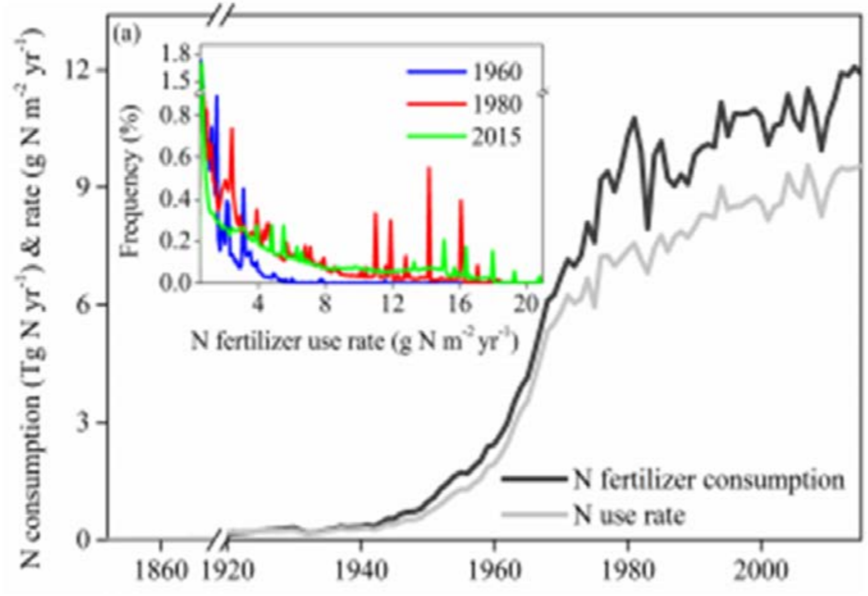
Comparison of storm-event transportation trends on Nitrate in Chloride in a low-gradient stream within Central Illinois

By Jackson Wassik

Nitrate (NO_3^-)



- NO_3^- is sourced from fertilizers whose usage has increased over the past 80 years[1]

- With ever growing food demands, we can infer that NO_3^- usage will continue to increase.

- High concentrations of NO_3^- in surface waters are exacerbated by tile drainage, preventing subsurface flow and NO_3^- removal[2]

NO_3^- affect on Ecosystems

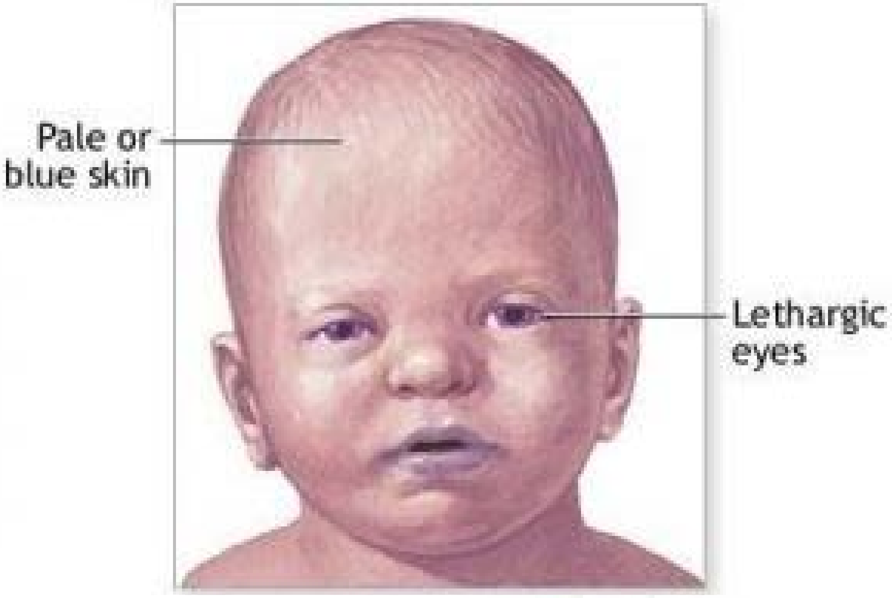
- Excess anthropogenic NO_3^- in surface waters are responsible for resulting in algal blooms leading hypoxia[3-6]

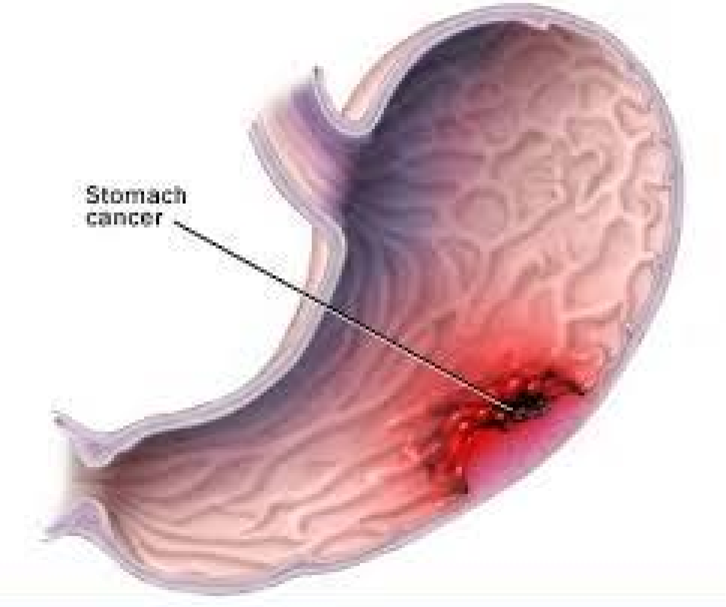
- The 16,000 km^2 Gulf of Mexico hypoxic zone is primarily attributed to anthropogenic NO_3^- sourced from the Midwestern United States[7-9]

