

Minnesota Ground Water Association

www.mgwa.org

Newsletter

March 2007
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MGWA President
Jeff Stoner

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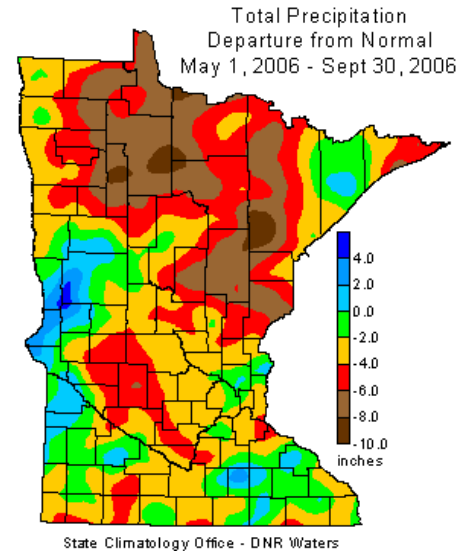
2006 Minnesota Dry Conditions Persist

Last summer's dry conditions continue in many parts of Minnesota. Impacts of the 2006 drought included surface water appropriation permit suspensions, municipal water restrictions and bans, an agricultural disaster declaration for 36 counties, some of the lowest lake levels in 30 years, and a number of major wildfires.

Last year's growing season precipitation departure from normal (Figure 1) shows the year's general lack of rainfall, especially in northern Minnesota.

Figure 1 (at right). Precipitation departure from normal for the 2006 growing season.

continued on page 3.



State Climatology Office - DNR Waters

President's Letter

Silver Opportunities

Jeff Stoner, MGWA President

It was not until several months into 2006 that I realized that MGWA would achieve 25 years of existence in 2007. This realization formed when the board received a letter from ambitious members Jim Lundy and Steve Robertson suggesting that we might want to produce a publication about ground water to commemorate this milestone in our history.

Hold that thought while we digress through a vacation to Chile to visit my Spanish student niece. No, you will not hear about Chilean ground water or wine, as I'm still attempting to learn about both of them. Rather some ideas lifted from a book I started reading during that vacation—Jared Diamond's "Collapse, How Societies Choose to Fail or Succeed." Diamond takes the reader through numerous societies; many of which "collapsed," such as Easter Island, Anasazi and Mayan. He gives a host of reasons, but a common theme was that the people lost sight of their connection to what sustained their civilization. Good examples of mistakes included deforestation and

over fishing. Without giving too much away, I'll simply summarize that Diamond gives some basic hope that our modern societies will not collapse if we truly pay attention and learn from the mistakes made by these distant societies.

"Could MGWA collapse?" I began to think as I take an officer's role. Are we connected to what sustains us as a viable association of people interested in and as promoters of ground water in Minnesota? The answer to that second question is a resounding "yes" based on MGWA writings, conferences, field trips, and most important of all the networking within the membership. To summarize what first MGWA president Gilbert Gabanski said after 20 years of existence, "Our (MGWA) viability is all about the members!"

Given that this is no time to become complacent as an association, the plan is to move forward with a 25th anniversary publication. The idea is to select key articles from all past newsletters and organize them by topic under a single volume. Some articles undoubtedly

continued on page 4.

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Newsletter Deadlines

Issue	Due to Editor
June '07	05/14/2007
September '07	08/15/2007
December '07	11/15/2007

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MGWA NEWS

Member News

New Officers at MGWA

Stu Grubb, a Senior Hydrogeologist and Principal Partner with Emmons and Olivier Resources in Oakdale, MN has been elected President-Elect of MGWA for 2007. **Craig Kurtz**, a Financial Risk Analyst for 3M Company has been re-elected as Treasurer of MGWA for a two-year term. Congratulations to Stu and Craig!

Professional News

Mark A. Collins and **Sarah L. Emery** work for HDR Engineering, Inc. The office has recently moved to 701 Xenia Avenue South, Suite 600, Minneapolis, MN.

Craig Anderson, **Paula Berger**, **Brandon Oman** and **Laura Scheid** have been working for Environmental Strategies Consulting, LLC, a MGWA Corporate Member. The company has recently merged with another company to become WSP Environmental Strategies.

Candace Sykora has recently accepted a new position as a hydrogeologist at the Minnesota Pollution Control Agency. She will be working in the Voluntary Investigation and Cleanup Program. Candace previously worked for ProTec Environmental Consultants as a staff geologist. Candace graduated from the University of Wisconsin-River Falls in August 2006 with a Bachelors of Science in geology and biology.

MGWA welcomes Candace as a new member.

Brian Rongitsch, long-time Ground Water Unit Supervisor in the Waters Division of the Department of Natural Resources, retired at the end of 2006 after more than 35 years of state service. Brian started with the state in 1971 at the Department of Transportation as a geologist. He transferred to DNR Waters in 1979 as a hydrogeologist to work on the underground storage of natural gas. Brian was also observation well network manager during

part of his DNR career.

Brian says, "Retirement is affording me more time to be with my daughter, who is a student at the University of Wisconsin, River Falls, and my son, who is a deputy sheriff for Ramsey County." He extends a warm hello to friends and colleagues and hopes to see you at the MGWA spring conference.

John Jaschke hired as Executive Director of BWSR

The Minnesota Board of Water & Soil Resources (BWSR) announced that John Jaschke has been hired as the Board's Executive Director. Jaschke currently is the Water Resources Manager for Dakota County. Prior to that, he worked as BWSR's Land and Water Section Administrator. He has also worked as an area hydrologist for the Minnesota Department of Natural Resources and as a hydrogeologist for the U.S. Bureau of Mines.

"John will be an asset to BWSR because of his variety of work experience and familiarity with the broad range of conservation issues across different parts of the state," said BWSR Board Chairman Randy Kramer. "He has a track record of building consensus, and I am confident that he will be a strong leader for the organization."

BWSR is the state's administrative agency for 91 soil and water conservation districts, 46 watershed districts, 23 metropolitan watershed management organizations, and 80 county water managers. The board consists of 17 members appointed by the Governor, who are charged with optimizing local delivery of conservation services. The agency works through local government to help the state attain its goals for clean water, clean air, and abundant fish and wildlife.

Jaschke will be replacing Ron Harnack, who has been BWSR's Executive Director for 15 years. Harnack announced his retirement in October. His future plans include working part-time for the Red River Watershed Management Board. "I am extremely proud of the BWSR accomplishments over the past 15 years," Harnack said. "The BWSR staff and the Board, working with local government units and private landowners, have been the key to those successes."

From a news release from the Minnesota Board of Water and Soil Resources, December 21, 2006.



Candace Sykora

2006 Dry Conditions, cont.

ll data from the USGS <http://waterdata.usgs.gov/mn/nwis/current/?type=flow>

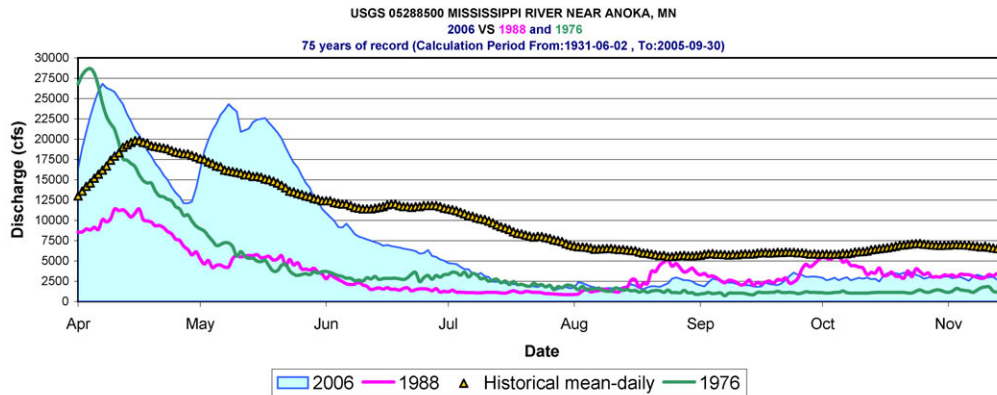


Figure 2. Discharge of the Mississippi River near Anoka during 2006. Prepared by Carl Rundberg, DNR Waters.

Figure 2 shows how the Mississippi River flow at Anoka was well below the historical average and similar to flow levels in two recent droughts during the late 1970's and late 1980's. Late summer and early fall rains brought relief to some central Minnesota counties but did not extend to northern Minnesota. Figure 3 shows that at the end of January, northern Minnesota was classified as in extreme drought while the rest of the state was classified as abnormally dry. As of January 2007 Lake Superior was approaching an 80-year low. Figure 4 is a graph of water table response in a surficial aquifer in central Minnesota for the period 1978 through 2006. The impact on the water table at that location of the drought of the late 1980's can be compared to the impact of the dry conditions in 2006. Generally around the state this winter snowfalls have been far short of expected as seen in Figure 5. Much of the northern two thirds of Minnesota reports snow depths that rank historically below the 5th percentile.

Looking forward to spring 2007, the Minnesota Climatology Working Group status report

continued on page 4.

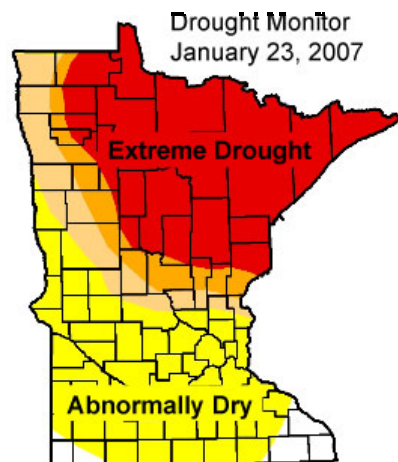


Figure 3. Drought classification of Minnesota as of January 23, 2007. Source: National Drought Mitigation Center Drought Monitor and DNR Waters State Climatology Office.

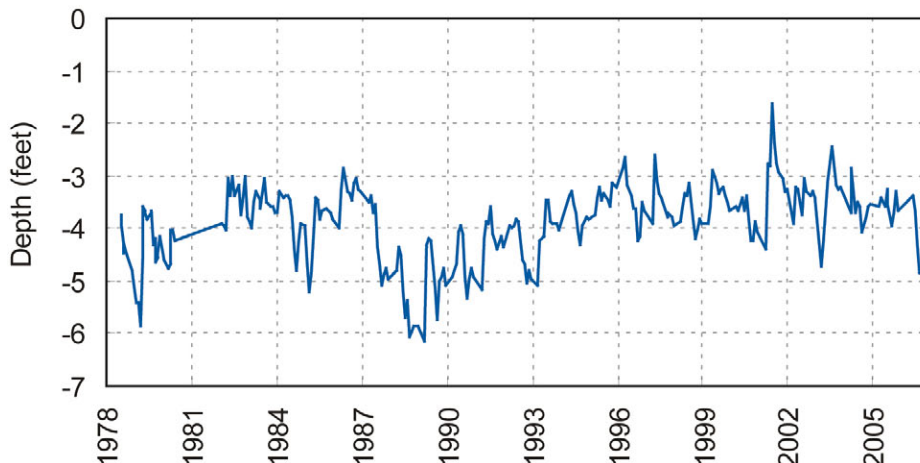


Figure 4. Depth to the water table for the period 1978 to 2006 of MN DNR 77022, a ground-water level monitoring well in a surficial aquifer near Staples in Todd County (MN unique number 244550). Compare the 2006 response to the water level impact of the drought of the late 1980's.

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The primary objectives of the MGWA are:

- ◆ Promote and encourage scientific and public policy aspects of ground water as an information provider;
- ◆ Protect public health and safety through continuing education for ground water professionals;
- ◆ Establish a common forum for scientists, engineers, planners, educators, attorneys, and other persons concerned with ground water;
- ◆ Educate the general public regarding ground water resources; and
- ◆ Disseminate information on ground water.

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Links at www.mgwa.org

MGWA Spring Conference:

Methods for Solving Complex Ground-Water Problems

April 19, 2007

Early Registration
Deadline April 6, 2007

2006 Dry Conditions, cont.

for January 30, 2007 states, "Spring and summer precipitation totals will need to far exceed normal for surface water systems to recover quickly from the 2006 deficits. This is possible, but not climatologically likely. The drought was quick to develop, but most likely the impacts will be slow to repair."

