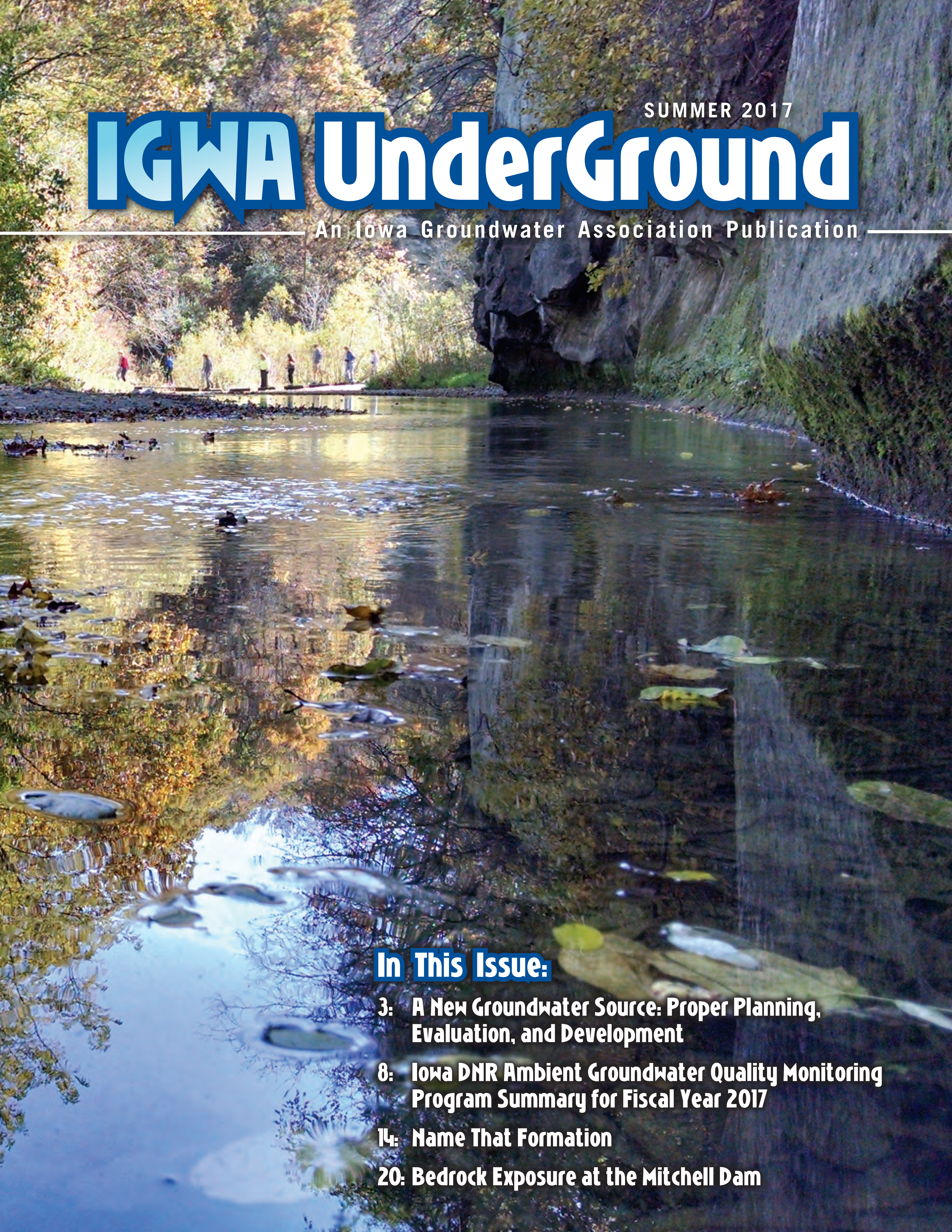
SUMMER 2017

IGWA UnderGround

An Iowa Groundwater Association Publication



In This Issue:

Iowa Groundwater Association 2017 Fall Meeting

THURSDAY - OCTOBER 5, 2017

KIRKWOOD REGIONAL CENTER CORALVILLE CAMPUS
2301 OAKDALE BOULEVARD CORALVILLE, IOWA 52242

FALL CONFERENCE SCHEDULE:

CEU's are available for Groundwater Professionals (3.0), Certified Well Contractors (6.5), and Water Treatment Operators (6)

8:00 am	**Registration and Continental breakfast**
8:20 am	**Welcome and Introduction to IGWA** *Laura Brandt - IGWA President*
8:30 am	**Water Quality Benefits of Reconstructed Oxbows** *Keith Schilling, Ph.D. – IGS-IIHR*
9:15 am	**Drought Strategies and Groundwater Sustainability at Rock Valley Rural Water** *Mike Gannon – IGS-IIHR*
10:00 am	**Break**
10:15 am	**Introduction to Neonicotinoids** *Bill Field, Ph.D., and Darrin Thompson - University of Iowa*
11:00 am	**Environmental Exposures to Neonicotinoid Insecticides** *Dana Kolpin - USGS*
12:00 pm	**Lunch**
1:00 pm	**IDNR, IGS, and USGS Updates – Panel Discussion** *Water Supply, USTs, Contaminated Sites, Water Resources*
2:30 pm	**Iowa LUST Program After 20-Years** *Jeff White - IDNR UST Section*
3:15 pm	**Break**
3:30 pm	**Cedar Rapids Airborne EM results** *Adel Haj, Ph.D. - USGS*
4:30 pm	**Closing Remarks**

Register online at www.igwa.org

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Objectives

- Promote education and research on Iowa groundwater issues.
- Foster cooperation and information exchange throughout its membership.
- Improve communication among state regulatory officials, professionals, and technicians working with groundwater.
- Cooperate with the activities of various state and national associations organized in the interest of groundwater use, conservation, management, and protection.

IGWA
Iowa Groundwater Association

We are a not for profit organization.

Iowa Groundwater Association
P.O. Box 744 • Des Moines, IA 50303
www.IGWA.org

the President's message

Laura Brandt – President, Iowa Groundwater Association

Laura Brandt and fellow cyclists entering Iowa on their 3,900 mile bike ride across the United States to raise awareness about global poverty.

Dear IGWA members,

Community, partnership, responsibility, and relationships have been on my mind this year. It is time for us to think more about how our planet is connected. We have seen drought kill off crops, livestock, and hundreds of people in Somalia this year. At the same time, we had hurricanes and flooding in Texas and Louisiana. The decisions we make in Iowa do not just impact Missouri and the Gulf of Mexico, they impact the world.

In 2013 I biked across the United States and Canada with one-hundred others on a mission to spread awareness about global poverty. It amazed me how vastly different our landscapes and surroundings were and yet how similarly my fellow cyclists and I were greeted in every community with food and fresh drinking water. Each night when we camped, we were afforded the opportunity of a warm shower. And laundromats were available to accommodate our dirty laundry each week. What a luxury we have in North America to have water in abundance. Thinking back to this time, I'm struck by the fact that we live in a world where we are all interconnected, and that I should not take water for granted. It would be impactful for me to remember the value of water on a daily basis. It all comes down to simple acts like turning off the water when we brush our teeth, using reusable water bottles, and taking shorter showers. We could protect our clean water by disposing properly of trash and recycling, pulling a few weeds by hand instead of using chemicals on our lawns, and carpooling. These simple acts can turn into bigger acts that positively impact our precious water resource.

My message to members, and especially myself, is to remember my impact on others, to submerse myself in different communities, and take responsibility for my actions. We spend most of our days in one office, perhaps with folks who have similar ideals and backgrounds talking about topics we can all agree on. It is a great time to get out in the community and talk to others, really talk. It is amazing what we can learn, the stories we will hear, and ways we can partner together to help one another.

See you all October 5th at the Fall Conference at The Kirkwood Regional Center in Coralville.

A New Groundwater Source:
Proper Planning, Evaluation, and Development

Greg Brennan, HR Green

The availability of an abundant and quality groundwater supply is often taken for granted and is sometimes even a secondary consideration during the siting of facilities that are water-dependent. In practice, however, there are many factors that should be considered when planning a groundwater source – whether it's a single well for commercial use or industrial cooling or a multi-well field for municipal supply. In terms of quantity, or quality, or both, the ability to identify and address such factors usually means the difference between a great well, an average well, or a bust.

A brief review of some of these key factors, along with a real-life story, is presented below in the hope of illustrating the importance of proper planning, evaluation, and development.

GEOLOGY

A discussion of the subsurface and its potential for development as a groundwater source of supply always begins with geology. The types of geologic formations (i.e., units, or stratigraphy) and their characteristics establish the framework for evaluation of the subsurface. Characteristics such as rock type, texture, geochemistry, etc. indicate the depositional environment in which the formations originated, which in turn gives clues as to whether or not the formations will yield the desired quantity and quality of groundwater. Crucial to understanding geology is the delineation of the lateral and vertical variations in stratigraphy because this directly impacts the occurrence, movement, and quality of groundwater.

For example, the depositional environment of a river valley deposit is vastly different than that of a ancient sedimentary deposit. The geologic framework provided by the former allows for the possibility of finding relatively shallow, river sand and gravel deposits of sufficient thickness and extent to support sustained groundwater pumping. In contrast, if possibilities are limited to the latter then the water-bearing potential may shift toward deeper, consolidated rock types like sandstone or limestone.

HYDROGEOLOGY

Hydrogeology deals with the occurrence, movement, and quality of subsurface water and its interaction with surface water. Aquifers, recharge, flow boundaries, and groundwater flow direction and gradient are some of the terms encompassed by hydrogeology which are important to define early in the well planning and siting process.

Aquifers are geologic formations that exhibit favorable water-bearing characteristics, such as sufficient thickness and permeability to transmit water to a well under the desired pumping conditions. In Iowa (as elsewhere), aquifer types can be broadly classified as alluvial, buried bedrock channel, or bedrock, and derive from the depositional history of the material. Recharge is the location and process by which groundwater within an aquifer is replenished. Recharge is typically from infiltration of precipitation or flow of groundwater from one aquifer into another. Groundwater flow boundaries occur where flow in the aquifer is either enhanced, such as a recharge boundary caused by incised river, or reduced due to a water-limiting condition, such as a thinning of an aquifer or the presence of an impermeable material. Groundwater flow pattern describes the direction(s) of groundwater flow and gradient is used to assess the horizontal and vertical components of flow rate.

It is also important to identify the proper conceptual model, for example, unconfined, semi-confined, or confined aquifer conditions. Identification of the correct model allows for a more realistic characterization of the hydrogeologic setting and groundwater flow regime.

PLANNING AND EVALUATION PROCESS

The City of Fort Madison's well field serves as an example of a well siting process as it progresses from planning to field testing to development. The desired new 6-million gallons per day (MGD) groundwater source was the Mississippi River Valley alluvial aquifer located southwest of the city. A 33 square mile area defined by a river meander was evaluated

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by a process that included literature research, field testing and analysis, and simulation. Based on a variety of factors a 120-acre preferred location was identified, with the most important considerations being its close proximity to the river (an advantage for recharge) and a lower potential to create pumping interference with existing industrial and irrigation wells. Even so, the presence of many private wells located within an approximate 2-mile radius of the proposed well field highlighted well and well field operating efficiency as a primary objective of the development.

The conceptual hydrogeologic model consists of an unconfined upper aquifer and a semi-confined (leaky) lower aquifer, which are separated by a low permeability aquitard. More specifically, the river deposits have a bulk thickness of about 175 feet with three distinct hydrogeologic zones, including: (1) an upper 90 foot thick alluvium deposit composed of fine to coarse sand and gravel, where recharge is derived mainly from the infiltration of precipitation and down-valley groundwater flow, and where the water table level is established by the river, (2) an intervening 10 foot thick layer of clay-rich glacial till which inhibits the vertical movement of groundwater between the upper and lower aquifers, and (3) a lower 75 foot thick alluvium (glaciofluvial) deposit composed of well sorted (uniform) fine sand with pockets of silt in its upper portion grading downward to moderately well sorted fine to medium sand, to a moderately to poorly sorted coarse sand and gravel near its bottom. **FIGURE 1** shows this stratigraphy and the corresponding conceptual model. Under this model, when the lower leaky confined aquifer is pumped for an extended period of time groundwater will be drawn mainly from the lower aquifer but also from the upper aquifer via vertically induced flow (recharge) through the aquitard.

Other factors considered were precipitation, river stage, and river channel depth and configuration as defined by the periodic dredging of shipping lanes (USACE, 1998). Site-specific hydrogeologic characteristics were defined through an extensive drilling and pumping test program, as shown in **FIGURE 2**.