- The Illinois River contributes 19% of the total NO_3^- load to the Gulf of Mexico hypoxic zone[3-6]

- These hypoxic zones deteriorate ecosystems, leading to fish kills and benthic organism mortality[9-10]

NO_3^- affect on Human Health



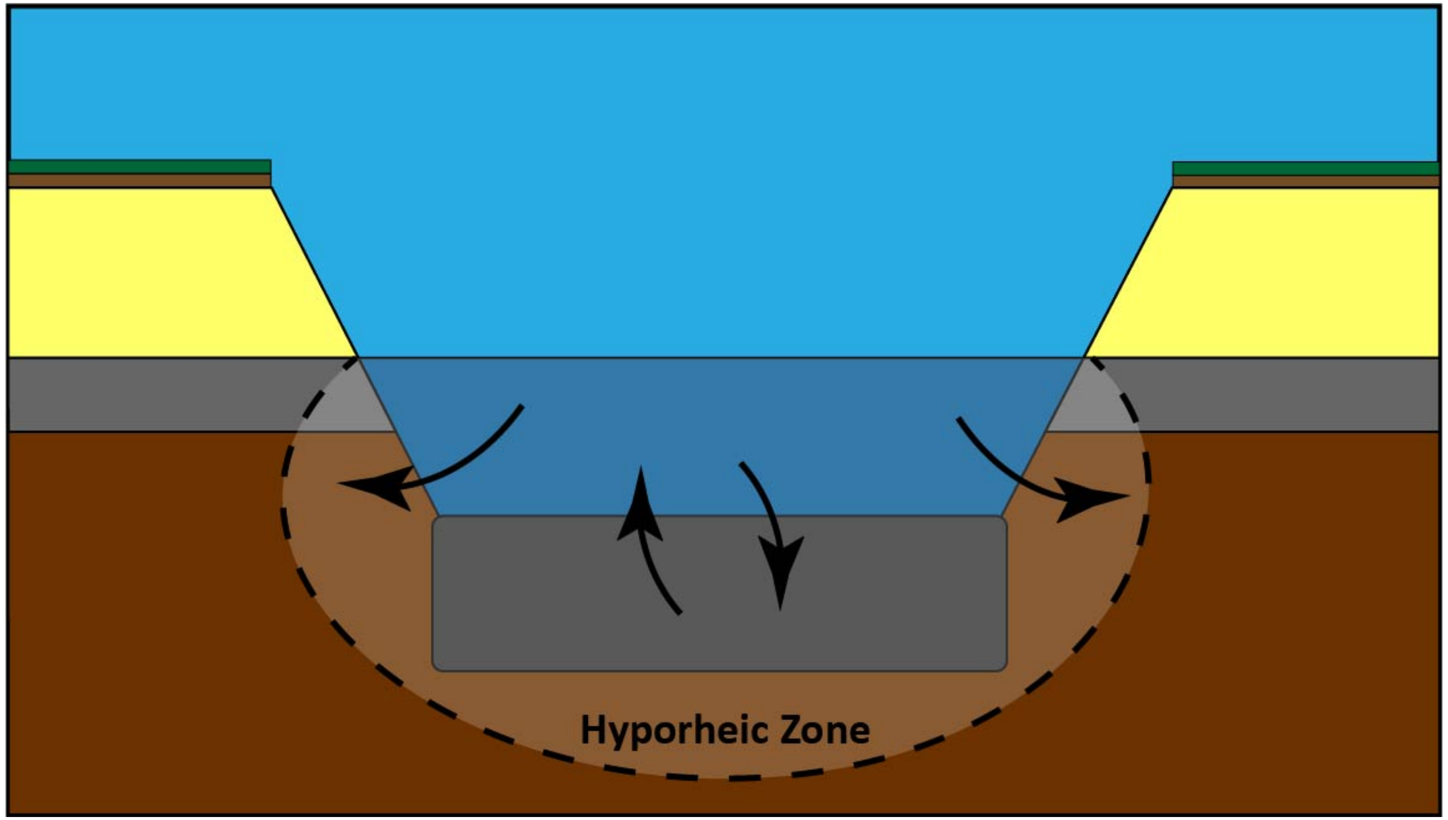


- National and Illinois EPA regard NO_3^- as a Primary National Drinking Standard[11-12]

