Minnesota Ground Water Association
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Newsletter

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Featured:

MGWA President Dale Setterholm

Inside:

Volcanoes Return to Northeastern Minnesota

By Andrew Streitz and Douglas Hansen, Minnesota Pollution Control Agency

Have you ever walked the rocky shore of Lake Superior in northern Minnesota, skipping rocks and jumping from outcrop to outcrop? Did you realize that the smooth rock underfoot is basalt, once molten lava flows resulting from volcanic activity 1.1 billion years ago? It may be hard to imagine Minnesota with belching volcanoes, but they once dominated the landscape. Even more surprising, it appears that volcanoes have returned to the northland. Don't worry about your favorite picnic spot on Lake Superior getting buried under some fresh lava these new volcanoes are erupting silt and sand and the scale is much smaller.

Deer Creek in Carlton county is the setting for this unusual geologic event. On behalf of the County researchers, Howard Mooers and Nigel Wattrus from the University of MN Duluth investigated and concluded that,

"Groundwater discharge is occurring around the perimeter of [a] former pond. The discharge is focused at discrete points that are easily identified by sand volcanoes. The sand volcanoes are located along fault scarps that are the surface expression of rotational slumps."

In this age of global climate change brought on by the excessive burning of fossil fuels, it is natural to ask if humans are the cause of this change in the watershed. Engineered

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President's Letter

The hot and mostly dry weather this summer has triggered some watering bans. I've also seen television news reports of diminished river flows and the threat of water supply reductions. As I write this, the weather has provided some relief and we may have dodged the bullet again. However, ground water scientists know that sooner or later there will be a drought that does strain our current water supply systems. When that crisis occurs the public and its elected representatives will likely demand that something be done, and done quickly. I'm often impressed with what ground water scientists can accomplish, but what we do is almost impossible to do quickly.

Based on conversations with non-scientists, I'd say the greatest impediment to achieving water supply preparedness is the public misconception that we know where our aquifers are, and how much water they can supply. In reality we have mapped approximately half of the area in which Paleozoic bedrock aquifers are a major water source, and they cover less than one-quarter of the state. The remaining three-quarters of the state relies on mostly unmapped glacially derived aquifers, or surface water bodies associated with them.

The depositional processes that create glacial aquifers (and modify them in subsequent glacial events) are far less laterally consistent than those that create bedrock aquifers. Unlike the marine sedimentary process, glacial processes do not produce a consistent vertical sequence either. Mapping glacial aquifers requires more closely-spaced data, better technology, a thorough understanding of glacial processes and local glacial history, and new formats to adequately convey a complex three-dimensional distribution. The ability to mentally model these processes and the sequence of sediment they produce requires total immersion in the data, and a good imagination doesn't hurt either.

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Newsletter Deadlines

Issue	Due to Editor
December '06	11/09/2006
March '07	02/15/2007
June '07	05/14/2007

MGWA NEWS

Member News

Craig Kurtz, PG, has transitioned into a new position as a financial risk analyst at 3M. He had worked previously for 13 years as an environmental and public water supply hydrogeologist at the engineering consulting firm SEH Inc. Although the decision was a difficult one, he decided the time was right to explore new career opportunities. To stay connected to the groundwater industry, Craig intends to remain a member of MGWA and will continue his role on the MGWA Board as Treasurer through at least 2006.

Amal Djerrari joined the Minnesota Department of Health in June 2006. He is working in the Source Water Protection Unit as a groundwater specialist supporting wellhead protection plan efforts in the Anoka, Chisago, Hennepin, Ramsey and Washington counties. Amal has over 28 years of experience in quantitative groundwater hydrology, surface water hydrology, water resources evaluation, remedial investigation of contaminated sites, aquifer test evaluation, and design of remediation systems. He holds an engineering degree from the School of Hydraulics in Grenoble, France, and an M.S. and a Ph.D. from the Grenoble Institute of Technology.

Mindy Erickson is starting two new jobs this fall. Dr. Erickson has been appointed as an Adjunct Professor in the Department of Civil Engineering at the University of Minnesota. She will be teaching CE 5541 - Environmental Water Chemistry during the 2006 fall semester. She will also be starting a new full-time position with the Minnesota Pollution Control Agency (MPCA). In October, Dr. Erickson will become an Environmental Research Scientist/Ground Water Specialist in the MPCA's Environmental Analysis and Outcomes Division. She will be leading MPCA's ambient ground water monitoring, data analysis, and reporting effort; working on ground water protection policy development; and strengthening ties between MPCA and other governmental agencies involved in ground water

Kelton Barr, PG, has joined Braun Intertec Environmental Consulting Group as a Principal Hydrogeologist. He will provide project management and consulting in ground water hydraulics, hydrogeology, bioremediation, and ground water modeling. Mr. Barr has 31 years of experience conducting hazardous waste investigations and cleanups and also has extensive experience with karst hydrogeology, designing bioremediation systems, and natural attenuation assessments.
Contact Kelton at (952)995-2486, kbarr@braunintertec.com.

Barbara Palen 1950-2006

Barbara Palen, formerly a geologist for the Minnesota Geological Survey (MGS), died in her Minneapolis home on June 2, 2006. Barb started at the MGS as a student worker in 1976 while she worked on her geology degree at the University of Minnesota. She became a full-time employee in 1978 and served until 2003. Barb's work focused on the hydrologic aspects of geology. She reviewed local water plans for many years and provided technical review of land-use proposals in environmentally sensitive areas. Barb was skilled at interpreting pumping test results and calculating aquifer properties. Her love of plants was evident in the many specimens in her home and yard, her office, and on the grounds of MGS. Her wry sense of humor was often a day-brightener for her colleagues. Barb had been a member of MGWA since 1993.

MGWA Welcomes New Corporate Member: Leggette, Brashears & Graham, Inc.

Founded in 1944, LBG was the nation's first consulting firm to specialize in hydrogeology. Today, the LBG organization is a recognized leader in the environmental field.

The LBG office in Minnesota is located at:
Northpark Corporate Center
8 Pine Tree Drive
Suite 250
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Staff in this office include:
J. Kevin Powers, Principal, David Hume, David Strand, Kimberly Blomker, Michael Plante, David Brown and John Oswald.

Volcanoes Return to Northeastern Minnesota, cont.

structures are implicated, but the builders are decidedly not human. The suspects in this case are beavers. A large dam constructed in the area of the pond in the early 1990s coincided with the onset of groundwater seepage and discharge of sand according to nearby landowners. Washed out in 2001, the dam has not been rebuilt as of 2006, and the volcanoes have remained active since that time.

Minnesota Pollution Control Agency (MPCA) Interest

MPCA interest in these volcanoes has arisen from a study of the impairment to the stream they cause and release of turbid water to Lake Superior from the Nemadji River, to which Deer Creek is a tributary. Turbidity in a river or stream may be caused by suspended soil particles that scatter light in the water column making the water appear cloudy. Too much turbidity can lead to degradation of the aesthetic value of the stream and people are then less likely to use it for recreation. It also can be harmful to aquatic life and contributes to sediment loading in downstream water bodies. In this case the downstream water body is Lake Superior.

A newly invigorated approach to help solve the old problem of water pollution is the development of Total Maximum Daily Loads (TMDLs). The federal Clean Water Act requires states to adopt water quality standards to protect the nation's waters. These standards define how much of a pollutant can be in a surface and/or groundwater while still allowing it to meet its designated uses, such as for drinking water, fishing, swimming, irrigation or industrial purposes. Many of Minnesota's water resources cannot currently meet their designated uses because of pollution problems from a combination of point and non-point sources.

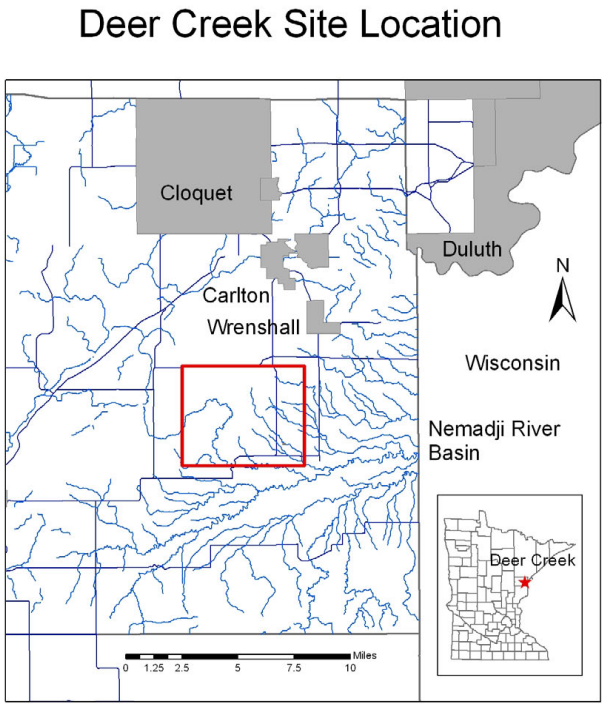

Figure 1 Deer Creek Site Location.

For each pollutant that causes a water body to fail to meet state water quality standards, the federal Clean Water Act requires the MPCA to conduct a TMDL study. A TMDL study identifies both point and non-point sources of each pollutant that fails to meet water quality standards. Water quality sampling and computer modeling determine how much each pollutant source must reduce its contribution to assure the water quality standard is met. Rivers and streams may have several TMDLs, each one determining the limit for a different pollutant.

The MPCA has placed both Deer Creek and the Nemadji River on the polluted waters list as impaired for excess turbidity (Figure 1). This has led us to become involved in a review of what is occurring in the Deer Creek watershed with the discharge of sand and silt from these sand volcanoes. An early spring trip this year to the site of the former beaver pond allowed us to see first hand the workings of several sand volcanoes visible along the periphery of the pond both above and below the water line (Figure 2).

Figure 2 Sand Volcano in stream bed. (Mooers et al 2005)

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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.

Volcanoes Return to Northeastern Minnesota, cont.

A mixture of water, fine sand, and silt bubbled from the volcanoes we could see and miniature plumes of sand and silt were rising along the bank at the downstream end of the pond area, where the stream channel once again became pronounced. Slumping was evident in the uplands surrounding the former pond, in some cases splitting trees at their base along the fault line as the land surface slumped toward the creek.

Closer examination along these faults showed the water table to be above the stream bank and in many cases water filled the lowest tier of faults. One sand volcano was active above the water line on the east bank and it was clear that anything coming close to it would be caught in the mire and would quickly sink out of sight. Viewing these sand volcanoes is better done from a distance.

It was clear from even a casual inspection that the discharge of reddish silt and sand was contributing to the turbidity problem in the creek. Our survey of the stream also included a trip to the mouth of the tributary at the Nemadji River, where a high flow rate of muddy water was seen exiting Deer Creek. Impairment in the Nemadji River watershed is important on several levels, not least of which is the large sediment load it transports into Lake Superior via the Duluth-Superior Harbor. Deer Creek therefore is part of the larger Great Lakes water quality process.

