Enhanced Aquifer Recharge (EAR): Potential Impacts to Groundwater

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OKI Meeting

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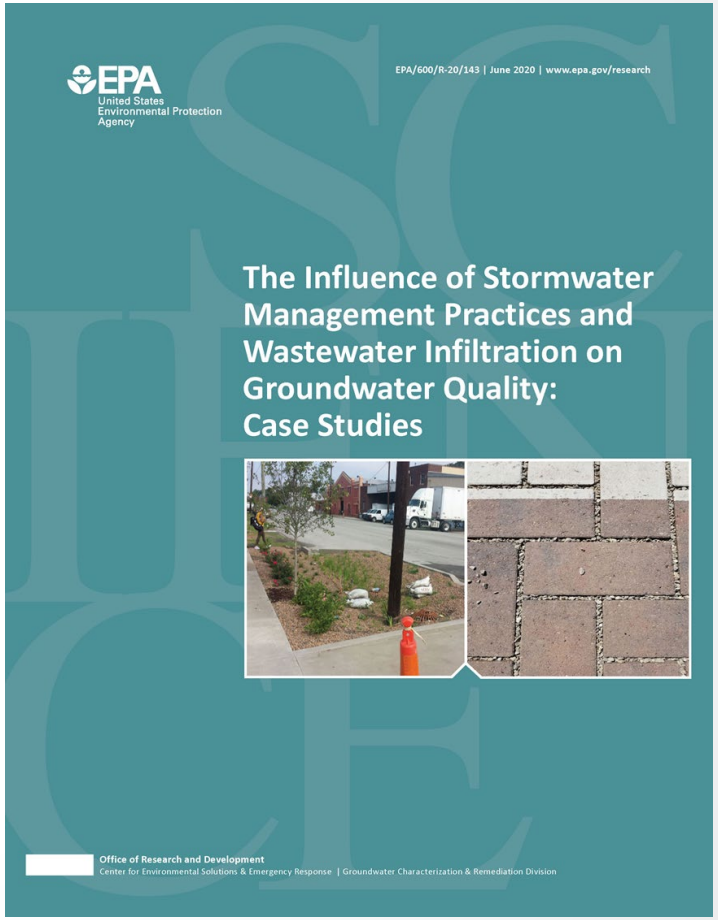
Previous EPA work

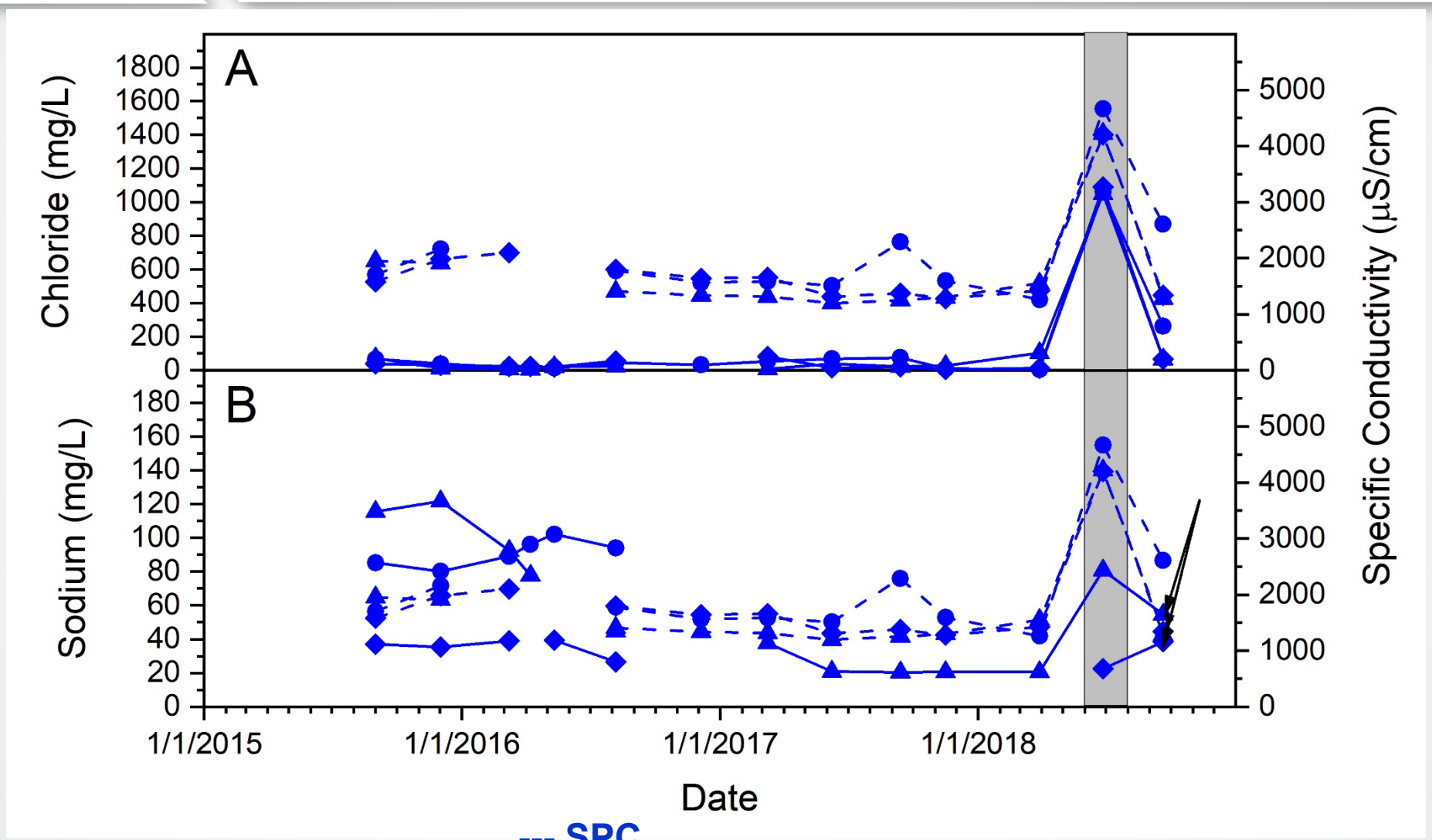
- GI work on stormwater infiltration
  - Report was released in 2020
  - Report summarized potential impacts to the vadose zone and ground water quality
  - Two of the study sites dealt with stormwater
  - One of the study sites dealt with treated wastewater



