2	UG/L	3	5
34247	BENZO (A) PYRENE	543	3	0.2	0.02	UG/L	3	3
34320	CHRYSENE	281	3	0.2	0.02	UG/L	3	3
34301	CHLOROBENZENE	4055	176	100	20	UG/L	2	6
613	NITROGEN NO2-N DISS	882	159	1	0.2	MG/L	2	10
39410	HEPTACHLOR	861	9	0.4	0.04	UG/L	2	5
39480	METHOXYCHLOR	861	8	40	4	UG/L	2	2
78133	METHYL ISOBUTYL KETONE	526	7	500	50	UG/L	2	4
39370	DDT WHL SMPL	86	6	70	7	UG/L	2	2
77651	ETHYLENE DIBROMIDE	2825	3	0.05	0.005		2	2
921	MAGNESIUM ICP TOTAL RECOVERABLE	2	2	0.05	0.025	MG/L	2	2
1009	BARIUM ICP TOTAL RECOVERABLE	2	2	2	0.4	UG/L	2	2
950	FLUORIDE DISS	561	497	4	0.8	MG/L	1	55
1145	SELENIUM DISS	690	144	50	10	UG/L	1	20
1147	SELENIUM AA FURNACE	1330	124	50	10		1	1
34546	1,2-DICHLOROETHYLENE	3981	112	100	20	UG/L	1	4
1042	COPPER ICP-MS A ELEMENTS	114	90	1300	130	UG/L	1	8
77128	STYRENE	3932	47	100	10	UG/L	1	5
80	COLOR	10	3	15	7.5	CATCH-ALL	1	1
978	ARSENIC ICP-MS TOTAL RECOVERABL	2	2	50	5	UG/L	1	2
34516	1,1,2,2-TETRACHLOROETHANE	3512	2	0.2	0.02	UG/L	1	1
1094	ZINC TOT REC	1	1	5	2.5	UG/L	1	1
34671	PCB 1016	75	1	0.03	0.003	UG/L	1	1
1020	BORON DISS ICP	792	708	960	190	UG/L	0	0
1030	CHROMIUM DISS	725	409	100	10	UG/L	0	19
34668	DICHLORODIFLUOROMETHANE	2643	368	1000	200	UG/L	0	0
34571	1,4-DICHLOROBENZENE	4022	247	75	15	UG/L	0	7
34488	TRICHLOROFLUOROMETHANE	2789	173	3490	698	UG/L	0	0
1040	COPPER DISS	335	164	1300	130	UG/L	0	2
85795	M/P-XYLENE	2009	158	10000	1000	UG/L	0	6
77135	O-XYLENE	1933	132	10000	1000	UG/L	0	4
71900	MERCURY AA COLD VAPOR	1322	111	2	0.2	UG/L	0	11
34536	1,2-DICHLOROBENZENE	4022	96	600	60	UG/L	0	1
32105	DIBROMOCHLOROMETHANE	2625	90	60	6	UG/L	0	0

Storet Code	Parameter Description	Total Wells Sampled	Wells With Detects	Enforcement Standard (ES)	Preventive Action Limit (PAL)	Units	# Wells Exceeding ES	# Wells Exceeding PAL
32104	BROMOFORM	3730	74	4.4	0.44	UG/L	0	43
39110	DI-N-BUTYL PHTHALATE	254	68	100	20	UG/L	0	0
1077	SILVER ICP COMPLEX MATRIX	1037	63	50	10	UG/L	0	0
1022	BORON DIG ICP	84	57	960	190	UG/L	0	0
39033	ATRAZINE	780	51	3	0.3	UG/L	0	15
78032	METHYL TERT BUTYL ETHER	2163	49	60	12	UG/L	0	0
1075	SILVER DISS	365	33	50	10	UG/L	0	1
1010	BERYLLIUM DISS	102	28	4	0.4		0	14
34551	1,2,4-TRICHLOROBENZENE	3409	28	70	14	UG/L	0	0
720	CYANIDE	213	23	200	40	MG/L	0	0
34566	1,3-DICHLOROBENZENE	3787	22	1250	125	UG/L	0	0
46373	DEETHYLATRAZINE	34	15	3	0.3	UG/L	0	4
34531	1,2-DICHLOROETHANE	1305	14	5	0.5	UG/L	0	2
46374	DEISOPROPYLATRAZINE	34	14	3	0.3	UG/L	0	7
34371	ETHYLBENZENE	1305	12	700	140	UG/L	0	0
77780	CYANAZINE	34	11	1	0.1	UG/L	0	7
81894	EPTAM (ERADICANE)	17	11	250	50	UG/L	0	0
77045	PYRIDINE	147	10	10	2	UG/L	0	0
39356	DUAL	562	5	15	1.5	UG/L	0	2
34469	PYRENE	281	4	250	50	UG/L	0	1
46317	ALACHLOR	771	4	2	0.2	UG/L	0	4
81408	METRIBUZIN	564	4	250	50	UG/L	0	0
34306	DIBROMOCHLOROMETHANE IN WHOLE WATER SAMPLE (UG/L)	1334	3	60	6	UG/L	0	0
34381	FLUORENE	281	3	400	80	UG/L	0	1
39055	SIMAZINE	773	3	4	0.4	UG/L	0	0
1114	LEAD ICP-MS TOTAL RECOVERABLE	3	2	15	1.5	UG/L	0	1
34433	N-NITROSODIPHENYLAMINE	254	2	7	0.7	UG/L	0	2
34699	1,3-DICHLOROPROPENE-TRANS	2946	2	0.2	0.02	UG/L	0	1
39340	BHC GAMMA (LINDANE)	838	2	0.2	0.02	UG/L	0	1
39390	ENDRIN	861	2	2	0.4	UG/L	0	1
39420	HEPTACHLOR EPOXIDE	861	2	0.2	0.02	UG/L	0	1
77562	1,1,1,2-TETRACHLOROETHANE	3015	2	70	7	UG/L	0	0
723	CYANIDE DISS	6	1	200	40	UG/L	0	0
34220	ANTHRACENE	281	1	3000	600	UG/L	0	0
34225	ASBESTOS	7	1	7	0.7		0	0
38437	1,2-DIBROMO-3-CHLOROPROPANE	2826	1	0.2	0.02	UG/L	0	0
39720	PICLORAM	749	1	500	100	UG/L	0	0
77443	1,2,3-TRICHLOROPROPANE	3014	1	60	12	UG/L	0	0
82052	DICAMBA	541	1	300	60	UG/L	0	0
1032	CHROMIUM HEX VAL	7	0	100	10	UG/L	0	0
1079	SILVER AA FURNACE	203	0	50	10	UG/L	0	0
1220	CHROMIUM DISS HEX VAL	7	0	100	10	UG/L	0	0
31502	COLIFORM TOTAL GENERAL	6	0	0	0	CODE	0	0
31508	COLIFORM TOTAL 5 TUBE MPN	1	0	0	0	CODE	0	0
34230	BENZO (B) FLUORANTHENE	281	0	0.2	0.02		0	0
34366	ENDRIN ALDEHYDE	91	0	400	80	UG/L	0	0
34478	TETRACHLOROETHYLENE	1	0	5	0.5	UG/L	0	0
34561	1,3-DICHLOROPROPENE	83	0	0.2	0.02	UG/L	0	0
34675	2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	31	0	0.00003	0.000003	UG/L	0	0
34704	1,3-DICHLOROPROPENE-CIS	2898	0	0.2	0.02	UG/L	0	0
38260	MBAS	2	0	0.5	0.25	MG/L	0	0
39053	ALDICARB	538	0	10	2	UG/L	0	0
39056	PROMETON	10	0	90	18	UG/L	0	0
39350	CHLORDANE	793	0	2	0.2	UG/L	0	0
39400	TOXAPHENE	861	0	3	0.3	UG/L	0	0
39488	PCB 1221	74	0	0.03	0.003	UG/L	0	0