After some discussion the MPCA is considering further study including the possibility of modeling the groundwater flow in the area. This would determine what, if anything, might be done to reduce or alleviate the upwelling of groundwater that might be contributing to the sand volcanoes and, in so doing, reduce the amount of sand and silt contributing to the turbidity problem. Inserting wells up gradient of the pond area to lower the presumed artesian effect locally may or may not help, but also creates a problem with how to remove pumped water from the area without putting it in the stream. The required pumping to lower the head may also affect private wells nearby.

Another consideration is whether this is a natural condition or has anthropogenic influences. Generally, an impairment caused by natural conditions is left to correct itself and available monies are put toward reducing other sources of the impairment in the watershed. If it is a natural condition, will it right itself or will slumping continue and for how long? The entire stream trace has not been walked and there may also be other areas with the same condition. These are the issues we will be wrestling with as the study proceeds. If this investigation continues, MPCA staff would benefit greatly due to the numerous groundwater models and assessments performed in the area by staff from the Drinking Water Protection Section of MDH.

Some background information is necessary to understand how Deer Creek became the home to such unusual features. The following technical review is broadly based on the work of Howard Mooers and Nigel Wattrus (Mooers et. al. 2005). Those interested in learning more about the Deer Creek project can download a copy of Mooers and Wattrus' paper via this link: www.d.umn.edu/~hmooers/Deer_Creek.pdf

Site Description

The trouble started in the early 1990's when beavers constructed a large dam on the Steve and Holly Lundquist property less than 10 miles southwest of Wrenshall. According to the land owners, groundwater seepage and discharge of sand to the surface began about the time the beavers arrived. The dam was apparently washed out by large thunderstorms in 1999. Two years later, the Minnesota Department of Natural Resources removed a beaver dam a short distance upstream, which washed out the dam on the Lundquist property once again, and it has not been rebuilt since.

Groundwater discharge, marked by the presence of the sand volcanoes, is occurring around the outer boundaries of the former pond. The groundwater discharge is a primary contributor to the excessive turbidity found in Deer Creek today.

Glacial History

The Nemadji River watershed, which encompasses the study area, is bound on the north, west, and south by hummocky topography of the Thomson and Nickerson glacial moraines. The lowland was formed by glacial erosion of bedrock by the Superior Lobe of the Laurentide Ice Sheet and this lowland is the westernmost extension of the Lake Superior basin.

In general, the geology of this area was worked and reworked during several glacial advances and retreats starting with the Superior Lobe of the Laurentide Ice Sheet, continuing through the Wisconsin

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President's Letter, cont.

We have traditionally used cross-sections to represent our understanding of the glacial deposits. We have also created maps with units that represent the vertical sequence of aquifers and confining units. From there we advanced to producing closely-spaced cross-sections that improve coverage of the subsurface. We have also created digital surfaces that represent the upper and lower boundaries of aquifers, effectively mapping the location, size, and thickness of glacial aquifers. Some of these methods are automated, and some require software that is too specialized and expensive to be commonly available to users of geologic mapping. Most importantly, these techniques have been applied to a small fraction of Minnesota.

While I concede that promoting geologic mapping is self-serving, it is my contention that it benefits the activities and goals of nearly everyone working in ground water. Adequate mapping of glacial aquifers will benefit aquifer sensitivity assessments, wellhead protection programs, monitoring of ground water quality and quantity, and remedial actions. Mapping the aquifers and investigating their hydrologic properties will also facilitate modeling of future water demands and assessing the effects of those demands on surface water features.

The hydro-illogic cycle of adequate rainfall followed by apathy, and drought followed by concern, will inevitably lead to increased support for geologic mapping. However, there are very few geologists with experience in this art, and the staff size of the agencies involved has been diminishing for years. This is another aspect of ground water management that needs to be heard, and you are the people that can effectively convey the message.

glaciation and ending with the Marquette phase nearly 10,000 years ago. Two glacial lakes, Lakes Nemadji and Duluth, appeared and reappeared in this time period and contributed near shore lacustrine as well as deepwater sediment deposits. Different lake levels are marked by prominent sets of beaches as different outlets for the lakes occurred during different phases of ice retreat.

The final glacial event, which occurred when the Superior Lobe advanced during the Marquette phase to the inner margins of the Thomson and Nickerson Moraines, left a thick deposit (10-40 meters) of till on top of the shallow lake deposits. The till in turn was covered by both shallow and deep lake sediments as the ice retreated for the last time and the glacial lakes reappeared.

Today we find a complex stratigraphy in the area with clay rich, impermeable till lying on top of the last sequence of shallow water lacustrine sand that is highly conductive and appears to be hydraulically connected to the gravels of the Thomson Moraine north of the area.

Problem Investigation

Recharge to the groundwater system probably occurs in the highlands of the Thomson Moraine and the gravels transmit the water south into the lowlands that make up the Nemadji River watershed via the shallow lake sand deposits. The groundwater is confined beneath clay deposits that extend to the surface. Artesian effects were noted in nearby well records, where static water levels at the time the wells were drilled were recorded as higher than the land surface.

To assess local conditions of subsurface geology, well driller's logs from the computerized database maintained by the MDH, County Well Index (CWI), were reviewed. The logs were then used to construct stratigraphic surfaces that could be displayed alongside surface elevations with 3D programs (Figure 3).

Surface elevation, stratigraphic elevations, and potentiometric surfaces were compared and displayed in order to develop a geologic conceptual model of the region. Stream flow measurements were taken upstream and downstream of the former beaver pond, sand volcanoes were mapped and engineering geophysics profiles were collected.

A failure analysis was performed to understand the rotational slumping of the clay confining layer along discrete planes. It was assumed the failure was tied to excess pore water pressure reducing the shear strength of the clay below its driving shear stress. The impacts of changes in hydraulic head on failure were evaluated.

The analysis showed that when the slope of the land surface exceeds about 10% the driving shear stress is greater than the shear strength of the clay. Stream incision locally increases slope, resulting in failure of the clay and rotational slumping toward the creek. The slumping allows groundwater under high hydraulic head in the confined aquifer to find a pathway to the surface, where it contributes to baseflow in the creek and at least locally increases the stream sediment load.

The situation at Deer Creek is probably not unique in the Nemadji River watershed. Groundwater recharge occurring at the topographically higher Thomson Moraine is transmitted to thin lacustrine sand sediments underlying the area. The potentiometric surface in these confined aquifers reflects the elevation potential of groundwater in the moraine. Add to this the results of the failure analysis which showed that the shear strength of the clay and the driving shear stress are very close to one another.

A reduction in the shear strength of the clay, for example, from an increase in pore water pressure as a result of local ponding of the creek could lead to failure, and rotational slumping of the confining unit. This would open up preferential pathways for groundwater under high hydraulic head to escape the aquifer and carry with it aquifer materials to the surface. The result is increased sediment to the discharge water and additional slumping as aquifer material is lost.

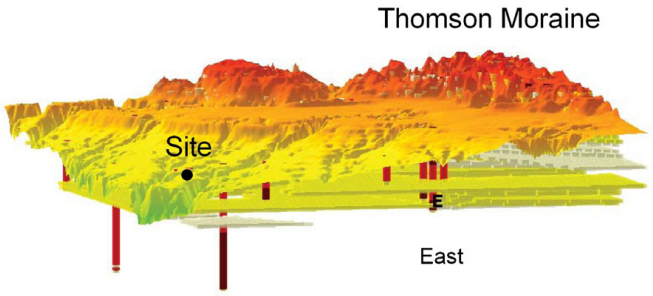

Figure 3 3D Representation of Area Geology (Mooers et al 2005).

Final Discussion

The sand volcanoes are interesting to watch as they bubble and ooze a muck of red sand, silt, and water, but their presence means a delicate balance between confining material and high hydraulic head in the aquifer has been upset. A preferential pathway has been established for the release of groundwater. By itself this isn't normally a matter of concern for State scientists, but due to unusual local conditions the resulting increase in turbidity is causing problems far downstream.

Is this discharge a new phenomenon or has it occurred previously whenever groundwater elevation heads and river geomorphologic conditions coincide? Is there a "solution" to this problem that can reduce the level of turbidity in the Deer and Nemadji Rivers that doesn't create new water-related problems? Should beavers be required to submit building proposals to township boards? Another consideration is that this discharge into the stream bed is not the only cause of turbidity in the watershed, and in the interests of reducing turbidity it may be more productive to turn attention to these other sources first.

These and other questions will need to be addressed as the MPCA works through the TMDL process for Deer Creek. But for now, it is enough to know that volcanoes have returned to northern Minnesota. And although they are not spewing molten lava, their presence signals another geologic change is in process.

Reference

Mooers et. al. 2005. Deer Creek Groundwater Seepage. "Report to Carlton County Planning and Zoning Results of Deer Creek Groundwater Seepage Investigation, July 2005", Howard Mooers and Nigel Wattrus. Department of Geological Sciences, University of Minnesota, Duluth.

Mapping Multiple Buried Aquifers for the Pope County Geologic Atlas, Part B

By Jim Berg, DNR Waters

You may not remember the name of the county, but many of the readers of this article visited this county during a University of Minnesota Glacial Geology class field trip. You traveled across the rolling but relatively flat terrain of central Minnesota and stopped at a bluff overlooking a very large hole in the ground that is Lake Minnewaska, west of Glenwood, in Pope County. Here your instructor described a great ice sheet that moved into Minnesota from the northwest. As this ice sheet began to melt and recede a tunnel valley, of super-sized proportions, formed beneath the leading edge of that glacier right where you were standing. The modern day lake depression of Minnewaska was excavated as billions of gallons of water and sediment rushed eastward from the mouth of the tunnel valley. The face of the land to the east was changed as far as you could see and beyond by loads of sand and gravel, as thick as 100 feet in places.

Like ground water in most counties in western and central Minnesota, where bedrock sources are limited or non-existent, most ground water in Pope County (Figure1) is pumped from unconsolidated bodies of sand and gravel. Eastern Pope County is dominated by a portion of one of the largest surficial sand deposits in the state: the Belgrade-Glenwood sand plain, which is a major source of irrigation water in the region (Figure 2). The northern Chippewa River sand plain in southwestern Pope County is another important irrigation district in the region. Beneath these surficial aquifers and the remainder of most of the county are complex, layered glacial deposits that contain other important ground water supplies for the county.

The Pope County Geologic Atlas, Part B, consists of a set of four plates recently published by DNR Waters, describing the county's hydrogeology. The purpose of the atlas is to provide data and maps showing the distribution and physical characteristics of the most important aquifers in the county; to describe the ground-water flow patterns, flow directions, aquifer connections, and important ground-water chemical characteristics; and to assess sensitivity to pollution of the surficial and buried aquifers. The Part B atlas is a companion report to Part A, geology, published by the Minnesota Geological Survey (MGS) in 2003. The atlas series is designed for units of government and citizens to use in planning for land use, water supply, and pollution prevention.