The recharge rate to the upper water table from infiltration of precipitation was estimated at 3.8 to 7.7 inches per year (0.3 to 0.6 feet per year) which is 10 to 20 percent of annual mean precipitation (USGS, 2001). The predominant groundwater flow direction was from the upland valley bluffs toward the river and, to a lesser degree, from north to south

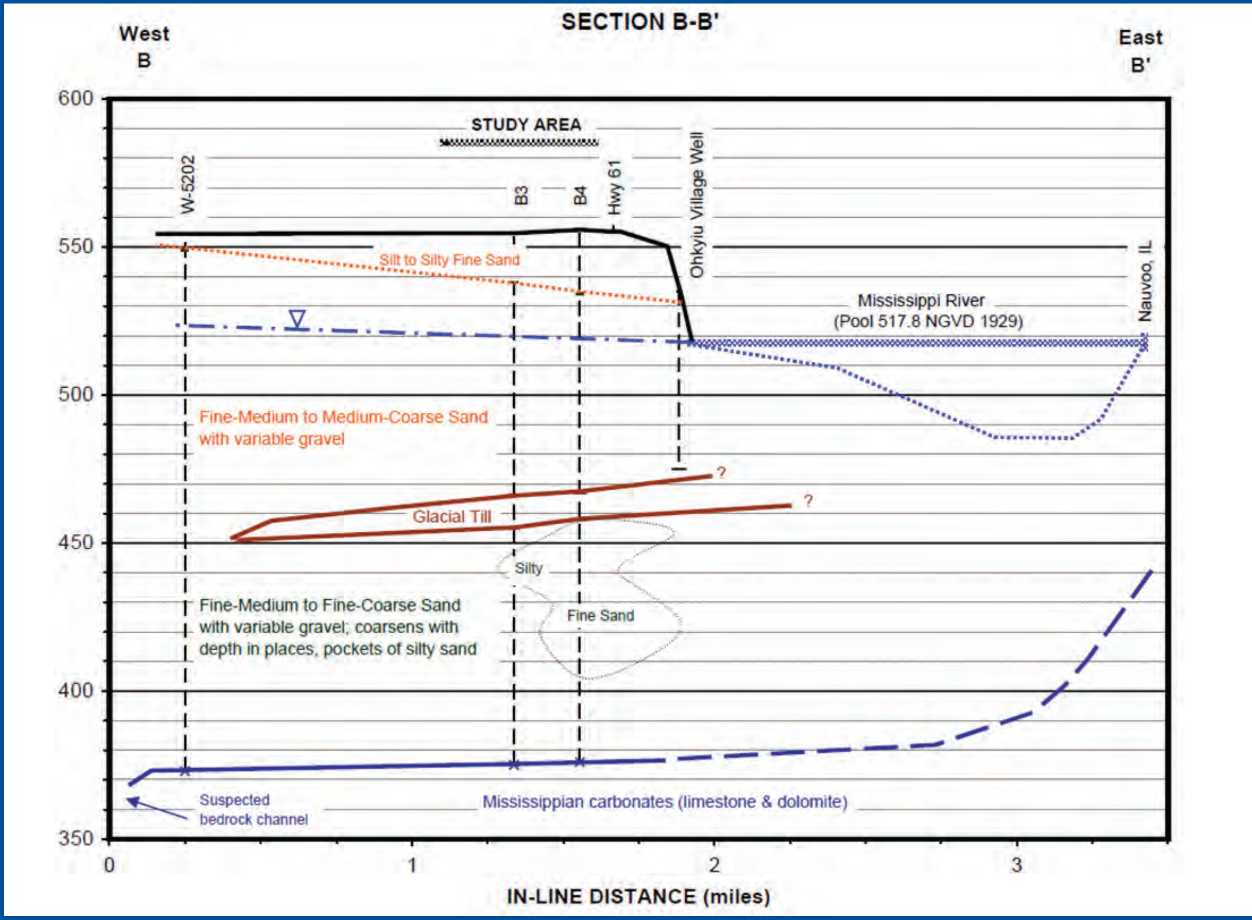

FIGURE 1: Section B-B'.

along the course of the river valley. The horizontal water table gradient was estimated using monitoring wells at 0.0006 feet/feet (3.17 feet/mile).

Based on the aquifer pumping and recovery tests, and as illustrated on **FIGURE 3** – Recovery Analysis, the calculated hydrologic parameters for the lower aquifer are Coefficient of Transmissivity at 120,000 GPD/ft (16,000 sq ft/day), storage coefficient at 0.01, and hydraulic conductivity at 1,500 GPD/sq ft (200 ft/day). The radius of pumping influence (ROI) was estimated at 1,000 feet under test conditions, which reflects the impact of the leaky aquifer recharge boundary. If leakage was not present the drawdown projection would have extended to a greater ROI.

Groundwater samples collected near the end of a 3-day pumping test show that water quality is similar to regional quality of the Mississippi River alluvial aquifer. Nitrate was of particular concern going into the study because the background literature search revealed that concentrations in the upper aquifer were variable with some areas ranging above the 10 mg/L MCL drinking water standard. At the test site the nitrate concentration in the upper aquifer was 12 mg/L. At the end of a 3-day pumping test the nitrate concentration remained undetected in the lower aquifer suggesting the overlying aquitard was an effective barrier to quality migration – at least over the very short term.

DEVELOPMENT

A primary consideration of any well or well field is the efficient utilization of available drawdown, which is the difference between the static (non-pumping) water level and the top of the lower aquifer, less a reserve margin in case of well losses, well interference, or drought. At the site the available drawdown

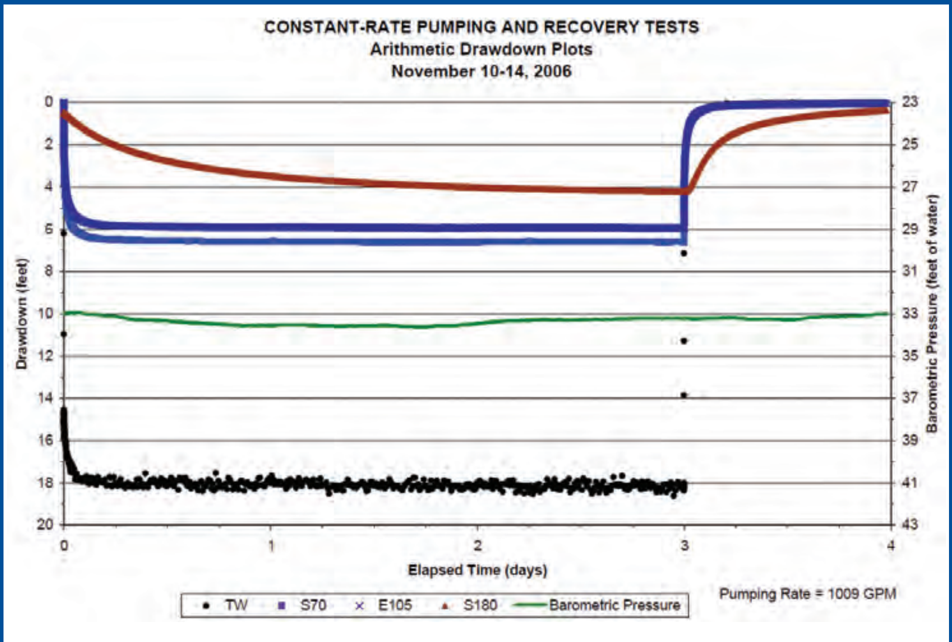

FIGURE 2: Constant-Rate Pumping and Recovery Tests.

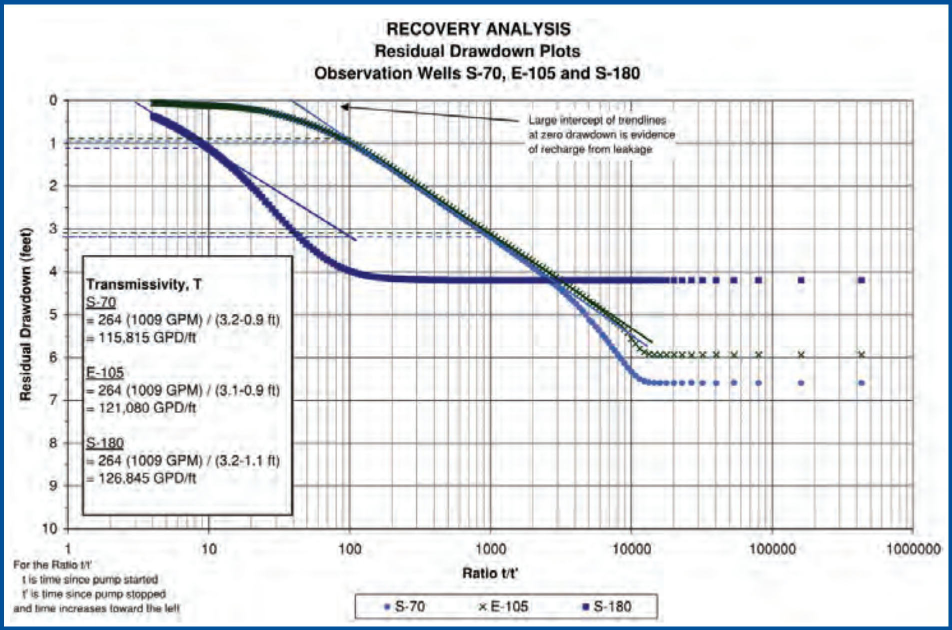

FIGURE 3: Recovery Analysis.

value of 55 feet was used as the pumping constraint.

The long-term production water level trend and the desired well field capacity are also considered. Even though the test pumping effort is a significant investment it provides data for only a small area and over a short 3-day period. In order to evaluate scenarios that satisfy the desired well field capacity the test pumping results were 'projected' to reflect a greater pumping rate over a longer period.

A well field scenario was then developed by analysis of distance-drawdown projections derived from the pumping test. Initially, a transient drawdown trend, utilization of available drawdown, and an extended pumping period (1 year) for various pumping rates were assessed. In this fashion different scenarios were evaluated to establish a well design and well field configuration that efficiently

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utilizes the aquifer resource. If time and financial resources permit a full-blown three dimensional groundwater flow model is recommended to perform a rigorous calibration and simulation of well and well field performance.

Projections showed that at 800 feet from a production well the projected drawdown in the formation would be about 7.5 feet. This means if two production wells are spaced 800 feet apart the total drawdown at each well would be the sum of that created by its own pumping (discharging at 1,000 GPM with a corresponding pumping water level drawdown of 31 feet) plus the interference (7.5 feet) from a second well operating under the same conditions for a total of 38.5 feet of drawdown, or 70% of the available drawdown. The drawdown in the formation midpoint between the two simulated wells would be about 18 feet. As other wells are added to the configuration the total drawdown in each well would be the sum of that created by its own pumping plus the interference from the other wells – all not to exceed the available drawdown constraint at any given well.

Based on test results and projections the recommended well field consisted of five (5) 16-inch diameter wells, each with a design capacity of 1,000 GPM collected through high-flow well screens to enhance each well's operating efficiency (i.e., mitigate drawdown thereby reducing the vertical flow component). This provides a total well field capacity of 7.2 MGD, whereby allowing for production losses and flexibility of operations and maintenance achieves a firm capacity of 5.76 MGD. Firm capacity means adequate source water capacity and production/treatment facilities (wells, pumps, etc.) to meet peak daily demand when the largest production well is out of service. The constructed production wells were spaced 800 to over 1,000 feet apart with the locations selected based on pumping projections, drawdown limits, geologic variation, and property constraints.

During longer-term operation of the constructed well field, which came online in 2010, production capacity and well and operating efficiencies have been maintained at each well such that: (1) the available drawdown limit has not been violated, and (2) the nitrate concentration in the lower aquifer remains undetected in 4 of the 5 wells and at a trace level in the 5th well (i.e., operations have not overstressed any one area of the 120-acre well field).

Further, to ensure that the quality of the aquifer source will be sustained the City also undertook proactive source water protection measures, including forming a Source Water Team, holding a public meeting to communicate key issues and present educational material relating to groundwater protection, and holding conversations with targeted landowners within the delineated well head protection area (IDNR, NRGIS Library) – particularly in relation to non-point source threats such as nutrients and pesticides.

This review demonstrates that when availability and quality of groundwater are not taken for granted, and when proper attention is given to planning, evaluation, and development, such effort converges to successfully manage our common and valued natural resource – groundwater.

REFERENCES:

U. S. Army Corps of Engineers, 1998, *Hydrographic Survey, Nauvoo, River Mile* 376.

U.S. Geological Survey, 2001, *Simulated Groundwater-Water Flow and Water Quality of the Mississippi River Alluvium near Burlington, Iowa, 1999*. WRIR 00-4274.

River Action Promotes Environmental Restoration of & Appreciation for the Mississippi River

Molly Arp Newell

Eastern Iowa – Non-Profit Organization known as RIVER ACTION works to protect and restore the Mississippi River through cultural, economic, and educational events. Since before the days of Lewis & Clark, the Mississippi River has governed our cultural and economic evolution along the riverfront. These days, the dedicated Executive Director of River Action, Kathy Wine, focuses on education, awareness, technology, and adventure to augment individual relationships with the River. She wants us to get out there and enjoy it.

River Action strives to foster environmental, economic and cultural vitality of the River by attracting and using grant funds for education, and by recruiting professionals to volunteer their time and talents to raise awareness of the River through recreational activities. Examples of recreational activities include Ride the River on Father's Day (bike ride event), Floatzilla in August (19th), Sr. Citizen Riverfront Golf Cart Tour in September (7th), Taming of the Slough in September (16th), and "Art in the Park" funded by River Action created in homage to Georges Seurat's Neo-Impressionistic painting *A Sunday Afternoon on the Island of La Grande Jatte* . The art is exhibited on the river bank of Credit Island, in Davenport. The Credit Island picnic ground is one of many provided in the riverway scenic tour publication, also by River Action, with 100 miles of area parks & trails.

River Action has created and sustained a summertime educational program called Riverine Walks and Channel Cat Talks. It engages people of all ages to explore one or more aspects of a specific topic, often at a unique riverfront location. Discussions are informal but led by an expert. For example, professors, engineers, authors, historians, habitat experts, conservationists, artists and municipal representatives all serve the public through River Action educational programs. Our appreciation of the River continues to grow as we learn details about the Mississippi's role in the strategy of historical battles, the location and economic impact of its lumber mills, the steamboats, ferries, the first bridges, railroad bridges, the locks and dams, ecological diversity of flora and fauna, and the blessings of our wide erosional flood plain.

"River Action has created and sustained a summertime educational program called Riverine Walks and Channel Cat Talks. It engages people of all ages to explore one or more aspects of a specific topic, often at a unique riverfront location. Discussions are informal but led by an expert."

Education and awareness of the River fosters respect, which in turn manifests into volunteer clean up events, invasive species control, river bank restoration and pollution prevention. The River is cleaner than it used to be, and respect for the River is growing. Thanks in part to River Action, water quality of the Mississippi River continues to improve.

River Action caters to community members and eco-tourists through workshops, ferry rides on its Channel Cat river boats, conferences for young and old on topics from hydraulics to endangered species; and other educational opportunities.

The RIVER ACTION fall conference of 2017 is entitled BIG RIVER BIG CHALLENGES.

THE DATES: October 11th and 12th 2017
THE LOCATION: IWireless Center, downtown Moline, IL
Topics include Green infrastructure, Run-off, Private-Public partnerships, Locks and Dams, and an update on the Gulf hypoxia concerns.