Some drought concerns for the 2007 growing season, especially northern Minnesota include:

- ◆ streams dropping below protected flow thresholds after the spring melt
- ◆ low lake levels and associated water access issues
- ◆ ground water levels lowering in lagged response to precipitation deficits. Ground water levels will also respond to increased pumping pressures.
- ◆ inadequate soil moisture conditions further impacting agriculture, especially forage crops
- ◆ inadequate soil moisture conditions further stressing forest communities, making them more vulnerable to pests
- ◆ antecedent dry conditions, along with a continuation of sparse winter snow cover,

President's Letter, cont.

will be timeless and need no further comment. Others may have been works-in-progress of an emerging issue or problem. Authors of those articles will be contacted and given the opportunity to add commentary about their original article, in which results have been updated. This document not only will keep the selected ground-water topics fresh for the membership, but could serve to educate non-members about the wealth of information that the MGWA has to offer about ground water in Minnesota over the past 25 years. Not a bad collapse check. Thanks to Lundy and Robertson who agreed to lead this effort. Please give their team your support as they select articles and contact member authors. The target publication time is December 2007.

Another obvious opportunity to stay connected is to join us at the Spring Conference this April. Once again we have a great lineup of presenters ready to explain their approaches to tackling complex ground-water problems in secondary-permeability systems and ground-water recharge. As you make your plans to attend, I challenge you also to connect with a student by inviting that student to attend the conference with you. MGWA can-

not collapse if we continue to connect with each other, bring in new ideas through student participation, practice long-term thinking about our future, and have fun along the way.

could lead to a significant increase in spring wildfire risk

For more information on Minnesota climate and the current dry conditions, please see the resources at http://climate.umn.edu/doc/journal/dry_summer_2006.htm.

submitted by Jan Falteisek, MGWA Newsletter Team

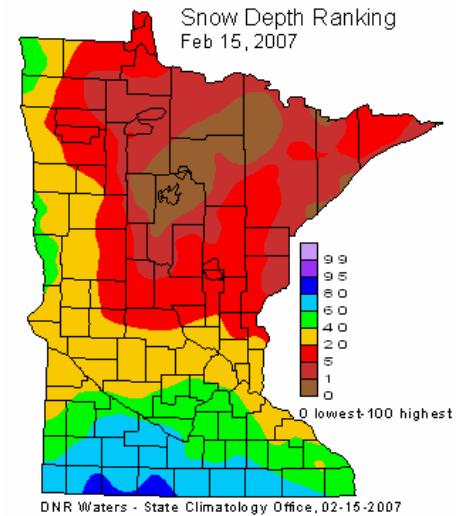


Figure 5. Minnesota snow depth ranking as of February 15, 2007.

Q & A on the Ground Water Rule

What is the Ground Water Rule?

The U.S. Environmental Protection Agency (EPA) published the Ground Water Rule (GWR) in the Federal Register on November 8, 2006. The purpose of the rule is to provide for increased protection against microbial pathogens in public water systems that use ground water sources. EPA is particularly concerned about ground water systems that are susceptible to fecal contamination since disease-causing pathogens may be found in fecal contamination.

The GWR will apply to public water systems that rely on ground water as a source of supply. The rule also applies to any system that mixes surface and ground water if the ground water is added directly to the distribution system and provided to consumers without treatment. Private wells are not affected.

It does NOT require disinfection of all ground water systems, a significant change from early versions of the rule. Key fact-based input from states, including virus sampling and analysis studies in Minnesota, helped to persuade EPA to change direction with the GWR. Instead, the rule uses a risk-based approach that targets monitoring and enforcement towards high risk systems.

What types of pathogens can be found in water provided by ground water systems?

Ground water that is susceptible to fecal contamination may contain harmful viruses or bacteria. Viral pathogens found in ground water may include enteric viruses such as Echovirus, Hepatitis A and E, Rotavirus and Noroviruses (i.e., Norwalk-like viruses) and enteric bacterial pathogens such as Escherichia coli (including E. coli O157:H7), Salmonella species, Shigella species, and Vibrio cholerae. Ingestion of these pathogens can cause gastroenteritis or, in certain rare cases, serious illnesses such as meningitis, hepatitis, or myocarditis. Health implications in sensitive subpopulations may be severe (e.g., hemolytic uremic syndrome) and may cause death.

What causes contamination of ground water by disease organisms?

Viral and bacterial pathogens are present in human and animal feces, which can, in turn, contaminate drinking water. Fecal contamination can reach ground water sources from failed septic systems, leaking sewer lines, and improper handling of animal wastes. Such potential sources may pose a heightened threat in areas with coarse-grained soils and aquifers containing secondary porosity features such as fractures or karst development. Fecal contamination from the surface may also get into a drinking water well along its casing or through cracks if the well is not properly constructed, protected, or maintained.

What are the basic requirements of the rule?

The risk-targeting strategy incorporated into the rule provides for:

- regular sanitary surveys of public water systems to look for significant deficiencies in key operational areas;
- triggered source water monitoring when a system that does not sufficiently disinfect drinking water identifies a positive

sample during its Total Coliform Rule monitoring and assessment monitoring (at the option of the state) targeted at high-risk systems;

- implementation of corrective actions by ground water systems with a significant deficiency or evidence of source water fecal contamination to reduce the risk of contamination; and,
- compliance monitoring for systems that are sufficiently disinfecting drinking water to ensure that the treatment is effective at removing pathogens.

What are the monitoring provisions?

A ground water system is subject to triggered source water monitoring if it does not already provide treatment to reliably achieve at least 99.99 percent (4-log) inactivation or removal of viruses. The GWR also allows states to require systems that do not provide sufficient disinfection treatment to remove 99.99 percent of viruses to conduct optional assessment source water monitoring at any time and require systems to take corrective action. States may evaluate the need for assessment monitoring on a case-by-case basis. EPA recommends that the following risk factors be considered by states in targeting high risk systems:

1. high population density combined with on-site wastewater treatment systems;
2. aquifers with restricted geographic extent, such as barrier island sand aquifers;
3. sensitive aquifers (e.g., karst, fractured bedrock and gravel);
4. shallow unconfined aquifers;
5. aquifers with thin or absent soil cover; and
6. wells previously identified as having been fecally contaminated.

For those systems that already treat drinking water to reliably achieve at least 99.99 percent (4-log) inactivation or removal of viruses, the rule requires regular compliance monitoring to ensure that the treatment technology installed is reliably removing contaminants.

— continued on next page.

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Ground Water Rule Q & A, cont.

What are the deadlines for completing actions required by the rule?

States have two years to adopt the rule. In Minnesota, the Department of Health (MDH) will seek delegated authority to implement the GWR. The compliance date for triggered monitoring (and associated corrective actions) and compliance monitoring is December 1, 2009. There are no timeframes associated with the assessment monitoring because it is at the option of state. States must complete their initial round of sanitary surveys by December 31, 2012, for most community water systems. States will have until December 31, 2014, to complete the initial sanitary survey for community water systems that are identified by the state as outstanding performers and noncommunity water systems.

How will the GWR be implemented in Minnesota?

MDH staff anticipates completing its primacy package within the allotted three years. At this early point, it is hard to know

specific ways in which the Minnesota program will be constructed, especially because EPA has yet to release much of its key guidance on implementing the GWR. The GWR offers states considerable flexibility in implementation. Opportunities for state flexibility generally fall into categories of defining 1) system deficiencies, 2) approaches for corrective actions, and 3) options for source assessments and monitoring. Much of how Minnesota already implements other Safe Drinking Water Act requirements overlaps with GWR requirements. Accordingly, the regulated community is not expected to notice radical changes.

Why is it called the Ground Water Rule and not the Groundwater Rule?

Because the EPA prefers acronyms with three letters (i.e. GWR rather than GR).

adapted from an EPA news release.

Legislative-Citizen Commission on Minnesota Resources (LCCMR) Recommends Water Resource Projects

The Legislative-Citizen Commission on Minnesota Resources (LCCMR) issued a Request for Proposals (RFP) in October 2006 for projects requesting funding from the Environment and Natural Resources Trust Fund for the FY 08-09 biennium. Proposal hearings were held late 2006 and recommendations for funding were released by the end of 2006. A total of \$ 23,366,000 is included in the recommendation.

Several ground-water related projects have been included in the recommendation and include:

- ◆ County Geologic Atlas Acceleration, Minnesota Geological Survey, \$400,000.
- ◆ Innovative Springshed Mapping for Trout Stream Management, University of Minnesota, \$270,000.
- ◆ Water Resource Sustainability, University of Minnesota, \$292,000.

To read all the proposals and any supplementary materials, see the link below.

Funding bills (H.F. 293 and S.F. 450) are currently being considered in the Minnesota Legislature.

The function of the LCCMR (formerly the Legislative Commission on Minnesota Resources [LCMR]) is to make funding recommendations to the legislature for natural resource projects primarily from the Environment and Natural Resources Trust Fund. These projects are to help protect and enhance Minnesota's natural resources.

The LCMR developed from a program initiated in 1963. Prior to June 1, 2006, over \$525 million has been appropriated to approximately 1,214 projects recommended by LCMR to protect and enhance Minnesota's natural resources.

For more information, go to the LCCMR web site at www.commissions.leg.state.mn.us/lcmr/

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Low Levels of PFBA Found in Six Cities' Wells in Southeast Metropolitan Area

Levels pose no immediate health risk to residents; source under investigation

The Minnesota Department of Health (MDH) has detected low levels of the chemical perfluorobutanoic acid (PFBA) in municipal wells in Woodbury, Cottage Grove, Newport, St. Paul Park, South St. Paul and Hastings. The contamination in all of these cities, except Woodbury, appears to be in an area of groundwater that is separate from the one in Lake Elmo and Oakdale. The source of this new area of contamination is under investigation.

PFBA is one of a family of chemicals known as perfluorochemicals or PFCs. They were made and used by several companies around the world in household and industrial products such as stain repellents, lubricants, fire retardants and suppressants, pesticides, surfactants, and emulsifiers. PFBA was made by the 3M Company at its Cottage Grove facility.

Studies in laboratory animals have shown that PFCs may cause health problems if consumed in large enough quantities over long periods of time, or consumed at a sensitive time during development. Studies by 3M of workers exposed to PFCs during manufacturing show no apparent impact on their health.

"Finding this chemical at low levels does not pose an immediate health risk for residents," said John Linc Stine, director of the Environmental Health Division for MDH. "It does mean we need to proceed cautiously, investigate further and, if necessary, take steps to reduce people's exposure for the long term. Our toxicologists are currently evaluating the limited scientific information available on PFBA."

Staff from MDH and the Minnesota Pollution Control Agency will be conducting extensive testing, including private wells, to determine the extent of the groundwater contamination. City wells will be monitored monthly for levels of PFCs.

The PFBA was found as part of MDH's ongoing investigation into groundwater contamination in southern Washington County. The investigation began several years ago when health officials learned 3M disposed of PFC wastes at three sites in Washington County: the former Washington County Sanitary Landfill, the former Abresch Dump in Oakdale, the 3M Cottage Grove facility and another disposal site on the border of Woodbury and Cottage Grove.

In 2004, MDH staff began collecting samples from private wells in the city of Lake Elmo to look for two PFCs, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). Low levels of PFOA were found in a few private wells near the Washington County Landfill. In 2005, more testing detected PFOS and PFOA in a larger group of private wells in Lake Elmo and several city wells in Oakdale. Tests in several other nearby municipal water supplies, including Cottage Grove, Woodbury, and Hastings did not find PFOA or PFOS.

In spring 2006, the MDH Public Health Laboratory developed methods to detect five more types of PFCs. Analysis of the water samples revealed that one of these, PFBA, is widespread. PFBA seems to move very freely in the groundwater; more so than PFOS or PFOA. It does not break down or degrade. PFBA has now been found in two distinct areas of southern Washington County. One area of groundwater contamination appears to originate from the former Washington County Landfill in Lake Elmo

and the former Abresch Dump in Oakdale. This area extends into the City of Woodbury. In drinking water near the disposal sites, multiple PFCs, including PFOA and PFOS, were found. Only PFBA was found in the Woodbury municipal wells.

A second area of groundwater contamination is located further south and is primarily PFBA, with no detections of PFOA or PFOS. PFBA has been detected in all of the city wells in Cottage Grove, St. Paul Park and Newport and in some city wells in South St. Paul and Hastings. This area of contamination may originate from the disposal site on the border of Woodbury and Cottage Grove. So far, PFCs have not been found in limited testing of groundwater elsewhere in the metropolitan area.

"Learning about chemical contamination in groundwater is a step-by-step process," Stine said. "Though the discovery of PFCs in the southeast metro is relatively new, testing information from the last couple of years suggests that the levels of PFCs in the groundwater are stable and not increasing. The testing information also suggests that PFCs have been present for some time. Our testing for these chemicals has improved since we began."

