Minnesota Ground Water Association

Newsletter

December 2017 Volume 36, Number 4

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MGWA President Evan Christianson

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MGWA Minutes

President's Letter

by Evan Christianson

It's been great to spend this last year serving as President of MGWA. The opportunity has allowed me to meet and learn from many outstanding people. MGWA remains healthy from a business perspective, mostly due to the success of our conferences. However, membership is down from years past for unknown reasons. Encourage your colleagues to join MGWA, it's one of the easiest ways to stay connected to the groundwater community in Minnesota. Even with lower than typical membership, the organization remains vibrant and energized. I look forward to many great things to come in the year ahead under the leadership of incoming President Ellen Considine.

The fall conference, titled *The Effect of Agriculture on Groundwater Resources*, was a great success. We had near record attendance and pushed the conference facility to capacity. The presentations were fantastic and covered a wide range of issues. Each conference brings in many familiar faces but also many new people interested in a particular topic. This fall was no different and it was great to see scientists, policy makers, academics, and others sharing ideas and experiences on a topic that is of great importance to Minnesota.

A common theme that I took away from the conference was that many of the issues we face today are often the result of unintended consequences and changes that occur gradually, often over many generations. I believe that most people understand that groundwater is a valuable resource and would like to manage it so that it can continue as a valuable resource for future generations. However, to the general public, changes to our groundwater resources are not perceptible, not only because of the time scales over which they occur but also because observing these changes requires the careful collection and analysis of data. You can't see or taste nitrate in groundwater (or tile drainage for those who were fortunate enough to see David Legvold's samples from his presentation), you can't watch a cone of

- Continued on page 2

Judges/Volunteers needed for the Anoka-Hennepin District Science, Technology, Engineering, and Math Fair!

Anoka High School will host the Anoka-Hennepin District Science, Technology, Engineering, and Math (STEM) Fair on Saturday, January 27, 2018 from 8:00 AM until noon.

Students in grades K-12 presenting the findings of their research and experimentation to the public at the STEM Fair. There are two divisions, grades 6-12 and grades K-5. With well over 2,000 students involved, this STEM Fair is the largest of its kind in Minnesota.

The organizers are looking for responsible adults who are willing to give back to the community. Judges talk



with students about their projects and give feedback. Students who participate in STEM Fairs improve critical thinking, public speaking, and research skills. They learn the nature of science and what it means to be a member of the scientific community. For more information about the STEM Fair, including a schedule, a location map, judge/volunteer registration, and STEM Fair Coordinator contact information, please visit their website at <u>Anoka-Hennepin Schools STEM Fair</u>! Contact Kevin Molohon at kevin.molohon@ahschools.us or 763.506.7084 with questions.

Contact Revin Motorion at <u>Revin.motorion@anschools.us</u> of 705.500.708

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MGWA Web Page

Visit <u>www.mgwa.org</u> for MGWA information between newsletters and to conduct membership and conference transactions.

Newsletter Deadlines

Issue	Due to Editor
March '18	02/02/2018
June '18	05/04/2018
September '18	08/03/2018
December '18	11/16/2018

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stated as such.

Tom Higgins Promotion

Tom Higgins was selected to temporarily replace Hans Neve as the Site Remediation supervisor at the MPCA for the next three years. Hans temporarily is stepping aside from this position to complete several recently funded time critical projects and initiatives at major sites. For the past two years, Tom has been the State Programs Administrator Coordinator (SPAC) for the Superfund/Remediation Section. The SPAC's job is to keep many aspects of the complex programs running smoothly and to assist all of the staff on a daily basis. Prior to that, Tom spent twelve years with the Petroleum Remediation Program (PRP). During his time in PRP Tom worked on both cleanups and brownfields, made important contributions in policy areas such as Institutional Controls and Quality Assurance/Quality Control, and played a key role in pioneering technical guidance in the areas of vapor intrusion and biofuels remediation. For over a decade Tom has also done an exceptional job of representing the MPCA and the state of Minnesota on the Interstate Technology Regulatory Commission (ITRC), going from technical team member to State Point of Contact to National Training Coordinator and at present serving as the Co-Chair of the Board of Directors.

President's Letter, cont.

depression develop, and you can't see water entering the atmosphere through evapotranspiration. We can only measure these through the careful collection of data, and that data often requires interpretation by professionals who understand groundwater. It is our job as groundwater professionals, and one of the pillars of MGWA's mission, to better inform the general public about groundwater, using sound scientific principles. An uninformed public leads to reactionary groundwater management, often not reacting to problems until after they are large and seemingly unsurmountable.

I left the conference with the opinion that





Tom has a BS in Environmental Science from Minnesota State University (Mankato) and a MS in Environmental Chemistry from the University of Minnesota (Twin Cities). Tom's Master's thesis work was on vapor intrusion at a time when very little was known about it.

there are many tough challenges to address in regards to agriculture's impact on groundwater resources. However, I'm not glum about these challenges. Many of the issues arose over generations with a lack of knowledge or understanding of the cumulative effect of various practices. Our science and understanding is better now. We just need to continue to educate the public so we can proactively manage groundwater and make informed decisions about what level of impacts are acceptable. Wishing you a happy holiday season and a prosperous 2018.