Get to know River Action and check out the exciting events occurring on the East Coast of Iowa.
www.Riveraction.org

Iowa DNR Ambient Groundwater Quality Monitoring Program Summary for Fiscal Year 2017

Claire Hruby, Ph.D

2017 marks the 30th anniversary of the Iowa Groundwater Protection Act (GPA). The GPA states that *"the intent of the state is to prevent contamination of groundwater from point and nonpoint sources of contamination to the maximum extent practical, and if necessary to restore the groundwater to a potable state, regardless of present condition, use, or characteristics".*[1] The GPA lists eight duties of the director of the Iowa Department of Natural Resources (Iowa DNR), including:

1. *Develop and administer a comprehensive groundwater monitoring network, including point of use, point of contamination, and problem assessment monitoring sites across the state, and the assessment of ambient groundwater quality.*

3. *Establish a system or systems within the department for collecting, evaluating, and disseminating groundwater quality data and information.*

4. *Develop and maintain a natural resource geographic information system and comprehensive water resource data system. The system shall be accessible to the public.*

7. *Disseminate data and information, relative to this chapter, to the public to the greatest extent possible.*

Although the GPA did establish a groundwater protection fund, it did not specifically allocate monies for ambient groundwater monitoring

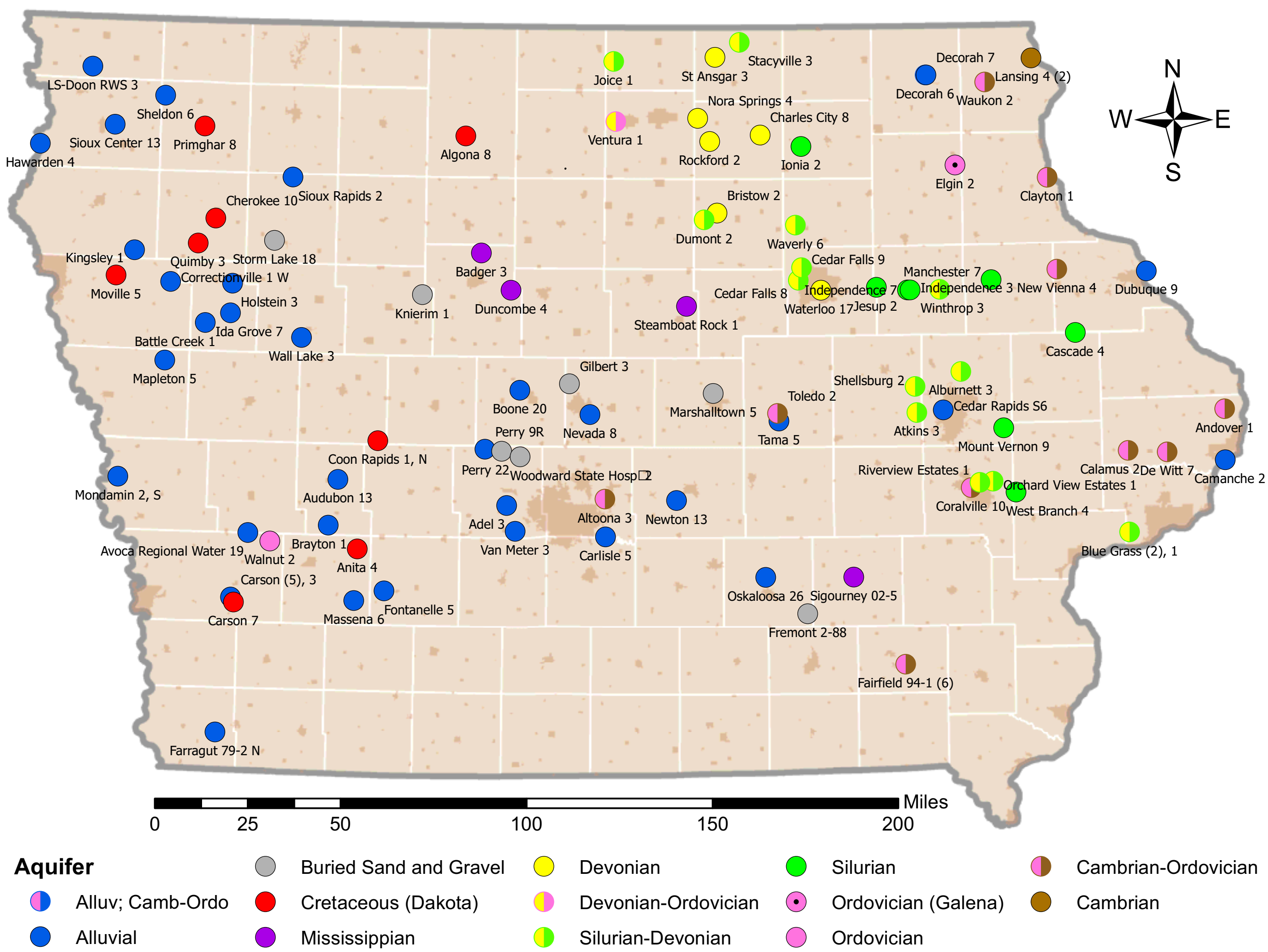

FIGURE 1: Ambient groundwater quality monitoring sites for FY2017 by aquifer.

	Analyte	Limit of Detection	Units	Method	N	Number of Detections	Percent Detections	Mean of Detections	Median of all values	Maximum
Field	pH			SM 4500 H+ B	94	94	100%	7.28	7.28	7.90
	Turbidity	1	NTU	SM 2130 B	94	55	59%	4.2	0.4	36
	Dissolved Oxygen	0.1	mg/L	ASTM D 888-09 C	94	92	98%	3.4	2.8	9.0
Laboratory	Total Suspended Solids	1	mg/L	USGS I-3765-85	94	37	39%	5.51	ND	34
	Chloride	1	mg/L	EPA 300.0	94	85	90%	28.9	15	230
	Nitrate + Nitrite nitrogen as N	0.1	mg/L	LAC 10-107-04-1J	94	39	41%	7.0	ND	40
	Ammonia Nitrogen as N	0.05	mg/L	LAC 10-107-06-1J	94	53	56%	0.95	0.11	6.8
	Total Coliform	1	MPN/100ml	SM 9223B	94	14	15%	47	ND	540ǂ
	Escherichia coli	1 (10)	MPN/100ml	SM 9223B	94	1	1%	1	ND	1

ǂ - After notification, the water operator collected a new sample for analysis, which had a reported concentration of <1 MPN/100ml.

TABLE 1: Summary statistics for field and laboratory parameters analyzed by the State Hygienic Laboratory for groundwater samples collected in FY2017.

activities. Tonnage fees were allocated towards solid waste-related activities. Fees charged to commercial fertilizer sales were allocated to an agricultural management account which supports closure of ag drainage wells, testing of private wells, and established the Leopold Center for Sustainable Agriculture and the Center for Health Effects of Environmental Contamination. The GWP also established household hazardous waste and storage tank management accounts to help prevent groundwater contamination from these sources and to educate the public. Despite budget cuts and staffing reorganizations, the Iowa DNR continues to fulfill its ambient groundwater monitoring duties using funds allocated to the Water Monitoring Section and supplemental grants when available.

FY2017: The purpose of the Iowa DNR's ambient groundwater monitoring program is to document the quality of water in Iowa's major aquifers. While public drinking water supplies are required to test for contaminants in finished water, the Iowa DNR's ambient program tests raw (untreated) water, most of which is currently collected from individual public water supply wells. Results of these analyses help us to understand which natural and anthropogenic contaminants are present, how they are distributed across the state, and whether their concentrations change over time. The ambient groundwater quality monitoring effort in fiscal year (FY) 2017 was designed to continue annual sampling for nitrate, and to repeat and expand the 2013 statewide survey for viruses and bacterial pathogens in public wells representing all major aquifers in Iowa. In addition, the ambient groundwater quality monitoring program has provided support for continuous monitoring of nitrate in Big Spring in a cooperative program with IIHR – Hydroscience & Engineering at the University of Iowa, which put a sensor at the Manchester hatchery. These sensors have been in place since December of 2015.

WELLS: From October 2016 to February 2017, untreated groundwater samples were collected from 94 public water supply wells in Iowa (**FIGURE 1**). Fifty-three wells are considered highly vulnerable to contamination from surface activities because they have less than 50 feet (ft) of confining layer thickness above the screened interval. Thirty-three of these highly vulnerable wells are alluvial wells, and the other highly vulnerable wells are Silurian-Devonian or shallow Cambrian-Ordovician wells in northeast Iowa. Seventeen wells (18%) were of intermediate vulnerability (50 - 99 ft), and 24 wells are considered low vulnerability wells (≥ 100 ft). Most wells (98%) were sampled between October to December, and 2 samples (2%) were collected in early February. Sampling was conducted by staff from the Iowa DNR and the State Hygienic Laboratory (SHL). Well water was analyzed for temperature, pH, turbidity, and dissolved oxygen in the field, and grab samples were transported on ice to SHL where they were analyzed for total suspended solids, chloride, nitrate + nitrite as nitrogen, ammonia as nitrogen, and the indicator bacteria, total coliform and *E. coli*. **TABLE 1** summarizes the results of these analyses.

NITROGEN: Groundwater samples were analyzed for two forms of nitrogen (N): nitrate + nitrite as N (referred to as nitrate from this point on) and ammonia as N. Thirty-nine of the wells sampled (41%) had detectable levels of nitrite, and fifty-three (56%) of the samples contained nitrogen in the form of ammonia (**TABLE 1**). With only four exceptions, wells that contained nitrate did not contain ammonia and vice versa. The FY17 sample set contained a greater percentage of low vulnerability wells compared to FY16, therefore, it is not surprising that a smaller percentage of the samples from FY17 (41%) contained nitrate than in FY16 (60%). The mean (average) concentration of nitrate in samples with detections was 7.0 mg/L. The maximum concentration of nitrate (40 mg/L) was found in a well with known point-source contamination in an alluvial aquifer. In FY17, seven (7%) samples contained nitrate concentrations at or above the drinking water standard of 10 mg/L, and 18 (19%) of samples exceeded 5.0 mg/L nitrate as N. The mean concentration of ammonia as N in groundwater samples with detections was 0.95 mg/L. The maximum concentration of ammonia as N was 6.8 mg/L, which is likely to be derived from the rock that forms the Silurian-Devonian aquifer rather than being caused by surface contamination.

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Microorganism	Host	Type	Target	Full Process 95% LOD (gc/L)*	Assay 95% LOD (gc/rxn)ǂ	Detection Frequency (%)	Maximum (gc/L)
Adenovirus group A	Human	DNA virus	Hexon gene	1.5	2.4	0%	-
Adenovirus group B	Human	DNA virus	Hexon gene	1.5	4.5	0%	-
Adenovirus groups C,D,F	Human	DNA virus	Hexon gene	1.5	3.9	1%	0.09
Enterovirus	Human	RNA virus	UTR region	4	2.6	0%	-
Norovirus genogroup I & II	Human	RNA virus	ORF1-ORF2	4	5.9	0%	-
Norovirus genogroup II	Human	RNA virus	ORF1-ORF2	4	5.7	0%	-
Human polyomavirus	Human	DNA virus	T antigen	1.5	3.3	0%	-
Bovine polyomavirus	Bovine	DNA virus	VP1 gene	1.5	3.5	1%	1.8
Hepatitis E virus	Swine	RNA virus	ORF3	4	4	0%	-
Avian influenza A	Birds	RNA virus	matrix gene	4	4.4	0%	-
Pepper mild mottle virus	Peppers	RNA virus	replication protein	4	32.2	4%	26.7
Salmonella sp.	Non-specific	bacterium	invA gene	1.3	8.5	0%	-
Campylobacter jejuni	Non-specific	bacterium	mapA gene	1.3	3.3	0%	-
Enterrohemorrhagic *E. coli*	Non-specific	bacterium	eae gene	1.3	3.6	0%	-

* - As reported by Stokdyk et al. (2016)[3] for a waterborne DNA virus (adenovirus), RNA virus (enterovirus), and bacterium (*Salmonella*).

ǂ - As determined for this study.

TABLE 2: Summary of virus and bacterial pathogen results for FY2017 (number of samples = 93).

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MICROBIAL INDICATORS: Two groups of microorganisms, total coliform and *Escherichia coli (E. coli),* were analyzed in FY17 using enzyme substrate tests (SM 9223B). Total coliforms were detected in 14 (15%) of wells at concentrations ranging from 1 to 540 most probable number (MPN) per 100 milliliters (ml). Twelve out of the fourteen (86%) detections of total coliforms occurred in samples from wells where the estimated confining layer thickness was less than 100 feet, and ten (71%) of these detections occurred in wells with confining layers less than 50 feet thick. Iowa DNR immediately notified the water operator of the sample containing 540 MPN/100ml. He then collected an additional sample, which was negative for total coliform. The water sample collected at the same time as the high total coliform sample was not found to contain any viruses or bacterial pathogens. *E. coli* was only detected (at 1 MPN/100ml) in one sample from a carbonate (Silurian-Devonian) aquifer, which also contained 3.1 MPN/100ml total coliform, but was negative for all of the viruses and bacterial pathogens assessed.

TESTING FOR VIRUSES: Testing for viral and bacterial pathogens required filtration of large volumes (>800 liters) of water. Sterilized tubing was connected directly to sample taps and water was directed through ultrafilters until the target volume was reached, or until the filter became clogged. Filters were shipped overnight to the Laboratory for Infectious Disease and the Environment, and an interagency laboratory between USDA-ARS and the USGS Wisconsin Water Science Center in Marshfield, Wisconsin. Samples were analyzed for ten viral pathogens and three bacterial pathogens using quantitative polymerase chain reaction (qPCR) methodology as described in Borchardt et al. (2012).[2] Results of these analyses are summarized in **TABLE 2**, where virus and bacteria concentrations are reported in genomic copies per liter (gc/L). Detection limits for qPCR vary depending on the exact procedure that is used (including sample volumes, extraction volumes, template volumes, and replications). Using probit analysis of the proportion of known positive replicate samples that are detected, a 95% limit of detection (95% LOD) can be calculated for the entire analytical procedure. The 95% LOD is the lowest concentration at which there is a 95% probability of detecting a positive sample. Concentrations measured below the 95% LOD are not false-positives, but there is a lower probability of detecting them. In **TABLE 2**, we report the 95% LOD determined by Stokdyk et al. (2016)[3] for a waterborne DNA virus (adenovirus), RNA virus (enterovirus), and bacterium *(Salmonella)*, which were performed in the same laboratory as our project's analyses. In addition, we report the 95% LOD for the qPCR reaction in genomic copies reaction (gc/rxn) as determined specifically for this project. Standard curve quality assurance parameters will be made available upon request.