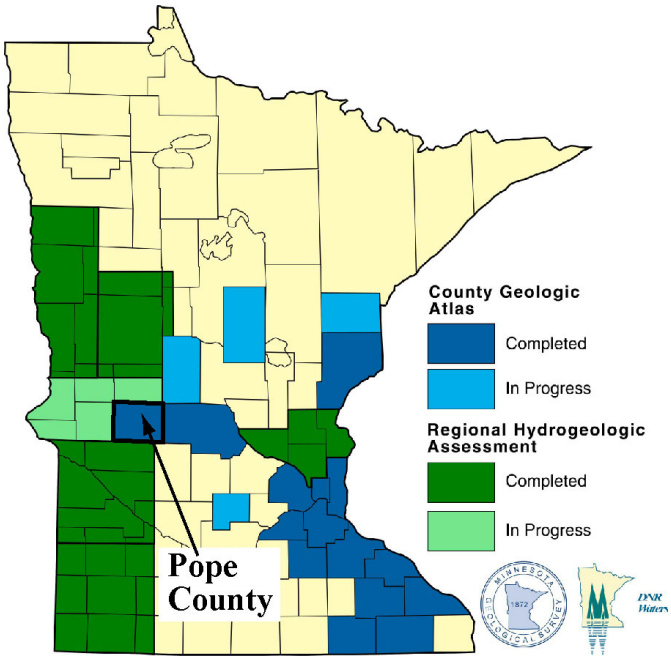

Figure 1 Location of Pope County and status of County Geologic Atlas series.

Surficial Aquifers

The first plate of the Part B atlas (Plate 6) focuses on the sand plains in the eastern (Belgrade-Glenwood area aquifer) and southwestern portions of the county with maps of sand and gravel thickness, depth to water table, and water table elevation. The water table elevation map of the northeastern portion of Pope County (Belgrade-Glenwood area aquifer) is shown in Figure 3 as an example. These maps are generalized estimates and are mostly useful for comparisons of water table depth and elevation across the county. The small black arrows on Figure 3 indicate ground-water flow directions. Since much of the water in the lakes and streams in sand plain areas is ground-water discharge, the ground water source areas of those surface-water bodies can be identified from these maps. This information can assist local units of government in managing these water bodies.

The Belgrade-Glenwood area aquifer straddles the boundaries of three major Minnesota watersheds: the Chippewa River to the west, the North Fork Crow River to the southeast, and the Sauk River to the northeast (Figure 3). In sandy, shallow water table areas, the ground-water flow directions are often similar to the surface-water flow directions. Therefore, the flow network of the surface-water system (Minnesota Department of Natural Resources, 2006) and the water table flow directions are shown together to create a comprehensive picture of shallow ground-water and surface water movement in this area.

Buried Sand and Gravel Aquifers

The majority (62 percent) of the approximately 2,600 wells in Pope County are used for domestic water supply. Irrigation is the other major use category representing 27 percent of the wells in the county. The combination of industrial, commercial, municipal, and public supplies account for 3 percent of the wells in the county. Buried aquifers are the major source of water for most of the domestic, industrial, municipal, and public supply wells. The surficial aquifers are used mainly for irrigation, but many irrigation wells also use the buried aquifers as a water source.

Although the buried aquifers may be the most important ground-water resource in the region, they are often the most difficult to map and predict. Our knowledge of these aquifers primarily depends on drill hole information, and the reliability of the aquifer maps depends on the spatial density of that information. The Pope County Atlas, Part B, includes thickness

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Mapping for the Pope County Geologic Atlas, cont.

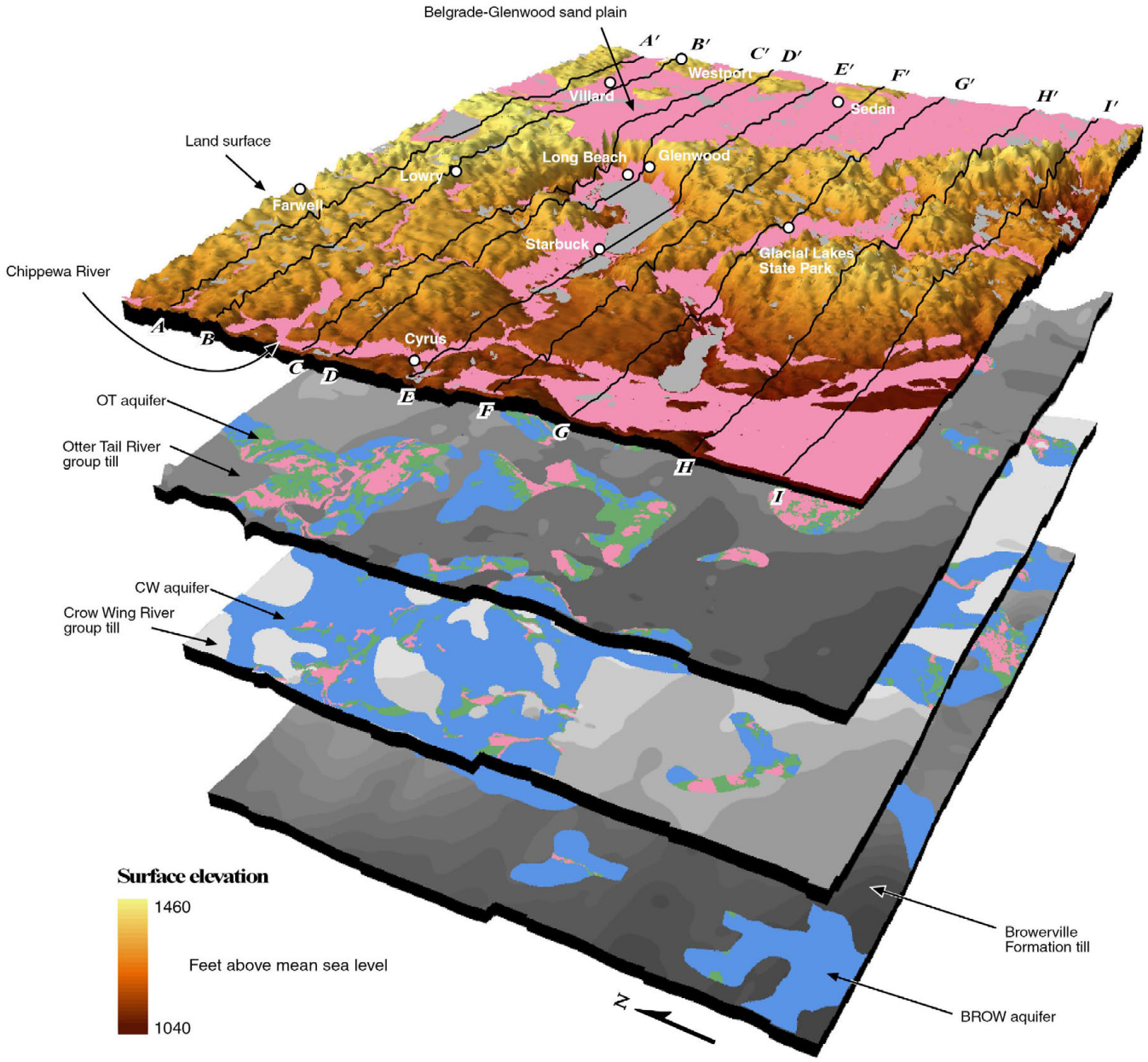

Figure 2 – This diagram depicts an oblique three-dimensional view of the county. The land surface and surficial aquifers have been separated from the underlying three mapped aquifers and the underlying till associated with those aquifers. The deepest layer shown is about 100 to 150 feet below land surface. The aquifers are shown in colors of pink, green, and blue indicating the relative age of the ground water and pollution sensitivity. Pink represents relatively young or "recent" ground water and a portion of the aquifer that is sensitive to pollution. Blue indicates relatively old or "vintage" ground water that is protected from pollution. The green color indicates a mixture of both conditions. By comparing the amount of pink and green in each aquifer (indicating recent and mixed water) a downward decrease in the amount of recent and mixed water becomes apparent suggesting less recent recharge to the deeper aquifers and greater protective cover.

and elevation maps of three buried sand and gravel aquifer systems. An example of a portion of one of these maps is shown in Figure 4. These maps were created through a new method of subsurface mapping pioneered by DNR Waters in collaboration with the MGS.

As with past subsurface sand and gravel mapping efforts the primary data included the Quaternary stratigraphy derived from the surficial geologic mapping (Part A), drill hole interpretations from shallow (5 feet to 25 feet) augered holes, deeper (150 feet to 200 feet) rotosonic cores, and lithology data from the County Well Index (CWI) database. The new part of the mapping approach used for this atlas is how these data were organized, correlated, and represented as three-dimensional grid surfaces. Sand and gravel layers and oxidized till samples (usually described as yellow or brown) were correlated and interpreted to create 39 closely spaced (1 kilometer) west-east cross sections with stratigraphic information extrapolated from the three core locations and the surface geology map on Plate 3 of Part A. The cross sections were correlated

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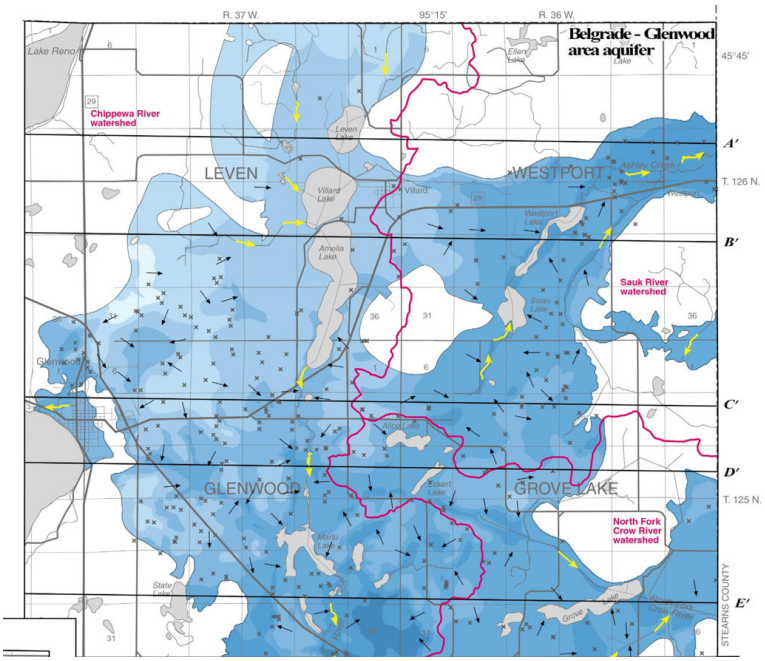
Mapping for the Pope County Geologic Atlas, cont.