MEMBER NEWS

MGWA NEWS

Andrew Retzler — Candidate for Secretary

Andrew Retzler, candidate for Secretary, is a Paleozoic bedrock geologist at the Minnesota Geological Survey (MGS). He joined the MGS in 2013 and specializes in carbonate sedimentology and stratigraphy, working alongside Tony Runkel and Julia Steenberg to produce bedrock geologic maps for the County Geologic Atlas program. Andrew is currently mapping the bedrock geology for Hennepin, Dodge, Steele, Rock, Nobles, Lincoln, and Pipestone Counties, while also serving as project manager for the Steele, Rock, Nobles, Lincoln, and Pipestone Part A County Geologic Atlases. Andrew is also a collaborator in a number of applied research projects focused on groundwater hydrogeology and Paleozoic stratigraphy in Minnesota. Additionally, he and Julia Steenberg have been working to update and maintain the MGS's downhole geophysical log database with funding from a National Geological and Geophysical Data Preservation Program Grant provided by the USGS. Andrew has a Bachelor of Arts in Geology (2011) from the College of Wooster and a Master of Science in Geosciences (2013) from Idaho State Univer-

Kate Pound — candidate for President-Elect

Kate Pound, candidate for President-Elect, is a geologist and earth science educator at St. Cloud State University. Kate teaches across the earth science curriculum, and developed the Environmental Geology Concentration at St. Cloud. Kate works with pre-service and in-service earth science teachers to help them better understand and use local geology as well as surface-water and groundwater concepts in their classrooms. Kate also works with students on a various local stream-, lake-, and till-related research projects. Prior to working

at St. Cloud, Kate was Editor at the Minnesota Geological Survey for several years. Kate completed post-doctoral research at Monash University (Australia) on Cambro-Ordovician and Proterozoic rocks. Kate has a B.A. in geology from Middlebury College and a PhD in geology from Otago University, New Zealand.

"MGWA is my favorite professional organization because not only does it support a broad network of professionals, academics, and resource managers across a sity. His undergraduate and graduate research has been published in Cretaceous Research and Geosphere, respectively. Andrew has diverse interests in earth sciences—including bedrock geology, paleontology, glacial geology, and hydrogeology—and enjoys learning more about the groundwater system of Minnesota as a member and incumbent Board Secretary of the MGWA.



wide range of groundwater-related disciplines, but it also takes responsibility for engaging and mentoring students as they move into employment. I have always been impressed with the dedication MGWA has to supporting continued education of its members through topical meeting themes and thoroughly-researched white papers, as well as a genuine interest in figuring out how to better communicate groundwater concepts to the public. I welcome the opportunity to continue the work MGWA does in support of its members, the greater community, and groundwater management."



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MGWA Primary Objectives

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

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Abbreviations and Acronyms

- ASTM American Society for Testing and Materials
- DNR Minnesota Department of Natural Resources
- MDA Minnesota
 Department of Agriculture
- MDH Minnesota Department of Health
- MGS Minnesota Geological Survey
- MPCA Minnesota Pollution Control Agency
- USEPA or EPA United States Environmental Protection Agency
- USGS United States Geological Survey

MGWA NEWS

Another Successful MGWA Conference

By Andrew Streitz, MGWA Newsletter Team

In what is becoming a wonderful routine, the MGWA Fall conference was again very well attended and provided many stimulating presentations! This year, the conference was held on Wednesday, November 15th, 2017, at the usual venue at the University of Minnesota's Continuing Education and Conference Center in St. Paul, Minnesota. The conference's theme was, "The Effect of Agriculture on Groundwater Resources".

The opening presentation was an interesting talk from Bill Simpkins on the "Bootprint" of agriculture in Iowa, and its effect on groundwater, drainage, and litigation. Bill is a professor at Iowa State University, and has ties to many Minnesota hydrogeologists. He started with a primer on Iowa, and then discussed the state's glacial hydrogeology and the impacts of tiling on water quality. He pointed out that nitrates are becoming a problem. This was a good segue into the topic of the Des Moines Water Works which is facing rising levels of nitrate in the two rivers that provide its water. He gave an interesting overview of the facts of the case and an explanation of why the City lost at the Supreme Court.

The second talk was by Jeffrey Peterson of the University of Minnesota. He discussed the impacts of groundwater use and depletion both locally and worldwide from an economic perspective. He then summarized the economic forces behind groundwater use, and how policies and developing technologies can mitigate some of the impacts.

Kevin Kuehner of the MN Department of Agriculture (MDA) gave a talk on, "Field to Stream: Measuring Nitrate Loss in Southeast Minnesota". His study divided the southeast part of the state into three different environments: clay soils, mixed karst/clay, and karst. He then presented results from sampling of runoff, tile flow, and watershed level flow, for nitrate-nitrogen. One of the surprising conclusions was that surface runoff in the clay soils tested low for nitrate, while the drain tile was 15x higher.

Yusong Li, from the University of Nebraska gave a detailed description of her research entitled, "Impacts of Climate Change on Nitrate Transport Beneath a Center-Pivot Irrigated Corn Field". She developed a numerical groundwater model for her site and used it to model historical data, in order to predict the effects of climate change.

David Legvold (Legvold farms) and Claire Hinthe (a student at St. Olaf College) gave a joint talk on the altered hydrology of Minnesota by focusing on how saturated buffer technology can lead to tile water nitrate abatement. David is a farmer and educator, and he described how he's used the technique of directing tile flow to grassy buffers along protected waterways on his farm, and how he finds this approach promising.

David Rindal from the Minnesota Department of Health (MDH) presented the results of a joint MDH/MDA study for pesticides and the compounds that they create through degradation, in groundwater samples collected from over 100 community public water supply wells in 2015. Pesticide-related compounds were detected in approximately percent of the samples, though none were at levels to threaten public health. He also added that no neonicotinoids were found. They are a new class of insecticides that affect the central nervous systems of insects, including bees.

Kim Kaiser (MDA) discussed a project focused on identifying townships through the state that are vulnerable to groundwater contamination and that are associated with significant row crow production. By the year 2019, they expect to have offered sampling over 70,000 private wells in over 300 townships for

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MGWA NEWS

Fall Conference Summary, cont.



Steve Thompson and Gail Haglund — MGWA Conferences are a wonderful place to catch up with people you haven't seen in a while! Steve was also helping out with conference logistics.

nitrate testing. The first step involves sending the homeowner a test kit, and if nitrate is detected, then a follow-up test is offered. MDA staff conduct the second round of testing, and check for the presence of 125 pesticides. As of January 2017, nearly 2,000 wells of approximately 20,000 tested have exceeded the HRL for nitrate-nitrogen, and 167 townships in 52 counties were determined to be vulnerable.