- NO_3^- limit for both National and Illinois EPA is 10 mgL^{-1} as (NO_3^--N)[11-12]

- Consumption of excess levels of NO_3^- can lead to:
  - Methemoglobinemia in infants and young children[13]
  - The formation of nitrosamines attributed to gastric cancer[14]

Hyporheic Zone (HZ) role in NO_3^- cycling

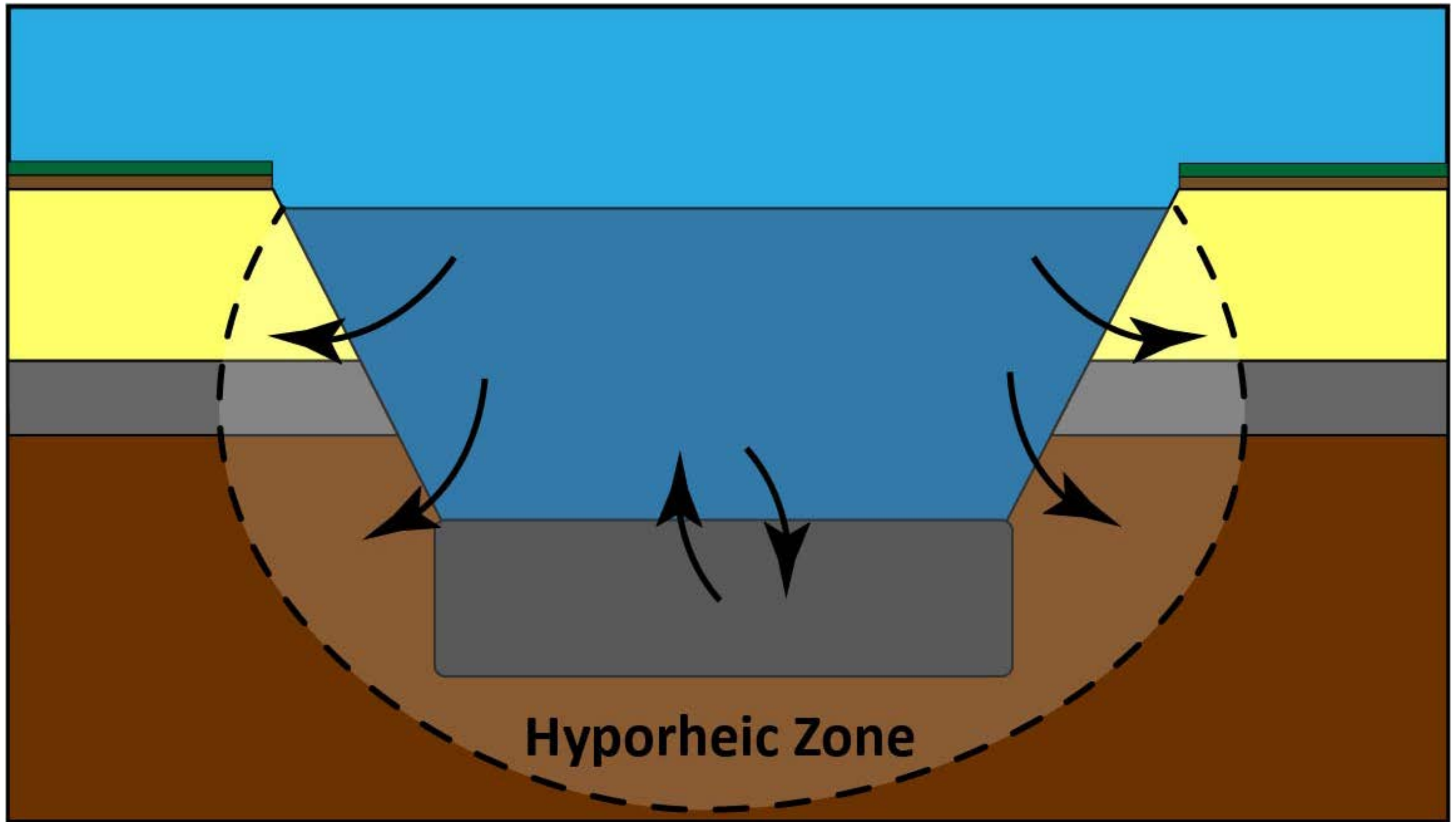


- HZ is an important area of surface-subsurface interaction within streams & rivers[15-22]

- Within the HZ denitrification can take place due to microorganisms who break NO_3^- down into N_2O (g) and N_2 (g)[23-24]
  - This reaction is anaerobic or low dissolved oxygen (DO)[23]
  - Requires high amounts of dissolved organic matter (DOM)[23]

- Furthermore plant uptake can occur predominantly from benthic stream algae[25-26]

Storms Impact on NO_3^- in streams



- **During storm events, stream stage increases as does the area of surface-subsurface exchange and the volume of the HZ[27-29]**
  - **DOC remains constant[28]**
  - **DO increases[27]**