Storet Code	Parameter Description	Total Wells Sampled	Wells With Detects	Enforcement Standard (ES)	Preventive Action Limit (PAL)	Units	# Wells Exceeding ES	# Wells Exceeding PAL
39492	PCB 1232	74	0	0.03	0.003	UG/L	0	0
39500	PCB 1248	74	0	0.03	0.003	UG/L	0	0
39504	PCB 1254	74	0	0.03	0.003	UG/L	0	0
39508	PCB 1260	74	0	0.03	0.03	UG/L	0	0
39516	PCB CONG TOTAL WATER	4	0	0.03	0.003	UG/L	0	0
39700	HEXACHLOROBENZENE	254	0	1	0.1	UG/L	0	0
39760	SILVEX WHL SMPL	765	0	50	5	UG/L	0	0
46314	DIMETHOATE	16	0	2	0.4	UG/L	0	0
77700	CARBARYL	541	0	960	192	UG/L	0	0
78121	XYLENE O & P	4	0	10000	1000	UG/L	0	0
81287	DINOSEB	770	0	7	1.4	UG/L	0	0
81405	CARBOFURAN	767	0	40	8	UG/L	0	0
81410	BUTYLATE	17	0	67	6.7	UG/L	0	0
81590	N-HEXANE	18	0	600	120	UG/L	0	0

APPENDIX A

LISTING OF PREVIOUSLY AND CURRENTLY FUNDED DNR PROJECTS

Project Number	Title	Principal Investigator
1	A Simple Stochastic Model Predicting Conservative Mass Transport Through the Unsaturated Zone into Groundwater.	J. Hoopes
2	Groundwater Monitoring for Pesticides.	J. Postle
3	Fate of Aldicarb Residues in A Groundwater Basin near Plover, Wisconsin.	G. Kraft
4a	Volatile Organic Compounds in Groundwater and Leachate at Wisconsin Landfills.	M. Friedman
4b	VOC Contamination at Selected Wisconsin Landfills - Sampling Results and Policy Implications.	J. Battista
5	Volatile Organic Compounds in Small Community Wastewater Disposal Systems Using Soil Absorption.	W. Boyle, W. Sonzogni
6	The Use of Groundwater Models to Predict Groundwater Mounding Beneath Proposed Groundwater Gradient Control Systems for Sanitary Landfill Designs.	J. Hoopes
7	Evaluation Techniques for Groundwater Transport Models.	J. Hoopes
8	West Bend Road Salt Use and Storage Study	M. Sucht
9	Barnyard Management Practices: Effect on Movement of Nitrogen Through Soils and Impact on Groundwater Quality.	B. Shaw
10	The Prediction of Nitrate Contamination Potential Using Known Hydrogeologic Properties.	D. Cherkauer
11	Nitrate Contamination in West-Central Wisconsin with Emphasis on Mill Run First Edition Subdivision.	J. Tinker
12	Investigation of Hydrogeology and Groundwater Geochemistry in the Shallow Fractured Dolomite Aquifer in Door County, Wisconsin.	K. Bradbury
13	Lead Migration from Contaminated Sites - Door County, Wisconsin.	J. Wiersma, R. Stieglitz

14a Graphical and Statistical Methods to Assess the Effect of Landfills on Groundwater Quality.

K. Potter

14b Methods for Determining Compliance with Groundwater Quality Regulations at Waste Disposal Facilities.

K. Potter

15 Groundwater Quality Monitoring - Long Term Effects of Intensive Farming and Sprinkler Irrigation on Groundwater Quality.

P. Kammerer

16 The Effects of Construction, Installation and Development Techniques on the Performance of Monitoring Wells in Fine-Grained Glacial Tills.

D. Cherkauer,
C. Palmer

17a Field Investigation of Groundwater Impacts from Absorption Pond Systems Used for Wastewater Disposal.

J. Hoopes

17b A Case Study of Nitrogen Transformations at a Rapid Infiltration System Used for the Disposal of Food Processing Wastewater.

W. Boyle,
J. Hoopes

18 The Occurrence of Volatile Organic Compounds in Wastewater, Sludges and Groundwater at Selected Wastewater Treatment Plants in Wisconsin.

C. Hunger

19 Fate and Mobility of Radium-226 in Municipal Wastewater Sludge Following Agricultural Landspreading.

T. Portle

20# Data Management

21a Filtration Preservation Study of Groundwater Samples.

D. Sauer

21b Groundwater Survey of Bacterial Contamination Near Rapid Infiltration Wastewater Treatment System.