Tim Cowdery of the US Geological Survey gave a presentation on the Glacial Ridge National Wildlife Refuge, covering his work on the site extending from 2002 to 2015. He described the beachridge hydrology of the Glacial Lake Agassiz area, and how they found that decreased cropland and increased wetlands and prairie, not surprisingly, led to a decrease in surface water runoff and ditch flow. This also led to an improvement in water quality as measured by decreases in both nitrate concentration and suspended sediment. He concluded that wetland and prairie restoration have the greatest potential for hydrologic benefits in areas with the highest density of surficial aquifers and drained wetlands.

The conference also included the popular lightning rounds covering groundwater/surface water mixing in karst country, a statewide presentation on the number of aquifers gaining or losing head, an update on the organization's second white paper, Minnesota's groundwater education gap, and a summary of the Water Conservation Reporting System. These subjects were all given with great energy in a short time slot, and conveyed a lot of useful information.

For those who missed the conference talks or want to view them again, links to the presentations are provided on the organization website.

What Kind of Science Do You Need?

Groundwater and Waste Water Testing | Phase 1 & 2 ESA's Water Resource Planning | Soil, Water, and Vapor Sampling Industrial Hygiene | Hazardous Materials Inspections



ORGANIZATION NEWS

Metro Area Children's Water Festival

The Metro Children's Water Festival celebrated 20 years on September 27th. This annual event teaches fourth graders about all aspects of water. The festival is designed to provide students with hands-on opportunities to learn about such things as where water goes when the toilet gets flushed, how tiny bugs can serve as an indicator of water quality, and the importance of wetlands and basic water science. Held at the Minnesota State Fairgrounds, this year's festival expanded to serve 1,600 students; an increase of 400 students from 2016. Over its existence the festival has reached over 23,000 area students. More information can be found on the Metro Area Children's Water Festival website.

These photos and more can be found one the organization's Facebook page:



DNR Awarded National Groundwater Monitoring Network Grant

By Tim Quan, DNR

DNR is awarded a \$60,000 grant from the USGS to provide groundwater site metadata, lithology information, and groundwater level data to the USGS National Groundwater Monitoring Network (NGWMN). This two-year project, starting in Federal Fiscal Year 2017, begins with a first year goal of becoming a data provider and second year goal of providing continual web service data support. This project will complete well selection and classification for select Minnesota groundwater-level sites that meet the USGS well selection criteria, with an emphasis on long-term data and sites where hand and continuous data is collected. DNR will be providing a match to the USGS funds, as well as in-kind services.

DNR was one of five original pilot partners for the NGWMN in 2010, along with the MPCA. However, subsequent updates to DNR databases requires new web services, which involves new Sensor Observation Services to reestablish the connection. The pilot study focused on two items of interest: testing the creation and approaches for a proposed NGWMN (network) and evaluating the practicality and resources necessary to implement a national network, and ultimately produced recommendations for full-scale implementation. The compilation of testing and feedback ultimately influenced the development of the NGWMN.

This initial pilot study concentrated on the Cambrian-Ordovician aquifer system within Southeastern Minnesota, covering an area of roughly 15,000 square miles, including the seven county Minneapolis-St. Paul metropolitan area (TCMA). The significance of the Cambrian-Ordovician system concerns its purpose as a water-supply source for this location of Minnesota, and most of the groundwater extracted within this part of the State is from the Cambrian-Ordovician system. With this current grant funded project, DNR will follow the NGWMN "Tip Sheet on Well Selection Criteria on Water Levels," providing groundwater level data from a greatly expanded selection of geographical and lithological sites. Most recent observation wells have been drilled in aquifers of high interest or areas of anthropogenic impact and include sites in Lower Cretaceous and Upper Carbonate Aquifers, in addition to the Cambrian-Ordovician Aquifer system.

Groundwater sites in the NGWMN are provided by participating Federal, State, Tribal, and local groundwater monitoring agencies. The network provides a web-based mapping application and delivers historical and current water level, water quality, lithology and well construction metadata. This NGWMN acts as a continuing collaborative partnership with data providers that will provide information on present and future groundwater management matters.

USGS National Groundwater Monitoring Network basic statistics as of November 13, 2017:

- 6,054 groundwater-level wells
- 1,322 water-quality wells
- 10 subnetworks
- 23 contributing agencies
- 54 US States or Territories
- 62 principal aquifers

As a data provider, the DNR will not only contribute valuable groundwater level data in areas of geographical gaps and aquifers

of interest, but will also have the opportunity to share field and data management procedures with other participating entities in the NGWMN.

Participation in the NGWMN also provides visibility for the DNR's Cooperative Groundwater Monitoring (CGM) network, Minnesota's own groundwater level network. This contains over 2,000 observation wells and a total of 2,540 groundwater level monitoring sites, which may also include appropriation-permitted groundwater withdrawal sites, wetland wells, or unclassified well sites. Minnesota has among the most extensive network of monitoring sites, measuring aquifers in areas of interest or impact, and providing decades amount of historical groundwater level data. Advancements to monitoring techniques, rigorous water level data quality coding and the advent of transducer installation into over half of all actively monitored sites ensures high quality data, with fine sampling intervals resulting in extremely precise groundwater level data over time.

Data provided by the CGM are readily accessible to the public with a hydrograph created for each site, basic well metadata including aquifer-type and measuring point elevations, and all hand and transducer readings are available through Excel and Comma Separated Value (CSV) downloads from the website. The CGM is continually being enhanced and improvements are being made to accessibility, data analytic tools and map interfaces ensures the CGM is a leader for groundwater level display innovation and data management.

For questions about the DNR Observation Well Program or the Cooperative Groundwater Monitoring website, please contact:

Tim Quan: <u>Tim.Quan@state.mn.us</u>, Groundwater Level Database Management, (651-539-2127)



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MINNESOTA CAVES: History & Lore, by Greg Brick

Reviewed by Danny A. Brass.

MINNESOTA CAVES: History & Lore (2017) by Greg Brick. The History Press. Charleston, SC. Paperback, 143 pages, 6" x 9" format, ISBN 978-1-4671-3592-4. Available for \$21.99.