MDH has been using the [former] well advisory guideline for PFOA, 1 part per billion (ppb), as a temporary guideline for PFBA. "It's important to note that these are guidelines and there is not a bright line of health risk for findings just above or below the number of 1," Stine said. "The levels of PFBA in each of the four cities is still very low. Some wells in Cottage Grove and St. Paul Park slightly exceed the MDH guidelines. The initial sampling results for South St. Paul and Hastings still need to be confirmed."

Scientific understanding of the relative toxicity of PFBA, along with the other PFCs is evolving. "Looking at new studies and some underway, we anticipate that PFBA should be less toxic to people than PFOA based on its chemical characteristics and on preliminary data from animal studies," Stine said. "In contrast to PFOA and PFOS, PFBA does not appear to accumulate in animals or people." Once the studies are completed and reviewed, MDH will develop specific advice for PFBA as well as revised values for PFOS and PFOA.

MDH will continue to provide technical support to cities for managing their drinking water systems. While there is no immediate concern for drinking water, residents who have PFBA in their drinking water and wish to reduce their exposure can take some simple steps. They can use bottled water for part or all of their drinking or cooking needs. Also, filters containing granular activated carbon (GAC) remove PFCs, including PFBA. Many common water filters contain GAC.

For further information contact the MDH Environmental Health Division at 651-201-4897 or visit MDH's Drinking Water Protection Web page at: www.health.state.mn.us/divs/eh/water/index.html. For a map of PFC plumes in Southern Washington Co.: www.health.state.mn.us/news/pressrel/drinkingwater011907.pdf. PFBA in the Groundwater of the South East Metro Area: www.health.state.mn.us/divs/eh/hazardous/topics/pfbasemetro.html

For more information, contact Doug Schultz, MDH Communications at (651) 201-4993. From a news release from the Minnesota Department of Health dated January 19, 2007.

Health officials issue new health guidelines for PFOA, PFOS; reiterate protective advice on PFBA

The Minnesota Department of Health (MDH) announced on March 1, 2007, that it is taking further steps to protect the health of residents in south Washington County from long-term exposure to perfluorochemicals (PFCs) in groundwater.

Based on the latest scientific information, MDH has lowered its Health Based Values (HBVs) for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), two members of PFC group of chemicals that have been found at low levels in groundwater in southern Washington County. The new HBVs are 0.5 parts per billion (ppb) for PFOA and 0.3 ppb for PFOS. The guidelines previously used were 1 ppb and 0.6 ppb respectively.

“We have been reviewing the available data over the last few months and concluded that there is sufficient scientific basis at this time to justify revising the health based values for PFOA and PFOS,” said Minnesota Health Commissioner Dianne Mandernach.

While research to date has shown no direct evidence that PFCs cause health problems in humans, studies in laboratory animals indicate that at higher doses, PFCs may interfere with liver and thyroid function and may cause developmental effects.

“The new values are protective, scientifically sound and well-researched,” said John Linc Stine, director of the Environmental Health Division for MDH. The new HBV for PFOA, 0.5 ppb, is the same as a number implemented by the Environmental Protection Agency (EPA) in an enforcement action in West Virginia that became effective Nov. 17, 2006.

A Health Based Value is the concentration of a groundwater contaminant, or a mixture of contaminants, that poses little or no risk to health, even if consumed daily over a lifetime. The updated HBVs for PFOA and PFOS take into consideration the potential for health impacts during fetal and other developmental life stages. A clearer understanding of how long these chemicals stay in the human body is also reflected in the revised HBVs.

MDH is working with Oakdale and Lake Elmo to address public and private wells that may be affected by the lowering of the HBVs for PFOA and PFOS. Most residents in the Lake Elmo and Oakdale area will not be affected by the change because they are connected to municipal water systems that don't contain PFCs or treat the groundwater before distribution.

The lowering of the Health Based Values for PFOA and PFOS does not affect those portions of southern Washington County and northern Dakota County where only perfluorobutanoic acid (PFBA), another PFC compound, has been found in groundwater.

Those areas fall under the department's drinking water advice on PFBA, which the department reiterated today.

“We recommend that anyone who has concerns about the potential health impacts from PFBA in their water should limit or reduce their intake of water that has a concentration of more than 1 ppb,” Stine said.

Intake of contaminated drinking water can be reduced by drinking bottled water or by filtering tap water used for drinking or cooking through a point-of-use (POU) activated carbon filter, which removes or greatly reduces PFBA. Water used for

bathing, showering or other non-ingestive household uses does not pose a health risk, based on current data.

“We've had an initial round of community meetings where more than 800 people heard our advice and heard us talk about things they can do to limit their exposure if they choose,” Stine said. “But we know that there are far more than 800 people in the communities and areas affected by the contamination, so we want to take every opportunity we can to re-emphasize our advice. We also want to share as broadly as possible what we know about point-of-use filters, small, inexpensive filters that can be used to filter tap water.”

Point-of-use (POU) filters can be an effective way to reduce exposure, MDH staff found. They recently tested a number of POU filters commonly available in stores. The testing found that a simple pitcher filter that contains activated carbon was partially effective at removing PFBA from the water, but allows more PFBA to pass through as additional water is filtered. A faucet-mounted filter containing activated carbon worked better, showing full removal of PFBA through about half of its manufacturer's predicted filter lifetime, and good removal at up to 70-80 percent of its lifetime. Faucet-mounted filtering devices commonly range in price from \$15 to \$25 and replacement filters cost approximately \$15 to \$20. Additional information on POU filters with activated carbon is available from the MDH Web site or by calling 651-201-4897.

Stine said MDH staff have determined that sufficient toxicity data does not exist to calculate a chemical-specific HBV for PFBA. However, the advice is based on a comparison of the existing PFBA data to what is known about other PFCs.

“The data that are available for PFBA indicate that this chemical is less toxic than PFOA, a similar chemical,” Stine said. “We believe that 1 ppb is a protective number for PFBA, based on the most recent science, and is protective even of those who may have higher relative water consumption rates, such as pregnant women, nursing mothers and small children.”

Mandernach added, “As more data become available, we will examine it, with the intent of developing a Health Based Value for PFBA. We will continue to work with the EPA, private sector and academia, to accelerate that research and continue to consult with experts on this group of chemicals.”

For more information, contact: Doug Schultz, MDH Communications at (651)201-4993 or John Linc Stine, MDH Environmental Health at (651)201-4675. From a news release from the Minnesota Department of Health dated March 1, 2007.

Send your comments on any article to editor@mgwa.org

The Seven Wonders of Minnesota Geology

For a state situated on the edge of the prairie, Minnesota has a remarkable abundance of both fascinating and scenic geological features. Surprisingly, many of these features have no connection to Minnesota's famous "10,000 lakes." Seven of these features are standouts that I believe deserve special recognition and are of interest to the geologist and general public alike.

To award the "Seven Wonders" I needed some selection criteria. To put it simply, I looked for natural wonders primarily of geological significance that are unique in some way. Naturally, there are many more than seven comparable wonders in Minnesota. And many alternative lists could be developed with equal standing. So it is after some weighty deliberation and a healthy dose of humility that I award the "seven wonders of Minnesota geology."

1. Shovel Point and Palisade Head - North Shore of Lake Superior (Lake County) Silver Bay

This is world class scenery on a still-wild section of freshwater coastline that cannot disappoint. Palisade Head is a reddish igneous intrusion forming a 200-foot escarpment that rises out of Lake Superior (see Figure 1). It consists mainly of rhyolite, part of the Proterozoic North Shore Volcanics. Shovel Point, a rhyolite sill, is a marvelous biome with unique plants and sweeping views of the lake. The hike down to the rocky shoreline can be chilly because it is a point that juts out far into the lake. Shovel Point is part of Tettegouche State Park which boasts other geological wonders that deserve mentioning like the falls of the Baptism River. The visitor also can descend on stairs to the lakeshore and get a better view of the rhyolite and basalt up close.

The 1.1 billion year-old rhyolite originates from midcontinental rift lava flows. Along Lake Superior these lava flows tilt to the southeast. The continent ripped apart from Kansas to Lake Superior. The lake itself is a natural wonder as the largest freshwater lake in area in the world. While shared by other states and Ontario, Lake Superior displays one of its most beautiful stretches of coastline here in

Minnesota. It is one of very few lakes where you can gaze across its expanse and not see the opposite shore.

2. Lake Itasca (Clearwater County)

In the land of lakes, Lake Itasca is unique in that it is the headwaters of the longest named river in North America, the



Figure 1. Palisade Head with Shovel Point in the Background. Photo, D. Pelto. www.dnr.state.mn.us/fall_colors/parkphotoviewer.html?id=1156968173996

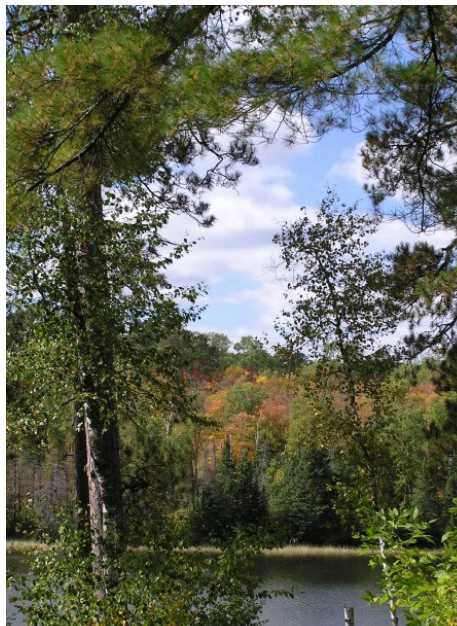


Figure 2. Lake Itasca. Photo, C. Cox www.dnr.state.mn.us/fall_colors/parkphotos.html?parkid=SPK00181

Mississippi. The river is roughly 2500 miles in length. The lake remains in near pristine condition since its inception as the Midwest's first permanent state park in 1891. The lake is bordered by an old-growth evergreen forest which towers cathedral style over park visitors. The Mississippi River is little more than a rivulet here and can be crossed on foot (see Figure 2).

Lake Itasca covers 4.7 square kilometers (1.8 square miles) in area and its maximum depth 12 meters (40 ft.) It is hydraulically connected to Elk Lake on its southwestern arm. Elk Lake, although many times smaller than Itasca, has been nominated by some as the true headwaters to the Mississippi given that it flows into Itasca during years of normal and high precipitation.

Lake Itasca is part of a knob and kettle landscape forming a glacial moraine. The lake formed in a buried bedrock valley behind a block of melting glacier.

3. Morton Gneiss (Redwood County) Redwood Falls

Morton gneiss is a metamorphosed granite-like rock that can be observed in Redwood Falls and also in downtown St. Paul at 4th and Market Streets at the base of the Qwest building. This migmatitic crystalline rock (see Figure 3) is quarried in nearby Renville County. Its mineralogy is quartz, biotite and feldspars.

Formed during the Archean age 3.6 billion years B.P., Morton gneiss is among the oldest of rocks in North America. It is likely the oldest decorative building stone

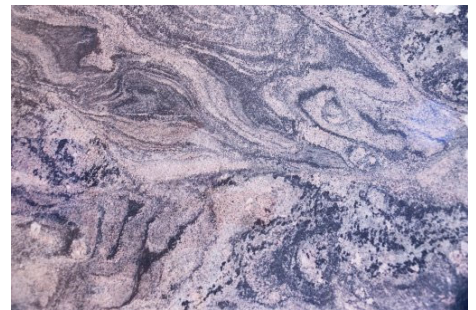


Figure 3. Morton Gneiss. Lafayette Geological Society (LA) www.lgsweb.org/field05a.html

continued on page 8.

Seven Wonders of Minnesota, cont.

in the world. Its history of subjection to tremendous heat and stress from tectonic uplift has created a swirling rainbow pattern that is unmistakable. The coloration and banded patterns make for wonderful building stone treatments in Minnesota and beyond.

Morton gneiss was thought to have remelted under tremendous heat 2.6 billion years ago. After folding and extreme deformation the rock attained its swirled appearance of today.

4. Stromatolites (St. Louis County) Hoyt Lakes - Mesaba

Stromatolites are fossil assemblages formed by blue-green algae or cyanobacteria (see Figure 4). They are found in rocks 2 to 3.5 billion years in age and are the oldest of fossils on earth. During formation, they were the most dominant species on earth, but now they are forming only in rare locations such as



Figure 4. Stromatolites
www.dnr.state.mn.us/fossils/stromatolites.html

Shark Bay, Australia and the Bahamas. Stromatolites occur in the Biwabik formation on the Iron Range of northeastern Minnesota. These fossils consist of chert that has replaced carbonate material. Reddish stromatolites are characteristic of hematite in the Biwabik Iron formation. They form in shallow marine environments where tidal fluctuations are evident and wave action is pronounced.