As with 2013, the most commonly detected virus was the pepper mild mottle virus (PMMV), which is a plant virus that is not known to infect humans, but is found in high concentrations in human waste due to ingestion of pepper products, such as hot sauce. In FY2017, PMMV was detected in four (4%) samples, with a maximum concentration of 26.7 genomic copies per liter (gc/L). PMMV was detected in two highly vulnerable alluvial wells with no documented confining materials (at 9.4 and 14.4 gc/L), one Dakota sandstone well with

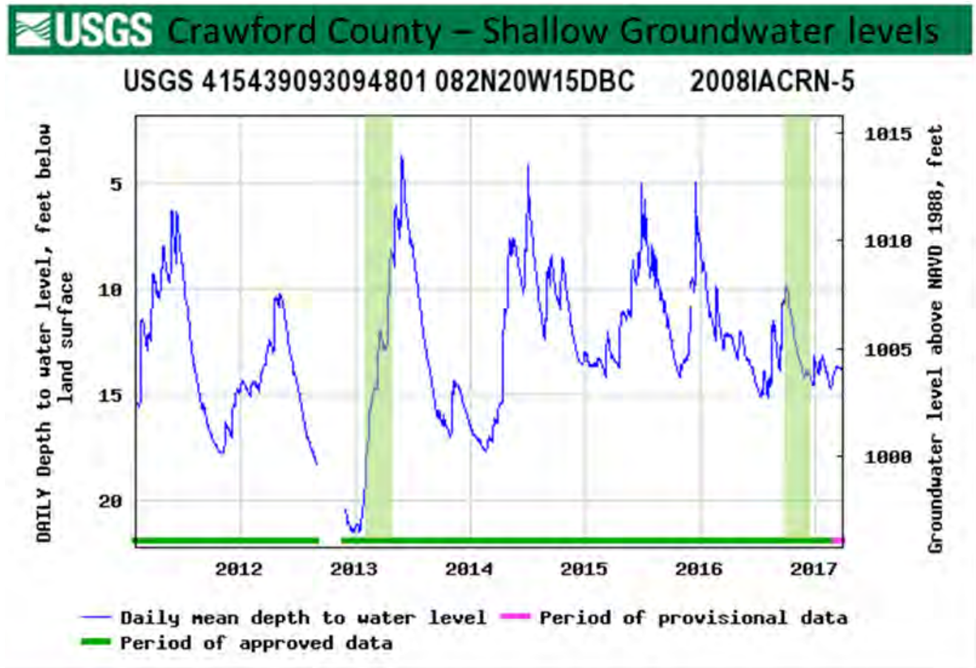

FIGURE 2: Summary of virus and bacterial pathogen results for FY2017 (number of samples = 93).

27 feet of confining material (at 11.2 gc/L), and one Cambrian-Ordovician (Jordan) well with greater than 200 feet of confining material (at 26.7 gc/L). The presence of PMMV does not necessarily indicate that human waste is leaking into groundwater, but it does indicate that some contamination from human or animal waste sources may be occurring.

In this broad survey of Iowa's aquifers, rates of detection and concentrations of human and animal pathogens were lower than what has been found in surface-waters in the Midwest[4,5,6] and in wells in highly vulnerable aquifers in Wisconsin.[7] In FY2017, there was one detection of a human virus (adenovirus C, D, F), which was found at a very low concentration (0.09 gc/L) in a deep, highly-confined (>400 ft) Jordan well in central Iowa. This concentration was below the estimated 95% LOD and was not found in a duplicate sample obtained simultaneously. There was also one detection of bovine polyomavirus at a concentration of 1.76 gc/L in a highly vulnerable (no confining material present) Jordan well in NE Iowa. Bovine polyomavirus is often carried by cattle but is not associated with a specific illness. Unlike 2013, GII norovirus, human polyomavirus, and *Campylobacter* were not detected in FY2017. Adenovirus A, adenovirus B, enterovirus, GI norovirus, swine hepatitis E, *Salmonella*, and enterohemorrhagic E. coli were not detected in either 2013 or FY2017. The avian influenza A virus, which was associated with the massive outbreak that occurred in 2015, was not found in any of the groundwater samples in FY2017. A recent publication by Borchardt et al. (2017) did detect avian influenza A in well water from an Iowa farm eight days after the outbreak was first detected at that site.[8] Therefore, it is important to consider that groundwater used for washing trucks or watering birds during an outbreak has the potential to spread the disease.

Duplicate samples were obtained at nine wells. Duplicates were obtained by splitting the hose attached to the sample spigot and running the water through two filters at once. At two sites, viruses were detected in one sample, but not in the duplicate sample. Since viruses and bacteria are not spread evenly throughout the water like dissolved contaminants usually are, it is possible that a "clump" of the viruses was captured by one filter and not the duplicate. For concentrations reported below the 95% LODs, it is also possible that viral genetic material was present at concentrations too low to be detected. No false positives were found for any of the negative controls run during the secondary concentration, extraction, reverse transcription, or qPCR steps of the analyses, with the exception of one detection of PMMV. In this case, the sample was re-extracted and reanalyzed. This sample was then confirmed positive and all the negative controls were compliant. Contamination during sampling is also possible; however, no viruses or bacteria were detected in the two field blanks, which were run with sterilized water.

The overall frequency of detection of pathogenic organisms was lower in 2017 (6%) than in 2013 (23%). Although recharge events did occur in Iowa during the 2017 sampling period, most locations around the state were experiencing declining shallow groundwater levels, as illustrated by groundwater level data from Crawford County in western Iowa provided by the USGS (**FIGURE 2**). The results of Iowa's monitoring for viruses and bacterial pathogens are consistent with recent groundwater studies in Minnesota and Wisconsin, which show that pathogen occurrence is intermittent, and is likely to be influenced by hydrological parameters, including recharge rate and groundwater temperature.[9,10]

All of the municipalities that cooperated with this monitoring currently disinfect their water, with the exception of four systems: two which did not have any microbial detections, and two other systems that are not operating, but continue to maintain their wells. Even if the water treatment systems failed, the virus monitoring results revealed no immediate threats to human health. However, these results do indicate that it is possible for microbial pathogens to be transported to groundwater, even to aquifers, like the Cambrian-Ordovician (Jordan) aquifer, traditionally considered to be

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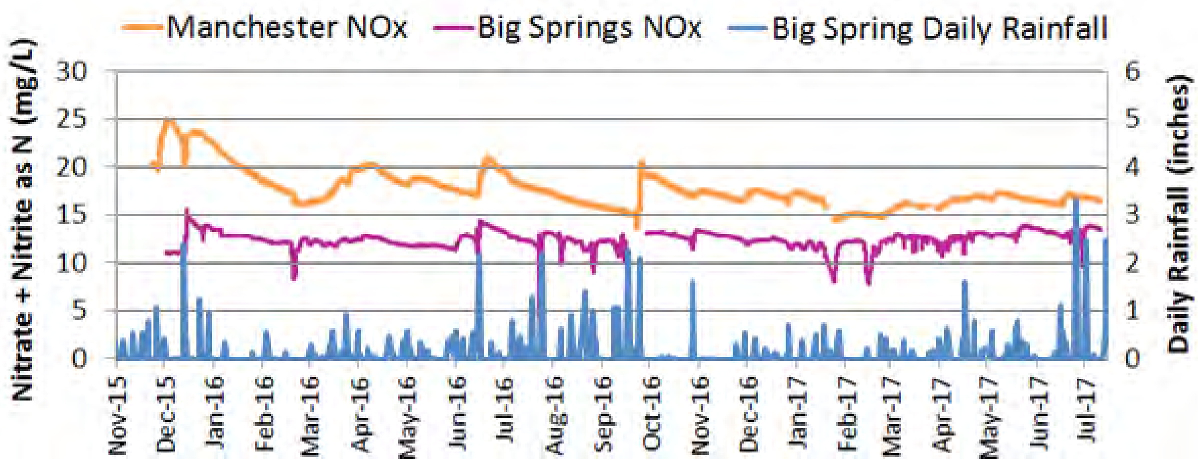

FIGURE 3: Nitrate + nitrite as N at Manchester and Big Spring Fish Hatchery's springs from November 2015 to July 2017 (data from IIHR) and daily rainfall data for Big Springs (from the Iowa Environmental Mesonet).

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protected from surface contamination. Other studies indicate that deep wells can become contaminated by viruses that are transported through poorly constructed or aging well casings, or preferential pathways, such as bedding-planes or fractures.[11] Users of private wells should be aware of the potential for transport of viruses and bacteria to groundwater, and should consider additional treatment especially when users are vulnerable due to age or medical conditions.

SPRINGS: Continuous monitoring data from two springs in NE Iowa allow for comparison between variations in nitrate concentrations in groundwater influenced by a high number of sinkholes in the Ordovician Galena limestone (Big Spring) versus a spring draining Silurian dolomite bedrock in an area with very few sinkholes (Manchester). Both locations drain landscapes dominated by row-crop agriculture (see more about Manchester in the article on page 16). Results of the continuous nitrate monitoring at Big Spring and Manchester hatcheries can be found at the IIHR's Iowa Water Quality Information System (IWQIS) website: http://iwqis.iowawis.org/. Nitrate + Nitrite as N concentrations at Big Spring have generally varied between 10 – 15 mg/L since December, 2015, with a few sharp dips as low as 3.8 mg/L in response to precipitation or snowmelt events (**FIGURE 3**). In contrast, nitrate in the spring at the Manchester hatchery has varied between 15 – 25 mg/L, with the highest concentrations recorded in December of 2015 (**FIGURE 3**) following a warm and wet fall. Dissolved oxygen concentrations, first reported in January 2017, are higher at Big Spring (7.7 – 9.3 mg/L) than at Manchester (6.6 – 7.6 mg/L). Continuous monitoring of specific conductance, pH, and water temperature are also available for these sites and efforts to verify discharge data are ongoing.

ACCESS TO DATA: Currently, all ambient groundwater monitoring data supplied by the State Hygienic Laboratory from 2002 – 2017 is housed in the Iowa DNR's EQuIS database and is available on the IASTORET website: https://programs.Iowadnr.gov/iastoret/. Users who search by "Station" can select "Iowa Groundwater Data" from the organization drop-down list, and then they can choose the station and date range of interest. Pharmaceutical and pesticide data analyzed by the USGS for the 2013 study can be found in the USGS NWIS database. Virus data from 2013 and FY2017 will be available in IASTORET in the near future.

FUTURE WORK: Both the Iowa DNR and the Iowa Geological Survey (at IIHR) have been awarded grants from the USGS to become data providers to the National Ground-Water Monitoring Network (NGWMN). This work will entail selecting sites from important regional aquifers that are regularly monitored, to be included on the NGWMN website, where data from multiple agencies will be linked. This will allow users to access water level and water quality data collected by multiple agencies from one location. Currently, only three shallow groundwater level monitoring sites are available for Iowa on this website (**FIGURE 4**).

ACKNOWLEDGEMENTS: The goals of the FY2017 ambient groundwater quality data collection could not have been accomplished without the cooperation of water operators, sampling assistance of Jason Palmer and guidance provided by Roger Bruner (Iowa DNR), funding provided by the Iowa DNR Water Monitoring Section and an EPA 106 grant, assistance with sampling, logistics, and analyses from SHL staff, help with continuous nitrate monitoring from IIHR, cooperation of Iowa DNR fisheries staff at Big Spring and Manchester hatcheries, ideas and support from Robert Libra, and the expertise of Dr. Mark Borchardt, Susan Spencer, Aaron Firnstahl, Joel Stokdyk, and the staff of the

Laboratory for Infectious Disease and the Environment.

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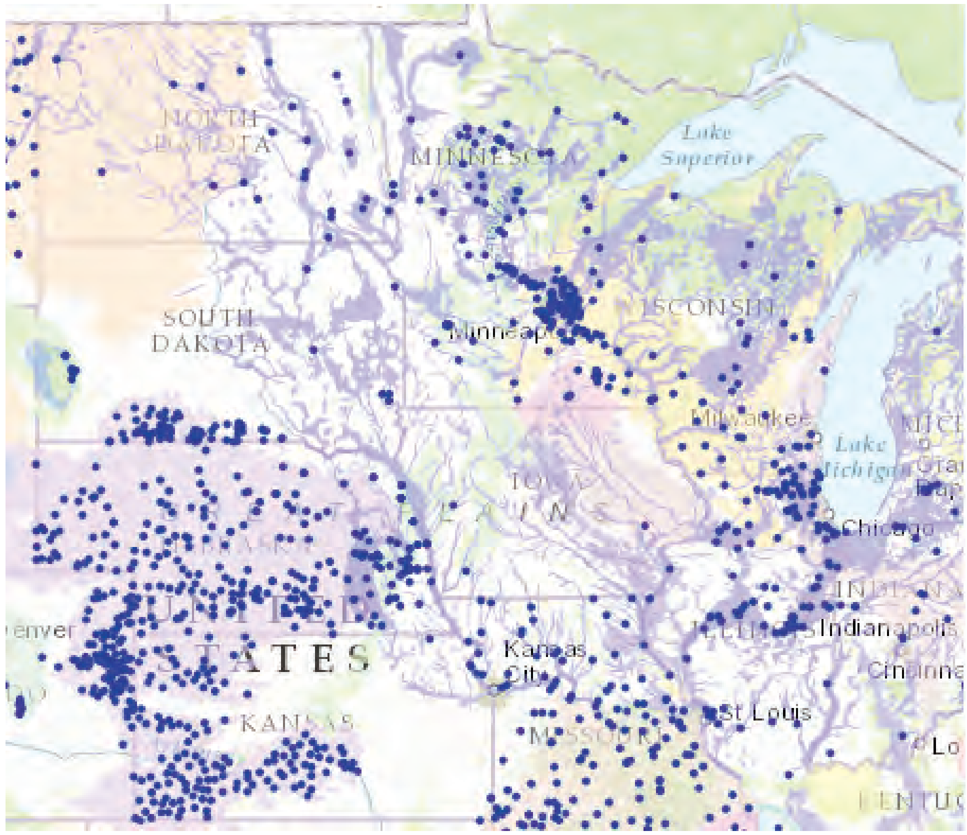

FIGURE 4: Locations for water quality and water level data on the National Ground-Water Monitoring Network website as of July 2017 (source USGS).