C. Norenberg,
J. Standridge

22 Hydrogeology of the Wisconsin River Valley in Marathon County, Wisconsin.

K. Bradbury

23 Treatment of Cheese Processing Wastewater by Ridge and Furrow Disposal - Nitrogen Transformations

W. Boyle

24 Environmental Investigation of the City of Two Rivers Landfills, Manitowoc County, Wisconsin.

T. Van Biersel

25# NCD Gas Probe

26 LMD Maplewood Investigation - Canceled

27 LMD Green Bay Terminal Study - Canceled

28	Hydrogeologic Investigation and Groundwater Quality Assessment. (Havenswood Landfill)	P. Singh
29	Groundwater Quality and Laundromat Wastewater: Summit Lake, Wisconsin.	J. Saltes
30	Flambeau Paper Sulfite Lagoon Site Contamination Study.	W. Lantz
31a	Monitoring of Volatile Organic Compounds in Tomah, Wisconsin.	C. Krohn
31b	Hydrogeological Investigation of VOC Contaminated Private Wells Near Hudson, Wisconsin.	J. Anklam
32#	WRM Computer	
33#	SIR System	
34	Sealing Characteristics of Sodium Bentonite Slurries for Water Wells.	T. Edil
35#	LMD Well Conversion	
36#	LMD Well Abandonment	
37	Barron County Nitrate Study.	D. Hanson
38	Mutagenic Effects of Selected Toxicants Found in Wisconsin's Groundwater.	L. Meisner, D. Belluck
39	Downward Movement of Water Below Barnyard Grass Filter Strips - Case Studies.	G. Bubenzer, J. Converse
40	1987 Volatile Organic Compound Testing Project in Rock County, Wisconsin.	D. Holman
41	Volatile Organic Compound Contamination of Private Water Supplies Adjacent to Abandoned Landfills in Marathon County.	T. Wittkopf
42	Investigation of Large Scale Subsurface Soil Absorption Systems.	D. Peerenboom
43	Characterization of Groundwater Impacts at an Above Ground Petroleum Storage Terminal.	G. Becker, R. Ham
44	Lead Contamination Study of Door County.	R. Stoll
45	Freedman Creek Hydrogeologic Baseline Report.	A. Wilson
46	Devils Lake Soils - CANCELED	
47	Analytical Determination of Atrazine, Alachlor and Their Selected Degradation Products in Contaminated Groundwater: Implication for Wisconsin Groundwater Standards.	W. Sonzogni

48	Plover Area Nitrate Study.	F. Bailey
49	Assessment of Geologic Controls on Groundwater Flow and Distribution in Precambrian Bedrock, Central Wisconsin, Using Remote Sensing and Geophysical Analysis.	B. Brown D. Davidson Jr.
50	Ground Penetrating Radar Study of Water Table Elevation in a Portion of Wisconsin's Central Sand Plain.	M. Anderson, C. Bentley
51	Mineralogical and Geophysical Monitoring Naturally Occurring Radioactive Elements in Selected Wisconsin Aquifers.	G. Morsky, R. Taylor
52	Degradation of Atrazine, Alachlor, Metolachlor in Soils and Aquifer Materials.	G. Chesters
53	Evaluation of the Effect of Stormwater Disposal on Groundwater.	G. Nienke, B. Shaw
54	Radionuclides in Drinking Water of Northcentral Wisconsin.	B. Dobbins, C. Fitzgerald
55	Pesticide Migration Study.	B. Shaw
56	Research and Data Analysis of Groundwater Contamination from Municipal Rapid Infiltration Land Disposal Systems.	W. Boyle, J. Hoopes, K. Potter
57	Digital Simulation of Solute Transport to Green Bay and Lake Michigan by Groundwater from Door County, Wisconsin.	D. Cherkauer
58	Grade A Dairy Farm Water Well Quality Survey.	G. LeMasters D. Doyle
59	Demo of Low Input Strategies for Potato/Vegetable Production in Irrigated Sands.	B. Shaw, D. Curwen, G. Kraft, T. Osborne
60	Groundwater Quality Investigation of Selected Townships in Jefferson County, Wisconsin.	F. Madison
61	Effects of Volatile Organic Compounds on Clay Landfill Liner Performance.	T. Edil, P. Berthouex, J. Park, L. Sandstrom
62	Effect of Soil Type on Atrazine and Alachlor Movement Through Unsaturated Zone.	T. Daniel

63	Designs for Wellhead Protection in Central Wisconsin.	T. Osborne, J. Sorensen, M. Knaak, D. Mechenich, M. Travis
64	Atrazine Contamination of Groundwater in Dane County, Wisconsin.	K. Bradbury, R. McGrath
65	Sources and Extent of Atrazine Contamination of Groundwater at Grade A Dairy Farms in Dane County, Wisconsin.	G. Chesters, J. Levy
66	Effects of Soil Type, Selected Best Management Practices, and Tillage on Atrazine and Alachlor Through the Unsaturated Zone.	B. Lowery, K. McSweeny
67	Subdivision Impacts on Groundwater Quality.	B. Shaw, P. Arntsen, W. VanRyswyk
68#	Incorporation of County Groundwater Inventory Data into the DNR Groundwater Information Network (GIN).	M. Bohn
69#	DNR and DATCP 1000 Well Sampling	
70	Follow Up to the Grade A Dairy Farm Well Water Quality Survey.	S. Cowell G. LeMasters
71	Optimum Manure Application Rate.	B. Shaw
72	Report on Bacteriological Water Quality Monitoring of Door County Variance and Special Casing Approval Wells.	K. Hutchinson
73	Fate of VOCs in Unsaturated Soil Surrounding a Drainfield in a Soil Absorption System.	P. Sauer
74	Variations of Hydraulic Conductivity in Sandy Glacial Till: Site Variation Versus Methodology.	D. Mickelson, K. Bradbury, T. Rayne
75	A Field Evaluation of Drainage Ditches as Barriers to Contaminant Migration.	J. Bahr, L. Chambers
76	Nitrogen Isotope Monitoring at Unsewered Subdivisions.	J. Tinker
77	Analytical Determination of Pesticide Metabolites and Carrier Chemicals in Wisconsin Wells.	W. Sonzogni, M. Eldan, J. Lawrence