Elsewhere in Minnesota, currently forming lake stromatolites have been identified. In 1992, the Minnesota legislature enacted a law to protect stromatolites in state waters. It states "A person may not possess, move, or disturb a stromatolite located in waters of the state except under a permit issued by the commissioner (DNR)." Stromatolites can be found in the former Cliffs-Erie mine and in and around other taconite pits.

5. Hunter's Lake Esker (Sherburne County) Zimmerman

Although seldom seen by the public, this is one of the most visually unique glacial features in Minnesota. An esker is a long, narrow ridge of sand, gravel and boulders deposited by a stream flowing under or in a decaying continental glacier. The Hunter's Lake esker (see Figure 5) also coincides with a 25-mile long tunnel valley that starts nearly 20 miles northeast near Stanchfield, Minnesota. This esker continues virtually uninterrupted for two miles going beyond the Hunter's lakes to the northeast and to the south. Related segments of the esker likely continue for up to seven miles. The subglacial fluvial discharge occurred to the south likely fanning out to the outwash found at the intersection of Sherburne, Anoka, and Isanti counties.



Figure 5. Hunter's Lake Esker - Photo, L. Maher.

The esker slithers snake-like across Hunter's Lake following a former subglacial meltwater channel that had icewalls as its banks. The deposits in and around the esker are sand, gravel and cobbles. The deposits that form this esker are likely associated with the Superior Lobe of late Wisconsinan glaciation. This glacial advance was responsible for glacial deposits of the St. Croix moraine in the

surrounding area of Sherburne County. The esker was formed as the glacier decayed around 20,000 years B.P.

The esker divides Hunter's Lake in half. West Hunter's Lake is 0.2 square kilometers (58 acres) while East Hunter's is slightly smaller (54 acres). The deepest part of the lakes is only two meters (seven feet). Because the landscape is young, poor drainage and wetlands surrounding eskers are relatively common.

6. Whitewater State Park (Winona County) Elba

Whitewater State Park boasts some of the most developed features of surficial karst in the Upper Midwest. The spires of carbonate rock are reminiscent of Chinese paintings from previous millennia. Most of the Prairie du Chien Group is fully exposed here with the results of limestone dissolution clearly visible. Caves and cavities in the rock reveal solution channels.

One formation easily observed at the park is the Oneota Dolostone. It is quarried in south central Minnesota as the Mankato-Kasota Limestone. The New Richmond Sandstone and Shakopee formation (dolomite) may be found in a road cut near the south entrance of the park on State Highway 74. These formations overlie the Oneota Dolostone. The highly fractured Shakopee formation is also visible at the top of Chimney rock (see Figure 6) and Coyote Point. The Jordan Sandstone



Figure 6. Chimney Rock, Whitewater State Park
www.winona.edu/geology/MRW/mrwimages/ChimneyRock2.jpg

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Seven Wonders of Minnesota Geology, cont.

(Cambrian Age) can be observed at the Whitewater River below Chimney Rock.

The meandering Whitewater River and mixed oak forest charm the visitor with beauty and provide multiple examples of weathering and erosion in action. The river and park are named after the color of the water after bank erosion from storm events.

7. Mystery Cave (Fillmore County) Preston

Part of Forestville State Park, Mystery Cave displays an abundance of karst features, visible mostly underground. The caverns are traversed by a disappearing stream, or rather a stream that appears above ground seemingly out of nowhere. The ground water flows out of the cave into a small tributary to the South Branch of the Root River. During high water, the cave is also linked to the upstream reaches of the South Branch.

Mystery Cave is the longest accessible cave in the upper Midwest. More than twelve miles of passageways pass between two formations with visibly varying composition. The Stewartville and the overlying Dubuque limestones of Ordovician age can be seen within the cave. These rocks are approximately 447 million years old.

Mystery Cave has been kept in a near-natural state by the DNR. The visitor's center is excellent as are the guided cave tours. There are fish that live in the cave after high water events, but they do not reproduce there so they are not related to the cave-dwelling blind species found in Missouri and Arkansas. Fossils embedded in the limestone may be inspected up close. Also flowstone and standing pools of water are visible in the cave (Figure 7).

A complete list of Minnesota geological



Figure 7. Pool of Water at Mystery Cave, Forestville State Park - Photo, T. Clark.

wonders would be very extensive and would take years to visit. A useful article by MN Department of Natural Resources staff on geological wonders of Minnesota State Parks can be found at www.dnr.state.mn.us/volunteer/marapr02/geological.html. Information on Tettegouche State Park and Forestville State Park are found there and were used in my article.

Kurt Schroeder, Newsletter Team

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On-Line Ground Water Data Sources

At MGWA's fall ground water conference, Cathy O'Dell of the Minnesota Pollution Control Agency (MPCA) presented a number of on-line ground water data sources. Because there were several requests for the website links to this information, we've provided them below.

MPCA's Baseline Water Quality of Minnesota's Principal Aquifers (1992-1996): www.pca.state.mn.us/water/groundwater/gwmap/gw-baseline.html

MPCA's current ambient ground water monitoring studies (see page 13): www.pca.state.mn.us/water/groundwater/gwmap/gw-conditionmonitoring.html

www.pca.state.mn.us/water/groundwater/gwmap/gw-trendmonitoring.html

Minnesota Department of Agriculture (MDA)'s Monitoring and Assessment for Agricultural Chemicals in the Environment:

www.mda.state.mn.us/appd/ace/maace.htm

U.S. Geological Survey (USGS) National Water Information System:

waterdata.usgs.gov/mn/nwis/gw

MPCA's What's in My Neighborhood (searchable inventory of sites enrolled in MPCA cleanup programs or are otherwise listed by the MPCA):

www.pca.state.mn.us/backyard/neighborhood.html

MDA's What's In My Neighborhood? (similar to MPCA inventory but for agricultural release sites) www.mda.state.mn.us/incidentresponse/

neighborhood.htm

MGWA link to the Minnesota Ground Water Information Guide:

www.mgwa.org/gwig/index.html

For more information, contact Cathy O'Dell at 651/296-7727 or Catherine.Odell@state.mn.us.

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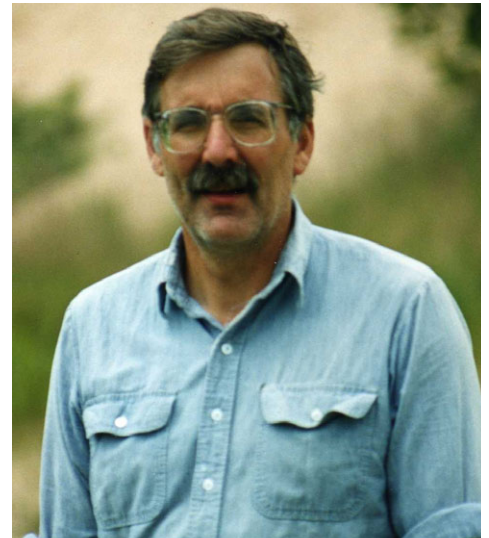


John McDermott, hydrogeologist, passes away

In mid-December 2006, John McDermott died after an abbreviated bout with cancer. He was a talented hydrogeologist and environmental advocate. He had a BS Degree in Geology from the University of Idaho and did graduate study at the New Mexico Institute of Mining and Technology.

John was part owner of Davis Drilling in Billings, Montana during the 1980's. He left Montana to work at the Minnesota Pollution Control Agency from 1987 to 1991 as a hydrogeologist. There John came up with the original concept for the current Minnesota Closed Landfill Program. He noticed that the Superfund program was ineffective in dealing with landfills. He suggested that clean up of closed landfills would be much more expedient if the State took over responsibility for them. The Minnesota Legislature adopted the concept in 1994, and it is still an active and effective program to this day.

John was renowned for his endless good humor and as a tireless bicyclist, gardener and community activist. He worked for Capsule Engineering from 1991 to 2001 and for several years more recently with EnviroRisk consultants. He was 59 at his passing. He is survived in the Twin Cities by his wife and son.



Send your comments to editor@mgwa.org

In Memoriam: Shelby J. Boardman

Shelby Boardman, professor of geology at Carleton College, died suddenly on January 19, 2007, at the age of 62. Shelby taught geology for 35 years at Carleton, where his specialty was teaching mineralogy and petrology. He joined the faculty in 1971 and, in addition to many years of teaching, performed several administrative functions for the college. He returned to teaching last fall after stepping down in 2005 from three years as dean of the College and enjoying a sabbatical year in 2005-2006.

Shelby's smile was a defining characteristic. It was a tool he wielded with aplomb in greeting all that he met, in putting nervous students at ease, and in carrying out the occasional mischievous prank. His straightforward honesty, cheerful demeanor, and abiding interest in educating undergraduates helped to make the geology department at Carleton a place of warm congeniality where excellence could blossom.



Taylor's Falls, 2004. Photo by Leah Morgan.

MDH Designates Four New Special Well Construction Areas

By Well Management Section, Minnesota Department of Health

The Minnesota Department of Health (MDH) has designated four new Special Well Construction Areas. These SWCAs are as follows:

- ◆ **Eckles Township (Beltrami County):** Sections 13, 14, 23, and 24 of Township 147 North, Range 34 West. Ground water is contaminated by nitrate at levels approaching 30 milligrams/liter (mg/l) in a surficial sand aquifer.
- ◆ **City of Spring Grove and Spring Grove Township (Houston County):** Sections 11,12,13, and 14, of Township 101 North, Range 7 West. Ground water is contaminated by 1,1,2-trichloroethene (TCE) in bedrock aquifers from the Galena Limestone down into the Jordan Sandstone.
- ◆ **City of Long Prairie (Todd County):** Portions of sections 16, 17, 20, and 21, of Township 129 North, Range 33 West. Ground water is contaminated by 1,1,2,2-tetrachloroethene and related chlorinated organics in an alluvial/outwash aquifer.

- ◆ **City of Perham (Otter Tail County):** Portions of sections 14 and 23, Township 136 North, Range 39 West. The surficial sand aquifer is contaminated with arsenic.

The authority to designate a SWCA are established in Minnesota Statutes, section 103I.101, subdivision 5 (7), and in Minnesota Rules, part 4725.3650. The MDH may establish specific requirements regarding the construction, repair, and sealing of wells within a SWCA, including plan review and approval, water quality monitoring, and other measures to protect public health and prevent further degradation of ground water. The primary objective of any SWCA is to make sure that wells provide a long-term, safe source of drinking water. In addition, there may be concerns regarding wells and borings aggravating an existing ground water contamination problem or interfering with remedial measures.

For more detailed information on these and other SWCAs, you may contact Michael Convery at 651/201-4586 or visit the Well Management Section website on SWCA's at www.health.state.mn.us/divs/eh/wells/swca/index.html.

Ambient Ground Water Monitoring at MPCA

By Mindy Erickson, Minnesota Pollution Control Agency

Do you need to know the background selenium concentration in Otter Tail County ground water so that you can complete a site investigation or remediation design?

Are you trying to assess whether increasing stormwater infiltration near a trout stream will help protect the fragile cold-water trout habitat?

Are wondering what the background iron, manganese, and arsenic concentrations are in ground water in western Wright County to know whether a treatment system would be advisable for a new home that will be served by a domestic well?

Do you need to estimate how much road salt is being introduced to an impaired urban stream via ground water base flow?

Are you trying to evaluate the effectiveness of efforts to reduce nitrate contamination in ground water in Brown County?

The data to help answer these types of questions – and many more – are available from the Pollution Control Agency's (MPCA) ambient ground water monitoring project.

In the midst of budget cuts during 2001, MPCA's Ground Water Monitoring and Assessment Program (GWMAP) ambient ground water monitoring activities were discontinued. Program discontinuation was the last news that many people in the ground water community heard about MPCA's ambient ground water monitoring activities. But in 2003, the program was quietly restarted on a small scale.

Ambient ground water monitoring is back at MPCA!

MPCA's ambient ground water monitoring is widely identified as the statewide baseline water chemistry survey conducted during the mid 1990s by GWMAP, but the baseline study is just one past project of the MPCA's ground water monitoring efforts.

The MPCA conducts ambient ground water monitoring in coop-

eration with the Minnesota Department of Health and Minnesota Department of Agriculture. Each agency's monitoring responsibility and role are outlined in a Memorandum of Agreement, which can be found online at www.pca.state.mn.us/publications/gw-monitoringsystemagreement.pdf.