According to author Greg Brick, geologist and cave historian, Minnesota is home to more than 300 caves. These are primarily located in the southeast portion of the state (especially Fillmore County) and the Twin Cities region (Minneapolis/St. Paul). In addition to natural caves, many are artificial in nature, hewn into the local bedrock for a variety of reasons.

Following a brief description of the "layer-cake geology" of the state, Brick provides an overview of select sites, principally those of significant historical interest and those which he has personally visited. In doing so, he defines several categories of caves, including sites of archaeological interest (primarily those used by Native Americans and from which a host of artefacts have been unearthed), those of historical interest (primarily those explored by early pioneers and settlers), artificial caves that were largely utilized by an assortment of innovative entrepreneurs, and show caves aimed at the tourist dollar. Discussion also features aspects of a number of imaginary or hybridized caves (i.e., those created in the mind when historical descriptions of two or more caves had been blended together, either accidentally or deliberately).

Beginning with late 17th-century descriptions of well-known local caves, Brick delves into the rich and storied history of

underground Minnesota. In addition to the creation of various show caves (including those outlandishly decorated for Halloween fright nights), Minnesota caves were utilized for such diverse functions as root cellars for storing vegetables during winter months, lairs for horse thieves and other outlaws, places for college students to host wild parties in, locations of ritzy night clubs, and sites of mushroom gardening or cheese ripening. A number of brewery caves for the fermentation of lager-style beer were also developed by intrepid investors.¹ Of course, a book by urban cave historian, Greg Brick, wouldn't be complete without at least some mention of sewer caves, and some information in this regard is included, as well.²

Brick sheds light on some of the bizarre and interesting facets of Minnesota caves and caving, especially as they relate to many historical associations that are now an integral part of Minnesota folklore. The book is well written and easily accessible to general readers. It will be of most interest to urban historians as well as to local cavers curious about various myths and legends or the early years of cave exploration in the state.

¹An interesting discussion of the brewery caves of St. Louis can be found in Hubert and Charlotte Rother's *Lost Caves of St. Louis: A History of the City's Forgotten Caves (2004), Virginia Publishing Company.*

²Interested readers may also enjoy Greg Brick's 2009 publication, *Subterranean Twin Cities*, University of Minnesota Press. Note: A review of both titles can be found in the February 2014 issue of <u>The Underground Movement</u>.



in changing times

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Renville County Geologic Atlas-Part B

by Randy Bradt

Part B of the <u>Renville County Geologic Atlas</u> was recently published by the DNR. Part B covers groundwater conditions and pollution sensitivity. It expands on the geology atlas (Part A) previously published by the Minnesota Geological Survey.

Renville County is located in the west-central portion of southern Minnesota, with the southern boundary largely defined by the Minnesota River. Precambrian crystalline bedrock underlies all of Renville County. Much of the upper surfaces of these deposits have some or most of its minerals weathered into various clay minerals (saprolite). Overlying these deposits are scattered Cretaceous sediments (less than 50 feet thick) composed mostly of shale with some sandstone. Only a small percentage of wells in Renville County are completed in one of these bedrock units because groundwater yields are often moderate to poor, and bedrock is often quite deep. Overlying these bedrock units are glacial sediments ranging in thickness from less than 100 feet to over 450 feet. The thickest deposits are associated with a bedrock valley trending west to east in the vicinity of highway 212. The vast majority of wells in Renville County get their water from buried sand aquifers within glacial till.

Groundwater flow maps were generated for each of the buried glacial aquifer systems using water level information taken from the Minnesota Well Index database and from data collected from wells for this study. Groundwater flow in most of the county is towards the Minnesota River and its tributaries, except for the northeast portion of the county which drains and discharges to Buffalo Creek eastward to the South Fork Crow River and eventually to the Mississippi River. It is interesting to note that four of the potentiometric surface maps have contour depressions. These depressions appear to be associated with long term pumping of high capacity wells including municipal water supplies, golf courses, an ethanol plant, and other high capacity uses.

Ninety-one domestic wells were sampled for chemistry throughout the county, with the generous cooperation of private well owners. The water is very hard with calcium and magnesium as the major cations; and bicarbonate or sulfate, or both, as the major anions. In many of the deep wells (greater than 200 feet) sodium ions, which are adsorbed onto clay surfaces in the glacial till, are exchanging with calcium and magnesium ions in solution. Sulfate concentrations in many of these deep wells are often low or absent. This is thought to be the result of sulfate reduction, a process that removes sulfate from solution. Evidence for this reduction is a rotten egg odor indicating hydrogen sulfide gas, a by-product of sulfate reduction. Methane gas coming out of solution (methanogenesis) was another indication that groundwater is in a strongly reduced condition favorable for sulfate removal.

Arsenic and manganese are two naturally occurring chemical constituents that have health related concerns that were included in the water sampling. Arsenic exceeded the maximum con-taminant level (10 ppb) for lifetime consumption in 25 of the 91 sampled wells. Manganese, which the MDH has set tiered human

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Pollution Sensitivity of the near-surface materials. Figure 14 from the Renville County Geologic Atlas.

The Glacial Lake Lind Spring-Line of the St. Croix Valley

Greg Brick PhD, Research Analyst, Minnesota Department of Natural Resources

The Minnesota Spring Inventory (MSI), established by the DNR and funded by LCCMR, has been mapping springs on public lands statewide, including the three Minnesota counties bordering the St. Croix River, since 2016. Before this, several isolated pockets of springs were reasonably well mapped in all three of those counties, but additional mapping of springs by MSI allows some broader generalizations to be made. The Glacial Lake Lind trend, more than 100 kilometers long and arguably the most extensive spring-related feature ever found in Minnesota by the examination of LIDAR coverage, was verified during the course of this routine spring mapping (Figure 1).