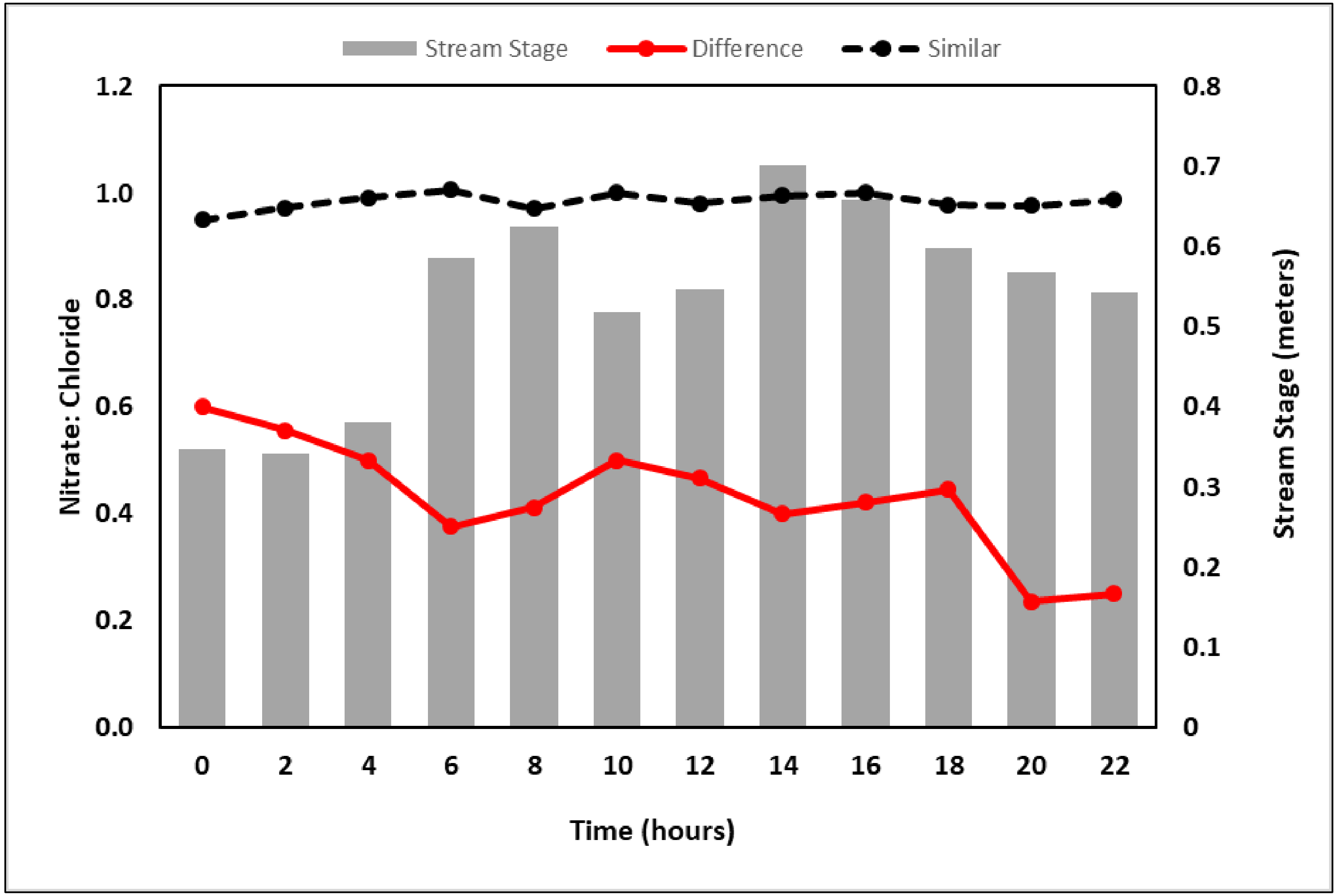
- **However, it remains to be studied how NO_3^- behaves during elevated stream stage and whether or not stream banks play a crucial role in NO_3^- removal and retention.**

- **Using Chloride (Cl^-), as a conservative tracer, we will compare its transport during storm events to that of NO_3^-.**

Objective

- If we measure that the behavior of NO_3^- and Cl^- concentrations during storm events are similar, then we can infer that transport during this time is conservative.

- If NO_3^- and Cl^- transport timing and amplitude of change differs may indicate that denitrification and uptake during storm events.