During 2007, the MPCA will conduct a range of ground water monitoring activities to meet the ambient ground water monitoring project's primary objectives, which are:

- ◆ Assess impacts of non-agricultural chemicals on the condition of ground water in Minnesota
- ◆ Evaluate trends in ambient ground water quality
- ◆ Identify and monitor factors that affect ambient ground water quality
- ◆ Provide expertise and sampling support for emerging contaminants

MPCA currently has a database of over 12,000 shallow and potentially vulnerable domestic and monitoring wells. The database serves as the program's candidate pool of wells. All candidate wells are located in non-agricultural areas. Candidate domestic wells are in sensitive hydrogeologic settings such as surficial sand aquifers or where the Prairie du Chien, Jordan, or Galena formations are the uppermost bedrock unit. Candidate monitoring wells primarily occur in coarse-textured surficial aquifers.

The ambient program's pool of candidate wells was designed to act as a 'sentry system' for ground water contamination: the program chooses wells that are vulnerable to contamination but that are not known to be contaminated from a particular source.

To assess impacts of non-agricultural chemicals on the condition of ground water, MPCA conducts annual sampling of domestic and monitoring wells randomly selected from the program's candidate wells. Analytes include chloride, nitrate, volatile

continued on page 14.

Ambient Ground Water Monitoring at MPCA, cont.

organic compounds (VOCs), and field parameters (e.g., temperature). At some monitoring wells, additional samples are collected to assist other ground water monitoring programs (e.g., pesticides for the Minnesota Department of Agriculture).

Long-term trends in ambient ground water quality are evaluated by re-sampling wells that meet at least one the following criteria: nitrate concentration exceeding 3.0 mg/L, a VOC detection, or chloride concentration exceeding 150 mg/L.

Several types of monitoring are conducted to support evaluation of factors that affect ambient ground water quality. For example, changes in ground water quality are monitored in urban areas that are undergoing land use transition. Examples of land use transitions include development of undeveloped land, brown-field redevelopment, or extension of municipal services to previously non-sewered residential areas. The MPCA is also monitoring the impacts to ground water from storm water infiltration systems and impacts from clay-lined manure containment systems.

When appropriate, ground water monitoring staff provides expertise and sampling support to other groups interested in ground water quality, such as MPCA's Emerging Issues Team. For example, in late 2006 a small number of monitoring wells were sampled for perfluorinated compounds (PFCs) in response to recent reports and concern about PFC detections in remote surface water bodies.

MPCA is actively collecting ground water information in support of its ambient ground water monitoring goals – but with the anticipation of supporting myriad other needs. If you are unfamiliar with MPCA's past and present ground water information, data, and reports, please visit our website at:

www.pca.state.mn.us/water/groundwater/gwmap/.

For more information, contact Mindy Erickson (651-297-8383 or mindy.erickson@state.mn.us) or Jim Stockinger (651-296-6549 or jim.stockinger@state.mn.us).

Ground Water and Flow Monitoring Unit Established at MPCA

Mike Sandusky, Director of the Environmental Analysis and Outcomes Division at the Minnesota Pollution Control Agency (MPCA) has announced the creation of a new Water Monitoring Section for the Division. The new Section, headed by Shannon Lotthammer, will consolidate lakes and streams monitoring, biological monitoring and ground water and flow monitoring in one area within the MPCA. In announcing the restructuring, Sandusky mentioned that part of the reason for the consolidation is to address new and anticipated funding increases under the Clean Water Legacy Act.

The purpose of the Water Monitoring Section is to monitor the physical, chemical and biological condition of Minnesota's surface and ground water; coordinate water monitoring activities with other Agency Divisions and external partners; support and promote volunteer monitoring; turn monitoring data into useful information to assess Minnesota waters; help identify sources of pollution, and track changes over time; and to provide that information to the Agency, stakeholders and the public.

The new Ground Water and Flow Monitoring Unit includes the unit supervisor (yet to be named at the time of this writing), 5.5 professional positions (filled from internal transfers), and a student intern to assist the ambient ground water monitoring program. Specific activities of the new unit are to:

- Plan and implement the MPCA's ambient ground water monitoring network and ground water data management/access improvements for the agency.
- Lead the Division and Agency's effort to identify and develop needed best management practices (BMPs) for ground water protection, as required by MPCA's Strategic Plan.
- Plan and implement focused ground water monitoring studies, such as the Stormwater BMP study.
- Provide technical support and expertise to the Section and Agency on ground water monitoring and ground water issues, including ground water-surface water interactions.

- Coordinate Agency ground water monitoring efforts with state, federal and local partners.
- Support volunteer ground water monitoring projects and develop monitoring and educational partnerships with schools and educators.
- Plan and conduct stream flow monitoring in support of condition monitoring, basin planning and total maximum daily load development.
- Work with MPCA's Regional Division to coordinate flow monitoring activities, plan and implement flow monitoring data management improvements, and develop common protocols and share expertise and resources.
- Analyze ground water and flow monitoring data and prepare reports.

Submitted by Tom Clark, MGWA Newsletter Team



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GREG BRICK'S GROUND WATER HISTORY

Ground Water History — Apocalyptic Waters: An Early Account of Ground Water Pollution in Minnesota

By Greg Brick, Geology Instructor, Normandale College

Fountain Cave in St. Paul, the longest natural sandstone cave in Minnesota, is a cave of many state firsts. The first graphic depiction of a Minnesota cave, in 1850, was of Fountain Cave; it became the first show cave in Minnesota in 1852; and it was the first cave in Minnesota to have its speleogenesis thoroughly and abundantly hashed over by the many visitors traveling up the Mississippi River. Another distinction, less happy, is that Fountain Cave was the first cave in Minnesota to become polluted by human activities, in the modern sense.

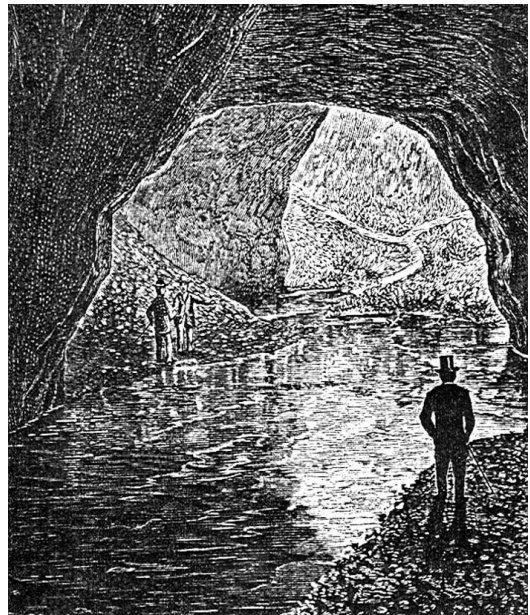
As background, Fountain Cave was a sinking stream system in St. Peter Sandstone pseudokarst. Fountain Creek, a surface stream arising from wetlands in the Fort Road neighborhood in St. Paul, drained into a sinkhole at the upper end of the cave, flowing through the cave and out again into a ravine that led to the Mississippi River. The early travel literature is replete with descriptions of the “pure white sandstone” of the cave, and so forth, employing a language redolent with purity. The Reverend Edward Duffield Neill, well-known local historian and founder of Macalester College, wrote gushingly of Fountain Cave and Creek in 1855: “Through it flows a stream as clear as crystal. As it hastens over the sand, that looks like powdered white sugar, one recalls the ‘pure river of water of life’ in the Apocalypse.”¹ As late as 1879, a guidebook, *Tourists’ Guide to the Health and Pleasure Resorts of the Golden Northwest*, which had been published by the Milwaukee Road, contained an engraving of top-hatted Victorian gentlemen with walking sticks strolling leisurely through Fountain Cave (see figure). But the imagery of unspoiled nature did not last much longer.

In 1880, the Omaha Railroad shops were built on the river terrace above Fountain Cave, and a shaft was advanced down to the cave to drain away sewage.² However, even though it can be thus inferred that the cave was polluted as early as 1880, I have not found any explicit accounts of contamination. But in 1892, a St. Paul assistant city engineer, George L. Wilson, reported that “The stream that formerly ran through [Fountain Cave] is still in existence, but is fouled by the waste from a brewery that finds its way to the river in the same channel.”³ This is one of the earliest accounts of cave pollution or ground water pollution in Minnesota.

Notice that this brewery pollution differs from the railroad waste in that the surface stream itself, before plunging into the cave, is polluted, rather than wastes being injected directly into the cave through the shaft. Brewery wastes typically have a high biochemical oxygen demand (BOD), sucking oxygen from the water, and this would have rendered the cave inhospitable to amphipods (also known as scuds, or freshwater shrimp), which almost certainly existed there, along with other macroinvertebrates, as they do in nearby Carver’s Cave to the present day.

It’s not easy to determine exactly which of several former breweries in the vicinity was responsible for polluting Fountain Cave. Although Duffy’s *Map of Ramsey County* (1859) shows Fountain Creek running through the grounds of the Stahlmann Brew-

ery, Bennett’s *Map of Ramsey County* (1867) depicts Cascade Creek in this location. Physically speaking, however, the Banholzer Brewery was closest of all to the cave. A newspaper columnist, Mark Fitzpatrick, writing in 1945, using unidentified sources, appears to have fingered yet a different brewery: “The waters feeding the fountain of the cave...gurgling through the swampy mounds passing near the old Wurm Brewery until it enters Fountain Cave on the grounds occupied by the Chicago, St. Paul and Omaha shops.”⁴



— Fountain Cave in 1879. Image from author’s collection.

Sadly, Fountain Cave was associated with another, unrelated pollution event many years later. In the 1960s, the Clark Oil Terminal, situated on the river terrace, leaked thousands of gallons of fuel oil into ground water, and the release migrated to the Fountain Cave ravine, from which it escaped to the Mississippi River through a stormwater outfall.⁵ To this day, the outfall still reeks of oil.

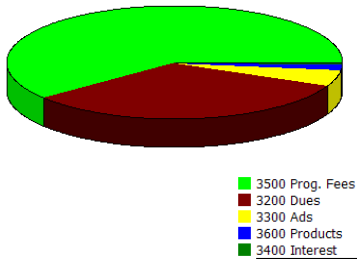
Notes

1. Edward Duffield Neill, “Saint Paul and its Environs,” *Graham’s Magazine* 46 (January 1855): 3-17.
2. William H. Dunne, “The Environs of St. Paul,” *Saint Paul Dispatch*, September 6, 1880. This is also mentioned in “Fine Bouilvard [sic] Approach to Historic Fountain Cave, Hope of Pioneer Body,” *St. Paul Pioneer Press*, August 8, 1920; and by George L. Nason, “Visiting Around St. Paul Parks,” *St. Paul Dispatch*, October 27, 1932.
3. “In the Sandrock,” *St. Paul Pioneer Press*, May 30, 1892.
4. Mark Fitzpatrick, “Otto W. Rohland and West End Gardens,” *St. Paul Shopper*, April 25, 1945.
5. PEER Environmental & Engineering Resources, Inc., *Storage Tank Release Investigation, Clark Oil Terminal, St. Paul, Minnesota*, September 1991.

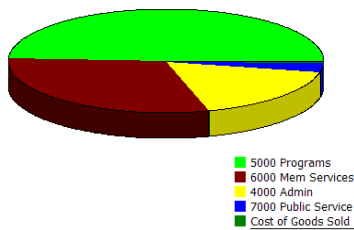
ASSOCIATION NEWS

2006 Year-End Financial Report

Income



Expenses



Income Statement January 1 - December 31, 2006

Income	Member and Corporate Dues	\$19,748.00
	Advertising	\$2,966.00
	Interest	\$105.32
	Conference and Program Fees	\$36,981.90
	Printed Materials Fees	\$947.16
Total Income		\$60,748.38
	Materials	(\$22.94)
Gross Income		\$60,725.44
Expenses	Administration	\$8,852.48
	Conference Expenses	\$25,245.19
	Membership Services	\$15,484.23
	Public Services	\$1,587.76
Total Expenses		\$51,169.66
Net Income		\$9,555.78

Treasurer's Report

- ◆ 2006 ended with a surplus of \$9,556 on a total income of \$60,725. This amount is nearly the same amount as last year.
- ◆ Upon the Board's approval the net income from 2006 will be transferred to the MGWA Foundation in mid-2007.
- ◆ At the end of 2006, the MGWA had approximately \$23,300 on hand.
- ◆ If you have any questions, comments, or concerns regarding the MGWA finances please contact Craig Kurtz at (763)757-6876 or at craigkurtz@msn.com.