Many Washington County springs emanate from the Cambrian sandstones of the river bluffs (Leaf, 2005). But in the two counties north of Washington, many springs are associated with a surficial ridge along the line of Government Road (the Point Douglas to Superior Military Road) in Chisago County, continuing into Pine County. This wooded ridge, averaging 15 meters in height and ranging from 0 to 7 kilometers inland from the modern river, represents the outermost scarps of the St. Croix River channel, and was a dry, elevated place to build a road in pioneer days (Figure 2). The river carved into the deltaic sands and underlying lacustrine clays of Glacial Lake Lind (Figure 3), and the springs emanate at the sand-clay contact, near the foot of the ridge. The geological cross-section by Meyer (2010) shows the water-bearing sand unit (Qsl) overlying the impervious lacustrine clay unit (Qlc) (Figure 4).

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Renville CGA Part B, cont.

health guidance, exceeded the lower standard (100 ppb) in over half of the wells sampled.

One of the primary objectives of the atlas is to identify and map sensitive groundwater areas. "Sensitive area" means a geographic area defined by natural features where there is a significant risk of groundwater degradation from activities conducted at or near the land surface." Minn. Statutes 103H.005 Subd. 13. (from the 1989 Groundwater Protection Act). This was accomplished by mapping the buried sand aquifers and summing the thickness of low permeability sediments from the land surface to the aquifer in question. A log scale time of travel scheme breaks out travel times into five different categories (very high to very low) based on 10-foot increments of low permeability material. Pollution sensitivity maps were generated for each of the glacial aquifer systems and one additional map for the top of bedrock. Tritium data was used to check the modeled pollution sensitivity. The results show that portions of the shallowest three mapped glacial buried sand aquifers are at greatest risk of degradation from surface contamination sources.

In addition to the pollution sensitivity maps of the buried sand aquifers, there is a near-surface pollution sensitivity map which maps time of travel to 10 feet below the land surface (Figure 14 in the Atlas, and included in this article). This method estimates travel time using soils data for the upper three feet and geology for the remaining seven feet. The results show most of the county is moderate to low sensitivity with higher sensitivity in areas where glacial and modern stream sediments are mapped at the land surface.



Figure 1. LIDAR imagery of the St. Croix valley, showing current spring locations (yellow circles) in MSI. The Glacial Lake Lind trend, more than 100 kilometers long, begins in mid Chisago County and continues through Pine County, bordering the St. Croix River, as shown by the red line.



Figure 2. The wooded ridge associated with numerous spring locations, showing marsh in foreground. Photograph by Greg Brick, 19 April 2017.



Figure 3. Glacial Lake Lind, modified from Johnson et al. (1999).

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The Glacial Lake Lind Spring-Line, cont.

The longest public stretch of this prominent spring ridge runs through St. Croix State Park (Figure 5). Springs downgradient from the 2011 derecho (straight-line winds), which leveled a swathe of trees in the park, were found overgrown with filamentous green algae, suggesting a pulse of nutrient enrichment in the years following, as documented in other watersheds after deforestation (Bormann *et al.*, 1974; Nordin *et al.*, 2007). Shorter public segments of this ridge may be found in North Sunrise Park Reserve, Spring Hill Park (North Branch, MN), and Wild River State Park.

Why has this major spring-line hitherto escaped notice? The ridge itself is most striking on LIDAR coverage, which has only become widely available in recent years. While Paint Rock Spring, associated with varves from this glacial lake, is a well-known spring along this trend (Figure 6), not enough springs had been mapped for the overall pattern to stand out, until the springs of St. Croix State Park had been more completely mapped by MSI. This required breaking through dense undergrowth, especially the raspberry brambles and fallen trees of the derecho. But much of the ridge runs through private land, which geologists had little reason to visit. The Wisconsin side of the St Croix River remains unexamined from this perspective.

This article has been modified from the author's presentation of the same title at the St. Croix Watershed Research Station Rendezvous, October 10, 2017.

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Figure 4. East-west crosssection of Chisago County showing the spring ridge circled in red. The waterbearing sand unit (Qsl) overlies the impervious lacustrine clay unit (Qlc) Modified from Meyer (2010).



Figure 5. St. John's Ridge in St. Croix State Park, showing the pattern of springs (yellow circles) at the base of the ridge. Screen shot from MSI webpage.

Figure 6. Paint Rock Spring, showing the varves of Glacial Lake Lind, which form an impervious base leading to springs. Postcard from author's collection.



New publications of interest to MGWA readership

Study Estimates about 2.1 Million People using Wells High in Arsenic

A new study by the U.S. Geological Survey and Centers for Disease Control and Prevention estimates about 2.1 million people in the U.S. may be getting their drinking water from private domestic wells considered to have high concentrations of arsenic, presumed to be from natural sources.

Using water samples from more than 20,000 domestic wells, the researchers developed a statistical model that estimates the probability of having high arsenic in domestic wells in a specific area. They used that model in combination with information on the U.S. domestic well population to estimate the population in each county of the continental United States with potentially high concentrations of arsenic in domestic wells.

The study, "Estimating the high-arsenic domestic-well population in the conterminous United States" by J.D. Ayotte, L. Medalie, S.L. Qi, L.C. Backer, and N. T. Nolan is available online in Environmental Science and Technology.

Domestic Well Locations and Populations Served in the Contiguous U.S.: 1990

Highlights of this study:

- The location of domestic wells in the US is not well known.
- Domestic wells are susceptible to contamination due to ۵ their typically shallow depth.
- Location is an important factor in domestic well susceptibility.
- Uses a novel approach that incorporates the proximity of roads to estimate domestic well locations.
- Presents two methods for creating a national dataset for the contiguous 48 States.

The study, "Domestic well locations and populations served in the contiguous U.S.: 1990" by T.D. Johnson and K. Belitz is in the Science of the Total Environment, available online at https://doi.org/10.1016/j.scitotenv.2017.07.018.