Explanation
Water-table elevation of Belgrade-Glenwood area aquifer (feet above mean sea level)

- 1370–1380
- 1360–1370
- 1350–1360
- 1340–1350
- 1330–1340
- 1320–1330

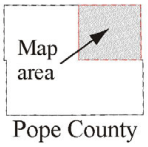
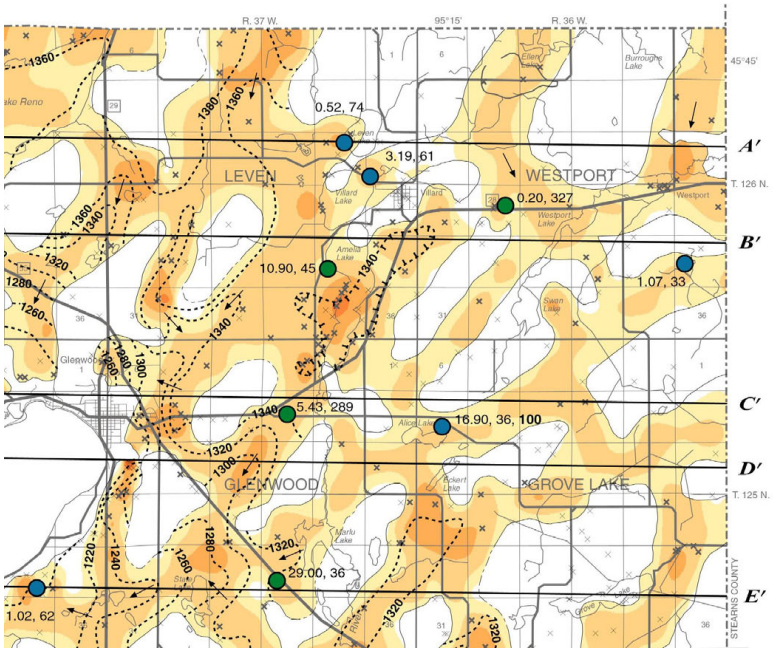


Figure 3 Water table elevations, surficial aquifer ground water flow directions (black arrows), surface water flow directions (yellow arrows), and major watershed boundaries (red lines) in northeastern Pope County.



Explanation
Water-table elevation of Belgrade-Glenwood area aquifer (feet above mean sea level)

- 0–20
- 20–40
- 40–60
- 60–80

Figure 4 Map of BROW aquifer sand and gravel thickness and potentiometric surface in northeastern Pope County. Colored dots show the location of ground water samples. Blue dots indicate samples with vintage tritium values and green dots indicate mixed tritium values. Sample locations are labeled (left to right) with arsenic concentration in parts per billion and Cl/Br ratio. Bold value label, if shown, is estimated ground water residence time in years estimated by carbon-14 isotope analysis.

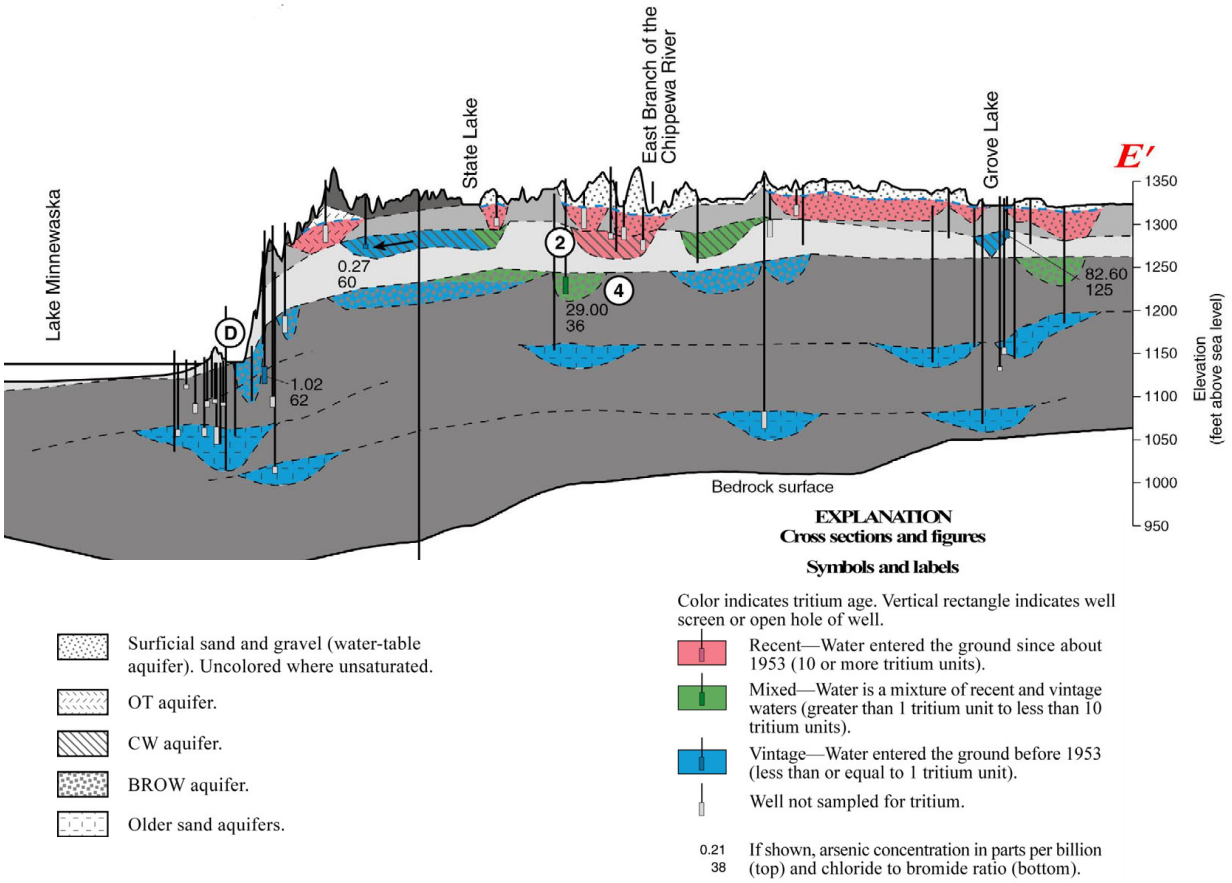


Figure 5 Eastern half of cross section E-E' showing measured or inferred ground water residence time. Sampled wells are labeled with arsenic concentration in parts per billion (top value) and Cl/Br ratio (bottom value). Circled numbers 2 and 4 indicate leakage from overlying aquifers and circled letter D indicates probable discharge location. See also Figures 3 and 4 for relation to plan view of a portion of the Belgrade-Glenwood and BROW aquifers, respectively.

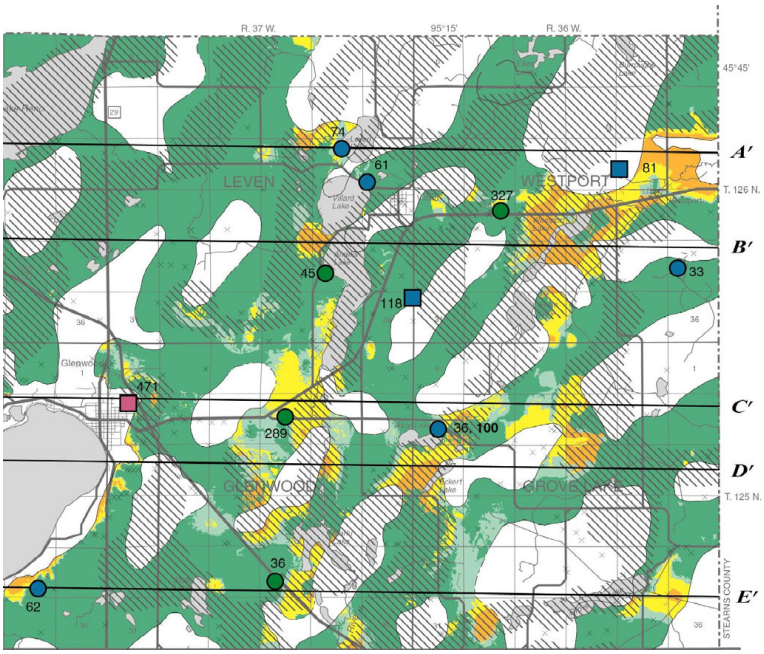
in the west to east dimension by matching tops of sand bodies and oxidized till occurrences at similar elevations. Digitized versions of these cross sections were also correlated in the north to south dimension by overlaying adjacent cross sections as shapefiles in ArcView. The thickness and elevation information for each stratigraphic unit from this set of correlated cross sections was transferred manually to a map, and the boundaries of each sand and gravel unit (aquifer system) were drawn based on a general understanding of the depositional environments and paleogeography of each stratum. The cross sections were subsequently adjusted to match these new sand and gravel distribution maps. Finally, the vertices of the digitized cross section lines were converted to geographic information system (GIS) points with X, Y, and Z coordinates for plotting the points in three-dimensional space using a custom DNR waters extension. The XYZ points for each stratum were interpolated to create three-dimensional surfaces. These surfaces were used to derive all the sand and gravel thickness (isopach) maps that are included in the atlas.

Figure 4 shows an example of the stratigraphically lowest mapped aquifer system (BROW sand and gravel aquifer) in northeastern Pope County, with thickness represented as shades of yellow and brown, contours representing the potentiometric surface. Locations of BROW aquifer wells that were sampled for this project are marked with dots and labeled with selected geochemical information. This BROW aquifer is shown in cross section on Figure 5 and exists at a depth of approximately 70 to 110 feet below land surface in this portion of the county. Between the BROW aquifer and the surficial Belgrade-Glenwood aquifer is the CW aquifer at about a 50 to 75 foot depth. The OT aquifer is not present in eastern Pope County. The most common thickness values for these three buried sand and gravel deposits range from 20 feet to 40 feet. Locally, the deposits can be 80 feet thick or greater.

Indicators of Ground-Water Residence Time

Tritium analysis of ground water samples has been a fundamental tool that we have used for many previous Part B atlases as indicators of ground water residence time. Tritium analysis results proved to be very enlightening in our evaluation of Pope County as well. Tritium (^3H) is a radioactive isotope of hydrogen that naturally occurs in the atmosphere. However, atmospheric testing of hydrogen bombs from 1953 to the early 1960s greatly increased the concentrations of atmospheric tritium. This tritium combines with atmospheric water molecules, precipitates as rain or snowfall, and enters aquifers through surface infiltration. The presence of tritium at more than 10 tritium units

continued on page 10.



Explanation

Sensitivity ratings

Estimated vertical travel time for water-borne surface contaminants to enter the aquifers (sensitivity targets).

VH	**Very High**—Hours to months.
H	**High**—Weeks to years.
M	**Moderate**—Years to decades
L	**Low**—Decades to a century. or more.
VL	**Very Low**—A century or more.

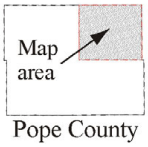


Figure 6 Pollution sensitivity of BROW aquifer in northeastern Pope County. This is the stratigraphically lowest mapped buried aquifer in the area with a depth range of approximately 70 to 110 feet. Diagonal pattern indicates extent of overlying CW aquifer.