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REPORTS AND PUBLICATIONS

New Publications by USGS Staff on Minnesota Ground-Water Recharge

Staff of the U.S. Geological Survey recently published two articles on ground-water recharge in Minnesota.

Lorenz, D.L., and Delin, G.N., 2007, *A regression model to estimate regional ground-water recharge in Minnesota*, *Ground Water*, v. 45, no. 2, doi: 10.1111/j.1745-6584.2006.00273.x.

Abstract

A regional regression model was developed to estimate the spatial distribution of ground water recharge in subhumid regions. The regional regression recharge (RRR) model was based on a regression of basin-wide estimates of recharge from surface water drainage basins, precipitation, growing degree days (GDD), and average basin specific yield (SY). Decadal average recharge, precipitation, and GDD were used in the RRR model. The RRR estimates were derived from analysis of stream base flow using a computer program that was based on the Rorabaugh method. As expected, there was a strong correlation between recharge and precipitation. The model was applied to statewide data in Minnesota. Where precipitation was least in the western and northwestern parts of the state (50 to 65 cm/year), recharge computed by the RRR model also was lowest (0 to 5 cm/year). A strong correlation also exists between recharge and SY. SY was least in areas where glacial lake clay occurs, primarily in the northwest part of the state; recharge estimates in these areas were in the 0- to 5-cm/year range. In sand-plain areas where SY is greatest, recharge estimates were in the 15- to 29-cm/year range on the basis of the RRR model. Recharge estimates that were based on the RRR model compared favorably with estimates made on the basis of other methods. The RRR model can be applied in other subhumid regions where region wide data sets of precipitation, streamflow, GDD, and soils data are available.

The above map can be used as a small graphic or near-thumbnail. The caption should read: Figure X. Average annual recharge to surficial materials in Minnesota (1971 to 2000) estimated on the basis of the regional regression recharge model.

Delin, Geoffrey N., Healy, Richard W., Lorenz, David L., and Nimmo, John R., 2007, *Comparison of local- to regional-scale estimates of ground-water recharge in Minnesota, USA*, *Journal of Hydrology*, vol. 2334, p. 231-249. doi:10.1016/j.jhydrol.2006.10.010

Summary

Regional ground-water recharge estimates for Minnesota were compared to estimates made on the basis of four local- and basin-scale methods. Three local-scale methods (unsaturated-zone water balance, water-table fluctuations (WTF) using three approaches, and age dating of ground water) yielded point estimates of recharge that represent spatial scales from about 1 to about 1000 m². A fourth method (RORA, a basin-scale analysis of streamflow records using a recession-curve-displacement technique) yielded recharge estimates at a scale of 10–1000s of km². The RORA basin-scale recharge estimates were regionalized to estimate recharge for the entire State of Minnesota on the basis of a regional regression recharge (RRR) model that also incorporated soil and climate data. Recharge rates estimated by the RRR model compared favorably to the local and basin-scale recharge estimates. RRR estimates at study locations

were about 41% less on average than the unsaturated-zone water-balance estimates, ranged from 44% greater to 12% less than estimates that were based on the three WTF approaches, were about 4% less than the age dating of ground-water estimates, and were about 5% greater than the RORA estimates. Of the methods used in this study, the WTF method is the simplest and easiest to apply. Recharge estimates made on the basis of the unsaturated-zone water balance (UZWB) method were inconsistent with the results from the other methods. Recharge estimates using the RRR model could be a good source of input for regional ground-water flow models; RRR model results currently are being applied for this purpose in USGS studies elsewhere.

USGS Ground-Water Recharge in Minnesota Fact Sheet Available

Delin, G.N., and Falteisek, J.D., 2007, *Ground-Water Recharge in Minnesota: U.S. Geological Survey Fact Sheet 2007-3002*, 6 p. pubs.usgs.gov/fs/2007/3002/

"Ground-water recharge" broadly describes the addition of water to the ground-water system. Most water recharging the ground-water system moves relatively rapidly to surface-water bodies and sustains streamflow, lake levels, and wetlands. Over the long term, recharge is generally balanced by discharge to surface waters, to plants, and to deeper parts of the ground-water system. However, this balance can be altered locally as a result of pumping, impervious surfaces, land use, or climate changes that could result in increased or decreased recharge.

- ◆ Recharge rates to unconfined aquifers in Minnesota typically are about 20–25 percent of precipitation.
- ◆ Ground-water recharge is least (0–2 inches per year) in the western and northwestern parts of the State and increases to greater than 6 inches per year in the central and eastern parts of the State.
- ◆ Water-level measurement frequency is important in estimating recharge. Measurements made less frequently than about once per week resulted in as much as a 48 percent underestimation of recharge compared with estimates based on an hourly measurement frequency.
- ◆ High-quality, long-term, continuous hydrologic and climatic data are important in estimating recharge rates.

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Met Council Publishes 2007 Legislative Report: Water Supply Planning in the Twin Cities Metropolitan Area

The Metropolitan Council (Council) has released its 2007 report to the Minnesota State Legislature, "Water Supply Planning in the Twin Cities Metropolitan Area." The 2005 Legislature charged the Council (Minnesota Statutes, Section 473.1565) with developing a base of technical information for water supply planning decisions and preparing a metropolitan area master water supply plan. The statute also established a Water Supply Advisory Committee to assist the Council in its planning activities and directed the Council to submit regular reports to the Legislature detailing progress. This report satisfies the statutory requirement as the first report to the legislature. Subsequent reports are due to the Legislature every five years.

The January 2007 report describes technical and policy recommendations in four broad areas:

- Water Demand and Availability;
- Water Supply Decision-Making and Approval Process;
- Safety, Security and Reliability of Water Supply; and
- Institutional Arrangements and Funding

The 44-page report is available at: www.metrocouncil.org/environment/WaterSupply/documents/WaterSupplyReporttoLeg07_Final_web.pdf

USGS Data Delivery and Mapping Over the Web

The National Water Quality Assessment (NAWQA) Program has announced the availability of its recent U.S. Geological Survey (USGS) Fact Sheet (2006-3101), "Data Delivery and Mapping Over the Web: National Water Quality Assessment Data Warehouse (accessible at: pubs.usgs.gov/fs/2006/3101/)

NAWQA's Data Warehouse integrates data (more than 11 million records) on water quality, ecology, and hydrology across the country, providing one of the largest nationally consistent on-line collections of water quality data and associated information that is available (accessible at: water.usgs.gov/nawqa/data/). Some examples of what the database contains are:

- Chemical concentrations in water, sediment, and aquatic organism tissue;
- Biological community data for 16,000 algae, fish and invertebrate samples;
- Data on 8,000 stream sites, 8,000 wells and associated basin information.



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New Well Disinfection Fact Sheet Available from MDH

The Well Management Section of the Minnesota Department of Health (MDH) has recently published a new fact sheet entitled "Well and Water System Disinfection for Private Wells." The fact sheet is intended for domestic wells with submersible pumps that either have a removable well cap or a well seal with a threaded plug in it. The publication provides step-by-step procedures for performing simple disinfection of private wells and water (plumbing) systems using chlorine bleach (sodium hypochlorite). A section is also included about disinfection of water softeners, water treatment equipment and water using devices.

Copies of the fact sheet can be requested by calling (651) 201-4600. In addition, it is available on the MDH web site at: www.health.state.mn.us/divs/eh/wells/waterquality/disinfection.pdf. From Minnesota Well Management News, Volume 26, No.2.

Midwestern Hydrogeological Studies Integral Part of Aquitard Course

By Ken Bradbury, Wisconsin Geological Survey and Dan Kelleher, Midwest GeoSciences Group

How many times have you learned of a shallow groundwater contamination problem and heard someone say "We don't have to worry about the deep aquifer, it is protected by an overlying aquitard"? How many times have you seen cross sections showing that downward migration of contaminants stops at a clay or shale layer? Have you ever really investigated these aquitards? How do you know they are effective barriers to contaminant movement?

Please read the following announcement of the publication "Contaminant Transport Through Aquitards: A State-of-the-Science Review and Technical Guidance for Aquitard Assessment." As a result of these emerging advances and the recognition of their importance, the researchers have collaborated with the Midwest GeoSciences Group by designing a 3-day course: *Assessing Ground Water Movement and Contaminant Migration Through Aquitards: From Field Investigation to Hydrogeologic Characterization*. The collaborators chose Fermilab in Batavia, Illinois

continued on next page

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Aquitard Course, Cont.

for the course location because of its conducive setting for testing *aquitard integrity*. The geologic framework at Fermilab consists of a stacked succession of clayey glacial units and underlying regional bedrock aquitard coupled with the extensive field instrumentation installed in each unit. Vertically nested wells and a single-borehole, multi-level monitoring system allow *aquitard integrity* testing and a side-by-side comparison of field methods appropriate to assess low-conductivity conditions. The glacial succession and the underlying sequence of Silurian-age dolomite and Ordovician Maquoketa Shale represent geologic conditions similar to those found throughout Wisconsin and in many other areas throughout the continental United States. Further information can be found on-line at www.midwestgeo.com. Also see the ad for this course on page 25.

AwwaRF Publishes Review and Technical Guide for Aquitard Assessment

By Ken Bradbury, Wisconsin Geological Survey and Dan Kelleher, Midwest GeoSciences Group

A team of researchers from the Wisconsin Geological and Natural History Survey, Marshfield Clinic, and University of Waterloo recently completed a review of aquitard science for the American Water Works Association Research Foundation (AwwaRF). The title of the publication is "Contaminant Transport Through Aquitards: A State-of-the-Science Review and Technical Guidance for Aquifer Assessment (Project #2760)". This work has evaluated the state of aquitard science and has also summarized the most appropriate methods for aquitard assessment, with emphasis on contaminant movement. Technical reports from this work are currently available to AwwaRF subscribers (including most water utilities) through the AwwaRF website www.awwarf.org/research/.

Although aquitards often seem to make up only minor parts of hydrostratigraphic sequences, they commonly control the overall groundwater flow system by influencing recharge, head distributions, groundwater flow paths, and contaminant migration. Characterizing aquitards for environmental and water resource projects is therefore essential for protecting deep aquifers, siting municipal wells, and understanding potential contaminant pathways for impacted aquifers. Both unconsolidated and bedrock aquitards share inherent low hydraulic conductivities, but approaches and field methods for characterizing each type can be completely different. Appropriate characterization requires site-specific understanding about the aquitard's origin, unit distribution, heterogeneity, fracturing, and the effects of secondary weathering or tectonics.

The AwwaRF study determined that aquitards are far more complex than the monolithic, extensive layers usually shown in hydrogeology textbooks. Many, if not most, aquitards contain fractures, macropores, windows, or other heterogeneities that can compromise their ability to protect adjacent aquifers. The concept of *aquitard integrity* addresses these issues. Investigations of aquitards should always collect data *inside* the aquitard as opposed to the common practice of data collection above and below the aquitard. Often, the protective or low-hydraulic conductivity zone of an aquitard is far thinner than the mapped

thickness of the stratigraphic unit containing the aquitard. Appropriate investigations for aquitard analysis should include a combination of hydraulic, geophysical, isotopic, and geochemical testing.

Recent studies in the Upper Midwest have launched deep aquifer contamination to the forefront of the public news. For example, some Midwestern municipal wells are cased through regionally-extensive and thick bedrock aquitards, yet contaminants, including relatively short-lived viruses, have been detected in these deeply-cased wells. In addition, recent studies of the regionally important Maquoketa Shale have shown that the shale is far more complex than the thick aquitard often shown on cross sections, and contains fractures, internal heterogeneity and flow systems, and cross-connecting wells.