78	Drinking Water and Groundwater Quality in the Lower Wisconsin River Valley.	K. Cates, F. Madison, J. Postle
79a	Special Groundwater Project: Towns of St. Lawrence and Little Wolf.	T. Wilson, G. Blonde
79b	Special Groundwater Project: Towns of Lebanon and Scandinavia.	T. Wilson, G. Blonde
80	Crop Rotations Effects on Leaching Potential and Groundwater Quality.	J. Posner, G. Bubenzer, F. Madison
81	A Study of the Response of Nitrate and Pesticide Concentrations to Agricultural BMPs in Sandy Corn Fields.	K. Cates, F. Madison
82	A Comparative Study of Nitrate-N Loading to Groundwater from Mound, In Ground Pressure and At Grade Septic Systems.	B. Shaw, N. Turyk
83	The Biological Impact of Landfill Leachate on Nearby Surface Waters.	S. Geis, W. Sonzogni, J. Standridge
84	Dependence of Aldicarb Residue Degradation Rates on Groundwater Chemistry in the Wisconsin Central Sands.	G. Kraft, P. Helmke
85	Municipal Wastewater Project.	M. Kopecky
86#	Never assigned a project.	
87	Arsenic as a Naturally Elevated Parameter in Water Supply Wells in Eastern Winnebago and Outagamie Counties.	R. Stoll
88	Spatial Attributes of the Soil-Landscape-Groundwater System of the Lower Wisconsin River Valley.	K. McSweeny, F. Madison, J. Attig, M. Bohn, P. Falk
89	Preliminary Comparison of a Discrete Fracture Model with a Continuum Model for Groundwater Movement in Fractured Dolomite.	K. Bradbury, M. Muldoon
90	Evaluation of NURE Hydrogeochemical Groundwater Data for Use in Wisconsin Groundwater Studies.	K. Bradbury, M. Mudrey, K. Shrawder

91 Distribution of Radionuclides in Wisconsin Groundwater.

K. Bradbury,
M. Mudrey

92 Assessment of Wisconsin's Groundwater Monitoring Plan Program for Active Non-Approved Landfills (1985-1990).

L. Pugh,
B. Gear

93 GIS Mapping of Groundwater Contaminant Sources, Quality and Contamination Susceptibility for Door County.

J. Carlson,
R. Stoll

94# Nitrate Analysis and Drainfield Regeneration with Aerobic Wastewater Treatment in Individual Residential Systems. **CANCELLED**

G. Deckert

95 Evaluation of Denitrification Systems for Improving Groundwater from On-Site Waste Disposal Systems.
And
Optimization of Two Recirculating Sand Filters for Nitrogen and Organic Chemical Removal from Domestic Wastewater

B. Shaw

96 Remediation of Soils Contaminated by Leaking Underground Storage Tanks by Vapor Extraction and Bioremediation.

B. Hickey,
K. Jacobsen,
G. Bubenzer

97 Municipal Wastewater Absorption Pond Renovation for Enhanced Nitrogen Removal.

T. Gilbert

98a Investigation of Potential Groundwater Impacts at Demolition Landfills and Deer Pits. (Preliminary Report)

L. Pugh,
J. Connelly

98b Investigation of Potential Groundwater Impacts at Demolition Landfills and Deer Pits and Yard Waste Sites.

L. Pugh,
J. Connelly

99 Hydrogeologic and Land Use Controls on Atrazine Detections in Dane County, Wisconsin.

M. Bohn,
F. Madison,
M. Muldoon,
N. Richardson

100 Evaluation of Five Groundwater Susceptibility Assessments in Dane County, Wisconsin.

M. Bridson,
M. Bohn

101 Tracer Study for Characterization of Groundwater Movement and Contaminant Transport in Fractured Dolomite.

K. Bradbury,
M. Muldoon

102	Urban Stormwater Infiltration: Assessment and Enhancement of Pollutant Removal.	D. Armstrong
103	Long-Term Transformation and Fate of Nitrogen with Mound Type Soil Absorption Systems for Septic Tank Effluent.	J. Harkin
104	A Further Study of Organics at Wisconsin Municipal Solid Waste Landfills.	J. Connelly
105	Integrated Computerized Mapping of Point Source Contaminants and Physical Environmental Characteristics to Protect and Manage Groundwater Quality.	R. Stoll
106	An Investigation of Field-Filtering and Low-Flow Pumping When Sampling for Metals.	J. Connelly
107*	Pesticide and Groundwater Impacts.	J. Postle
108#	Evaluation of NR140 Groundwater Standards Compliance, NR103 Wetlands Water Quality Standards Compliance, and Groundwater Monitoring Requirements for Zone of Saturation Design Landfills in Wisconsin. **CANCELLED**	
109	Groundwater Hydrogeology of an Agricultural Watershed.	K. Potter
110	The Further Incidence of Native Arsenic in Eastern Wisconsin Water Supply Wells: Marinette, Oconto, Shawano and Brown Counties.	R. Stoll
111	Factors Affecting the Determination of Radon in Groundwater.	W. Sonzogni
112	Groundwater Survey of Alachlor and Its Polar Metabolite.	J. Vanden Brook
113	Application of a Discrete Fracture Flow Model for Wellhead Protection at Sturgeon Bay, Wisconsin.	K. Bradbury, M. Muldoon
114	A Comparison of Low Flow Pumping and Bailing for VOC Sampling	J. Connelly, H. Kuehling
115	An Evaluation of Long Term Trends and a Mineralogical Interpretation of Naturally Occurring Metals Contamination and Acidification of the St. Peter Sandstone Aquifer	A. Weissbach
116	Agricultural Impacts to Groundwater Under Irrigated Vegetables in the Central Sand Plain	G. Kraft, L. Binning
117	Characterization of E. Coli and total coliform Organisms Isolated from Wisconsin Groundwaters and Reassessment of Their Health Significance	W. Sonzogni, J. Standridge
118	Collection of Hydraulic and Geologic Data to Improve the Quality of the Wisconsin Ground-Water Monitoring Network	A. Zaporozec

119	Vertical and Horizontal Variability of Hydrogeologic Properties in Glaciated Landscapes	D. Mickelson
120	Direct and Residual Effects of Land-Applied Sweet Corn Processing Wastes on Nitrate Loss to Groundwater	L. Bundy
121	Delineation of Capture Zones for Municipal Wells in Dane County, Wisconsin	K. Bradbury
122	Optimum Management of Ground-water Resources in the Lower Fox River Valley	J. Krohelski
123	Variability of Nitrate Loading and Determination of Monitoring Frequency fir a Shallow Sandy Aquifer, Arena, Wisconsin	F. Madison
124#	An Investigation of VOC Sampling Techniques at Slowly Recovering Monitoring Wells **CANCELLED**	
125	Evaluation of Shallow-soil Absorption Fields Associated with Advanced On-site Disposal System	R. Stieglitz, J. Wiersma
126	GIS as a Tool to Prioritize Environmental Releases, Integrate Their Management, and Alleviate Their Public Threat	R. Stoll M. Hronek
127	A Study of Well Construction Guidance for Arsenic Contamination in Northeast Wisconsin	A. Weissbach E. Heinen
128	Improved Detection Limits for Ground Water Monitoring	W. Sonzogni H. Noll
129	Stratigraphic Controls on Distribution of Hydraulic Conductivity in Carbonate Aquifers	J. Simo M. Muldoon
130	Evaluation of the Use of DUMPSTAT to Detect the Impact of Landfills on Groundwater Quality	K. Potter
131	Nitrate-Contaminated Drinking Water Followback Study	M. Kanarek L. Knobeloch H. Anderson
132	Relationships Between Water Quality in Stream Base Flow and Private Wells and Land use in the Tomorrow/Waupaca River Watershed.	B. Shaw
133	Northeast Region Public Water Supply Location Utilizing Geographic Information Systems and Global Positioning Systems.	R. Stoll