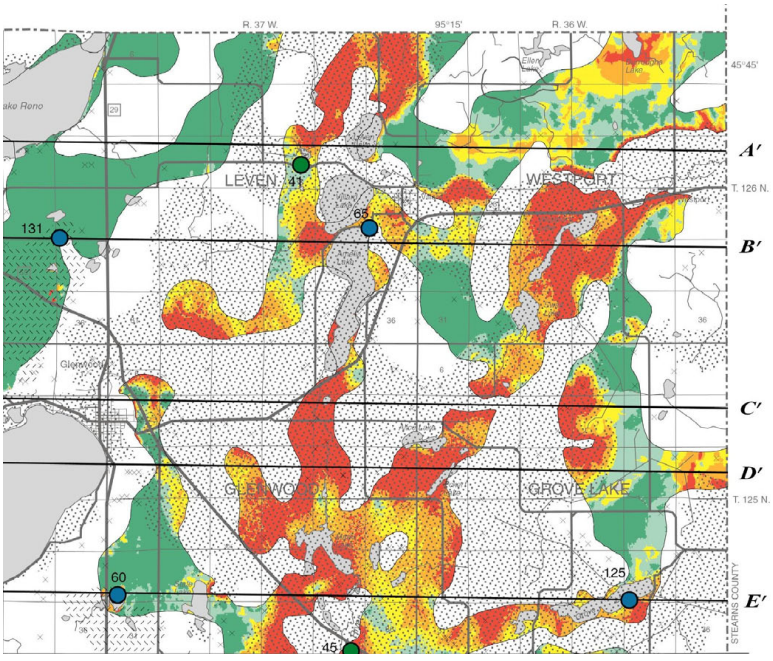


Figure 7 Pollution sensitivity of CW aquifer in northeastern Pope County. This is the uppermost buried mapped aquifer in the area with a depth range of approximately 50 to 75 feet. Stippled pattern indicates extent of overlying surficial aquifer.

(TU) in a water sample indicates recent water (recharged since 1953). Samples with tritium values of 1 or below are interpreted as vintage water (recharged before 1953). Tritium values between 1 and 10 are mixtures of recent and vintage water. Recent tritium values were found in samples from several locations in the shallowest buried aquifers; water can travel rather easily and quickly from the land surface to these aquifers because of shallow conditions or connections with surficial aquifers. Figure 4 shows four instances of ground water samples with mixed tritium from the buried BROW aquifer in northeastern Pope County indicating some downward leakage of precipitation through overlying surficial and buried aquifers. Examples of ground water with mixed tritium are also shown on the eastern portion of cross section E-E' in the BROW aquifer (Figure 5).

Pollution Sensitivity

The atlas includes four maps depicting pollution sensitivity of aquifers to surface or near-surface releases of contaminants. Sensitivity to pollution is defined as the ease with which a surface contaminant moving with water might travel to and enter a subsurface water source. The maps are intended to assist Pope County in protecting and managing its ground-water resources. Figure 6 shows an example of a portion of one of the four pollution sensitivity maps included in the atlas. In this example the BROW aquifer is shown with sensitivity values ranging from very low to high. Figure 7 shows an example of the sensitivity of the shallowest buried aquifer system in northeastern Pope County (CW aquifer), which has large areas of high to very high pollution sensitivity due to widespread hydraulic connections to the overlying surficial aquifer (see Figure 5, center).

The goals of the sensitivity modeling and mapping process were to calculate the thickness of protective material overlying

continued on page 11.

each aquifer and interpret protective thickness as different levels of pollution sensitivity. The sensitivity modeling and mapping process had three steps. In the first step, the top and bottom elevation surfaces that define aquifers and till layers were created using the previously described large set of closely spaced cross sections. These surfaces are represented in three dimensions on Figure 2 and in two-dimensions on Figure 8.

The second step for creating the sensitivity maps was to develop a simplified three-dimensional model that describes how water from precipitation, which first infiltrates the surficial aquifers, can directly recharge portions of the first underlying aquifer and, indirectly, portions of deeper aquifers. The central concept of this process has been referred to as focused (relatively rapid) recharge. This is the concept that portions of the aquifers overlap and are connected by complex three-dimensional pathways that allow some surface water to penetrate into even the deepest aquifers in some areas. The sensitivity model for the buried aquifers uses this idea by dividing this focused recharge into discreet surfaces at the base of each aquifer, which were called recharge surfaces. Each buried aquifer receives focused recharge from the base of the overlying aquifer if the confining layer separating those aquifers is thin or absent. For the purposes of this model and the process of determining the elevations of the recharge surfaces, "thin" is considered to be 10 feet.

Just as the aquifer and till layer surfaces were created as elevation grid layers, the recharge surfaces were also created in this same GIS file format. Each recharge surface was produced through a series of GIS calculations starting with the land surface elevation grid and proceeding stepwise downward to the top of the BROW aquifer (Figure 8). With each succeeding step, the deepest portion of the recharge surface becomes progressively smaller, thereby mimicking a general reduction of recharge with depth that occurs in the natural system.

The calculated elevation surfaces for all the aquifers, till layers, and recharge surfaces are used in the third step to generate pollution sensitivity maps for each buried aquifer. In the final step of the sensitivity evaluation, the thickness of the

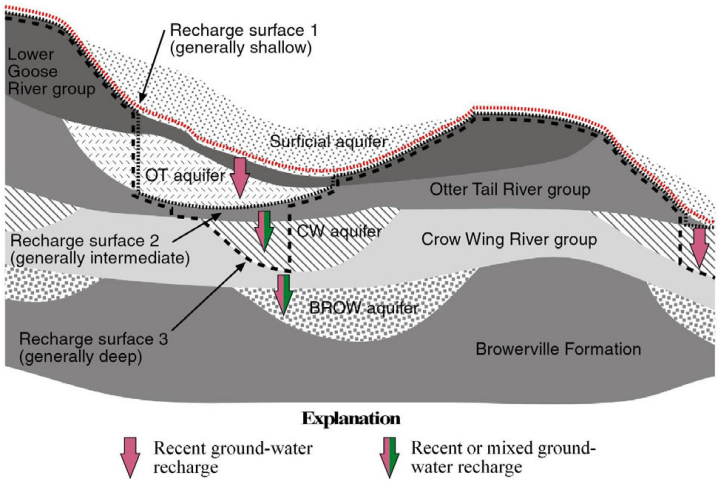


Figure 8 Generalized cross section showing recharge concepts for the three buried sand and gravel aquifers considered in the sensitivity evaluation.

fine-grained or protective sediment (till) that covers each aquifer is calculated and a sensitivity rating is applied. The sensitivity of the aquifer is inversely proportional to the thickness of that protective layer. The protective layer thickness is calculated by subtracting the elevation of the top of the aquifer from the elevation of the adjacent overlying recharge surface.

The most sensitive portions of the buried aquifers in Pope County underlie the central and western parts of the county for the OT aquifer and the eastern part of the county for the CW and BROW aquifers. The OT aquifer in central and western Pope County is sensitive to pollution mostly because it is generally shallow. The sensitive Belgrade-Glenwood surficial aquifer intersects or is generally close to the top of the CW aquifer in eastern Pope County. That proximity creates pathways for relatively rapid infiltration to buried aquifers. The BROW aquifer is sensitive at scattered locations but is relatively protected from rapid recharge. A comparison of ground-water residence time indicators and pollution sensitivity ratings shows a general consistency with some exceptions.

Arsenic

A previous large-scale study (Minnesota Department of Health, 2001) of naturally occurring arsenic in well-water samples from western Minnesota showed that more than 50 percent of 900 private drinking water wells had arsenic concentrations that exceeded the federal drinking water standard of 10 parts per billion (ppb) or 10 micrograms per liter (g/L). The elevated ground-water arsenic values appeared to be more common from wells in glacial sediment deposited by a sequence of ice lobes that moved into Minnesota from the northwest (Des Moines lobe till). The Des Moines lobe till contains approximately 10 percent to 50 percent shale (Traverse-Grant Regional Hydrogeologic Assessment, Part A, in press) as a proportion of the sand size fraction. This relatively abundant shale fragment component contains finely disseminated pyrite (an iron sulfide mineral), which may be the dominant source of arsenic and the reason for the association of Des Moines lobe till and elevated arsenic in well water samples. Erickson and Barnes (2005) confirmed through statistical analysis that this spatial relationship is valid and conjectured that the significant characteristics of these Des Moines lobe sediments that contribute to elevated arsenic in ground-water samples include a high proportion of fine-grained material (clay and silt) and sufficient entrained carbon from wood and plant debris.

In addition to this till composition factor, elevated arsenic values are only found in ground water that has little or no dissolved oxygen (reducing conditions). Pope County is within the boundaries of these Des Moines lobe glacial sediments and 45 percent of ground-water samples collected for this project contained arsenic concentrations that exceeded 10 ppb. The

continued on page 12.

samples with elevated arsenic values came from wells throughout the county.

Conclusion

For the past few years County Geologic Atlas projects have been moving more and more toward representing geological and hydrogeologic surfaces as GIS grids. The Pope County Part B atlas represents a complete transformation of our methodology for evaluating the subsurface with these types of GIS files. The obvious advantage to this approach is that a whole assortment of derivative products, such as aquifer thickness maps, bulk aquifer volume, protective cover thickness, depth to water table, and saturated thickness can be rapidly calculated with GIS software. Correlating and evaluating surfaces within the Quaternary sediment package are difficult and will probably remain difficult, especially with the relative lack of core material that we are able to acquire for these projects. However, with our new ability to rapidly create and correlate large sets of regularly spaced cross sections, and then transform the resulting 2D stratigraphic boundaries into 3D surfaces, we have more confidence in our ability to map complex inter-till sand and gravel aquifers. Since the buried sand and gravel aquifers of Pope County are similar to the most important types of ground water resources found in western, and central Minnesota we now have more reason to believe that we will be able to understand more of these aquifer systems with the completion of each atlas.

For More Information

The Pope County Geologic Atlas, Parts A and B can be purchased at the Minnesota Geological Survey, Publications Office, 2642 University Avenue, St. Paul, Minnesota 55114, (612) 627-4782. Portable document file (.pdf) images of the plates are available for download. Please see the DNR Waters web site at: www.dnr.state.mn.us/waters/groundwater_section/mapping/status.html for Part B access and download instructions. Data files for Part B will be posted soon. PDF images and data files for part A of the report can be downloaded from the MGS ftp site at ftp://mgssun6.mngs.umn.edu/pub3/c-15/. For additional information, contact Jim Berg (651) 259-5680, Jan Falteisek (651) 259-5665, or Dale Setterholm (612) 627-4780.

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Minnesota Department of Natural Resources, 1:24,000 watershed stream data, http://deli.dnr.state.mn.us/metadata?id=L260000072102 (accessed January2006).

Send your comments to editor@mgwa.org

An Introduction to the Environmental Laboratory Certification Program

By Susan R. Wyatt, MDH

Environmental laboratories conduct analyses of our air, water, soil and other materials. Clients of environmental laboratories include municipalities, consultants, public health officials and commercial entities. These entities use the data to make policy decisions. The Minnesota Department of Health (MDH) environmental laboratory certification program was established in 1989 to help ensure that laboratories are submitting reliable and consistent data to Minnesota's various environmental programs. The program offers certification designed to accommodate the needs of many state and federal agencies including testing required by the USEPA; the state departments of Health, Human Services, Commerce, and Agriculture; and the Pollution Control Agency.

State regulations such as the Underground Storage Tank Program, Clean Water Act, Resource Conservation and Recovery Act and the Safe Drinking Water Act require data from certified laboratories. Reliable technical and scientific analyses are essential for making sound decisions necessary for the protection of the environment and public health. With this in mind, MDH environmental laboratory certification program has developed procedures and requirements for ensuring that laboratories are producing accurate and precise analytical results. Certification requires the laboratory's quality systems, staff, facilities, equipment, test methods, records and reports to be evaluated using objective and measurable criteria. A real-time, searchable list on the program's webpage https://www2.health.state.mn.us/cert/search.jsp shows approximately 160 laboratories currently certified to perform environmental testing in the state.