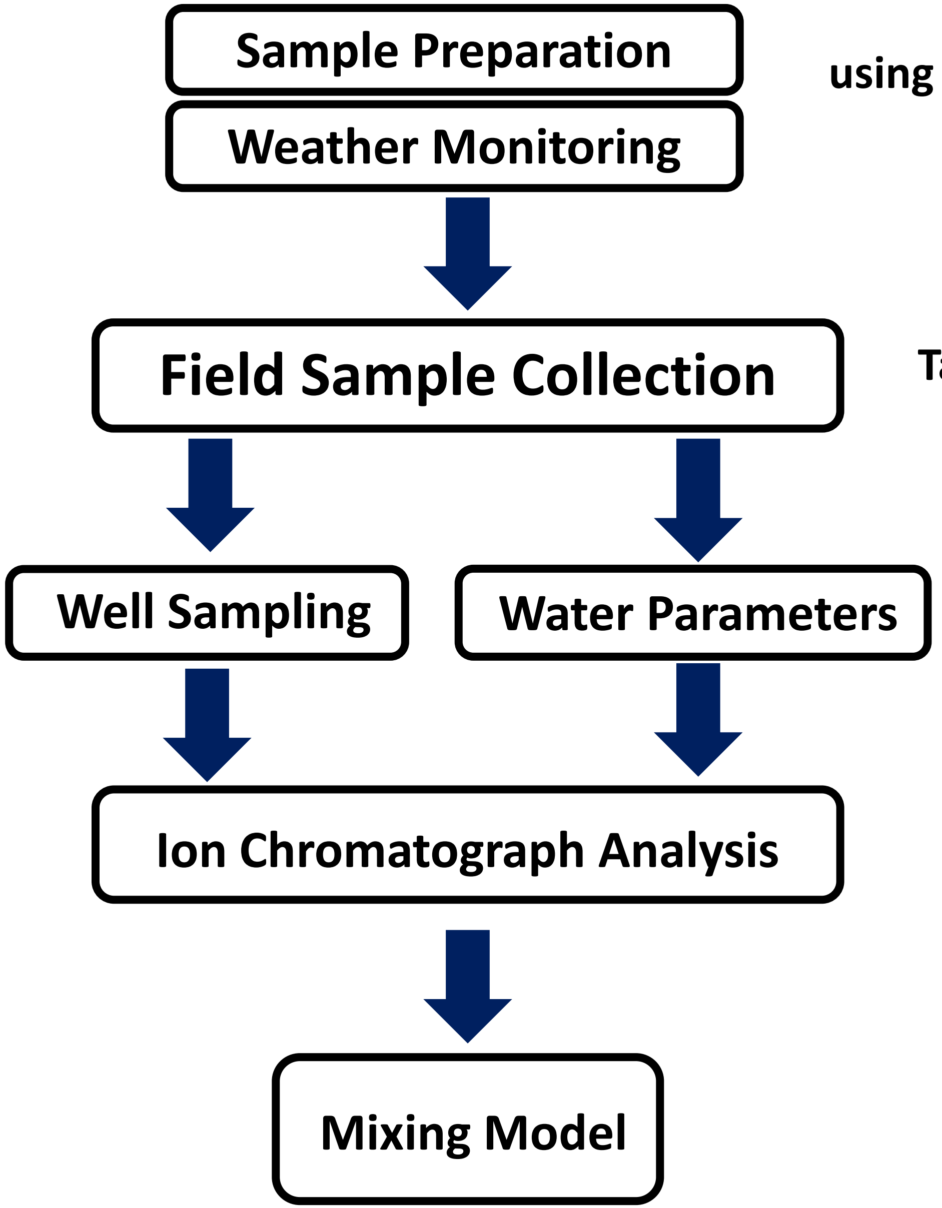
Questions

1. How do concentrations of NO_3^- and Cl^- change in response to storm events within the stream, hyporheic zone, and bank storage?