134	Determination of the Hydrostratigraphy of the Deep Sandstone Aquifer in Southeastern Wisconsin.	T. Eaton
135	Evaluation of Geology and Hydraulic Performance of Wisconsin Ground-Water Monitoring Wells	A. Zaporozec
136	Further Evaluation of Well Seals Using an Ultrasonic Probe.	T. Edil
137	Groundwater-Surface Water Interactions in the Nine Springs Watershed.	J. Bahr
138	Evaluation of the Confining Properties of the Maquoketa Formation in the SEWRPC Region of Southeastern Wisconsin.	K. Bradbury
139	Preliminary Model Design and Literature Review for the Sandstone Aquifer System in Southeastern Wisconsin	T. Eaton
140	Acute and Chronic Toxicity of Nitrate to Brook Trout (*Salvelinus fontinalis*)	R. Crunkilton
141	Maquoketa Shale as Radium Source to the Cambro-Ordovician Aquifer System	T. Grundl
142*	Mechanical Controls on Fracture Development in Carbonate Aquifers: Implications for Groundwater Flow Systems	M. Muldoon
143*	Analysis of Microbiological and Geochemical Processes Controlling Biodegradation of Aromatic Hydrocarbons in Anaerobic Aquifers	W. Hickey
144*	Viral Contamination of Household Wells Near Disposal Sites for Human Excreta	M. Borchardt W. Sonzogni
145	Pheasant Branch Groundwater Study	R. Hunt
146	A Groundwater Model for the Central Sands of Wisconsin: Assessing the Environmental and Economic Impacts of Irrigated Agriculture	M. Anderson
147*	Remediating Groundwater Using Reactive Walls Containing Waste Foundry Sands	C. Benson G. Eykholt
148*	Field Verification of Capture Zones for Municipal Wells at Sturgeon Bay, Wisconsin	K. Bradbury
149*	Improvement of Wisconsin Groundwater Monitoring Network	A. Zaporozec
150	Refinement of Two Methods for Estimation of Groundwater Recharge Rates	K. Bradbury
151*	Evaluating Options for Changing Groundwater and Leachate Monitoring Requirements for Landfills to Reduce Mercury Used by Laboratories	J. Connelly

R. Stephens

152* Geologic and Geochemical Controls on Arsenic in Groundwater in Northeastern Wisconsin

M. Gotkowitz
T. Simo
D. Krabbenhoft
M. Schreiber
R. Hunt

153* VOC Trend Analysis of WI Solid Waste Landfill Monitoring Data: A Preliminary Analysis of the Natural Attenuation Process

J. Connelly
J. Battista
T. Hegeman

154* Development of Analytical Methods for Comprehensive Chemical and Physical Speciation of Arsenicals in Groundwater

J. Aldstadt

155* New Approaches to the Assessment of Microbes in Groundwater: Application to Monitoring Bioremediation and Detection of Pathogens

M. L. Collins

156* An Analysis of Arsenic Replacement Wells to Determine Validity of Current DNR Well Construction Guidance

K. O'Connor
K. Lauridsen

157* Verification and Characterization of a Fracture Network within the Maquoketa Shale Confining Unit, SE Wisconsin

T. Eaton

158* Public Health Impacts of Arsenic Contaminated Drinking Water — L. Knobeloch

159* A Study of Microbiological Testing of Well Water Quality in Door County and Incidence of Illness in Humans

L. Braatz

160* Improved hydrogeologic model of the Token Creek watershed

J. Bahr

Final reports and summaries of projects 1-138, (except projects 68, 95, 107, 113, and 133) are available for viewing or loan at:

The Water Resources Institute
1975 Willow Drive
Madison, WI 53706
(608) 262-3069

Summaries of these projects and other state-funded groundwater projects conducted between 1989 and 1994 are also available for viewing or downloading at the Water Resources Institute World Wide Web Site:

www.wri.wisc.edu/wgrmp/wgrmp.htm

All other reports as noted are available through the Principal Investigator or the Groundwater Section of the Bureau of Drinking Water and Groundwater:

Wisconsin DNR
Groundwater Section - DG/2
101 South Webster Street
P.O. Box 7921
Madison, WI 53707-7921

(608) 267-7610

* = final report not yet submitted
# = project did not involve a final report

APPENDIX B

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
FY 02 GROUNDWATER MANAGEMENT PRACTICE MONITORING PROGRAM

Management practice monitoring is defined as groundwater monitoring or support activities associated with groundwater monitoring, such as laboratory technique development or geologic resource description, for establishing or improving management practices necessary to meet the state groundwater quality standards of NR 140, Wis. Adm. Code.

Applicant Requirements

Funds are restricted to use by UWS and state agency contractors. Others may submit proposals if they include a state-affiliated co-principal investigator.

Budget Considerations

Monitoring proposals will be considered for a maximum of two years. Projects costing less than $35,000 annually will be given greater consideration than more expensive projects. Management practice monitoring projects are funded solely by state funds; there are no federal funds involved. Budget items to be identified should include such things as personnel costs, supplies, equipment, necessary travel, and other appropriate items. The management practice monitoring funds cannot support indirect costs or the purchase of capital equipment.

A number of projects that are being funded in FY 01 will continue into FY 02. As a result, some money will be set aside to fund continuing projects. Approximately $125,000 will be available to fund new monitoring projects in FY 02 (July 1, 2001 through June 30, 2002).

In preparing the budget be aware of the following contractual requirements.

Contractual Requirements

All monitoring wells installed shall meet DNR regulations and approved procedures for installation, construction and documentation (Chap. NR 141, Wis. Adm. Code.)

For each new monitoring well, a soil boring form (Form 4400-122), a well construction report (Form 4400-113A), and a monitoring well development form (Form 4400-113B) shall be submitted on paper or in a computer format supplied by the DNR.