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For more information:

Claire Hruby, Ph.D.
Iowa Department of Natural Resources
502 E. 9th St., Des Moines, IA 50319
Phone: 515-725-8348
Email: claire.hruby@dnr.iowa.gov

Iowa DNR Ambient Groundwater Monitoring Website: http://www.Iowadnr.gov/Environmental-Protection/Water-Quality/Water-Monitoring/Groundwater

NAME THAT FORMATION!

Here is a good test for the geonerds among us! For the rest of us, these photos (by geologist Matt Graesch) are a great reminder that there is always more to explore and learn in Iowa!

1

2

3

(1) Sioux Quartzite (Precambrian) at Gitchie Manitou State Preserve **(2)** Cherokee Group (Pennsylvanian) at Dolliver State Park
(3) Cherokee Group flame structures **(4)** Galena Group (Ordovician) sliding down the St. Peter Sandstone (Ord.)
(5) St. Peter Sandstone **(6)** Wonewoc Fm. (Cambrian) at Lansing
(7) Morgan and Alden glacial till members of the Dows Fm. (Quaternary) along the Skunk River
(8) Platteville Fm. near Monona **(9)** Ripples on the top surface of the Dakota Sandstone (Cretaceous)

May 2017

IOWA GEOLOGICAL SURVEY

Groundwater Vulnerability in the Manchester, Iowa, Area

Introduction

Nitrate concentrations measured in the city of Manchester public wells and in springs feeding the Manchester Fish Hatchery are prompting careful examination of groundwater vulnerability in the area. The city of Manchester and fish hatchery are located along the Maquoketa River in Delaware County, Iowa (*Figure 1*). Groundwater in the Honey Creek and Spring Branch Creek watersheds flows through fractured Silurian-age dolomite bedrock to city and private wells, and to the hatchery springs.

Nitrate concentrations in Manchester-area wells and springs are quite high (*Figure 2*). For example, nitrate concentrations in Manchester city well #5 hover around the Maximum Contaminant Level (MCL) of 10 mg/l. The U.S. Environmental Protection Agency established the MCL as the drinking water standard for nitrate (measured as N). High nitrate concentrations in city wells require expensive treatment to meet drinking water standards.

Historical nitrate data available for the well indicated that concentrations have greatly increased since the early 1970s. Increasing nitrate concentrations are well-correlated to the increasing percentage of land devoted to production of row crops (corn and soybeans). Nitrate comes from various sources, but the predominant source in most of Iowa is row-crop agriculture, with commercial fertilizer and livestock manure the primary contributors.

Since late 2015, IIHR—Hydroscience & Engineering at the University of Iowa has operated a continuously-reading nitrate sensor at the upper hatchery spring. Concentrations in 2016 (*Figure 2b*) were 15–20 mg/l, which is 1.5 to 2 times the MCL and much higher than Manchester city wells.

This study assesses groundwater vulnerability in the Manchester area using existing geologic, groundwater, and water-quality data. Results are intended to assist with developing strategies of nitrate reduction in area wells and springs.

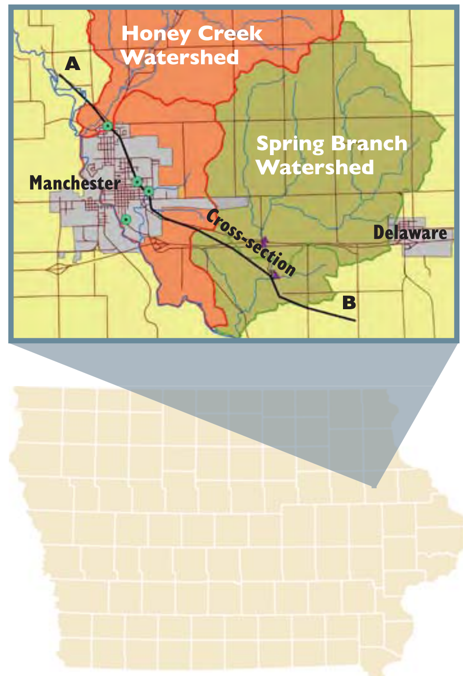


Figure 1: Manchester, Iowa

Nitrate Concentrations (mg/l)

Figure 2a: *Manchester Well #5*

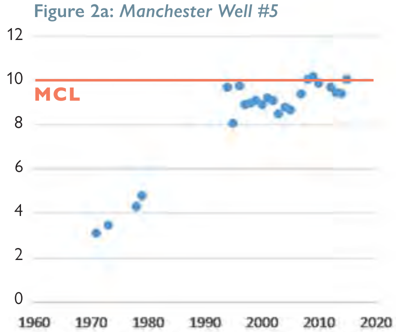
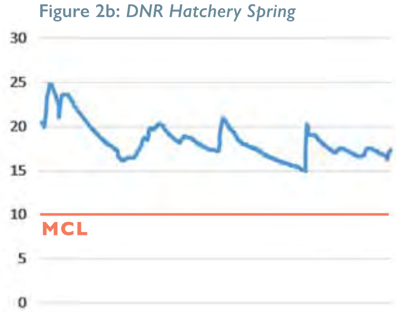
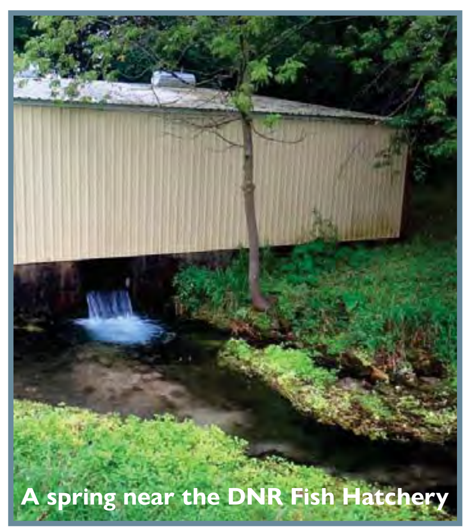


