

# POSTER ABSTRACTS

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## The Effect of Agriculture on Groundwater Resources

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### Method for Calculating and Mapping Areas of Groundwater-Intensive Cropping Practices

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#### Abstract

Groundwater is an essential natural resource in Dakota County, supplying drinking water to approximately 90% of the County's citizens either by municipal wells (151) or private domestic wells (estimated 8,000 in use). Groundwater also is used for manufacturing, commercial businesses and agriculture. More than half of the agricultural land in Dakota County is irrigated.

In 1999, Dakota County initiated the Ambient Groundwater Quality Study with the objective of characterizing the groundwater quality of domestic wells supplied by the three principal aquifers, located in various land use regimes. A total of 76 private wells were sampled multiple times between 1999 and 2013. Contaminants that exceeded human health standards included naturally occurring manganese (33% of the sampled wells), agriculturally derived nitrate (29%), and the degradates of the herbicide cyanazine (19%). Statistically, the occurrence and concentrations of anthropogenic contaminants in groundwater is highly correlated with land use and well depth. All anthropogenic substances negatively correlate with well depth while the presence and concentration of nitrate and herbicides are highly correlated with agricultural land use. Nitrate and herbicide levels are also highly correlated with each other.

To further understand the relationship between row crop agriculture and groundwater contamination with nitrate, we prepared a GIS project to identify areas of intensive agriculture. Data representing the percentage of land in row crop agriculture and the percentage of irrigated cropland by quarter section were combined and weighted. ArcGIS Spatial Analyst extension and tools were then used to create a smoothly curved surface representing the density of intensive agricultural land use. The symbology was adjusted to represent a four-category quantile classification of groundwater-intensive cropping. Groundwater nitrate data collected as part of the Minnesota Department of Agriculture (MDA) Township Testing Project were used to evaluate the model. The results showed a correlation between the calculated intensive agriculture index and the concentration and depth of groundwater nitrate.

# Time Lapse Movies of Nitrate Concentrations in Dakota County Aquifers

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## **Abstract**

Time lapse movies of nitrate concentration on horizontal or vertical section lines in Dakota County aquifers are presented. The movies were made to provide visual support to water quality trend analyses in the Dakota County Ambient Groundwater Study. Nitrate was selected because nitrate concentrations are statistically correlated with other contaminants, and because large data sets of nitrate measurements were available both internally and from state agencies. Over 8500 samples from about 6000 wells were identified.

A moving window interpolator in 4 dimensions: x,y,z, and time, was written in Python. The vertical and time dimensions are scaled differently from the horizontal dimensions, and the window shape is a hyper-ellipsoid. Data inside the window are weighted using the scaled Euclidian distance from the window center, and the interpolator reports the weighted mean or a weighted percentile. The method is like a LOWESS trend line, only in 4-D. It is very convenient for exploring new cross section lines, since the search radius automatically selects the relevant data. An important problem in designing the movies is to indicate the level of data support. For example, an isolated extreme data point may result in a large area being displayed with an extreme data value, yet the predictive power of a single observation is practically nil. A legend was developed using color hue for the nitrate concentration and color intensity for the data support; interpolation grid nodes with less support are colored more faintly. A concurrent plot illustrating the contributing observations can also be shown.

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

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## **Abstract**

The Minnesota Spring Inventory (MSI), established by the Minnesota DNR and funded by LCCMR, has been mapping springs on public lands in the three Minnesota counties bordering the St. Croix River, since 2016. Before this, several isolated pockets of springs were reasonably well mapped in each of those counties, but additional mapping of springs by MSI allows some broader generalizations to be made. Many Washington County springs emanate from the Cambrian sandstones of the river bluffs. But in the two counties north of that, many springs are associated with a ridge along the line of Government Road (the Point Douglas to Superior Military Road) in Chisago County and continuing as the St. John's ridge in 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. The river carved into the deltaic sands and underlying lacustrine clays of Glacial Lake Lind and the springs emanate at the sand-clay contact, near the foot of the ridges. The longest public stretch of this prominent spring ridge runs through St. Croix State Park. Springs downgradient from the 2011 derecho, 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. Shorter public segments of this ridge may be found in North Sunrise Park Reserve, Spring Hill Park (North Branch, MN), and Wild River S.P. 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 the best known named spring along this trend, not enough springs had been mapped for the pattern to stand out, until the springs of St. Croix S.P. 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 Glacial Lake Lind trend, more than 100 kilometers long, is arguably the most extensive spring-related feature ever found in Minnesota by the examination of LIDAR alone. The Wisconsin side of the St Croix River remains unexamined from this perspective.

## **Comparison of Dry Oxygen Scavengers for Preparing Anaerobic Injection Waters for EISB**

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## **Upscaling Nitrate Transport in Till Fractures from Core to Watershed Scale**

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