2. Are NO_3^- and Cl^- transported similarly in a low-gradient system?

3. Are NO_3^- and Cl^- transported similarly during different storm events?

Methodology

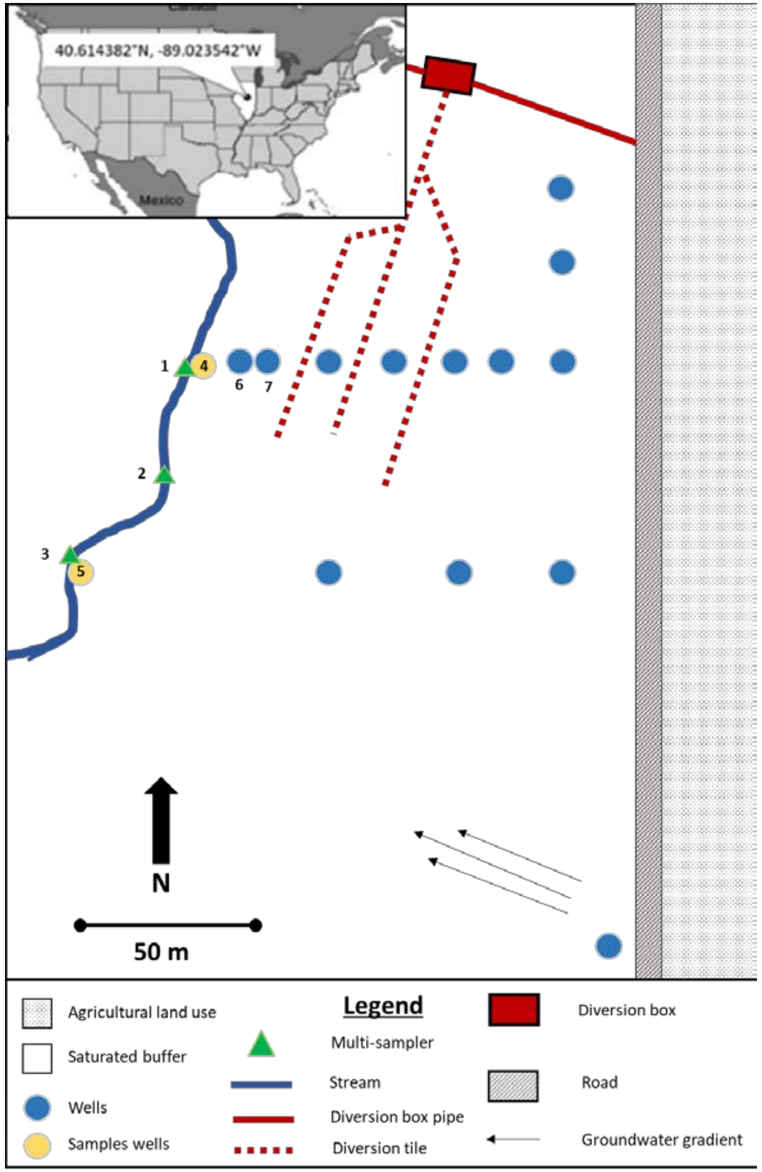


using Weather.gov in to monitor weather events

Take place over 24-hour storm event

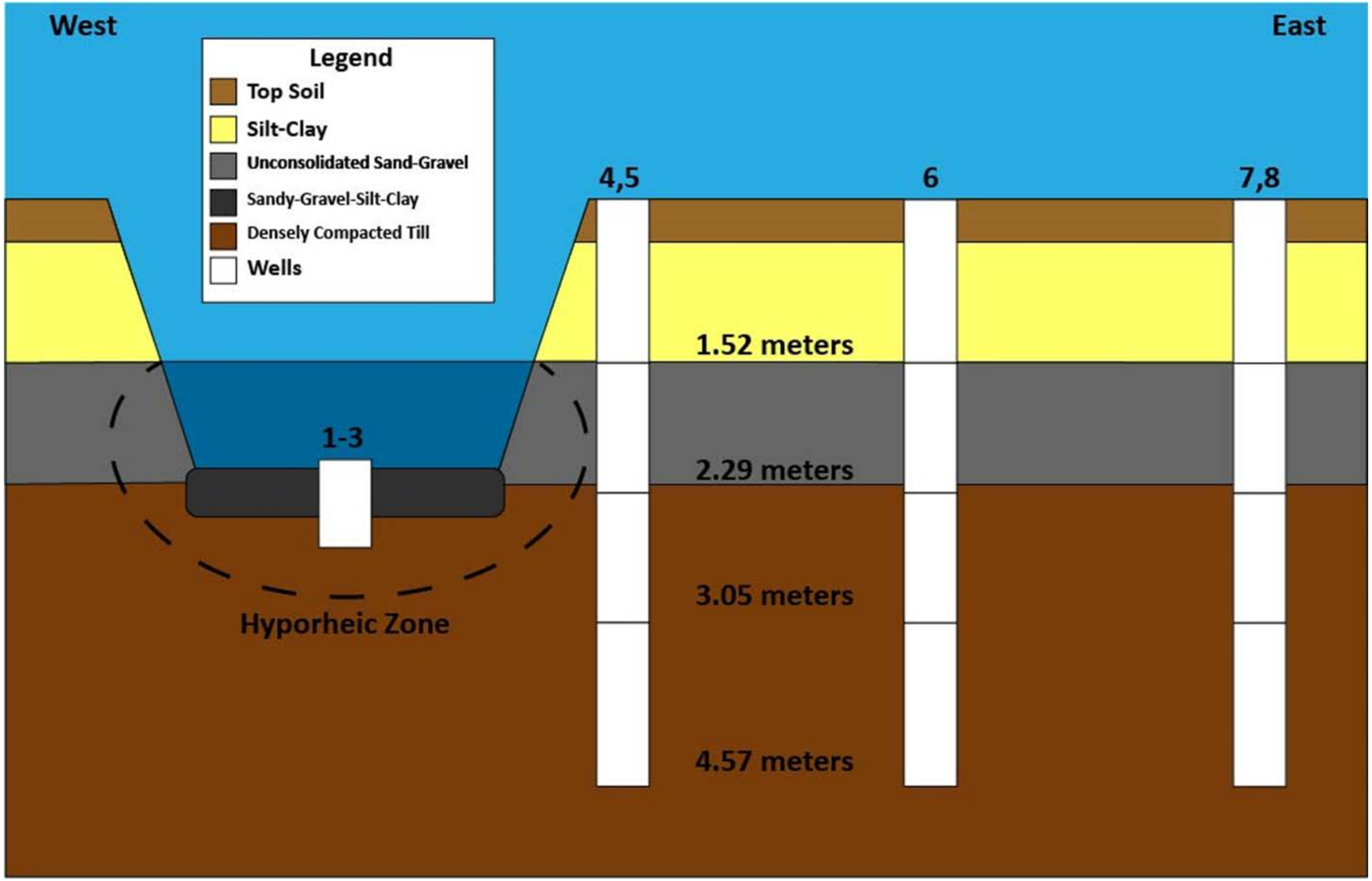
Occur every 2-hours during event

Study Site



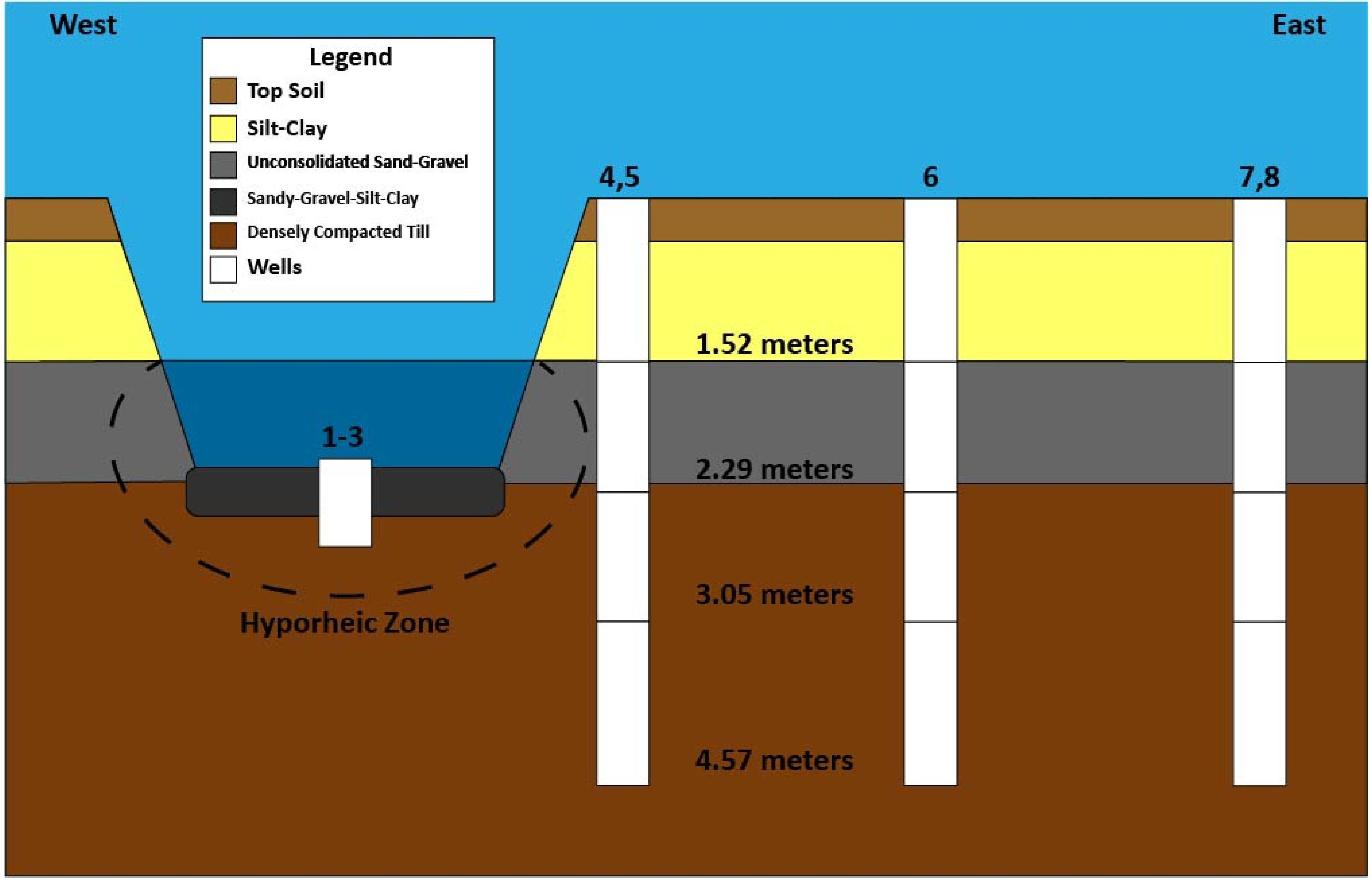
- T3 study site is a tributary of Evergreen Lake Watershed ELW) (105.45 km^2)
  - ELW primary land cover is cultivated crops of 77.6%
  - ELW secondary land cover is developed land of 13.3 %
- T3 stream is a modified low-gradient stream fed by tile drainage.

Study Site



- Silt-Clay layer is 1 meter in depth composed of organic-rich alluvium.
- Unconsolidated sand-gravel layer ~ 1.25 meters in depth.
- Compacted glacial till sits beneath.
- Stream bed composed of sandy-gravel-silt-clay layer ~50 cm in depth.