For all existing groundwater sample points (monitoring wells, piezometers, and private water supplies), an inventory form (Form 3300-67) supplied by the DNR shall be completed and submitted on paper or in computer format.

For any water supply well that is sampled, the contractor shall determine if a well construction report was prepared. A copy of the well construction report, if available, shall be attached to the inventory form.

All groundwater quality monitoring data shall be submitted in a computer format compatible with the state Groundwater Retrieval Network and shall be reported to the DNR within two weeks after the contractor has received the data. The contractor shall verify computerized data.

All groundwater samples shall be analyzed by a laboratory certified in Wisconsin for that purpose under Chapter NR 149, Wis. Adm. Code.

The contractor shall request and use labels with Wisconsin Unique Well Numbers from the DNR for wells constructed and/or sampled to allow identification of wells.

Abandonment of monitoring wells shall be the responsibility of the contractor. Wells shall be abandoned in accordance with DNR regulations (Chap. NR 141, Wis. Adm. Code) and approved procedures upon completion of the project, unless alternative prior arrangements have been made with the DNR. A well abandonment report shall be submitted on a form (Form 3300-5) or in a computer format supplied by the DNR.

Quarterly project status reports shall be submitted to the project manager within 30 days of the end of each quarter. A final report and a project summary shall be submitted to the project manager within 60 days of the end of the contract period. The final report shall be submitted unbound. The project summary shall be submitted in electronic format in an outline form provided by the project manager. If reports are not received, investigators will be ineligible for future solicitations until contractual obligations are met.

Review of Proposals

All proposals will be reviewed and rated by DNR staff, and the Monitoring & Data Management and Research Subcommittees of the Groundwater Coordinating Council.

Two important criteria in evaluating each proposal are: 1) whether the proposal addresses an emerging issue or a ongoing monitoring need as listed below; and 2) whether the project involves either groundwater monitoring or activities conducted to support groundwater monitoring. Support functions can include, among other things, laboratory analysis technique development, well drilling and construction methodology development, data management and definition of geologic and hydrogeologic conditions for groundwater management purposes. Other criteria for funding include project cost, proposed timeline, whether the proposed project methodology meets the stated objectives, whether the resources requested are adequate to carry out the project, and whether the project investigators have the abilities to complete the proposed project.

In making final funding decisions, the DNR's Groundwater Section will formulate its recommendations based on: 1) input from all project reviewers, and 2) available funds. The Director of the DNR's Bureau of Drinking Water and Groundwater will make the final funding decisions.

Management Practice Monitoring Priorities

Proposals will be considered for funding that address one or more of the following emerging issues or ongoing monitoring needs.

Emerging Issues

In September 2000 the Research and Monitoring & Data Management Subcommittees of the Wisconsin Groundwater Coordinating Council and Department staff identified the following emerging issues as being of the highest importance for groundwater monitoring and research in the state. Unlike the ongoing priority monitoring topics that follow the emerging issues, these are specific ideas for projects for which state groundwater experts see an immediate need.

Groundwater Withdrawals and Connections to Surface Waters – Recent events (high capacity well permits, aquifer storage and recovery pilot programs, arsenic, and urban growth near recharge areas) have highlighted the need for continued understanding of the implications of groundwater use on groundwater quality, groundwater quantity, and surface water resources. Research is needed in the following areas: monitoring of surface and groundwater flow to determine hydrologic connections and pathways between them; investigation of the occurrence and causes of aquifer drawdowns that affect surface water features such as springs, streams and wetlands; identification of areas of the state sensitive to groundwater withdrawals; quantification of environmental, social and economic impacts of groundwater withdrawals; impact of induced flow of surface water to groundwater. Further information on this issue may be obtained by contacting Tim Asplund (608-267-7449).

Natural Attenuation – In September 1996, chapter NR 726 was revised to allow case closure of sites above NR 140 groundwater enforcement standards. A case can be closed above enforcement standards if is demonstrated that natural attenuation is effectively cleaning up groundwater. Once the site is closed there is a presumption that natural attenuation will continue cleaning up groundwater until enforcement standards are met. Many sites have been closed since 1996. There is a need to go back and audit a sub-set of these sites to determine whether the assumptions made at closure were appropriate. Questions that need to be addressed include: 1) Has the plume margin changed since closure and how much? 2) Have contaminant concentrations in groundwater changed since closure and how long will it take to meet enforcement standards? 3) Has land use surrounding the site changed since closure, e.g., have potable wells been installed near the site? 4) Was site closure appropriate? Further information on this issue may be obtained by contacting Steve Karklins (608-266-5240).

Water Quality in the Deep Sandstone Aquifer - Elevated sulfate and total dissolved solids (TDS) 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 TDS have been increasing over the years. Naturally occurring radium is also a problem in many of these wells. At present the sources of these dissolved substances and the hydrogeologic and geochemical mechanisms for mobilizing them are unclear. Research is needed to define the extent of these water-quality problems, to determine the sources of the dissolved constituents, to determine the hydrogeologic processes responsible for mobilizing the constituents, and for developing advice for the design and placement of new wells and the remediation of older wells. Further information on this issue may be obtained by contacting Ken Bradbury (608-263-7921).

New Pesticides – Evaluate the impacts on groundwater of new pesticides such as those in the sulfonylurea class of herbicides. Develop laboratory analytical methods to detect and quantify new pesticides and their metabolites in groundwater. Further information on this issue may be obtained by contacting Jeff Postle (608-224-4503).

Antibiotics and Hormones - Research is needed to determine whether antibiotics and hormones are entering Wisconsin's groundwater. Antibiotics and hormones are widely used in medicine. Certain drugs are also used to enhance the health of livestock, swine and poultry. Pharmaceuticals can enter the environment via municipal sewage effluent, private septic tanks, and animal feedlots. Research proposals should address at least one of the following questions: 1) Can commonly used drugs be detected in groundwater? 2) How do antibiotics and hormones behave in the environment, e.g. do they leach, how quickly do they breakdown? and 3) What are the most cost-effective analytical methods for antibiotics and hormones in water? Further information on this issue may be obtained by contacting Lynda Knobeloch (608-266-0923).

Microbial Pathogens – Research is needed to develop and test cost-effective screening tools that indicate the presence of, and/or quantify microbial pathogens in groundwater. Further information on this issue may be obtained by contacting Don Swailes (608-266-7093).

Nitrogen Contamination - Conduct site-specific studies to compare the NRCS 590 standard as proposed in ATCP 50 to current management practices. Further information on this issue may be obtained by contacting Jim Vanden Brook (608-224-4501).