MDH Drinking Water by the Numbers

The Minnesota Department of Health (MDH) publishes Drinking Water by the Numbers annually for staff, state agencies, and other partners to use in communications, planning, and performance measures. MDH calculates numbers on the first day of the new fiscal year (July 1, 2017 for the most recent edition). The document is now online. Navigate to the Annual Reports page or go directly to the report Drinking Water by the Numbers for Fiscal Year 2017-2018 (PDF)

A Statewide (Minnesota) Compilation of Quaternary Lithostratigraphy

This MGS report follows guidelines of the North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 2005) to create a framework for establishing formal lithostratigraphic units in Minnesota. MGS evaluated over 100 lithostratigraphic units that have been identified in Minnesota. Eighty units are considered to be useful lithostratigraphic units of formation and member rank, and these are formally accepted in this report or are recommended to be so in future 12

publications. These 80 units include previously named formal lithostratigraphic units that are recognized and accepted as originally defined, but also formally defined units that we have revised or redefined to better fit into our stratigraphic framework. The remaining lithostratigraphic units have been used informally in earlier reports or are newly named in this report. Additional units that are no longer considered necessary as lithostratigraphic units are abandoned in this report. These units include previously used units of both formal and informal status. Of the 80 lithostratigraphic units recommended to be retained, 47 are formally defined, revised, or redefined in this report. The remaining 33 units are recommended to be formally named in a future Minnesota Geological Survey Report of Investigations.

This MGS study is available online: "RI-68 Quaternary Lithostratigraphic Units of Minnesota," by M.D. Johnson, R.S. Adams, A.S. Gowan, K.L. Harris, H.C. Hobbs, C.E. Jennings, A.R. Knaeble, B.A. Lusardi and G. Meyer.

The N&E Metro GW Model Report

Simulation and assessment of groundwater flow and groundwater and surface-water exchanges in lakes of the northeast Twin Cities Metropolitan Area, Minnesota, 2003 through 2013: Chapter B of Water levels and groundwater and surface-water exchanges in lakes of the northeast Twin Cities Metropolitan Area, Minnesota, 2002 through 2015

This USGS study by P.M. Jones, J.L Roth, J.J. Trost, C.A. Christenson, A.L Diekoff and M.L Erickson was prepared in cooperation with the Metropolitan Council and MDH is available online: "Simulation and assessment of groundwater flow and groundwater and surface-water exchanges in lakes of the northeast Twin Cities Metropolitan Area, Minnesota, 2003 through 2013: Chapter B of Water levels and groundwater and surface-water exchanges in lakes of the northeast Twin Cities Metropolitan Area, Minnesota, 2002 through 2015. Scientific Investigations Report 2016-5139-B

Groundwater Restoration and Protection Strategies Reports

Groundwater Restoration and Protection Strategies (GRAPS) reports are designed to help prioritize and target local efforts to restore and protect groundwater resources as part of local water



New Publications, cont.

planning. While groundwater is not broken into watersheds like surface water, several state agencies have worked together to compile information and strategies for groundwater below surface water watersheds. A GRAPS report uses existing state data and information about groundwater and land-use practices that affect groundwater in the watershed to identify key groundwater quality and quantity concerns. The interagency GRAPS team has recently completed a report for the Cannon River Watershed, which is available on the <u>MDH GRAPS website</u>. The report for the Missouri River Basin Watersheds is almost complete, and will be uploaded to the website soon.

Capillary Fringe

Book Review: Fieldwork Fail

Reviewed by Anneka Munsell

<u>Fieldwork Fail</u>, by Jim Jourdane, July 2017, Makisapa Editions, 31 rue Robert Mesuret, 31100 Toulouse, France. ISBN: 978-2-9560045-1-6

The Fieldwork Fail book started as a bunch of scientists tweeting their worst fieldwork fails with the tag #fieldworkfail on Twitter in summer of 2016. A French artist, Jim Jourdane, started to illustrate the stories and began a Kickstarter campaign to create a book. I found the book through the Twitter hashtag and immediately ordered it. While my fails haven't been quite as catastrophic as those found in the book, I've had my fair share (mountain lion sitting on the hood of our truck because it is warm, water freezing in the sample line, to name a few). The book is a fun read and has additional information about the fieldwork fail tasks. It's a little bit of comedy and a little bit of science combined into one delightful book.

Gil Gabanski Student Scholarship

MGWA Foundation Board of Directors

The Minnesota Ground Water Association Foundation is pleased to announce the annual Gil Gabanski Student Scholarship. There is a \$1500 scholarship for undergraduate students and a \$1500 scholarship for graduate students majoring in hydrogeology, groundwater hydrology, or similar programs at an accredited college or university in Minnesota or an adjoining state or province. The goal of this scholarship is to alleviate a portion of the educational costs of qualified students, while also increasing their interest in the professions of hydrogeology, groundwater geology, and related programs.

 The application form and additional information can be found on the website at <u>http://www.mgwa.org/</u> <u>mgwa-foundation/funding-requests/</u>. The application deadline is January 29, 2018.

Please pass this on to any students who may be interested in applying. Contact <u>stephanie.souter@co.washington.mn.us</u> with questions about the scholarship or application process.

A Geoscience Career can/must be Flexible

The American Geosciences Institute (AGI) developed the infographic below to help students entering the workforce redefine what it means to have a career in geoscience. Having a successful geoscience career is not solely about mastering the technical fields of study, but additionally includes how students seamlessly integrate their interests and competencies to build a professional portfolio that will bolster their geoscience career. Recognizing the importance of emphasizing the transferability of skills across different fields is imperative to students' employability as geoscientists. This image is not meant to be definitive, but used as a tool to help those entering the workforce think outside the box. The colored rings signify the different sectors where geoscientists work. The wedges, in turn, represent the fields where geoscientists are employed and include different examples of occupations. Where the wedges intersect with the rings indicate that those fields are included in those sectors. To learn about workforce trends in the geosciences, see AGI's Geoscience Currents.