Figure 2b: *DNR Hatchery Spring*



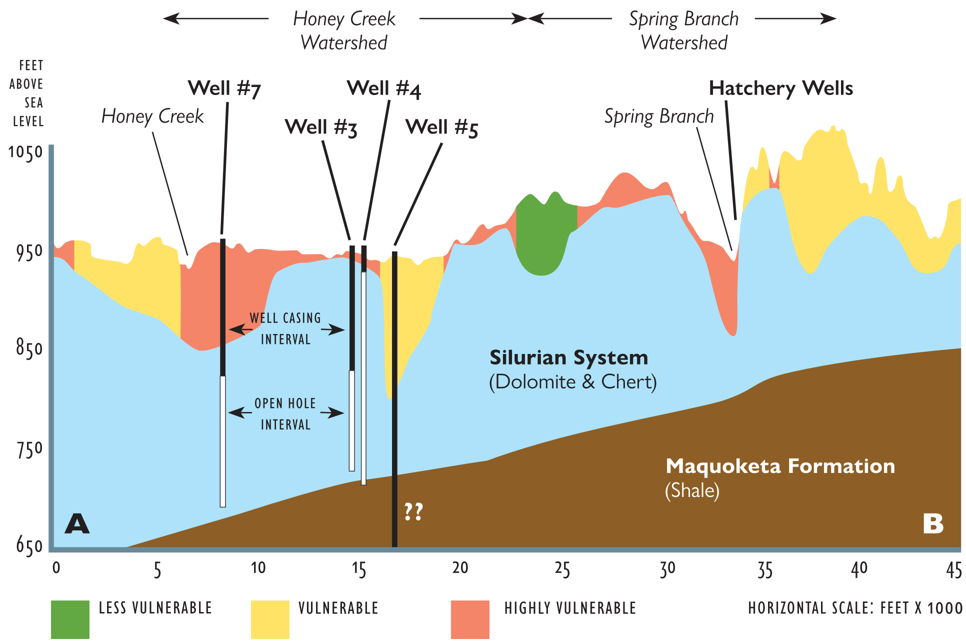


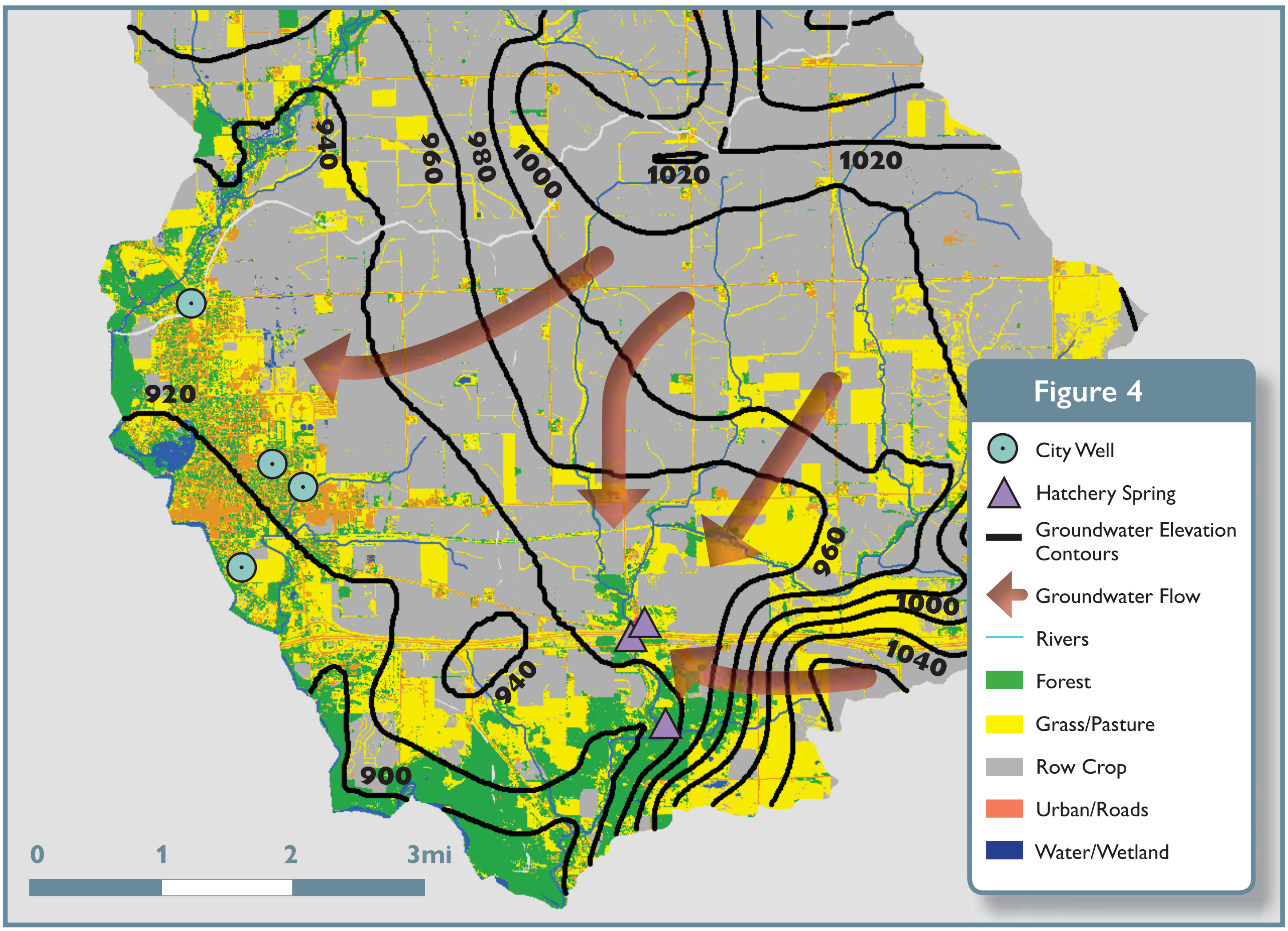
A spring near the DNR Fish Hatchery

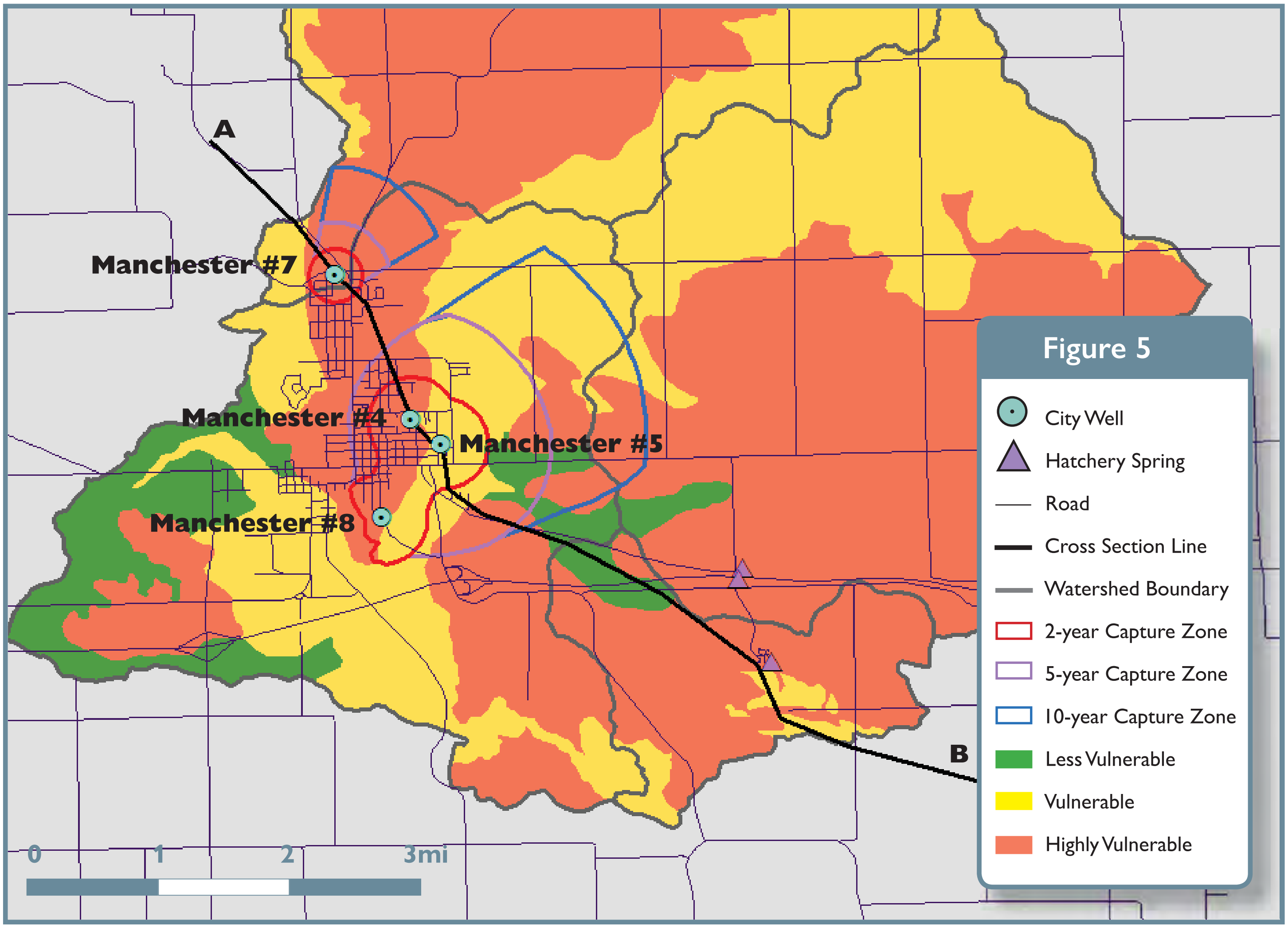
Geologic Setting

A cross–section view (*Figure 3*) illustrates the highly variable thickness of surficial deposits overlying the Silurian bedrock aquifer. Several deep valleys cut into the bedrock are filled with sand or a mixture of sand and clayey glacial till, or sand and finer grained alluvium. A relatively thin cover of weathered glacial till and/or sand overlays the bedrock uplands. The surficial deposits have been grouped into three vulnerability classes based on their potential to allow significant downward movement of infiltrating water to the Silurian aquifer. The classes were determined based on material composition and thickness. Highly vulnerable areas are typified by sandy deposits or thin surficial cover overlying the Silurian aquifer.

Figure 3—Aquifer Cross-Section







Groundwater Elevation & Flow

Figure 4 (*preceding page*) shows groundwater elevations (in feet above sea level) based on information from wells drilled into the Silurian aquifer.

Groundwater flows from higher elevations to lower elevations perpendicular to the contour lines. As shown by the arrows, groundwater flow in the Silurian aquifer is directed to the west from upgradient watershed areas toward the Maquoketa River. The city of Manchester wells and the hatchery springs intercept groundwater moving along these flow paths. The flow directions suggest the groundwater supplying the Manchester city wells originates from a different area than the water supplying the hatchery springs.

Land Use

Figure 4 also shows land use in the Manchester area. Row crop dominates land use upgradient of the Manchester city wells and the hatchery springs. The region around the city wells includes additional contributions from urban areas. Upgradient of the lower hatchery area, there is a greater proportion of land area in forest and pasture. Land use exerts a dominant control on groundwater nitrate concentrations. Nitrate concentrations are often greater than 10 mg/l beneath row-crop land cover and less than 1 mg/l beneath perennial grass and forest. Concentrations in urban areas are typically less than 2–3 mg/l.

Groundwater Vulnerability

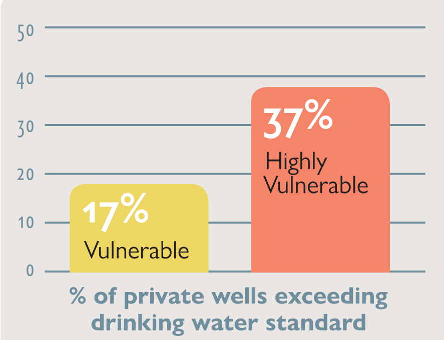
Figure 5 (*above*) maps the vulnerability of the Silurian aquifer to nitrate contamination according to the thickness and characteristics of surficial materials. Highly vulnerable areas are noted where surficial materials are thin or are composed chiefly of sand. Most areas east of the city wells and near the hatchery springs are vulnerable to nitrate leaching into the aquifer. Groundwater vulnerability is greatest when geologically vulnerable areas are covered with row crops.

Figure 5 also shows 2-, 5- and 10-year capture zones that delineate the areas contributing water to city wells during specified *time of travel* periods that account for aquifer permeability and groundwater flow. Highly vulnerable areas located within 2-year capture zones have the greatest potential to contribute nitrate to city wells in the near future.

Fractured Silurian-age dolomite bedrock adjacent to the DNR Fish Hatchery

Private Wells

Aquifer vulnerability in the Manchester area is evident not only in public wells but also in private wells. Approximately 37% of the private wells located in highly vulnerable areas exceed the MCL for nitrate compared to 17% of wells located in vulnerable areas (*Figure 6*). While all areas are susceptible to nitrate exceedances, wells located in highly vulnerable areas are particularly at risk.



Conclusions & Further Work

Results from this analysis indicate that groundwater in the Manchester area is vulnerable to high nitrate concentrations because the Silurian aquifer is overlain by variably thin and sandy surficial materials that promote the infiltration of nitrate-rich water from row-crop dominated watersheds.

This evaluation was conducted using existing data available to the Iowa Geological Survey and IIHR. It could be refined with additional field investigation, including more detailed mapping of surficial geology, installation of monitoring wells for determination of groundwater levels and quality, and development of a groundwater flow model. The Manchester area may provide a unique opportunity to implement groundwater-based nutrient reduction practices and document their success.

Iowa Geological Survey

Since 1892, the Iowa Geological Survey has provided earth, water, and mapping science to all Iowans.

The mission of IGS is collect, reposit, and interpret geologic and hydrogeologic data, to conduct foundational research, and to provide Iowans with the knowledge needed to effectively manage our natural resources for long-term sustainability and economic development.

The IGS vision to serve Iowa through research, education and outreach is as valid today as it was 125 years ago.

BEDROCK EXPOSURE
AT THE MITCHELL DAM

Ryan Clark – Iowa Geological Survey

In 2016 a new bedrock geologic map of Mitchell County, Iowa (Clark et al., 2016) was published by the Iowa Geological Survey (IGS) as part of their cooperative mapping project partially funded by the United States Geological Survey (USGS) STATEMAP program (**FIGURE 1**). Creating the bedrock geologic map took three years. The first two years were spent making smaller scale maps of the Osage (Rowden et al., 2014a), St. Ansgar (Rowden et al., 2014b), and New Haven (Clark et al., 2015) quadrangles, then building the county scale map in the third year. Bedrock mapping in Iowa primarily relies on the vast amount of information gleaned from water well drilling records (via GeoSam), however locating and studying places where the bedrock is exposed at the surface is vital to providing the detailed context where drilling records fall short. Limestone quarries are excellent places to view the bedrock in a freshly exposed state, rather than natural exposures where weathering and vegetation try their best to obscure characteristic features geologists need to observe in order to identify what bedrock formation they are looking at. Of course, quarries can be difficult places to access due to strict safety regulations to which the quarry operators must adhere. Natural exposures, and I'll include man-made road cuts too, are generally accessible and are usually limited to river valleys. In the case of Mitchell County, rivers and streams have been working their way through the glacial overburden for almost half a million years. The Cedar River is a classic example of one that has successfully made its mark on the bedrock surface in Mitchell County, where approximately 80 percent of its length is flowing on or near bedrock.

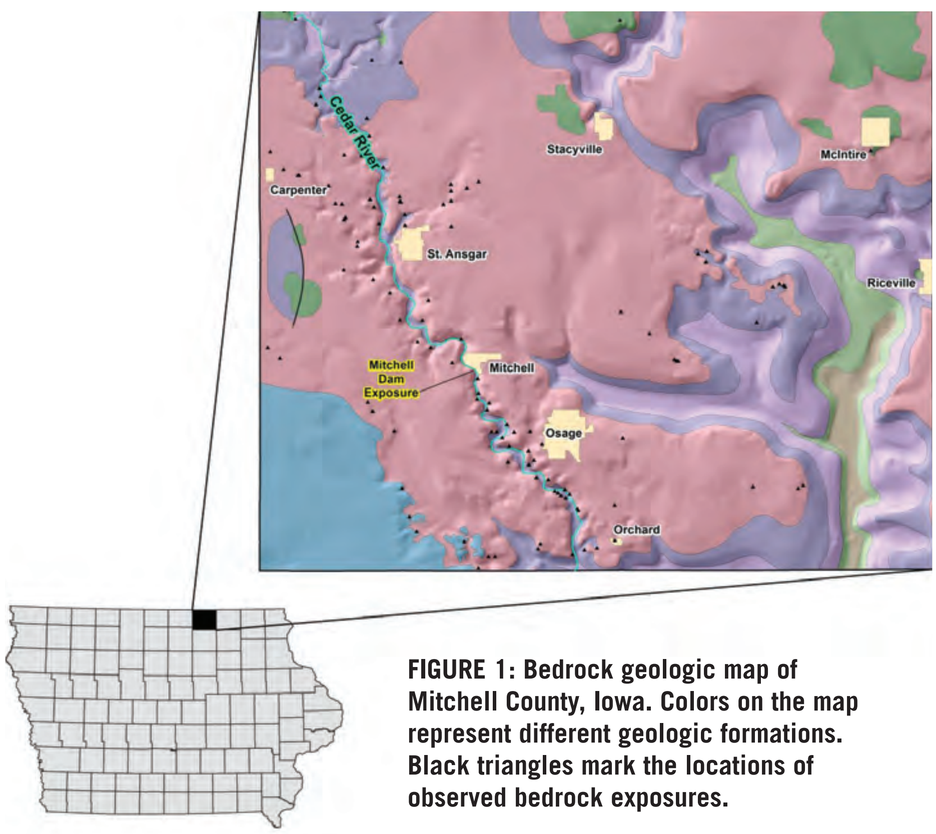


FIGURE 1: Bedrock geologic map of Mitchell County, Iowa. Colors on the map represent different geologic formations. Black triangles mark the locations of observed bedrock exposures.

The small town of Mitchell sits on the Cedar River between Osage and St. Ansgar. A low-head dam located at Mitchell backs up the river enough to create enough slack water area to do most things one might do on a lake. However immediately downstream of the dam on the west bank stands a beautiful exposure of Devonian age (~385 million years old) bedrock. This exposure is an important reference point because it is one of the few places where the contact between two bedrock formations is exposed in the county (**FIGURE 2**). To help make sense of Earth's geologic past, geologists divide bedrock units that were deposited at different times and in different geologic settings into groups. That way geologists can map out the thickness, orientation, and regional extent of similar bedrock units. The Mitchell Dam exposure reveals the contact between the overlying Lithograph City Formation and the underlying Coralville Formation. The rocks that make up these formations are similar and thus difficult to identify in well records and well chip samples.

The lower part of the Lithograph City Formation is called the Osage Springs Member and is generally composed of dolomite that has open voids (vugs) and is quite porous,

FIGURE 2: Paul Liu and Phil Kerr of the IGS at the Mitchell Dam exposure in October 2014. Red line marks the contact between the Lithograph City and Coralville formations.

FIGURE 3: Groundwater seeping from the rock exposure just below the overhanging Osage Springs Member in October 2014.

FIGURE 4: Caves in the Osage Springs Member between Otranto and St. Ansgar along the Cedar River.

making it part of the uppermost bedrock aquifer in this area. The Osage Springs Member seen at the Mitchell Dam exposure is very vuggy and one can even find groundwater seeping out of it on a regular basis (**FIGURE 3**). The upper part of the underlying Coralville Formation is called the Iowa City Member and is generally composed of dense limestone with some thin shale seams. The association of vuggy dolomite laying on top of a dense limestone and shale package provides a prototypical setting for springs and seeps. Groundwater movement through bedrock to the surface can accelerate the chemical weathering of carbonate rocks like dolomite and create an environment that is all too familiar to Iowans, known as karst. The Mitchell Dam exposure displays the effects of karst very well. The abundance of voids in the dolomite ledge undercut by the Cedar River did make me a little nervous when I was there back in the Fall of 2014, but of course I did not let it deter me from doing my work. I climbed under the ledges to view the uppermost Iowa City Member, conveniently wetted by the aforementioned seepage of groundwater. I saw mud cracks and worm burrows in the shaly limestone that told me it was in fact the top of the Coralville Formation. I could not have been more pleased!

Fast forward to July 2017 when the Iowa DNR's infamous river cleanup event, Project AWARE, took over the Cedar River for an entire week. Myself, and over 450 other volunteers put in at the Iowa-Minnesota border and paddled through Mitchell and Floyd counties, eventually ending in Nashua. This event afforded me the opportunity to see bedrock exposures along the river that I could not access while mapping. Many of these exposures illustrated the vuggy dolomite of the Osage Springs Member (**FIGURE 4**). I also observed multiple springs feeding into the Cedar River from both bedrock exposures and bubbling up from the river bed alluvium. The first two nights Project AWARE set up camp at Interstate Park in Mitchell, just across the river from the Mitchell Dam exposure. This was going to be the ideal setting for me to give an educational program on the IGS and our mapping efforts in Mitchell County. I was so excited to tell folks

(continued on next page)

FIGURES 5 AND 6: View of the Mitchell Dam exposure from the powerhouse on the east end of the dam in July 2017. The fresh pile of boulders sits where the photo in Figure 3 was taken.