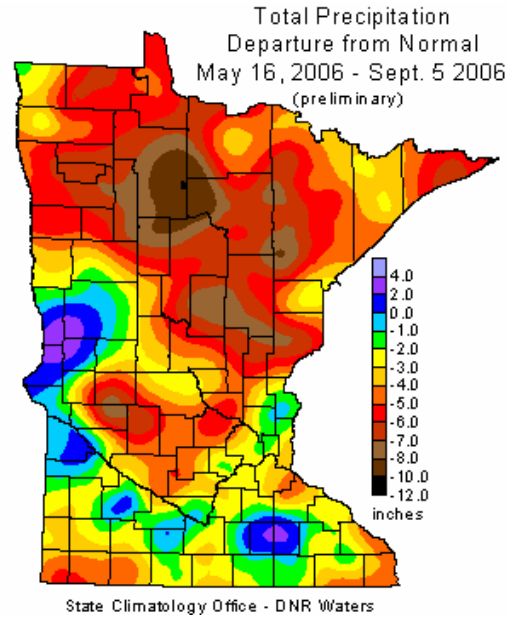
In December 2005, the MDH published revisions to the current rules for certification with input from the program's stakeholders and incorporated the standards for quality control adopted by a national conference of state and federal agencies. Rule amendments (www.health.state.mn.us/divs/phl/cert/rulemaking.pdf) will assure a high standard for the quality of data produced by laboratories engaged in environmental testing and will further clarify the intent of the current Minnesota Rules. Adoption of these rule amendments will ensure that Minnesota regulations for laboratory certification are in-line with those of other states.

This consistent approach to regulation of laboratories allows meaningful exchange of laboratory information between states and in reporting to federal agencies. The proposed rules will allow the department to respond quickly to ensure adequate laboratory capacity when changes in state and federal regulations occur (e.g. such as the arsenic in ground water rules currently under revision) and when responding to public health concerns (such as the ground water tests performed for the citizens of Bayport, Minnesota).

The certification program expects to complete its rulemaking process and publish the final rule as early as September 2006.

2006 Drought Information Online

This summer, Minnesota saw widespread rainfall deficits exaggerated by extreme heat in July. The figure below shows that negative precipitation departure from normal for the season extended across much of Minnesota, but especially hard hit were the central and northwestern areas of the state. As of early September much of northern and central Minnesota remain in extreme drought status.



For the latest on the 2006 drought, check the comprehensive information resources provided by the Minnesota Climatology Working Group Web Site at climate.umn.edu/climatology.htm.

MGWA's Corporate Members

Leggette, Brashears & Graham, Inc.

ARCADIS

Interpoll, Inc.

Environmental Strategies Consulting LLC

Liesch Associates, Inc.

TestAmerica, Inc.

ASSOCIATION NEWS

Fall Conference of the Minnesota Ground Water Association

Comprehensive Local Ground Water Management- Data, Tools, techniques, and Organization

The Spring 2006 conference focused on land use practices and waste treatment systems and their potential for impacts on ground water. The Fall Conference on November 14th will be an opportunity to understand how those impacts are, or could be, managed in Minnesota.

The conference will explore:

- the technical tools and data sets that are employed to help us understand the hydrologic system,
- the policies that determine how the impacts on ground water are monitored and regulated, and
- the roles and the interaction of state and federal agencies and local units of government.

The conference will be useful to local water planners, state and federal water management agencies, and the consulting community that often participates in local water management activities. This is an opportunity to evaluate our current practices and consider the future.

Two MGWA Officer Positions Open for 2007

The MGWA membership needs to fill two officer positions — Treasurer and President-Elect — for 2007. The treasurer oversees MGWA financial matters, reviews financial reports and assists with meeting planning. The President-Elect takes a leadership role in the planning of one or more of the MGWA meetings while "learning the ropes" of MGWA leadership. Here's a chance for you or someone you nominate to get in on the front end of ground-water resource protection in Minnesota.

The treasurer serves a two-year term, and the President-Elect serves a year before becoming President in 2008, followed by a year as Past-President. Send nominations by November 1 to MGWA, 4779 126th St. North, White Bear Lake, MN 55110, or send an e-mail to office@mgwa.org.

Medical Geology: Stones That Make You Sick — or Well

A year ago, an interesting article on medical geology appeared in Science (www.sciencemag.org/cgi/content/full/ 309/5736/883). It is still on line and worth looking up. The article's author discussed the medical geology of Sri Lanka in particular, but the basic ideas can be applied anywhere in the world. This we know from the distribution of elevated arsenic in Minnesota's ground water (see "Mapping multiple buried aquifers" on page 6), the presence of radon in Minnesota indoor air (see www.health.state.mn.us/divs/eh/indoorair/radon/index.html), and the now-common addition of iodine to table salt to prevent goiter.

In the United States, with our mobile population, international food supplies, and regulated public water systems, perhaps knowing the essential and trace nutrient content in our food and water isn't of great concern. However, for people in many parts of the world living in close association with their surrounding geology, it can be a matter of every-day health.

Jan Falteisek, Newsletter Team.

USGS, MDH issue water quality reports

The U.S. Geological Survey released a report in April ("Volatile Organic Compounds in the Nation's Ground Water and Drinking Water Supply Wells") describing the occurrence of volatile organic compounds (VOCs) in groundwater as measured in drinking water supply wells nationwide. VOCs were detected in wells completed in aquifers from across the nation. While the distribution of VOCs is widespread, most of the wells sampled were clean. Seldom were the concentrations above current U.S. Environmental Protection Agency standards. The entire report is available at the following site: water.usgs.gov/nawqa/vocs/national_assessment/.

Locally, the Minnesota Department of Health released its annual drinking water report, summarizing its regulatory compliance efforts for 2005. While isolated instances of contamination are noted, in general the report concludes that drinking water quality supplies are of high quality throughout the state. The full report is available at the following web site: www.health.state.mn.us/divs/eh/water/com/dwar/report05.html.

USGS Publishes Report on Inorganic and Organic Contaminants in Domestic Wells

U.S. Geological Survey (USGS) scientists evaluated a range of inorganic and organic contaminants in domestic wells from every state and Puerto Rico.

Inorganic compounds arsenic (11 percent) and nitrate (8 percent) exceeded the U.S. Environmental Protection Agency's drinking water standards in well water most often, of those wells sampled, while uranium, mercury, and fluoride also exceeded standards at a smaller percentage.

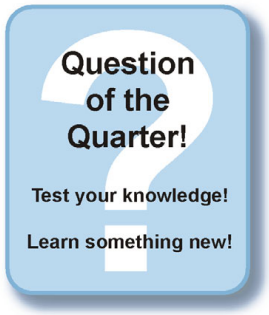
Organic compounds rarely exceeded drinking water standards: however, atrazine, metolochlor, simazine, methyl *tert*-butyl ether (MTBE), and chloroform were all detected in more than 5 percent of the wells sampled.

Since the water quality of domestic wells is not federally regulated or nationally monitored, this study provides a unique, previously nonexistent perspective on the quality of the self-supplied drinking water resources used by 45 million Americans in the United States.

For more information on this report, go to the USGS web site at health.usgs.gov/.

From a news release by the USGS.

QUESTION OF THE QUARTER



Ground Water Cryptoquiz

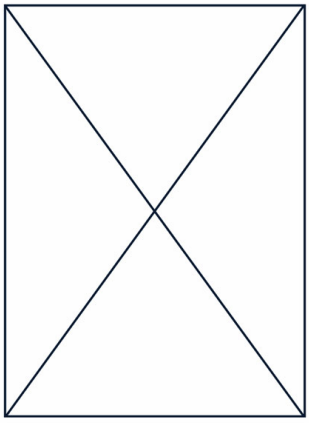
A **cryptoquiz** is a letter substitution code puzzle. The letters are the same throughout the list. The subject of this cryptoquiz is "ground water terms" and an example might be "infiltration". HINT: Look for what might be a commonly repeated letter like "E" and go from there. Look for the answers in the December newsletter.

TEVPMAQU	XMINYP	TPVKPMGQWQAC
UMYQZL	MZQYNAVNTC	YPPTMLP
TQPJNKPAPV	QYNTMUE	GNVPENWP
GPZANZQAP	KMLZPANKPAPV	FSQTNAPZAQMW
YANVMAQXQAC	AVPKQP	MVAPYQMZ

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

Answer to the June '06 Question of the Quarter

The June Question of the Quarter was:
A ground water professional has arrived at a well network of five wells that looks like the map to the right. The map surface features a set of paths represented by six lines. The wells are located at the intersections of the lines. Is there a spot on the pattern where our professsional can begin sampling and follow the entire pathway without retracing any steps? (Crossing a path is okay, however.) If so, where should our pro start sampling?



The answer may be a little more than disturbing to any of you who puzzled over the graphic to no avail. The answer is "nowhere." An even numbered closed network of six or more paths with more than one three-path node cannot be traveled in total without repeating one of the paths.

Brad Moore Appointed Acting Commissioner of the Minnesota Pollution Control Agency

Governor Pawlenty has appointed Brad Moore as Acting Commissioner of the Minnesota Pollution Control Agency to replace Sheryl Corrigan who has returned to private industry, accepting a job with Koch Industries Inc., effective September 5. Brad Moore was most recently Deputy Commissioner of the Minnesota Department of Natural Resources, having 17 years of experience at DNR. Most of his professional career has been spent in the areas of natural resources management and conservation. On a personal note, Brad and his wife have two children and they are active in the outdoors, enjoying fly-fishing, canoe-camping, hunting and gardening.

Baldwin Latham, The Engineer Who Supposedly Brought You "Ground Water" in 1890

By Greg A. Brick, Geology Instructor, Normandale College

Unlike the word "hydrogeology," whose origin has been explained many times (see, for example, Stringfield, 1966, and Mather, 2001), the exact origin of the term "ground water" is more elusive, perhaps because, like the air we breathe—or should I say, the water we drink?—we take it for granted.

The Oxford English Dictionary (OED) is popularly supposed to present, in addition to the definition of a word, "the earliest available printed example of the sense" (OED, 1989, p. lxiv). The OED's entry for "ground water" takes its example from the scientific periodical Nature, November 27, 1890, which carried an interesting address by Baldwin Latham, which I have abridged below.

[As background, Baldwin Latham (1836-1917) was an English consulting engineer who published a textbook, Sanitary Engineering. "He left his mark in many places but most of his work lies underground…. He became an authority on underground water…. He found that the chalk aquifer under Twyford provided an enormous reservoir which was so extensive that variations in rainfall were hardly significant" (Course, 2002). He was a member of many organizations, including the Royal Meteorological Society, which he served as president in 1890 and 1891. Latham was best known in meteorological circles as the owner of the first self-registering rain gauge from which records were published (Insley, 1997).

Notice that Latham uses the term "ground water" to refer to all water below the ground surface, including soil water, whereas the term has a more specialized meaning today, referring to water in the zone of saturation.]