Illustrator: Kathleen Cantner. Content: Heather Houlton & Abigail Seadler

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MGWAF BOARD MINUTES

Meeting Date: Monday, June 19, 2017

Directors Present: Scott Alexander, Stu Grubb, Cathy von Euw, Ole Olmundson, Lanya Ross, Kara Dennis, Stephanie Souter. Others Present: Jennie Leete and Sean Hunt, MGWA Management

- 1. March 2017 Minutes. Motion to approve: Scott. Cathy seconded. All approved.
- 2. New board members. Kara Dennis, Hydrologist at MDH. Grad work at Syracuse, undergrad at Macalester College. MGWA Board meets June 20, 2017 to approve her nomination to MGWAF Board.
- 3. Review Current finances (Cathy). Kent from Wells Fargo (WF) provided a document to designate a new "associated person" for the WF accounts, to add Kara as an authorized user. Cathy asked about transition process for making sure Kara is up to date on everything The total of all accounts is \$243,811.12. According to Kent, returns on WF investments are averaging 11%. Total earnings to date are \$2,145.81, whereas in the past are earnings would have been about \$1,000. (Note that there is some level of risk taken on with the WF investments)

Endowment Account

Beginning balance: \$197,471.32 Debits:

\$2500 Carver County Grant \$2000 U of M HazWoper \$458.30 Advisory Fee (Wells Fargo) \$60,000 - Transfer to WF Account from Affinity Plus \$15 fee from Affinity \$2000 (2 MGWAF scholarships) \$168.42 Advisory Fee (Wells Fargo) \$2000 Transfer to Affinity Plus \$241.74 – Travel expenses for one scholarship winner

Credits:

\$60,000 transfer from Affinity Plus \$200 K Foundation Deposit (Give to the Max) \$50 Donation C Wildlund \$5 Deposit \$2045 Deposit (transfer from WF back to Affinity, plus \$45 in finance charges \$125.75 – Amazon Smile Donation

Ending balance: \$192,886.16

HOP fund:

Credits:

\$20,258 Donations (Jones, Alexander, Terhaar, and MGWA) Beginning balance is \$30,656.56

Ending balance: \$50,924.96

Motion from Cathy: For HOP funds, with a target of \$50,000 reached, Cathy and Kara will contact WF and ask to move HOP funds over to Wells Fargo. Funds will be managed separately from regular MGWA funds. In addition, to roll over additional funds from Affinity and Hiway funds into WF account and close those other accounts. Lanya Seconded. In favor: All. Cathy will ask whether advisory fee will go up, and if the funds in the liquid checking account are also subject to the fee. Cathy and Kara will contact Wells Fargo, after Kara's nomination is approved, to let them know that Kara is the new contact.

Stu also suggested that we consult with Kent regarding the current investment strategies, given the current state of the stock market. Will also invite Kent to come to the next MGWAF meeting. Jeanette will order new checks with generic name and MGWA address, instead of treasurer name.

New grant applications. None.

MGWAF Directors.

4.

5.

Board is full with Kara's nomination. Motion from Scott: Nominate Stephanie for secretary position. Second from Stu. In favor: All.

Question about meeting minutes and process for those. Secretary will send out via email within a week to ask for edits and changes. Then upon receipt of edits, send out final minutes for approval, and the Secretary can post to the Google Drive. Would like to get minutes into the MGWA newsletter in a more timely fashion.

2017/2018 budgeting 6.

Now that overall fund balance is higher, board members discussed how funds should be allocated on an annual basis.

Stu - 3-5% of endowment is a standard for philanthropic organizations. For our current funds, that would be about \$10,000.

Children's water festivals, scholarships.

For fall meeting: discuss and decide on increasing scholarship amounts for next round (current is \$1000 for undergrad and grad). Lanya asked if there is any way to offer support for nontraditional students. Could we tap some local programs like Step Up or Right Track? Will do some research before next meeting. Stu suggested talking to drillers as well.

MGWA Foundation **Board of Directors**

President Scott Alexander University of Minnesota (612)626-4164 alexa017@umn.edu

Secretary Stephanie Souter Washington County Public Health & Environment 651-430-6701 stephanie.souter@ co.washington.mn.us

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Director Eric Mohring retired (BWSR) (651)297-7360 eric.mohring@state.mn.us

The MGWA Foundation is a 501(c)3 charitable organization. Donations to the Foundation are deductible on your state and federal income tax returns.