(continued from previous page)

about my mapping project and eventually point across the river to the exposure that was so instructive to me just twenty months ago.

The night before my presentation I walked up the levee to the old powerhouse, where hydroelectric power is still being generated, and gazed across the river at the exposure. Something had definitely changed. The ledge that I had crawled under and around was now a huge pile of angular boulders (**FIGURE 5**)! The gentleman leading tours of the powerhouse said the rock fall happened sometime over the winter. The Osage Springs Member had apparently fallen victim to freeze-thaw weathering and gave way. The reality that bedrock exposures are as dangerous as they are intriguing hit hard at moment. Nonetheless, the Mitchell Dam exposure is still one of the most instructive and beautiful that I have seen in Iowa.

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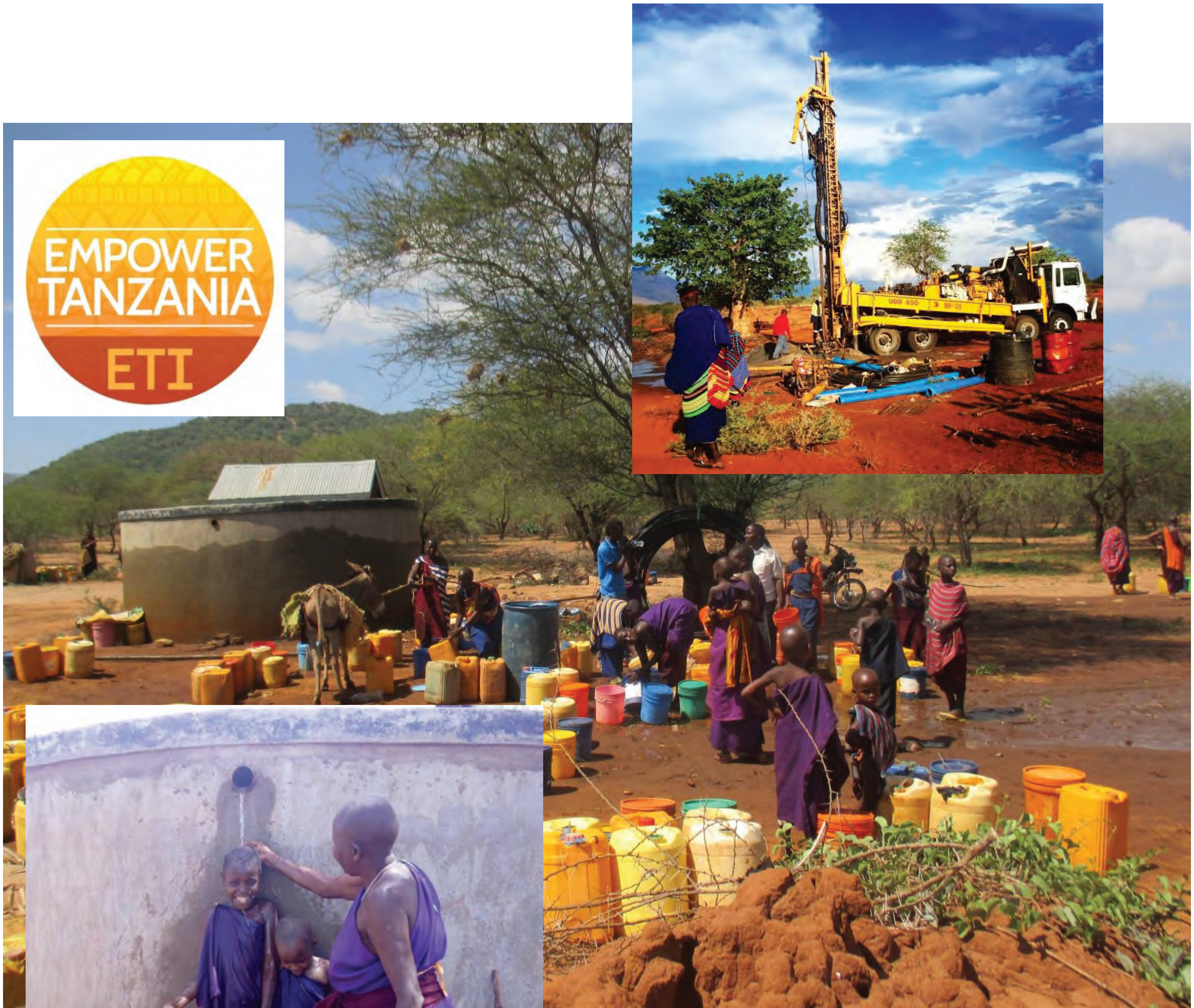
GeoSam homepage: https://www.iihr.uiowa.edu/igs/geosam/home

Project AWARE homepage: http://www.iowadnr.gov/Things-to-Do/Canoeing-Kayaking/Project-AWARE

EMPOWER TANZANIA ETI



IGWA encourages its members to support efforts to supply clean water to people around the world. At our 2017 Spring Conference, Justin Rewerts described several drilling projects in Tanzania that supplied clean water to villages. These projects freed local women from the time-consuming task of transporting water long distances, allowing them more time for other activities like education, growing crops, and becoming entrepreneurs. Empower Tanzania is an organization based in Iowa and Tanzania that is currently working on a $50,000 goal to get clean water to the village of Njiro.

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ETI EMPOWER TANZANIA

Drought Resiliency and Sustainability Rock Valley Rural Water District

Mike Gannon, Iowa Geological Survey

Iowa experienced a severe statewide drought starting in the fall of 2011 with dry conditions continuing throughout most of 2012 and 2013. Discharge in many rivers reached historic lows during the widespread drought. Annual rainfall was more than 5 to 10 inches below normal in some areas. The lowest average daily discharge in the Rock River at Rock Rapids (USGS #06483290) was recorded in 2013 at 26 cubic feet per second (cfs). Like rainfall, river discharge has been low during other drought years, including 1958, 1976, and 2003. However, unlike previous droughts, the security risk associated with the 2012-13 drought increased significantly due to sociological and economic changes in water distribution and use. The rapid expansion of rural water systems and the concentration of livestock in animal feeding operations (AFOs) combined to place additional strain on the limited water resources. Unlike the past, when most farms and small rural communities relied on their own wells, regional rural water systems now supply most of the water to individual farms, livestock producers, AFOs, and rural communities.

Northwest Iowa, especially Sioux County, was hit particularly hard by the extended drought. Although Sioux County has a relatively low population of 34,937 residents (U.S. Census Bureau, 2015), 1.2 million hogs and 395,000 cattle were marketed in 2015 (USDA, Census of Agriculture, 2015). In addition, Sioux County is

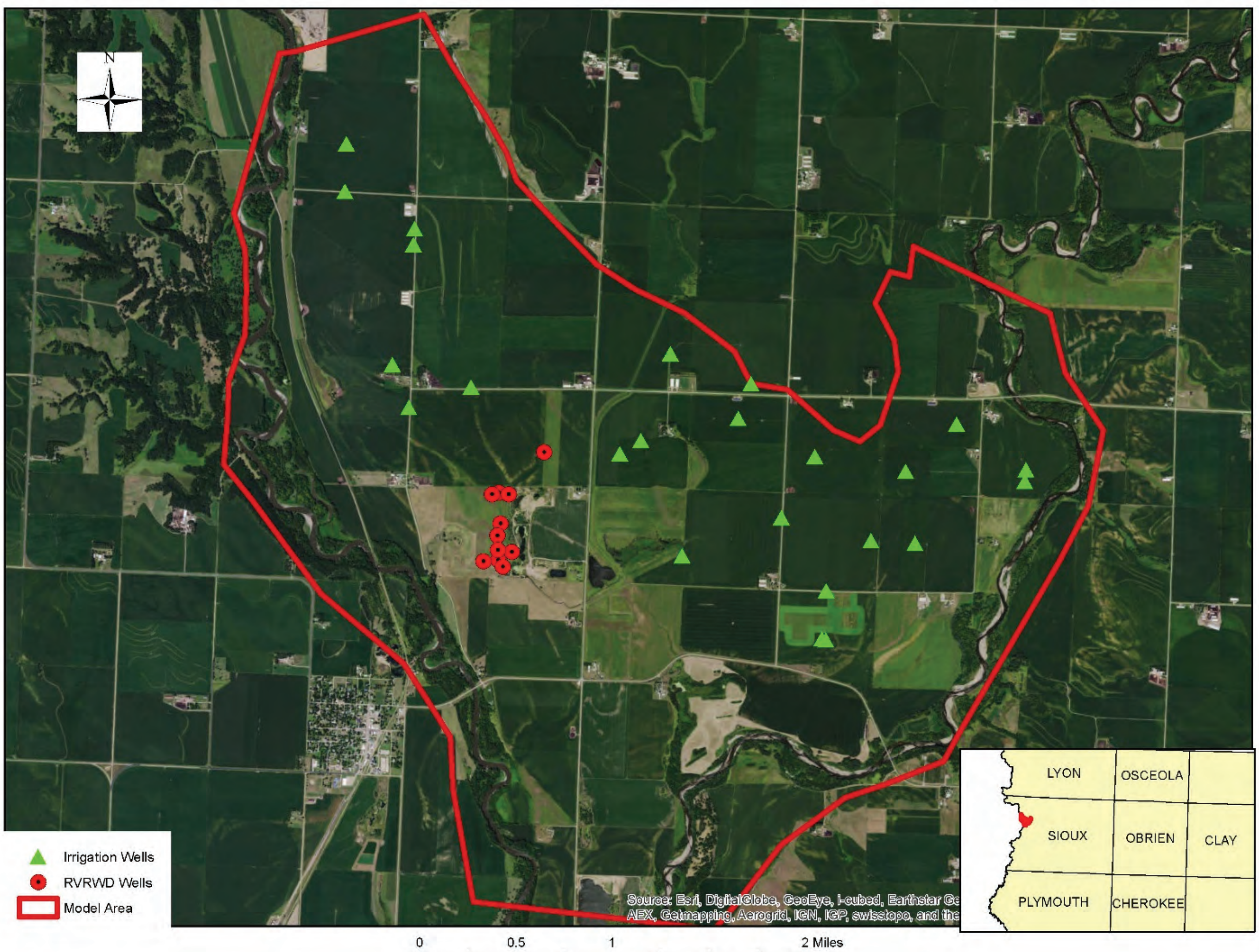


FIGURE 1: Rock Valley Rural Water District location and model extent.

FIGURE 2: Sand and gravel quarry converted into a recharge basin with an unnamed creek re-routed into the basin to provide a water supply.

the state's leader in dairy production and second in egg production. The increase in water consumption by both urban and rural users in 2012 and 2013 put an enormous strain on water utilities, especially rural water districts. The largest public water system in Sioux County is Rock Valley Rural Water District (RVRWD) (**FIGURE 1**). The billion dollar agricultural industry in Sioux County relies heavily on RVRWD for water with over 75 percent of the water sold by RVRWD in 2012 going toward livestock usage.

Drought depleted the alluvial aquifer to such an extent that an emergency water plan had to be implemented in May 2013. The goal of the emergency water plan was to alleviate the stress on the aquifer in order for RVRWD to maintain a continuous water supply to its users. The emergency water plan involved pumping water from the Big Sioux River using a temporary water use permit obtained from the Iowa Department of Natural Resources. Water was pumped from the river to a nearby sand and gravel quarry (**FIGURE 2**) at approximately 3,000 gallons per minute. As the pit was filled, both static and pumping water levels in the RVRWD production wells began to rise, and water production increased to pre-drought levels (**FIGURE 3**). The emergency water plan provided a short term solution to the water quantity needs at RVRWD, however, long-term water sustainability still needed to be addressed.

To help improve long-term water sustainability, the sand and gravel pit utilized as part of the emergency water plan was re-designed into an engineered recharge basin by DGR Engineering, Inc. As part of the design, a small unnamed creek draining a17 square mile area was diverted into the recharge basin. In June 2014, surface water from the unnamed creek began to fill the basin. Over the next 3 months, groundwater elevations rose approximately 11 to 15 feet in the RVRWD wellfield. This additional recharge has allowed RVRWD to maintain water production from its 11 shallow wells during periodic dry periods and droughts. However, important questions still remained regarding the benefit of the basin during an extended drought and the potential impacts of the basin on groundwater quality.

(continued on next page)

FIGURE 3: Sand and gravel quarry turned engineered recharge basin at its design elevation of 1203 feet in the summer of 2014.

FIGURE 4: Mike Gannon (left) and Jason Vogelgesang (right) from the Iowa Geological Survey collecting water samples.

(continued from previous page)

In 2016 and 2017, the Iowa Geological Survey completed a two-year hydrogeologic investigation of the alluvial aquifer and recharge basin near the RVRWD wellfield. The main purpose of the investigation was to evaluate the recharge basin as a drought resiliency strategy, and to evaluate the potential groundwater quality impacts related to the basin. Monthly water level measurements and groundwater quality samples were collected at the site for approximately 12 months (**FIGURE 4**). In addition, a three-dimensional groundwater flow model was developed to evaluate the groundwater quantity benefits.

Based on the calibrated groundwater flow model, the recharge basin would provide additional groundwater storage to the RVRWD production wells for approximately 2 years during a severe drought. During the late summer and early fall of the second year of simulated drought the groundwater elevations would reach the pump elevations in five of the RVRWD production wells, and water production would need to be reduced to allow periodic recovery in the wells.

Nitrate is a major concern for many alluvial wellfields in Iowa. Nitrate as nitrogen concentrations in both the RVRWD production wells and the on-site observation wells were found to fluctuate seasonally, with the highest concentrations generally occurring during the winter and early spring months. Biological reduction in the recharge basin and the low-nitrate precipitation recharge to the aquifer related to the uptake by prairie grass slowly reduced the nitrate concentrations in the shallow groundwater throughout the growing season and into the fall.