2007 GSA Annual Meeting & Exposition

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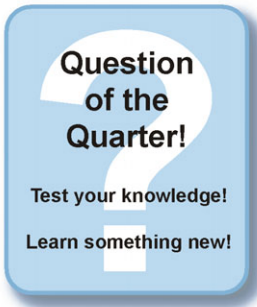
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QUESTION OF THE QUARTER



Hydrochemistry Sudoku

NO ₃					PO ₄		OH	
	CO ₂	PO ₄			H ₂ O			Fe
Fe		HCO ₃	NO ₃		O ₂	Ca	PO ₄	
		OH	H ₂ O	Ca			O ₂	NO ₃
	Ca						CO ₂	
HCO ₃	Fe			PO ₄	CO ₂	OH		
	O ₂	Fe	OH		NO ₃	CO ₂		PO ₄
PO ₄			CO ₂			NO ₃	Ca	
	NO ₃		PO ₄					O ₂

Instructions

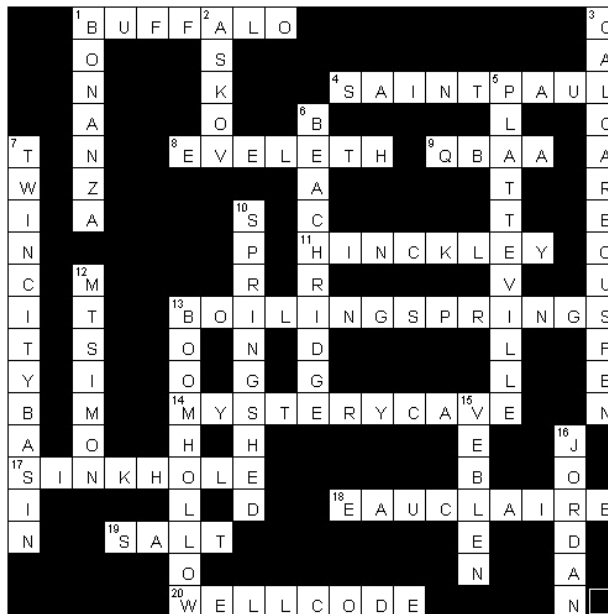
Use these nine Minnesota ground water constituents:

H₂O O₂ OH CO₂ HCO₃ Fe PO₄ Ca NO₃

to complete the board so each column, row, and block of 3 x 3 contains one each of the constituents. Our crack team of puzzle testers report that you should be able to complete the board in about 10 minutes. The solution will be included in the June 2007 issue.

Email your answer and your "two cents worth" to: editor@mgwa.org

Answer to the December '06 Question of the Quarter

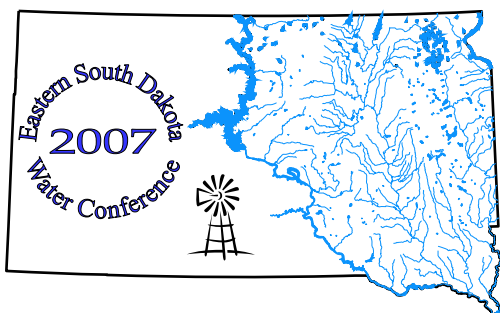


CALL FOR PRESENTATIONS

Joint Conference

2007 Eastern South Dakota
Water Conference

& 52nd Annual Midwest Ground
Water Conference



October 29-31, 2007
Sheraton Hotel & Convention Center
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Field trip Oct. 29 to
(1) USGS-EROS Data Center and
(2) US Army Corps of Engineers
Gavins Point Dam Powerhouse
and Fish Hatchery

52nd Annual Midwest
Ground Water Conference

Website: <http://wri.sdstate.edu/esdwc/> Presentations Oct. 30-31

Abstracts for the joint 52nd Annual Midwest Ground Water Conference and 2007 Eastern South Dakota Water Conference are being solicited. Abstracts for oral and poster presentations are limited to a maximum of 300 words. Abstracts will be accepted through Friday, June 29, 2007. (By submitting an abstract, the author grants the conference organizers the right to publish the accepted abstract.)

Biographical sketches must be in paragraph form and are limited to 100 words.

Authors will be notified of acceptance by July 13, 2007. (Accepted speakers are subject to conference registration fees.)

Program format for oral presentations will be limited to 30 minutes, including introduction and questions; Microsoft® PowerPoint format required for oral and poster presentations. (Accepted presentations will be posted on the conference website, unless otherwise instructed.)

Topics for which abstracts will be considered include, but are not limited to:

Water Supply

- Reclaimed water
- Conservation/demand management
- Security
- Water rights/allocation
- Policy planning

Water Quality

- Non-point source pollution
- Urban best management practices
- Standards
- Emerging contaminants
- Ag best management practices
- Volunteer monitoring

Surface Water

- Missouri River Basin
- River management
- Lake/reservoir management
- Wetlands
- Monitoring
- Streambank stabilization

Ground Water

- Remediation
- Aquifer delineation
- Monitoring networks
- Trends
- In-situ leach mining
- Karst hydrology
- Contaminant fate and transport
- Geophysics

Water Information Management

- Data collection techniques
- Data dissemination
- Data security
- Data standards

Environmental Issues

- Hypoxia
- Carbon sequestration
- Climate change
- Drought

Submit abstract and biographical information one of three ways:

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The newsletter team appreciates the efforts of article contributors, without whom our newsletter would not be possible. To make the process easier on the author, the newsletter team and production staff, we have established some guidelines we would like authors to follow. For a complete list of guidelines, please see the MGWA web site:

- ◆ Submittals should be complete and ready for publication.
- ◆ The text of the article should be submitted as a Microsoft Word document in an attachment to an e-mail or on disk.
- ◆ Tables, captions, figures and graphics should be submitted as separate high quality files.
- ◆ A version of the article with embedded tables, figures, and graphics may be submitted as an additional file to indicate the preferred layout of the tables, figures and graphics within the article.
- ◆ The contributor should include the contributor's name and affiliation following "By" below the title of the article.
- ◆ The contributor should secure permission to print or reprint if applicable and provide the required text to be included with the article.
- ◆ Materials should be submitted before the deadline.
- ◆ If there is any question about the suitability of a proposed article's content for the MGWA newsletter, it is advisable for the contributor to call the editor before investing significant time in article preparation.

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Half Page	7.5 x 4.8	\$225	\$190
Full Page	7.5 x 9.75	\$425	\$360
Inside Cover	7.5 x 9.75	not available	\$395

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E-mail notices:

A one-time e-mailing to the membership costs \$10 for an individual (e.g., seeking a job), and \$50 for an organization (e.g., announcing a new product, address change, etc.). E-mails from companies announcing job openings will no longer be accepted. A 200 word limit is imposed. The advantage of e-mail is the speed of dissemination.

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Join the Minnesota Ground Water Association!

If you are reading this newsletter secondhand, we'd like to take this opportunity to invite you to become a member of MGWA for 2007. Annual dues are \$30 for professional members and \$15 for students (for corporate membership, see www.mgwa.org).

Members receive e-mail notice of the availability of the quarterly newsletter for downloading from the MGWA web site. If desired, members may subscribe to a printed edition of the newsletter (4 issues for \$10).

Members are also entitled to purchase a paper copy of the annual membership directory for \$7; an electronic version will be available on the website for paid members.

Tax deductible contributions to the MGWA Foundation scholarship fund will be gratefully accepted.

Dues paid to MGWA are **not** deductible as charitable contributions for federal income tax purposes. However, dues payments are deductible as ordinary and necessary business expenses to the extent allowed by law.

Just complete the form below and mail to: MGWA, c/o WRI, 4779 126th St. N, White Bear Lake, MN 55110-5910 or visit our web page and join on-line at www.mgwa.org.

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MGWA Spring Conference Methods for Solving Complex Ground Water Problems

The Spring 2007 conference, to be held April 19, 2007, at the University of Minnesota Continuing Education and Conference Center on the St. Paul campus, will address some tools and methods that practitioners have used to tackle two complex problems associated with Minnesota ground water, secondary-permeability systems and recharge.

The first problem will be broadened to include not only karst conditions, commonly found in southeastern Minnesota, but also fractured rocks, soils, and manmade conduits. All of these can have significant influence in solving questions about flow of and contaminant movement in ground water.

The second problem begins to address one of the most uncertain processes in understanding ground-water systems. Recharge at any time- or space-scale is difficult to measure—yet is of critical importance to anyone who has developed conceptual and numerical-simulation models of ground water flow systems. Conference presenters will provide insights based on their research from within and outside of Minnesota ground-water systems. The results should benefit technical practitioners, students, managers and policy makers engaged in these complex problems in ground water.

Topics include:

- ◆ Fractures and other secondary pores in relatively undeformed, Paleozoic bedrock — **Tony Runkel**, MGS
- ◆ Fractured sandstone karst aquifers
Calvin Alexander, U of MN
- ◆ Hydraulic character of subsurface fracture systems using borehole geophysics — **John Williams**, USGS, Troy, NY
- ◆ Role of earthworms in preferential transport through soils — **Satish Gupta**, U of MN
- ◆ Protecting source waters in secondary permeability environments — **Bruce M. Olsen**, MN Dept. of Health
- ◆ Role of multi-aquifer wells in coal-tar migration — **Bill Gregg**, ENSR
- ◆ Overview of recharge to surficial ground water systems in Minnesota — **Jan Falteisek**, MN DNR
- ◆ Comparison of recharge estimation methods used in Minnesota — **Geoff Delin**, USGS
- ◆ The unsaturated zone is not a black box: Implications for contaminant transport — **Art Baehr**, USGS, Trenton, NJ
- ◆ Recharge to Minnesota aquifer systems — **John Nieber**, U of MN
- ◆ Stream losses to ground water based on integrated ground-water and surface-water modeling — **Ray Wuolo**, Barr Eng. Co.
- ◆ Use of recharge estimates to describe water sustainability in Minnesota — **Princesa VanBuren**, MN EQB

**Don't forget:
Professional Geologist
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include continuing
education.**

Regional and Local Events

March 29th, 2007

Bridget Scanlon, 2007 Birdsall-Dreiss Lecturer will speak on the Implications of Climate Variability for Groundwater Resources and Waste Disposal in Semiarid Regions" at the Minnesota Department of Health, Freeman Building - OLF B144, 1:00pm
gsahydrodiv.unl.edu/general/birdsalldreiss.htm

April 11-13, 2007

41st Annual North-Central Geological Society of America Meeting
Kansas Geological Survey and the University of Kansas Joint Meeting South-Central and North-Central Sections of the Geological Society of America
University of Kansas, Lawrence, Lawrence, Kansas
Information: Greg Ohlmacher
ohlmac@kgs.ku.edu

May 10-11, 2007

53rd Annual Institute on Lake Superior Geology Institute on Lake Superior Geology Lutsen Resort and Sea Villas Lutsen, Minnesota
Information: Laurel Woodruff (763)783-3291
www.lakesuperiorgeology.org

May 18-20, 2007

53rd Midwest Friends of the Pleistocene Field Conference
Park Plaza Hotel, Oshkosh, Wisconsin
Wisconsin Geological and Natural History Survey and the University of Wisconsin-Oshkosh Department of Geology.
To be put on the mailing list, contact Kathie Zwettler (kmzwettl@wisc.edu); for more information, visit www.uwex.edu/wgnhs/fop.htm

Assessing Ground Water Movement and Contaminant Migration Through Aquitards

From Investigative Techniques to Hydrogeologic Characterization

May 8, 9, 10, 2007

Location:
Northern Illinois Univ. Extension
- Naperville, Illinois

with field components at:
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(Fermilab)

Ken Bradbury, PhD, PG
Wisconsin Geological & Natural History Survey

Paul Kesich
Fermi National Accelerator Laboratory

Tim Kemmis, PhD, PG
Earth Tech, Inc.

Dave Hart, PhD, PG
Wisconsin Geological & Natural History Survey

Madeline Gotkowitz
Wisconsin Geological & Natural History Survey

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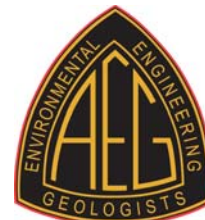
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24 Contact Hours (2.4 CEUs)



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Aquitards (low-hydraulic conductivity hydrogeologic units) are critically important to groundwater and contaminant movement. Characterizing aquitards for environmental and water resource projects is important for protecting deep aquifers and understanding potential contaminant pathways for previously impacted aquifers. Both unconsolidated and bedrock aquitards share inherent low hydraulic conductivities, but approaches and field methods for characterizing each type can be completely different. Appropriate characterization requires site-specific understanding about the aquitard's origin, unit distribution, heterogeneity, fracturing, and the effects of secondary weathering or tectonics. From basic hydraulics to comprehensive fracture analysis, this course addresses the practical aspects of hydrogeologic analysis for *environmental, engineering and water resources projects*.



Co-Sponsored with the
North Central Section

Learn Up-To-Date Methods for Investigating & Characterizing Aquitards

- Improve your characterization of ground water movement & contaminant migration through aquitards by gaining a better understanding of aquitard hydraulics, vertical seepage, confining conditions and more
- Discover the importance of differentiating a sequence of low hydraulic conductivity units
- Discover new techniques and field instrumentation for monitoring aquitards
- Compare water sampling and slug test procedures in low hydraulic conductivity units
- Identify and characterize fractures from an angle boring using continuous rotasonic sampling
- Examine a regional bedrock aquitard and understand fracture distribution and mapping
- Explore new approaches for ground water and solute transport modeling in aquitards
- Gain better understanding about petroleum contamination in weathering zones within fine-grained sediments
- Understand the potential for pathogenic virus contamination in deep aquifers thought to be protected by overlying aquitards

Apply this course to any aquitard setting. This course features the most up-to-date information and procedures on petroleum (LNAPL) subsurface behavior, distribution and recoverability in fine-grained sediments. We will also cover recent advances in pathogenic virus contamination discovered in deep aquifers where the procedures for identifying, sampling, sample transport and lab testing is continually being updated and improved. Join us in May for this unique one-of-a-kind course.