MGWA BOARD MINUTES

MGWA Board of Directors Regular Meetings

Meeting Date: Tuesday, August 15, 2017

	Location:	Fresh Grounds Café, 1362 West 7th Street, St. Paul, MN
	Attendance:	Evan Christianson, President; Ellen Considine, President-Elect; Anneka Munsell,
		Treasurer; Andrew Retzler, Secretary; Sean Hunt, WRI; Jeanette Leete, WRI; Sherri
The MGWA Board meets	Past Minutes	Approved with changes
aneo a month ourrently	Gil Gabanski Mem	orial Fund: Money intended to go to the Foundation's Gil Gabanski Student
once a month, currently		Scholarship Fund were given to MGWA in the MGWAF's name. Leete has passed
over lunch, on the		this money to the Foundation, and will ask Kelton Barr (cc'ing Scott Alexander) if he
third Tuesday in the	Noweletton	could write personal thank you notes.
meeting room at Fresh	INEWSICILEI:	the newsletter items are in with the exception of a few smaller nieces and the
Grounds on W 7th Street		President's letter. Kroening expects the newsletter will be sent to Leete in about a
in St. Paul.		week. Christianson asked whether the content has grown, and Kroening replied it is
		more substantial than it was in June. Kroening said the Newsletter Team looked over
Members are welcome to	Web Page:	Hunt undated a number of the checkout items and the scholarship names on the
attend and observe		web page. Olmanson (not present) informed the Board via email that he added a
		Facebook button to the web page sidebar to the MGWA Facebook page.
	Treasury:	Munsell discussed the Treasury Report with the Board, and an error in the reported
		the books for the 2018 fiscal year. The numbers as reported with errors include a
		total income for the period of January 1, 2017 to August 14, 2017 of \$57,821.59; net
		income for this period of \$25,426.08; total assets for this period of \$80,055.32. Leete
	WDI Damanta	will work on correcting this error and will send out an updated Treasury Report.
	wki keport:	2018 fiscal year
	MGWAF Report:	Hunt reported that the MGWAF has not met since our last Board meeting, and
	-	the only current updates is regarding the requested funds for the Brown-Nicollet
		Children's Water Festival. Christianson still plans on a joint meeting between
		2017.
	Old Business:	White Paper Review: The Board discussed updates for the current White Paper
		Group. Christianson would still like to include the White Paper findings in the
		upcoming Fall Conference—meaning the White Paper Group should ideally have a draft by mid. September
		Fall Conference: Christianson updated the Board on the current speakers lined up for
Save These Dates		the conference, and that Dave Legvold offered to give a talk. Christianson needs to
		follow up with the White Paper Group to figure out how they might be incorporated
		into the schedule. Christianson would still like to fill the gaps with speakers having experience in policy, economics, and consulting. Considing has two individuals in
MGWA Conferences		mind and will forward their info to Christianson. Leete and Retzler suggested there
		might be a professor through the U of MN that deals with groundwater economics.
		Considine suggested having a speaker from the Irrigation Association. Christianson
		notential speaker regarding nitrates at the MDH and will pass along their info. Hunt
04/26/2018		suggests a Fall Conference brochure should be made prior to our next meeting in
		mid-September.
11/15/2018		MGWA Operations Manual Update: The Board continued their discussion on the
		the duties outlined within the Treasurer section. The Board will resume discussion
		updates at the next meeting, with the intention of revising the Operations Manual
		in September. Hunt will provide Munsell with Google Drive access to MGWA
		These of the Board discussed now the Newsletter Editor role is outlined in the current Operations Manual Newsletter Editor discussion will resume at the next Board
		meeting.
		Social Events: Berquist (not present) informed the Board via email that there are no
		new updates. Munsell attended the previous Social Hour and reported it was well
		Social and said it went well.
	New Business:	MGWA Rep for SMAC: The Board needs to appoint a new MGWA representative
		for the State Mapping Advisory Committee (SMAC) previously filled by Gil
		Gabanski. Munsell nominated John Clark for the position and discussed his
		the MGWA representative for the State Manning Advisory Committee Christianson
		seconds—motion passed.

MGWA BOARD MINUTES

MGWA Minutes, cont.

Meeting Date: Tuesday, September 19, 2017

Location: Attendance:	Fresh Grounds Café, 1362 West 7th Street, St. Paul, MN Evan Christianson, President; Ellen Considine, President-Elect; Ole Olmanson, Past President; Anneka Munsell, Treasurer; Andrew Retzler, Secretary; Sean Hunt, WRI; Jeanette Leete WRI: Sherri Kroening MGWA Newsletter
Past Minutes	Annoved with changes
Newsletter:	Kroening reported draft of the upcoming newsletter was finished. Leete added in portions for MGWAF and a call for MGWA Board nominations. Leete discussed
White Paper Comm	new InDesign styling ideas to help streamline the newsletter.
white I aper Collin	Crisman are soaking to become new members of the White Paper Committee
	Munsell motions to approve the appointment of Carrie Jennings and David Crisman as members of the MGWA White Paper Committee. Olmanson seconds—motion passed. Christianson will send out thank yous to those leaving the Committee— Kelton Barr and Mark Collins. Christianson checked in with Andrew Streitz about the current White Paper. The White Paper will not be finalized in time for the Fall Conference, but the working group will briefly present what they have so far. The working group is still discussing a few items of the White Paper before finalizing
	everytning.
Web Page: Treasury:	Hunt updated the exhibitor and registration page for the Fall Conference. Munsell discussed the Treasury Report with the Board. The numbers as reported include a total income for the period of January 1, 2017 to September 17, 2017 of \$59,007.26; net income for this period of \$26,478.59; total assets for this period of \$81,292,83
WRI Report:	Leete made changes in the accounting books with new codes for credit card
w KI Keport.	charging and dealt with the fiscal accounting error reported in last meeting's minutes. Hunt has been working on the exhibitor page for the Fall Conference, and currently there is one exhibitor and one inquiry for another possible exhibitor.
Old Business:	<u>Fall Conference Planning</u> : The Board reviewed the draft brochure. Retzler asked about making a call for poster presentations, and Leete mentioned a call for lightning talks. The email regarding conference registration will include a call for posters and lightning talks. The Board agreed on a November 3rd due date for posters and talks. Christianson plans to use Pigeonhole for this conference too. Christianson has been in contact with conference presenters in regards to any necessary hotel arrangements. Exhibitor space will be provided for the Water Bar at
	the conference. <u>MGWA Operations Manual Update</u> : Christianson suggested rolling all of the White Paper guidelines into the Operations Manual, as well as a list of current members updated periodically. Hunt suggested a master spreadsheet to handle that list. Christianson has made review comments on the Operations Manual
	on Google Drive for the Board to fook over. Christianson suggested drafting a standard template of monthly Board meeting agendas based on routine calendar events. Olmanson, Hunt, and Leete discussed ideas of adding these agenda items to the Google Calendar as notes. Retzler asked about the MGWA Annual Report as described in the Operations Manual. Leete described how the Annual Report has been put together in past years, and what is expected from the Secretary. The Annual Report will be discussed in detail during the December meeting, and a shortened report will likely be included in the newsletter. Considine suggested we add the Social Coordinator items to the Annual Report to update membership on the social events that occurred for the year. Considine also mentioned her preference for appendices, discussing how they could help simplify the Operations Manual. Christianson plans to comb through the manual, labeling specific areas as keep, modify, or delete. Other Board members can then go through and review. Munsell offered her place for the Board to meet and finalize the Operations Manual review. The Board will meet on November 21 at 6pm at Munsell's home to review the manual. Retzler asked about the Distinguished Award referenced in the manual and suggested that we make a call for nominations in the June newsletter regarding possible candidates. Hunt will gather more details about the award. Considine suggested adding a Table of Contents to the Operations Manual

MGWA 2018 Membership Dues

Sustaining Member	\$65
Professional Member:	\$45
Retired Member	\$25
Full-time Student Member	\$20
Newsletter	
(printed and mailed)	\$20

Membership dues rates were revised at the July 1, 2015 meeting of the MGWA Board.



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