> *Royal Meteorological Society, November 19. — Mr. Baldwin Latham, President, delivered an address on "The Relation of Ground Water to Disease." The pages of history show that when the ground waters of our own or other countries have arrived at a considerable degree of lowness, as evidenced by the failure of springs and the drying up of rivers, such periods have always been accompanied or followed by epidemic disease…. As a rule, it is only in those places in which there has been a considerable amount of impurity stored in the soil that diseases become manifest…. Mr. Latham defines "ground water" as all water found in the surface soil of the earth's crust, except such as may be in combination with the materials forming the crust of the earth…. Mr. Latham has found that those districts which draw their water supplies direct from the ground, are usually more subject to epidemics and disease than those districts in which the water supply is drawn from rivers supplied from more extended areas, or from sources not liable to underground pollution…. Mr. Latham finds that the general death-rate of a district is amenable to the state of the ground water, years of drought and low water being always the most unhealthy.*

In this address, Latham discusses ground water in the context of his research into epidemic diseases. If his reasoning seems a bit odd, keep in mind that Latham was a late holdout from pre-bacterial days (Lorch, 1965). The disease theory he advocated, known as Bodentheorie (translated as "soil theory"), is usually associated with the well-known German hygienist Max von Pettenkofer (1818-1901) (Garrison, 1929, pp. 658-659). In the simplest terms, the correlation between ground water and disease suggested by Pettenkofer, is that when the water table falls, as during dry years, a larger soil volume becomes available for the production of toxic miasma (Dolman, 1974). Indeed, Hume (1925) reproduces Pettenkofer's graph showing the correlation between cholera morbidity and ground water levels in Munich.

Figure 1 Baldwin Latham (1836 - 1917).

Unfortunately, however, my tidy investigation of the term "ground water" unraveled at this point. As has been shown in many instances, the examples given in the OED are not in fact the earliest, and I found that this applies with a vengeance to ground water. To begin with, Latham, himself, had used the term a few years earlier (Latham, 1886). But the usage wasn't confined to Latham, or even to the British Isles. For example, while the term "underground water" was overwhelmingly preferred in U.S. Geological Survey publications prior to 1900, Thomas Chamberlin had already used the term "ground-water" in his classic 1885 report on artesian waters (Chamberlin, 1885, p. 139). Before that, judging from keyword searches in GeoRef, ground water was usually referred to by content (mineral water) or source (spring water, well water).

But earlier usage of the term "ground water" extended well beyond the technical literature, as I found by consulting additional

continued on page 19.

Regional and Local Events

September 24-28, 2006

14th National Nonpoint Source Monitoring Workshop
Minneapolis, MN
Contact: Greg Johnson gregory.johnson@pca.state.mn.us

September 27, 2006

Twin Cities Metro Children's Water Festival
State Fairgrounds, St Paul, MN
Information: www.co.carver.mn.us/Divisions/LandWaterServices/EnviroServices/CWF
Contact: Joe Enfield jenfield@co.carver.mn.us

October 4, 2006

Aggregate Mining: Processes Impacts and Permits
Rochester Public Utilities, Rochester MN
Registration: Bea Hoffman bhoffman@winona.edu

October 24-25, 2006

Minnesota Water 2006 and Annual Water Resources Joint Conference
Earle Brown Heritage Center
Information: wrc.umn.edu/waterconf/

November 7-9, 2006

Midwest Ground Water Conference (51st)
Embassy Suites Hotel, Lincoln, Nebraska
Information: snr.unl.edu/midwest

November 14, 2006

MGWA Fall Conference
Topic: Comprehensive Local Ground Water Management - Data, Tools, Techniques and Organization
Continuing Education and Conference Center
University of Minnesota, St Paul Campus
Information: www.mgwa.org/meetings/

National and International Events

October 8-14, 2006 is Earth Science Week
Theme: "Be a Citizen Scientist"

October 17 & 18, 2006

Aquifer Testing for Improved Hydrogeologic Site Characterization: Featuring AQTESOLV and the In-Situ Level TROLL, held in Fort Collins, Colorado
The Midwest GeoSciences Group
Information: www.midwestgeo.com
Location: In-Situ HQ in .

November 9 & 10, 2006

Improving Your Personnel and Project Management Skills for Environmental and Engineering Projects, Mt. Shasta, California
The Midwest GeoSciences Group
Information: www.midwestgeo.com

March 11-17, 2007 is Ground Water Awareness Week
www.ngwa.org/awareness/aware.cfm

national ground water awareness week

Ground Water History, cont.

electronic resources. The electronic index for the New York Times, for example, revealed that the term "ground water" was used in newspapers, without special explanation, as early as 1866—again in association with Latham's mentor, Pettenkofer, in the context of the cholera epidemic that struck New York City in that year (Anon., 1866).

And what about cognate languages? According to Grimms' Deutsches Wörterbuch (1935), the corresponding term in the German language, Grundwasser, appears in the literature as early as 1571. Could it be that the great nineteenth century cholera epidemics, through the influence of the German hygienist, Pettenkofer, played a role in originating, or at least promoting, the English term "ground water"? In any case, I have at least demonstrated that the term considerably predates the example given in the venerable Oxford English Dictionary.

Acknowledgment

Thanks to the Hampshire Industrial Archaeology Society in the United Kingdom for emailing information on Baldwin Latham and the portrait used in this column.

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Guidelines for Submission of Newsletter Articles

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.

Share your knowledge!

Submit a newsletter article!

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Display ads:

Size	Inches H x V	Quarterly Newsletter 4 issues	Membership Directory 2 issues
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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.

There are no commissions on ads. Advertising copy must be received by the publication deadlines as published in the newsletter. Advertisers should submit material as a digital file in TIFF, GIF, JPEG or PCX format at 300 to 600 dpi.

Please make checks payable to "Minnesota Ground Water Association" or "MGWA." Direct your orders and questions concerning advertising rates to Jim Aiken, Advertising Manager, c/o MGWA, 4779 126th Street, White Bear Lake MN 55110-5910; (952)346-3854; jaiken@mccainassociates.com. Questions concerning advertising policy should be directed to the MGWA President: Dale Setterholm; (612)627-4780x223; sette001@umn.edu.

Join the Minnesota Ground Water Association!

If you are reading this newsletter second-hand, 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.

Members receive e-mail notice of the availabilty 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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Which Address should we use for Mailings and for Directory Listing? _____

Which Telephone Number should we use for Directory Listing? _____

MPCA and EPA Co-sponsor Workshop on Vapor Intrusion from Contaminated Sites

Government and private consultants figured prominently as speakers at a recent workshop held at the Thompson Park Center in West Saint Paul. The Minnesota Pollution Control Agency (MPCA) and the U.S. Environmental Protection Agency (EPA) conducted a Soil Vapor Intrusion Workshop on June 15 and 16. The purpose of the workshop was to educate personnel at MPCA, Minnesota Department of Health (MDH), local governments, consultants and others in conducting accurate and cost-effective vapor intrusion investigations at contaminant release sites. "Vapor intrusion" refers to soil gas that migrates from the subsurface into buildings.

"Minnesota is in the vanguard of the states that are dealing with this emerging issue," Sandeep Burman, unit head in the MPCA Remediation Division's Petroleum and Closed Landfill Remediation Section, said. "We were very fortunate to get such distinguished speakers to share their expertise with such a broad cross-section of the environmental industry."

Henry Schuver of EPA Office of Solid Waste gave a fascinating talk highlighting recent experience at the Redfield Site in Colorado and IBM in Endicott, NY. There is great spatial variability in soil gas, subslab and indoor air sampling results. Subslab soil gas samples are considered the best samples for indicating the risk to a building of the vapor intrusion alone. This is because background concentrations are often elevated within a building, masking the effect of vapor intrusion.

David Folkes of EnviroGroup described methods for differentiating background effects. When multiple contaminants are present in the ground water, analysis of the ratios of the contaminants is an effective tool for identifying background of indoor air.

Lynne Grigor, hydrogeologist, MPCA Voluntary Investigation and Cleanup Program, introduced new draft Screen Values for Vapor Intrusion (ISVs). These will be followed up with Vapor Intrusion Guidance from the MPCA later in 2006. A fact sheet is available at www.pca.state.mn.us/cleanup/vic.html.

Tom Higgins presented the MPCA approach to evaluating vapor intrusion risks at petroleum contaminated sites. The MPCA guidance for petroleum sites can be found at www.pca.state.mn.us/publications/c-prp4-01a.pdf.

A field demonstration of soil gas sampling techniques was given at Spring Lake Park County Park just east of Hastings, MN. Terracon led the demonstration using push probe technology.

With the help of Sarah Larsen, Jim Pennino and Tom Higgins of the MPCA, the workshop was a low-impact, zero-waste event. Dakota County provided composting stations to use and a great conference facility. Golden's Deli catered the event and provided a tasty lunch that minimized the amount of noncompostable waste. Attendees carpooled and brought their own cups and all of the educational materials distributed were recyclable.

Kurt Schroeder, Newsletter Team

Don't forget: Professional Geologist license requirements include continuing education.

Metropolitan Council's Regional Water Supply Workshops

The 2005 Minnesota State Legislature passed a measure that directed the Metropolitan Council to carry out planning activities addressing the water supply needs of the Twin Cities Metropolitan Area. To assist the Council in these activities, the legislation established a Metropolitan Area Water Supply Advisory Committee. The Committee is comprised of 16 members representing the major state agencies with water resource responsibilities, as well as members of county and city governments.

During May and June 2006, the Advisory Committee held three workshops to gather input from local officials, utility representatives, planners, or other interested parties, as well as members of the public. They met at three locations across the Twin Cities to discuss the work of the committee, the state of existing water supplies and participant views about issues that will affect future water supplies. A presentation of the workshop results was made at the June 22, 2006 Water Supply Advisory Committee meeting.

A summary of attendee comments may be found at: www.metrocouncil.org/environment/WaterSupply/Committee.htm.

MGWA FOUNDATION NEWS

LCCMR Approves Funding for Science Museum Well Display

by Amanda Goebel, MGWA Foundation

Funding for the project "Enhancing civic understanding of groundwater," was reinstated at the end of the 2006 legislative session, after having been vetoed in 2005. Funding for the project was recommended by the Legislative Citizens Commission on Minnesota Resources (LCCMR).

The MGWA has been working with the Science Museum of Minnesota (SMM) to develop a groundwater exhibit at the museum's Big Back Yard and to develop a statewide traveling groundwater classroom program.

SMM's proposal to LCCMR requested funding of $150,000 ($75,000 each over two fiscal years). As part of this groundwater exhibit, MGWA Foundation Board contributed $20,500 in 2005 to the SMM. The funds were used to install a flowing water well which would be used as an interactive part of the proposed groundwater exhibit. The well has been drilled and is now capped, ready for the construction of the exhibit.

The display will include information on what groundwater is and why is it important; Minnesota groundwater facts, such as users, amounts, importance of the resource; groundwater resources for Minnesota and groundwater regions; groundwater chemistry; and interaction of groundwater and surface water. There will likely be bedrock cores or samples and a variety of other interactive display components.

The MGWA Board and Foundation would like to thank everyone who contacted their representatives and senators during the 2006 Legislative session. The emails and communication from MGWA members were crucial in generating interest and support for the project.