Fractures in Aquitards Workshop: Professionals use a variety of techniques to identify and characterize fractures, macropores, and other discontinuities in aquitards. Share your successes and ideas during a special workshop session.

REGISTRATION FORM

Assessing Ground Water Movement
and Contaminant Migration Through Aquitards:
From Investigative Techniques to Hydrogeologic Characterization
May 8, 9, 10, 2007

Last Name: _____ First Name: _____
Position: _____
Company: _____
Address: _____
City, State, Zip: _____
Phone: _____
Email: _____

*For AEG Discounted Rate, registration must be received by 02/28/07; for early registration, registration must be received before 04/26/07. Cancellations may be made up to April 21, however 25% of the fee will be charged. No refunds. Registration is accepted on a first come, first served basis. Minimum registration of 25 people must be registered at early registration deadline to conduct this course. Questions? Call Dan Kelleher at 763.607.0092 or email dan@midwestgeo.com.

Course Fee: Register Now \$1,295
After April 26 \$1,495



AEG Member Discounted Rate \$995

Active AEG Membership in Good Standing during 2007
required for discounted rate (DISCOUNTED RATE UNTIL FEB 28)

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Or Register On-Line: www.midwestgeo.com

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**MGWA Foundation
Grant Request Deadlines
are quarterly:
March 1
June 1
September 1
December 1**

MGWA FOUNDATION NEWS

2006 Metro Children's Water Festival Has Biggest Post-Event Scores Ever

On average, post-event test scores at the Metro Children's Water Festival were 30 percent higher than pre-event scores in 2006. Historically, post-event scores have stayed remarkably close to the 25 percent improvement level.

When asked what they liked best about the Festival, classroom teachers mentioned presentations in the top five things listed:

- ◆ Organization of the day's events
- ◆ Variety and hands-on nature of the presentations
- ◆ Helpfulness of Classroom Guides
- ◆ Presenters and their enthusiasm for their topics
- ◆ Unique methods of presentation

This article is based on a letter from Ron Struss, Water Quality Advisor, at the Minnesota Dept. of Agriculture to Jim Lundy at the Minnesota Department of Health.

Minnesota Ground Water Association Foundation Board Meeting Minutes

Meeting Date:	Tuesday – December 12, 2006
Location:	Johnson Screen, New Brighton
From:	Cathy Villas-Horns (Secretary)
Members Present:	David Liverseed, Cathy Villas-Horns, Gilbert Gabanski, Amanda Goebel, Laurel Reeves, Al Smith and Chris Elvrum. MGWA Management Present: Sean Hunt and Jennie Leete
Review of Minutes Treasurer's Report	The December 2006 meeting minutes were approved as revised Jennie has compiled MGWAF financial information into the same financial software as used by MGWA. David provided the MGWA Quarterly Financial Report. Foundation balance to date is \$64,852. David took funds from a previously expired CD and \$9500 obtained in September and purchased another 29-month CD for \$30,045.74. Approximately \$2900 in interest is being earned from investments each year. The interest is being rolled into the MGWAF endowment, which is currently at \$55,869.11.
New Business	Gil presented Al Smith with a plaque and a thank you for serving on the MGWAF board for over two years. Gil also thanked Laurel for her service on the MGWAF board as the MGWA liaison. Ground Water Awareness Week will be in March 2007, and the MGWA is coordinating a public outreach effort with the Minnesota Water Well Association and the Minnesota Rural Water Association. <u>Grant Request</u> – a request for field trip funding for \$1000 was received from the U of Wisconsin-Parkside Geosciences Club. The field trip appears to be primarily focused on surface water and flooding issues within the Mississippi River system. Concerns were raised about the relationship of the field trip to ground water. The board members decided to postpone action on the proposal until the hydrogeologic aspects of the trip could be clarified. Gil will contact the professor and discuss the concerns and ask that the proposal be revised and re-submitted with more emphasis on ground water if MGWAF funding is being sought.
Old Business	<u>SMM Groundwater Display</u> – MnDOT rock cores for possible inclusion in the exhibit will be reviewed on December 15. Large bedrock samples were obtained by subcommittee and SMM staff in September and October. The SMM subcommittee met with SMM staff in November and reviewed the prototype ground water displays that will be included, and the subcommittee continues to work with SMM staff on various aspects of the exhibit. <u>Student Funding</u> - Laurel moved that a grant of \$660 be provided for student funding for the fall MGWA conference. This was seconded by Cathy. Motion passed. <u>Fund Raising</u> – Cash donations were received after the fall MGWA conference; no donations of time were offered. <u>Fall Conference and MGWA Board Update</u> – The fall conference was successful. The 25th anniversary of the founding of MGWA will be in 2007 and special activities to celebrate are being considered by the MGWA board. <u>Bylaws Update</u> - Laurel mentioned that the MGWA bylaws are also being reviewed and revised. Gil will be working with Jeff Stoner and Dale Setterholm on the MGWAF bylaws revision, and he will bring a final draft back to the MGWAF board for review before the bylaws are finalized.
Next Meeting	The next meeting will be in March. Meeting adjourned

MGWA BOARD MINUTES

Minnesota Ground Water Association Board Meeting Minutes Regular Monthly Meetings

Meeting Date	12/8/06
Place	Keys Café, Lexington and Larpenteur in Roseville, Minnesota
Attending	Dale Setterholm, President; Laurel Reeves, Past President; Jeff Stoner, President Elect; Craig Kurtz, Treasurer; Jon Pollock, Secretary; Sean Hunt, WRI; Jennie Leete, WRI; Steve Robertson, Newsletter
Past Minutes	Minutes for the meeting held 10/13/06 were approved as corrected.
Treasurer	Net income from January 1 through December 7, 2006 at \$13,907.97. Net income for 2006 fall conference at \$7178.30. Treasurer will conduct audit when financial records for 2006 are closed. Treasurer will provide a year-end financial report at the February 2007 Board Meeting, and the results of an audit at the March Board Meeting.
Membership	Printed out membership renewals for previous members who were not members in 2006. Election ballot passed out for review.
Web Page	Updates on financial reports. Presentations and biographies from fall conference added. Two open positions added to employment page.
Foundation	No report – will be meeting next Tuesday.
Education	No report
Newsletter	Newsletter representative gave editing changes to proof to WRI.
New Business	Birdsall-Dreiss Distinguished Lecturer: Has been partly sponsored by MGWA in the past. President drafted letter to Dr. Scanlon suggesting an afternoon seminar at University of Minnesota and another at a different venue. Letter went out November 30th.
Old Business	MGWA Fall Conference: Feedback reviewed. <u>Minnesota Environmental Partnership (MEP)</u> : February 21, 2007, will be MEPs Citizen's Day at the capitol. MEP legislative forum at the Science Museum on January 8, 2007. Past President volunteered to continue to be MEP contact. <u>MGWA and MGWA Foundation Bylaws</u> : Discussion of postponing MGWA bylaws indefinitely and the appointment of a special committee to consider MGWA and MGWA Foundation Bylaw changes. Special Committee will report to MGWA Board for final consideration and MGWA membership to vote on any changes. Motion: Committee to consider MGWA Foundation bylaw changes will be 2007 MGWA President, 2007 MGWA Past President and 2007 MGWA Foundation President with the chair of the committee being the 2007 MGWA Past President with the ability to name more members to the committee prior to meeting. Motion passed.
Next Meeting	January 12, 2006 at 1130 at Keys Café at Lexington and Larpenteur in Roseville. Meeting adjourned

Meeting Date	1/12/07
Place	Keys Café, Lexington and Larpenteur in Roseville, Minnesota
Attending	Jeff Stoner, President; Dale Setterholm, Past President; Stu Grubb, President Elect; Craig Kurtz, Treasurer; Norm Mofjeld, Newsletter Editor; Sean Hunt, WRI; Jennie Leete, WRI
Past Minutes	Minutes for the meeting held December 8, 2006 were approved as amended.
Treasurer	Checking/savings: \$23,008.12. Dues and other income for 2007: \$6,981.50. Net income in 2006: \$10,041.65. These numbers subject to change until audited.
Membership	Membership of 576 in 2005 grew to approximately 650 in 2006. So far 284 members have paid dues for 2007.
Web Page	Updated calendar.
Foundation	Past President Reeves reported on Foundation activities. Minutes of the Foundation meeting are on page 25 of this newsletter.
Newsletter	The next issue will come out in March. February 15 is the deadline for submissions.
Old Business	The special committee to consider bylaws revision did not meet. President Stoner has initiated planning for the Spring Conference and suggested a theme of Methods for Solving Complex Ground Water Problems, with a focus on secondary permeability systems and ground water recharge.
New Business	The Birdsall-Dreiss lectures will take place March 28 and 29, 2007. Past President Setterholm will contact Macalester College as a potential venue. The board discussed the possibility of creating a publication to honor the 25th Anniversary of the creation of the MGWA. This idea came from members Lundy and Robertson and President Stoner is developing the idea with their input. A committee will be charged with leading this effort. A field trip associated with the Fall Conference is under consideration. The interaction of water resources and biofuels is a potential theme. The President and Past President have been contacted by staff of legislative committees on Environmental Policy and MGWA will likely be asked to provide information regarding ground water issues. The Board approved the annual contract with WRI with amendments. MGWA received notice of a volunteer position with the Washington Co. Groundwater Advisory committee. WRI will forward an announcement to members.
Next Meeting	February 9, 2007 at 1130 at Keys Café at Lexington and Larpenteur in Roseville.

The MGWA Board of Directors meets once a month.

All members are welcome to attend and observe.

Send your comments to editor@mgwa.org

Minnesota Ground Water Association Board Meeting Minutes, cont.

Meeting Date	2/9/07
Place	Keys Café, Lexington and Larpenteur in Roseville, Minnesota
Attending	Jeff Stoner, President; Dale Setterholm, Past President; Stu Grubb, President Elect; Craig Kurtz, Treasurer; Jon Pollock, Secretary; Norm Mofjeld, Newsletter Editor; Sean Hunt, WRI; Jennie Leete, WRI
Past Minutes	Minutes for the meeting held January 12, 2007, were approved as amended.
Treasurer	Net income \$13,322.02 so far in 2007. Checking/savings: \$27,473.84. 2006 Annual Financial Report was distributed to those in attendance. Dues up \$5470.00 in 2006 over 2005. Gross profit up \$7745.63 in 2006 over 2005. Net income in 2006 was \$9555.78. Net income in 2005 was \$9610.91.
Membership	Email reminder to be sent to those that have not renewed. Second paper notice to be sent to those that have not renewed. President Elect suggested no membership dues for students. WRI indicated students move and mailings are returned. Discussion of perhaps using a corporate type membership for schools.
Web Page	Sending out emails on Wisconsin Ground Water Association event and Washington County Advisory Committee Volunteer position. IP Address detected on web page that could send user to another web site. Item removed from web page.
Old Business	<u>Bylaws</u> : The special committee to consider bylaws revision did not meet. Past President is looking at scheduling a meeting next month. <u>The Birdsall-Dreiss lectures</u> : Lectures will take place March 29, 2007. U of M venue not available. Past President and Jennie will work on this issue. <u>Spring Conference</u> : President handed out draft outline. <u>Legislature</u> : Several groups associated with ground water to meet at capitol in March to bring attention to a ground water issues. Past President working on this issue.
New Business	<u>MGWA 25th Anniversary Publication</u> : ideas include taking a few articles out of past newsletters to put into one binding. Part of audience could be legislators. Could make this publication the December Newsletter. Could ask people who wrote selected articles if they had any additions to the articles – if so could ask them to speak at conference. Document may be 60 pages plus in length. <u>Fall Field Trip</u> : President Elect organizing conference on ethanol in conjunction with the Freshwater Society. Sent an outline to Freshwater Society, but has not heard back yet. MGWA would be primarily responsible for field trip focusing on southwest Minnesota. Could visit ethanol plant. <u>Fall Conference</u> : WRI provided information on potential venues including costs. Fall conference date is November 13.
Next Meeting	March 9, 2007 at 1130 at Keys Café in Roseville. Meeting adjourned at 1:30.

Members can access the current year's newsletters in the 'Members Only' area of the web page.

The user name is mgwa and the password is emailed to members with each announcement of newsletter availability.

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