Beyond providing a means for storing water, the basin sediments were observed to be a good filter for removing nitrates as water traveled from the basin into the aquifer. Nitrate as nitrogen concentrations in the shallow groundwater directly downgradient of the recharge basin were consistently lower than in the basin as shown in **FIGURE 5**. Based on water quality results, nitrate reduction in the recharge basin ranged from 41% in November 2016 to 98% in January 2016, with an average reduction for the 12 month period of 64%.

In order to prevent water quality issues from arising in RVRWD's wellfield, surface water entering the basin via the creek can be managed using the control valve (**FIGURE 2**). An optimum management strategy requires balance between reducing drought impacts on water quantity by increasing groundwater storage, while minimizing the nitrate concentrations in the recharge basin and shallow groundwater. In general, the valve should be shut during periods of flooding and excessive runoff to prevent high-nitrate surface water from entering the basin and opened during the spring to maximize groundwater storage prior to the summer peak-usage season. Depending on the monitoring results in the creek, the valve should be left open under normal baseflow conditions and

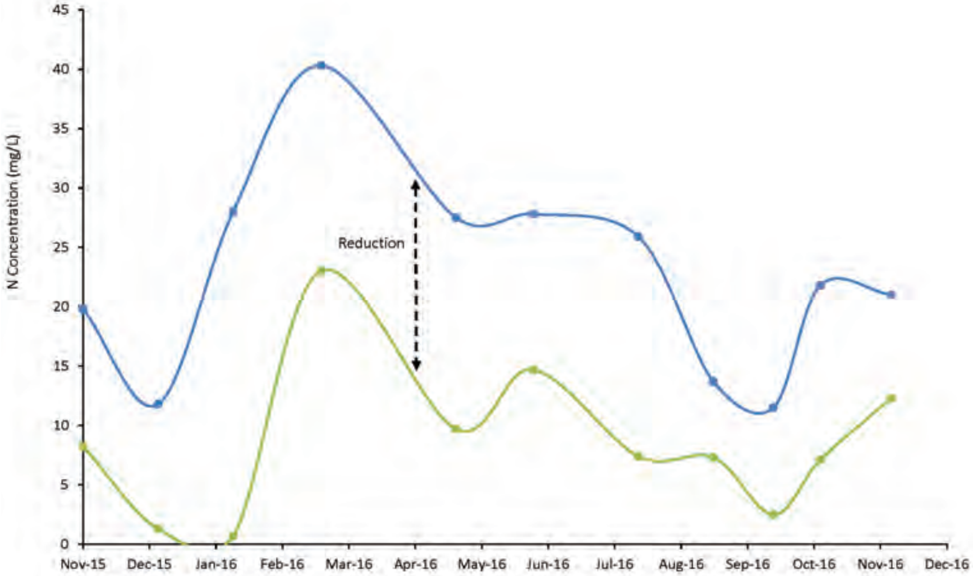


FIGURE 5: Monthly nitrate as nitrogen concentrations measured in the recharge basin and in the shallow groundwater downgradient of the basin.

during dry or drought conditions. With proper management the basin will provide extended drought resiliency without deteriorating water quality. A severe multi-year drought may still require water to be pumped from the Big Sioux River into the basin as an emergency contingency plan.

https://www.agcensus.usda.gov/Publications/2012/Full_Report/Census_by_State/Iowa/

http://www.census.gov/quickfacts/table/PST045216/19167,19

LUKE VONESCHEN

LUTHER COLLEGE

IGWA began funding student research projects in 2016. In 2017, we are proud to support Luke Voneschen! Luke is a senior (Fall 2017) biology and chemistry double-major at Luther College in Decorah, Iowa. Luke is also an avid soccer player from St. Louis Park, Minnesota! Luke and his lab-mates have already sampled Dunnings Spring and the Upper Iowa River for *E. coli* and *Staphylococci*. They are first looking at the occurrence of antibiotic resistance in these samples. Next, they plan to select some samples for microbial source tracking analysis. These analyses will help to determine whether waste from humans, livestock, wildlife, or some combination of these sources, are contributing to water quality issues.

P.S. – In related news, IGWA supported Sheri Schwert in 2016, who has recently graduated from Luther College and taken a job doing water monitoring in Illinois!

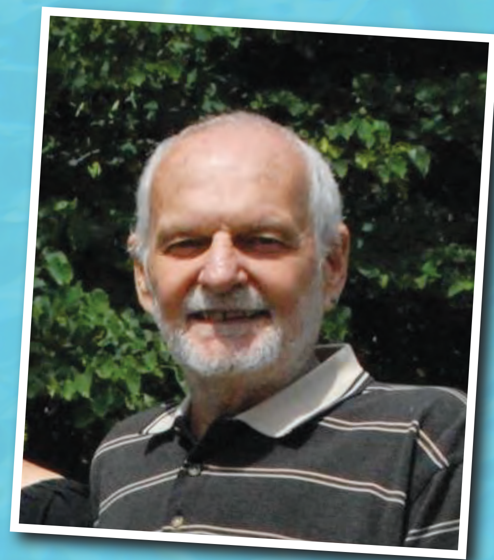
CONGRATULATIONS SHERI!

Also, you can find a podcast that Sheri and her friend, Cassie, made about water quality issues in karst areas, by going to:

https://soundcloud.com/sheri-s-703290116/a-leaky-system

GROUNDWATER HERO

DONALD LEROY KOCH (1937 – 2016)



Don Koch passed away in October of 2016 after a long battle with cancer. He in was born in Dubuque, Iowa on June 3rd, 1937. His family moved to Manchester when he was 7 years old. He attended grade school at St. Xavier and high school at Manchester High School. In 1959, after receiving his Bachelor of Science degree in geology from the University of Iowa, Don began work with the Iowa Geological Survey as a laboratory technician and then a Research Geologist. He advanced through a series of promotions including Chief, Subsurface Geology; Assistant State Geologist; and in 1980 was appointed State Geologist and Director.

While working full time, Don completed his Master of Science in geology and subsequently completed courses toward a PhD. His research responsibilities and publications at the Iowa Geological Survey included paleontology, stratigraphy, groundwater hydrology, coal geology, oil exploration, and underground storage of natural gas and liquefied petroleum gas. He led the State's scientific exploration of Coldwater Cave in Winneshiek County. Don was a member of the American Association of State Geologists, the Iowa Academy of Science, the Geological Society of Iowa (President), the Iowa Groundwater Association (founding member and President), and Society of the Sigma Xi.

Don was a bicycling enthusiast, delivering the Cedar Rapids Gazette in his early years, and commuting to work throughout most of his career. Don rode in 29 of the Des Moines Registers' RAGBRAI treks across Iowa, and rode eight times to the start of RAGBRAI on Iowa's "West Coast" with a few friends. In 1995 Don rode the 5,000-mile jaunt from Long Beach, CA to Washington, DC, organized by the Des Moines Register, with 307 other riders, to promote celebration of Iowa's 1996 Sesquicentennial. Several riders from that group held a 10th anniversary ride in 2005, travelling about 1,700 miles from New Orleans to International Falls, MN.

Don retired in 2002 after serving 22 years as State Geologist and 43 years with the Iowa Survey. He is survived by his wife Jean of 54 years, and one son and daughter.

GSA North-Central Section Meeting

April 16-17, 2018

Iowa State University

Technical Program and Meeting Information

Email: *ncgsa2018@iastate.edu*

Website: *http://www.geosociety.org/nc-mtg*

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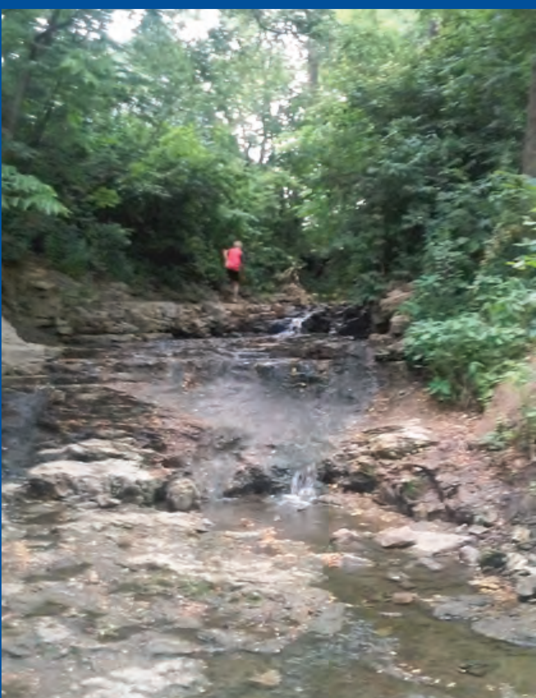
DID YOU KNOW



This unnamed waterfall is located on a small unnamed tributary entering into Duck Creek, Devils Glen Park, Bettendorf, Iowa, at coordinates 41.533379 N, 90-476167 W.

Steve Gustafson's son Jack exploring the waterfall. In training to be a future geologist.

The outcrop consists of laminated sublithographic limestone of the Devonian Wapsipinicon Group, Pinicon Ridge Formation, Davenport Member. The overall elevation change is roughly 12 feet, with the largest single vertical drop at approximately 3 feet. The waterfall is flanked by eroded Quaternary Glasford Formation Kellerville Till and Peoria Loess. (Brian Witzke et.al., 1988)

Devils Glen Park was previously the site of numerous small caves. In the 1940's and 50's, Bettendorf citizens dynamited the caves and other formations to prevent children from getting stuck or hurt. The origin of the name Devils Glen is debated, but locals say it was because the many children that played there thought it was haunted by evil spirits.

Wizke, B.J., Bunker, B.J., and Rogers, F.S., 1988, Eifelian through Lower Frasnian stratigraphy and deposition in the Iowa area, Central Midcontinent, U.S.A.: in McMillan, N.J., Embry, A.F., and Glass, D.J. (eda), Devonian of the World, Canadian Society of Petroleum Geologists, Memoir 14, Volume I: Regional Syntheses, p. 221-250.

IGWA Member News

IGWA Spring 2017 Conference, Lunch time at DMACC in Newton

Mark Moeller presenting as part of a panel discussion at the Spring 2017 Conference. Pictured left to right: Mike Gannon and Matt Graesch

Panel Discussion on Animal Feeding Operations at the Spring 2017 Conference. Pictured left to right: Bob Libra, Brett Meyers, Frank Moore, Paul Petitti, and John Beard

MEMBERSHIP RECOGNITION

New Members

• Debbie Dietzenbach • Katie Goff • Steve Gustafson
• Joseph Honings • Benjamin Maas • Matthew Mahler
• Shane McClintock • Catherine Miller

1-Year Members

• Rose Amundson • James Baxter • Catherine Bazylinski
• Lanie Boas • Scott Byram • Adam Corcoran • Megan Down
• Africa Espina • Matthew Even • Jessica Flondro
• Angela Green • Dan Green • Jennifer Harkin • Jerry Hentges
• Kirk Johnson • Sid Juwarker • Scott Killip • Kathleen Logan
• Jerald Lukensmeyer • Jesse Nelson • John North
• Julie Oriano • Joseph Smith • Sara Smith • Matt Trotter

5-Year Members

• Sue Albrecht • Edward Bertch • Alexandra Bruns
• Brian Lenz • Matt Sheeder • Gina Wilming

20-Year Member

• Greg Brennan

25-Year Member

• Bill Gross

Thank you to the following members for being with IGWA for over 30 years:

• Michael Burkart • Reed Craft • Bob Drustrup
• Dana Kolpin • Gary Shawver

DID YOU KNOW

that IGWA accepts government groups, such as Iowa DNR sections or county public health departments and corporate memberships?

Contact an IGWA Board member for details.

IGWA
Iowa Groundwater Association

Upcoming Events

Indiana Ground Water Association Central District Fall Meeting September 8, 2017
Carmel, Indiana • *www.indianagroundwater.org/*

IRWA Okoboji Fall Conference September 12-13, 2017
Okoboji, Iowa • *www.iowaruralwater.org/events_fall_conference.html*

2017 IEHA/NEHA Region 4 Iowa Environmental Health Conference September 20-21, 2017
Minneapolis, Minnesota • *www.ieha.net/event-2590729?CalendarViewType=0&SelectedDate=8/16/2017*

NAAMLP 2017 Annual Conference September 24-27, 2017
Lexington, Kentucky • *http://aml.ky.gov/NAAMLP2017/Pages/NAAMLP2017.aspx*

Iowa Groundwater Association Fall Meeting October 5, 2017
Coralville, Iowa • *www.igwa.org*

IRWA Dubuque Fall Conference October 10-11, 2017
Dubuque, Iowa • *www.iowaruralwater.org/events_fall_conference.html*

2017 Iowa Section AWWA Annual Conference October 10-12, 2017
Council Bluffs, Iowa • *www.ia-awwa.org/conferencesandtraining/annualconference.html*

Minnesota Ground Water Association Fall Conference November 15, 2017
St. Paul, Minnesota • *www.mgwa.org/meetings.php*

NGWA 2017 Groundwater Week December 5-7, 2017
Nashville, Tennessee • *www.groundwaterexpo.com/*

IWWA Annual Convention & Trade Show January 31- February 1, 2018
Altoona, Iowa • *www.iwwa.org/water-well-education*

IRWA 43rd Annual Conference February 12-14, 2018
Des Moines, Iowa • *www.iowaruralwater.org/events_annual_conference.html*

2018 Annual Iowa Water Conference March 21-22, 2018
Ames, Iowa • *www.aep.iastate.edu/iwc/*

IAMU Operator's Workshops
Details available online • *www.members.iamu.org/events/event_list.asp*

2017 EPI Fall Symposium
Details unavailable, check web site. • *www.epiowa.org*

IGWA
Iowa Groundwater Association

Iowa Groundwater Association
P.O. Box 744
Des Moines, IA 50303

www.IGWA.org

COVER PHOTO: Ledges State Park, Photo Taken by Deborah Williams, IDNR.