**ILLINOIS GROUNDWATER ASSOCIATION**

Advancing Groundwater Knowledge Since 1983

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**Earth Day Spring Meeting - April 22, 2022**

Virtual via Zoom

Program Speakers/Topics:

8:00 AM — *Check-in and Reconnect*

8:30 AM — **Joe Krienert (Chair)** — Opening Remarks

9:00 AM — **Cecilia Cullen and Vlad Iordache (ISWS)** – Investigating Illinois Groundwater Issues: The Power of Stakeholder Engagement

10:00 AM — **Alhassan Sahad (ISU)** – Using a Tracer Test to Assess the Transport and Fate of Nitrate in a Saturated Buffer Zone

10:30 AM — **Joe Hoberg (ISU)** – Breaking down a Tracer in a Saturated Buffer Zone: Comparing the use of Rhodamine WT to sodium chloride and sodium bromide

11:00 PM — *Break, Quizzes, and Polls*

11:15 AM — **Michelle Gibson and Essence Brown (IPCB)** – Groundwater Rules and the Illinois Pollution Control Board

12:15 PM — *Optional Virtual Lunch and Discussion*

1:00 PM — **Chris Greer (Fermilab)** – Monitoring Challenges of an Intermittent Shallow Groundwater Zone at Fermilab

1:45 PM — **Joe Krienert (Chair)** - Closing Discussion

2:00 PM — *Meeting Adjourned*

2:00 PM — *Virtual Commons remain open until 2:30pm*

**Investigating Illinois Groundwater Issues: The Power of Stakeholder Engagement**

Cecilia Cullen and Vlad Iordache
Illinois State Water Survey, Champaign, IL

On Earth Day, people around the world pause to appreciate the natural environment and reflect on its preservation. Groundwater, while an indispensable resource for many communities, industries and private citizens, is invisible until extracted. The inherent obscurity of this resource complicates efforts to conserve and plan for equitable, long-term use. At the Illinois State Water Survey, scientists work in partnership with stakeholders to understand their unique groundwater usage and best management strategies. Community data collection is the primary driver behind projecting how groundwater responds to changes in land use, climate, and evolving demand scenarios. In this presentation, we investigate cases throughout the state of Illinois where community data and ISWS partnerships have been instrumental in answering the water supply and sustainability questions of today.

**Using a Tracer Test to Assess the Transport and Fate of Nitrate in a Saturated Buffer Zone.**

Alhassan Sahad, Eric Peterson, Eli Schukow, and Joe Hoberg

Department of Geology, Geography, and the Environment, Illinois State University, Normal, IL, USA

The Upper Mississippi Basin (UMB), which includes Illinois, has highly fertile soils and therefore, experiences intensive agricultural practices. While fertile, the soils do not drain well, resulting in the installation of tile-drainage systems. Agricultural practices within the UMB include the application of nitrogen (N)-rich fertilizers. The tile systems coupled with the application of N have led to the excessive export of nitrates (NO3-) from the agricultural fields into surface and subsurface waters through subsurface tile drainage systems. Excess $NO_3^-$ contributes to eutrophication and to development of hypoxic zones in aquatic environments.

One method that has exhibited success in lowering nitrate (NO3-) concentration is the diversion of tile drained waters from the agricultural fields into a saturated buffer zone (SBZ) before the water enters a stream. A SBZ is an area of perennial vegetation between agricultural fields and water ways where a tile-outlets drain. The SBZ serves as a sink where NO3- is reduced through natural processes such as plant uptake, denitrification, and dilution with groundwater. Previous works have shown a reduction in the $NO_3$-N content in the SBZ, but the extent to which this removal occurs cannot be quantified without knowing the residence time of the water through the SBZ.

Our goal was to use sodium bromide (NaBr) and sodium chloride (NaCl) as tracers to determine the residence time of the tile waters in a SBZ at the T3 site in Hudson, Illinois and to quantify the amount of reduction or dilution of the NO3- in the SBZ using a mixing model. Results from the tracer test show an average groundwater velocity of 0.36 m/day with a standard deviation of 0.18 m/day, using the arrival time of the chloride tracer and 0.61 m/day with a standard deviation of 0.24 m/day using the arrival times from the bromide tracer. The residence time of the NO3- is estimated to be between 40 days to 50 days. The average horizontal hydraulic conductivity from the tracer test was calculated to be $6.62\times10^{-5}$ m/s, which conforms with results obtained from slug tests performed on the site ($3.03\times10^{-5}$m/s). The results from the mixing model showed a significant reduction in NO3- of about 80%. This research further reinforces the effectiveness of using SBZ as NO3- reduction strategy.