Field Sampling



- Sampling from 10, 30, and 50 cm depths in the stream and vertical HZ zone.
- 14 samples will be collected in total per rotation.
  - monitoring of pH, temperature, DO, and specific conductivity.
- Sample rotation will take place every 2 hours, with maximum monitoring duration lasting 24 hours.

Analysis

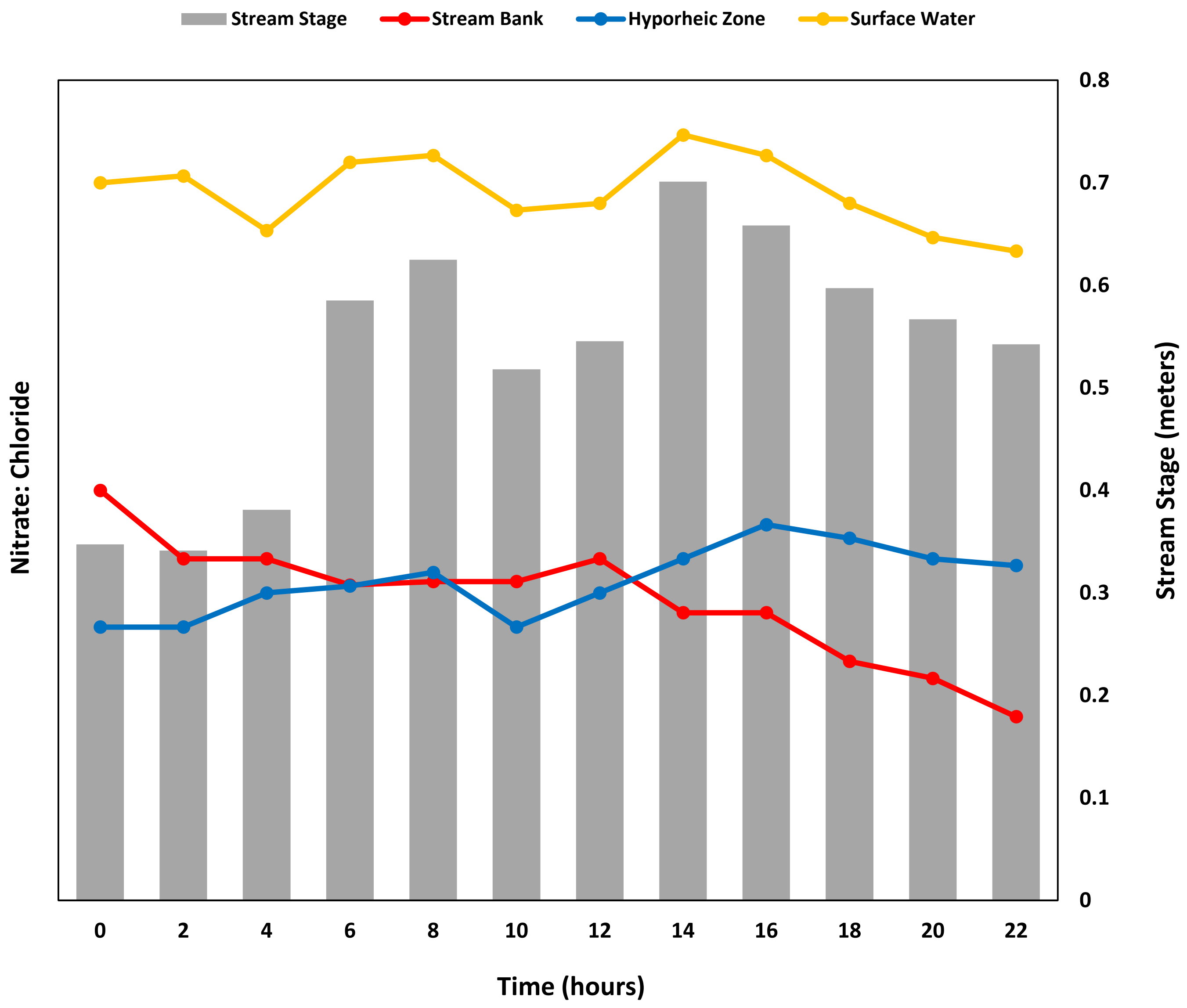
All samples will be analyzed in the Laboratory for Environmental Analysis (LEA) on a Dionex Ion Chromatograph, primarily measuring concentrations of $\mathbf{NO_3^-}$ and $\mathbf{Cl^-}$

Will utilize a two-end member mixing model between Surface Water (SW) and Ground Waters (GW) to infer Stream Bank Concentrations of $\mathbf{Cl^-}$ [30] in order to determine $\mathbf{NO_3^-}$ mixing [30]

$$\%SW = \frac{(Cl_{HZ} - Cl_g)}{(Cl_S - Cl_g)}$$

$$\mathrm{NO_3 - N} = \%\mathrm{SW} * (\mathrm{N_s} - \mathrm{N_g}) + \mathrm{N_g}$$

Expected Results



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Questions