MGWA Foundation Board Meeting Minutes
Regular Quarterly Meetings

Meeting Date	3/15/2006
Place	Keys at Lexington & Larpenter in Roseville
Attending	Members Present: David Liverseed, Cathy Villas-Horns, Gilbert Gabanski, Amanda Goebel, Laurel Reeves, and Al Smith. MGWA Management Present: Sean Hunt. Gil called the meeting to order.
Review of Minutes	David made a motion to approve the minutes as presented. Cathy seconded the motion. Motion passed.
Treasurer's Report	Foundation balance to date is $55,441.00. The MGWAF Quarterly Financial Report is attached for your review. David will transfer $24,774.75 to a new 29-month CD Odyssey account to take advantage of increased interest rates. A minimum $5000 must remain in the existing 29-month CE Odyssey account. An unspecified credit amount of $435 was received as a donation.
New Business	Student Support for attending MGWA conferences – Motion was made by Laurel and seconded by Cathy to support student sponsorship for Ground Water Conferences. Motion passed. Science Madness – Proposal to fund 2 days booth related expenses to promote Ground Water at the Science Museum. Motion made by Cathy and seconded by Amanda to provide $762.50 requested for booth expense at Science Madness March 31 – April 1. Motion passed.
Old Business	MGWA Board Meeting – Laurel Reeves has joined the Foundation Board as liaison from MGWA Board. The MGWA Board at its Feb. 10, 2006 meeting agreed to increase the MGWAF Board to seven members. The actions of the MGWA Board were reported to Gil on Feb. 13, 2006. Chris Elvrum was appointed by the MGWA Board to remain on the MGWAF Board as a Director at large after his term as liaison expires. MGWA Foundation Board Director Appointments - Amanda Goebel has been appointed to be on the Foundation Board as an at large member. Bylaws Revision - Gil and Laurel will work on the Bylaws of the Foundation Board. Budget for 2006 – Discussion revolved around the amount that the Foundation Board should have available for funding programs through the year. Estimates of funding needs for 2006 are estimated to be $6000. Discussion continued regarding requirements for funding proposals be submitted to the Foundation Board by Dec. 1, March

continued on page 24.

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MGWA Foundation Board Meeting Minutes
Regular Quarterly Meetings, cont.

1, June 1 and September 1. Further discussion is to follow at future meetings.
Written Procedures and Policies – Gil will continue to work on Policy, Operational, and Financial Manuals for the Foundation Board.

Next Meeting June 12, 2006 at 11:30 AM
Meeting adjourned.

Meeting Date **6/12/2006**
Location Johnson Screens, New Brighton
Attending Members Present: David Liverseed, Cathy Villas-Horns, Gilbert Gabanski, Amanda Goebel, Laurel Reeves, Christopher Elvrum, and Al Smith MGWA Management Present: Jeanette Leete and Sean Hunt. Gil called the meeting to order.
Past Minutes Laurel suggested revision of minutes referring to process of addition of newly appointed MGWAF Board Members. Laurel made a motion to approve the minutes as corrected. David seconded the motion. The motion passed.
Treasurer's Report Foundation balance to date is $55,367.38. The MGWAF Quarterly Financial Report is attached for your review. There was discussion of how much of MGWA Boards proceeds should be in the Endowment versus unrestricted fund. David made a Motion to transfer $6,222.50 from the unrestricted fund to the Endowment Fund (29-month CD Odyssey account). Chris seconded the motion. The motion passed.
Old Business SMM Groundwater Display – Gil mentioned that funding for the display was approved.
Bylaws Update - Laurel summarized progress on bylaws revision. We will set aside time at the September Meeting for extensive review of MGWAF Bylaws.
Budget – Our current estimate for 2006 is $5000 to $6000. Student support estimates for spring and fall conference will be $300 per conference or $600 total. Only $150 was used at the past spring conference.
Fall Conference update – Theme being considered is Comprehensive Local Groundwater Management. Laurel reported that the potential speakers and attendees would draw from a diverse group of people in our membership.
Fund Raising – We have a goal of reaching $100,000 within the Foundation for Scholarships and Groundwater promotion. We discussed working at the Excel Center, Target Center or Metrodome concession stand. David will investigate what is involved to become a part of the program. A motion was made by Laurel to investigate concessions concept. Motion was second by Chris. We will arrive at a consensus of whether to pursue concession contract after David gets the information.
New Business Grant Request – From Metro Area Children's Water Festival for $1000. Motion was made by Laurel to approve, seconded by Kathy. Motion passed.
Next Meeting September 12, 2006 at 11:30 AM at Opus Office Center.
Meeting adjourned.

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

One of the projects MGWAF has funded is the Metro Children's Water Festival.

MGWA BOARD MINUTES

Minnesota Ground Water Association Board Meeting Minutes
Regular Monthly Meetings

Meeting Date	5/23/06
Place	Keys Café, Lexington and Larpenteur in Roseville, Minnesota
Attending	Dale Setterholm, President; Laurel Reeves, Past President; Craig Kurtz, Treasurer; Jon Pollock, Secretary; Norm Mofjeld, Newsletter Editor; Sean Hunt, WRI; Jennie Leete, WRI
Agenda	See attached. Meeting called to order at 1136. President requested to move through agenda in a different order to address some issues first.
Past Minutes	Minutes for the meeting held 4/19/06 were approved as written.
Treasurer	Finished internal audit of 2005 finances. Report of audit will be typed for file. Net income estimate for 2005 is $9,590.00. WRI had filed an extension and will now start working on taxes for 2005. Checking/savings: $32,465.36. Dues: $19,628.00. Spring conference gross income: $17,358.90. Total income in 2006: $40,116.89. 2006 net income: $17,533.36.
New Business	LCMR: Announcement of LCMR request for input on setting priorities will be in June issue of newsletter. LCMR funding of Science Museum groundwater display is currently in legislation, but may be removed by Governor prior to signature. Water for People: President received letter from Water for People, a non-profit organization supporting drinking water for third world countries. Letter was looking for someone to serve on a committee or support with funding. Finance request needs to go to MGWA Foundation. Anyone serving on a committee would be doing so as an individual not representing MGWA. Minnesota Water Well Association: MGWA President and Past President will be attending a meeting of their education committee on June 14. MGWA Fall Conference: President handed out an outline for the Fall Conference: Comprehensive Local Ground Water Management-Data, Tools, Techniques, and Organization.
Next Meeting	Treasurer and Past President have another commitment to attend and excuse themselves from the meeting leaving two of five MGWA Board members at meeting (no quorum). Next MGWA Board Meeting scheduled for 1130 on Tuesday June 27, 2006 at Keys Café at Lexington and Larpenteur in Roseville.
Membership	No report as there was not much activity.
Web Page	Spring conference files and pictures on website. Added more non-profit filings (1994-present).
Foundation	No report
Education	No report.
Newsletter	Newsletter team looking for more space between lines and considering changing from 11.5 to 12 point leading. June issue will be the same as previous issues. WRI likes the flexibility of selecting leading and will look at an overall increase in leading.
Adjourn	Adjourn at 12:52

Meeting Date	6/27/2006
Place	Keys Café, Lexington and Larpenteur in Roseville, Minnesota
Attending	Dale Setterholm, Craig Kurtz, Laurel Reeves, Norm Mofjeld, Jennie Leete and Sean Hunt
Call to Order	Called to order at 11:33AM
Agenda	Added under “Old Business” Water for People discussion and under “New Business” LCCMR and Awards
Past Minutes	Approval of May Minutes – Approved as corrected.
Treasury	Craig Kurtz – Our balance is slightly higher than compared to last year at this time probably due to the different spring conference format last year.
Membership	Sean Hunt - Two new members have joined.
Web Page	Sean Hunt – The June Newsletter and an updated Directory were put up. Two new “Help Wanted” ads are advertised.
Foundation	Science Museum project is moving forward again. Will be working with the SMM on design.
Education	No report
Newsletter	Norm Mofjeld is the issue editor. Deadline is Aug. 11.
Old Business	Water For People- We received information about this AWWA sponsored project which supports drinking water projects in third world countries. Bernie Bullert is the Committee Chair for Minnesota. He was asking for our support and possibly for

continued on page 26.

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 Regular Monthly Meetings, cont.

	someone to serve on the committee. Laurel will check with a member who is known to be have an interest in this area. Bylaws revision – Laurel – Revisions are in progress and being coordinated with the Foundation bylaws revision. MEP membership – Membership categories have changed. Moved by Laurel Reeves and seconded that MGWA join MEP at the "Investing Member" level at $250. Motion carried. MWWA Education Committee meeting June 14 – Dale reported that Laurel and he had attended this meeting. Also attending were representatives of several other water related associations. The purpose of the meeting was to discuss potential activities on Ground Water Awareness 2007, March 11-17, 2007. Several interesting potential activities were discussed.
New Business	Awards – whether the Outstanding Service Award should be given and potential recipients for were discussed. Fall Conference (November 14, 2006) Planning – Dale noted that he will be calling a planning meeting in August . LCCMR – Reorganization of LCMR was discussed. Opinions on areas of resource needs are being solicited via the LCMR webpage. Dale suggested we all take advantage of this opportunity.
Next meeting	August 15, 2006
Adjorn	Meeting adjourned at about 1PM

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.

Meeting Date	**8/15/2006**
Place	Keys Café, Lexington and Larpenteur, Roseville
Attending	Dale Setterholm, Jeff Stoner, Laurel Reeves, Norm Mofjeld, Jennie Leete and Sean Hunt
Call to Order	Called to order at 11:37AM
Agenda	No additions
Past Minutes	Approval of June Minutes – Approved as corrected.
Treasury	Leete explained post-tax balance sheet for 2005 and suggested a transfer of funds to the Endowment. Reeves moved to transfer $9,500.00 to the Endowment fund of the MGWA Foundation. Motion carried.
Membership	Sean Hunt - Two new members have joined. Reminder that August 2006 is the official beginning for accepting calendar 2007 memberships.
Web Page	Sean Hunt – Renewed the following Web services: (1) domain registration, (2) Web hosting, and (3) electronic mail.
Foundation	No report
Education	No report
Newsletter	Mofjeld is finishing up with last contributions this week and will be submitted for publishing. Will attempt to post the May and June Board-meeting minutes.
Old Business	Fall Conference—Planning is moving along. A planning meeting was held on August 3 to brainstorm ideas centered on local ground water management. A draft agenda was reviewed during this meeting. Several invited speakers and panel members have accepted invitations from Setterholm. Mofjeld suggested that something like the introduction paragraph of the draft announcement be placed into the next newsletter. Setterholm agreed to send that to Norm. MGWA Outstanding Service Awards—Setterholm presented justification on potential nominees. Stoner moved to nominate the awards to Legislators Ozment and Frederickson. Motion carried. Setterholm will follow-up by contacting recipients and by drafting citations and words for award plaque. MWWA Education Committee—Reeves and Setterholm plan to attend the August 23 Meeting
New Business	None
Next Meeting	September 15, 2006 (11:30 a.m.)
Adjorn	Meeting adjourned at 12:54 p.m.