**Breaking down a Tracer in a Saturated Buffer Zone: Comparing the use of Rhodamine WT to sodium chloride and sodium bromide**

Joe Hoberg, Eric Peterson, Eli Schukow, and Alhassan Sahad
Department of Geology, Geography, and the Environment, Illinois State University, Normal, IL, USA

Tracer tests are a common means to discern hydrologic and transport properties of an aquifer. Conservative ion tracers, such as dissolved salts, are common choices for use as groundwater tracers, but the introduction of large quantities of salts can elevate the concentrations to acute levels for organisms and can create density driven flows. Rhodamine WT dye is widely used in karst systems but not in Darcian systems. We explored the questions “Can Rhodamine WT dye be used as a groundwater tracer is a Darcian system comprised of weathered diamicton?”, and “How well does Rhodamine transport compare to transport of ion tracers?” Six (6) Kg of sodium chloride (NaCl), 4 Kg of sodium bromide (NaBr), and 1 Kg of Rhodamine WT dye (25000 ppm) were injected into a saturated buffer zone (SBZ) via diversion box and drainage tiles. Following the injection, water samples from wells installed in the SBZ were collected and analyzed for dye, Cl, and Br concentrations. Note, Br concentrations were negligible in magnitude and failed to present useful data, thus Br results are omitted from this article.

Breakthrough curves for the dye were similar to those of Cl and Br, confirming similar transport dynamics. Inspection of the breakthrough curves for travel times indicated that on average 12 days after injection each well received its largest concentration of the dye (Peak), and two days after peak arrival dye concentrations for all wells had lowered. Peak concentrations for Cl arrived on average 16 days after injection. Identification of the time each ion tracer had left the system was difficult to discern, a storm event occurring 31 days after injection will serve as the upper limit.

Breakthrough curves modeled utilizing TRAC simulated travel velocities and longitudinal dispersitives based upon known hydrologic parameters for the system. Average velocities for both Cl and dye were relatively equal, however, dye displayed high variance. Contrastingly, these models suggested velocities that were smaller than values calculated based on breakthrough curve peak times and known travel distances. Modeled Cl dispersitives are two orders of magnitude larger than the dye, and the same high variance is seen in the dye. Overall, the similar arrival times and breakthrough curves of Rhodamine dye and Cl suggest that Rhodamine dye can be used as a groundwater tracer in weathered diamicton. Future research and replication must be conducted in order to further explore and refine this technique.

**Groundwater Rules and the Illinois Pollution Control Board**

Michelle Gibson and Essence Brown
Illinois Pollution Control Board
Springfield, Illinois

The Illinois Pollution Control Board (IPCB) recently shared news of the Illinois Environmental Protection Agencies proposal to modernize groundwater quality regulations, and uphold the Illinois Groundwater Protection Act 415 ILCS 55/2(b) by making new amendments to 35 Ill. Adm. Code 620. This presentation will discuss the new legislations rulemaking process, as well as technical details on how the recent changes reflect on groundwater quality standards.

**Monitoring Challenges of an Intermittent Shallow Groundwater Zone at Fermilab**

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Established in 1967 as America's national particle physics laboratory, Fermilab operates powerful particle accelerators for investigating sub-atomic particles. Today, the 6,800-acre site hosts an accelerator complex that has grown to comprise multiple particle accelerators and storage rings. It delivers proton and other beams to particle detectors and experiments that involve international scientists from more than fifty countries.

While the focus of my previous IGA presentation was on the NuMI tunnel up to 360 feet deep in bedrock, most of the subsurface accelerator enclosures and targets at Fermilab are at an average depth of thirty feet below ground surface. Unconsolidated deposits extend to a depth of up to 80 feet below ground surface at Fermilab. They are predominantly ice-contact clay tills of the Yorkville and Batestown Members of the Lemont Formation, interspersed with several non-continuous units of lacustrine silts and outwash sands and gravels of the Equality and Henry Formations. Multiple aquifers are regularly monitored as part of the Groundwater Management Plan at Fermilab, with particular attention paid to the inconsistent presence and character of a saturated “deep till” zone near the top of the Yorkville Member Facies B unit between 25 and 40 feet below ground surface that frequently intersects the enclosures.

Where present, this deep till zone has played a central role throughout the development of the groundwater monitoring program at Fermilab. Its position above the less-weathered Facies B and C clay till units of the Yorkville Member makes it a key monitoring level in vertical gradient studies of flow through aquitards and in the sole remaining site with RCRA permit monitoring requirements. Exposure of this zone during construction of the enclosure for the Short Baseline Neutrino Detector allowed the direct and continuous observation of its variability in thickness and sedimentology over a distance of less than 100 feet. A National Environmental Research Park project at Fermilab conducted by Northern Illinois University, utilizing geophysical methods and shallow piezometers, further defined the variability of this zone over a larger area of interest surrounding the Booster Neutrino Beam (BNB) particle decay pipe. New monitoring wells were recently installed within this deep till zone around the BNB decay pipe area and future monitoring plans below the BNB decay pipe will be guided by results from monitoring in the deep till zone.