Infiltration of Urban Runoff - As part of the Runoff Management Program Redesign, Wis. Adm. Code Chapter NR 151 has been proposed to encourage infiltration of stormwater and preserve groundwater recharge. There is a need to monitor the impact of stormwater infiltration on groundwater quality including organic compounds, metals, bacteria and viruses to evaluate DNR performance standards for pretreatment and infiltration devices at residential, commercial and industrial sites. Further information on this issue can be obtained by contacting Laura Chern (608 266-0126).

Ongoing Needs

The following priority topics for groundwater management practice monitoring represent ongoing needs as determined by the Research and Monitoring & Data Management Subcommittees of the Wisconsin Groundwater Coordinating Council, a number of state agency staff, and university researchers. The list of priorities is not in any specific order. Further information on any of these topics may be obtained by contacting Tim Asplund (608-267-7449).

Arsenic in Groundwater – Serious arsenic problems exist in Wisconsin, especially in the Lower Fox River Valley. Research to further characterize the source, extent, health effects, and treatment is a continuing need. Examples: define the lateral and vertical extent of the arsenic contamination as well as other associated metals and water quality problems; improve understanding of the system geochemistry, including reaction triggers and the mobility of the contaminants released; find solutions to drinking water problems such as well construction/reconstruction options and treatment; and conduct toxicological and risk assessment studies that may be needed to determine impacts on human health and the environment.

Nitrogen Contamination - Evaluate the extent of impacts of nitrate contamination on groundwater quality. Examples: monitoring and evaluation of the impacts of animal operations on groundwater; evaluating the effectiveness of Best Management Practices (BMPs) in reducing nitrogen levels in groundwater. Compare methods that can be used to evaluate the groundwater impacts of current farming systems as well as the economic and water quality impacts of alternative farming systems.

Data Management/Data Integration – Improve existing state methods for managing and integrating groundwater monitoring data. Examples: working with state agencies to identify existing archives of data related to groundwater quality and management practice monitoring; conducting a survey to identify data elements common to management practice monitoring projects.

Microbial Contaminants - Investigate the incidence and analytical and monitoring techniques for microbial contaminants, including parasites, bacteria, and viruses in groundwater.

Health Effects of Groundwater Contaminants - Research is needed to better characterize the impact of contaminated groundwater on public health. Proposals should focus on contaminants that are commonly encountered in public and private drinking water supplies at levels of health concern. Pathogenic microorganisms, toxic chemicals (both naturally-occurring and synthetic), and their metabolites are of interest.

Groundwater Remediation - Evaluate current or developing remediation technologies, with an emphasis on natural attenuation. Examples: comparing the effectiveness of pump & treat versus natural attenuation through modeling by running sensitivity analysis on permeability, electron acceptor availability, contaminant mass in smear zone, and extraction well location; and identifying biogeochemical parameters for cost effective evaluation of natural attenuation at petroleum contaminated sites.

Pesticide Management – Evaluate pesticide use impacts on groundwater quality. Examples: monitoring to determine if changes in pesticide application procedures and/or tillage practices have significant potential for reducing pesticide impacts on groundwater; evaluation of the extent of groundwater contamination from agricultural and nonagricultural pesticide use and handling in various geologic settings; monitoring at pesticide loading facilities to evaluate the effectiveness of the facility to protect the surrounding soils and groundwater from contamination; monitoring to identify the soil and geologic conditions under which pesticide contamination is likely to occur.

Wellhead Protection/Source Water Assessments – Delineate wellhead protection areas in karst and confined geologic settings. Evaluate methods and planning strategies to protect groundwater in wellhead protection areas. Investigators should be familiar with the state Wellhead Protection and Source Water Assessment Plans.

Landfill Regulation – Evaluate current or innovative landfill design, operation or monitoring criteria in relation to compliance with groundwater quality standards. Investigate groundwater impacts of closed landfills.

Wastewater Treatment/Disposal – Monitor and evaluate the extent to which current and alternative on-site wastewater (private sewage) systems comply with state groundwater quality standards. Examples: evaluate new onsite wastewater treatment performance as a function of pretreatment, soil depth, texture and structure, and other factors; and monitoring of nitrogen and phosphorus near lakeshore communities. Also monitor different types of wastewater land application and land spreading practices. This would include the landspreading of wastewater byproduct solids, such as sludges and septage, as well as the land application of industrial, agricultural and municipal wastewaters.

Substances of Concern – Evaluate sources, fate, transport and risk to potable wells from substances (man-made and naturally occurring) detected in groundwater. This includes review and evaluation of existing groundwater databases; identification and sampling of at-risk potable wells; and correlation of land-use and hydrogeology with risk to potable wells from the substances. Substances detected in groundwater that require an evaluation include, but are not limited to, rhodamine (used as tracer), p-isopropylbenzene (cumene), strontium (non-radioactive), tert-butyl alcohol (TBA) and aluminum.

New Technology - Develop new laboratory or field technology (or new applications of existing technologies) for determining the characteristics of groundwater and geologic formations for management purposes, including downhole monitoring techniques.

Resource Definition – Conduct studies to better describe the geologic, hydrogeologic, and geochemical conditions that affect the groundwater quality and quantity in an area of the state. Example: evaluation of groundwater flow and/or contaminant transport in karst areas.

APPENDIX C

DESCRIPTIONS OF FY 2001 MANAGEMENT PRACTICE MONITORING PROJECTS

Continuing Projects

Remediating Groundwater with Reactive Walls Containing Used Foundary Sands - Benson and Eykholt (Project 147)

The objective of this study is to determine if waste foundary sands can be used as a reactive medium for constructing reactive walls for groundwater treatment. Foundary sands are a potential reactive medium since they contain organic carbon for sorption and metals for electron donation. A variety of laboratory tests are being conducted. Tests include water leach tests and total elemental analysis to examine if contaminants of concern are likely to leach from foundary sands, batch tests to study reaction rates and sorptive potential, and column tests to study the sorption-reaction process.

In FY00, work was completed on the water leach tests and elemental analysis of the foundary sands, including PAHs and TOC. Batch and column studies were completed for TCE and initiated for alachlor and metalochlor. In FY01, additional column and batch studies for the two herbicides will be performed.

Evaluation Options for Changing Groundwater and Leachate Monitoring Requirements for Landfills to Reduce Mercury Used in Laboratories - Connelly and Stephens (Project 151)

This study will evaluate the effectiveness of using chemical oxygen demand (COD) to identify groundwater contamination at solid waste landfills and to evaluate alternative methods or analysis to potentially replace the use of COD at sites with waste types where COD is effective. In FY00, data were reviewed from the DNR Groundwater and Environmental Monitoring System (GEMS) database at both contaminated and uncontaminated sites. Data were evaluated to determine if COD was a useful parameter for indicating the presence of groundwater contamination around landfills. Other parameters, such as metals and VOCs were also evaluated.

In FY01, metals, other indicator parameters, and an alternative COD analytical method will be evaluated to determine if they can be substituted for traditional COD analysis. The Environmental Task Force Laboratory at UW-Stevens Point is performing the sampling and laboratory analyses from 18 landfills.

New Projects

Geologic and Geochemical Controls on Arsenic in Groundwater in Northeastern Wisconsin - Gotkowitz and others (Project # 152)

This project will use geologic and hydrogeologic field studies to investigate controls on the occurrence, fate and transport of naturally occurring arsenic in drinking water supplies in northeastern Wisconsin. Controls to be evaluated include the presence of arsenic-rich mineralized horizons below the sulfide-cement horizon (SCH), the spatial variability of arsenic within the SCH, and the spatial variability of the stratigraphy across the study area. Another objective is to characterize the geochemical and hydraulic conditions that contribute to low- and high-level arsenic concentrations in wells, either by local oxidation of pyrite or from advective and dispersive transport of arsenic within the aquifer. This latter objective will be evaluated using experimental pump tests to simulate conditions that might release arsenic from the SCH.

VOC Trend Analysis of WI Solid Waste Landfill Monitoring Data: A Preliminary Analysis of the Natural Attenuation Process - Connelly, Battista, and Hegeman (Project # 153)

The objective of the study is to determine if groundwater contamination is declining at old, closed landfills in Wisconsin based on analysis of VOC and inorganic parameter monitoring data. Sites will be reviewed to identify whether natural attenuation is more likely to be successful at sites with certain characteristics and how quickly groundwater quality responds to site closure and capping. This study may identify landfills where more detailed follow-up studies focusing on natural attenuation parameters and zones would be beneficial.

Development of Analytical Methods for Comprehensive Chemical and Physical Speciation of Arsenicals in Groundwater - Aldstadt (Project # 154)

The objective of this project is to develop new methods that will allow for a better understanding of the nature of arsenic in the environment. State-of-the-art analytical techniques are under development to comprehensively characterize the specific chemical and physical forms of arsenic that are present in groundwater formations in the State of Wisconsin. The arsenicals to be measured cover the major and monitor classes of inorganic and organic species. The investigators will work closely with WGNHS staff to obtain groundwater samples and assist with the analysis of groundwater collected as part of Project #152. The study will help decision-makers better assess the risk to humans and other biota of the more toxic arsenicals in the Fox River Valley.

New Approaches to the Assessment of Microbes in Groundwater: Application to Monitoring Bioremediation and Detection of Pathogens - Collins (Project # 155)

This study will test whether a simplified approach to using the polymerase chain reaction (PCR) can be applied to the detection and quantification of a variety of bacteria in groundwater, including pathogens. Direct PCR will be evaluated as a more efficient method of detecting pathogens (such as *E. coli O157:H7*) from whole water samples. A second objective is to develop methods for the qualitative and quantitative assessment of the methanotroph bacterial community in groundwater. Direct PCR in conjunction with single-stranded conformational polymorphism (SSCP) is the approach that will be evaluated. This latter objective has applications for monitoring bioremediation and natural attenuation at contaminated sites

An Analysis of Arsenic Replacement Wells to Determine Validity of Current DNR Well Construction Guidance - O'Connor and Lauridsen (Project # 156)

The primary objective of this study is to determine if the current well construction guidelines for arsenic replacement wells - i.e. case 80 feet through the top of the St. Peter Sandstone - is consistently having the intended result of eliminating or reducing naturally occurring arsenic in drinking water. The study will involve sampling and monitoring wells that were reconstructed or replaced due to arsenic problems in the Arsenic Advisory Area in northeastern Wisconsin. Part II of the study will involve physical analysis (video, pressure test, water table measurement, etc.) of several arsenic replacement wells where arsenic levels increased over time ("failed wells") to determine why they failed.

Verification and Characterization of a Fracture Network within the Maquoketa Shale Confining Unit, SE Wisconsin - Eaton (Project # 157)

The goal of this study is to characterize hydraulic and transport properties of a fracture network within the Maquoketa Formation and its connection to the overlying Silurian dolostone in southeastern Wisconsin. Specialized methods, such as short-interval packer testing and tracer experiments, will be used to demonstrate and characterize this fracture network. The study complements ongoing characterization of the Maquoketa Formation using more conventional techniques for porous media.

Public Health Impacts of Arsenic Contaminated Drinking Water - Knobeloch (Project # 158)

The principal objectives of the study are to add an additional seven years of data to a study of arsenic exposure in northeastern Wisconsin and to establish a statewide registry of Wisconsin residents exposed to arsenic in their well water. In addition, the study is designed to assess risks associated with bathing and showering activities;

evaluate the response of private well owners to public health advisories; and determine the feasibility of analyzing the health status of Wisconsin residents served by community water supplies with arsenic concentrations between 5 and 50 µg/L. The study will involve an intensive voluntary well-sampling campaign in three townships in conjunction with detailed health surveys.

A Study of Microbiological Testing of Well Water Quality in Door County and Incidence of Illness in Humans - Braatz (Project # 159)

The purpose of the study is to evaluate the effect of proposed drinking water standards for fecal contamination in EPA's Groundwater Rule. 25 Door County public water supply wells will be sampled monthly for a year to determine incidence of contamination based on the indicators. The wells were selected based on volunteers, location, and well information available. Monthly samples will be required at public systems in vulnerable areas like Door County when the Groundwater Rule is implemented.

The second part of the study is an attempt to identify whether a correlation exists between gastrointestinal illness in a limited number of residents of Door County and the source of their drinking water supply. Participants in this portion of the study will be identified based upon diagnosis of gastroenteritis at a local clinic and will be asked to fill out health survey. Volunteers will be screened based on their answers to the survey. Water samples for analysis of coliform and other fecal indicators will be collected. Stool samples will also be analyzed to help identify potential causes of the illness. A limited number of participants with positive fecal indicators will have their groundwater source tested for viruses.

The results of the study will be used to assess the need for more frequent monitoring and potential treatment of drinking water supplies in areas susceptible to microbial contamination.