Alluvial and Glacial Outwash Aquifers

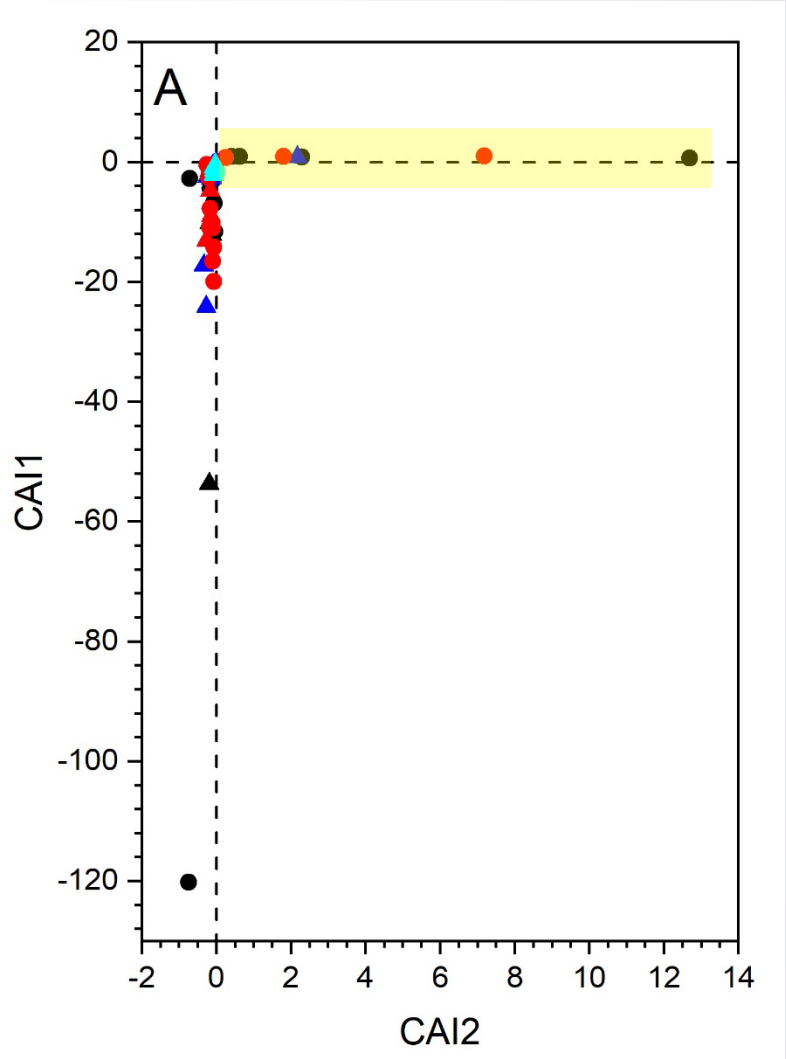
- Aquifers composed of sediments composed of gravel, sand, silt or clay
- Considered unconfined aquifers
- Generally shallow aquifers
- Can be susceptible to contamination and pollution

De-icing Agents in Vadose Zone

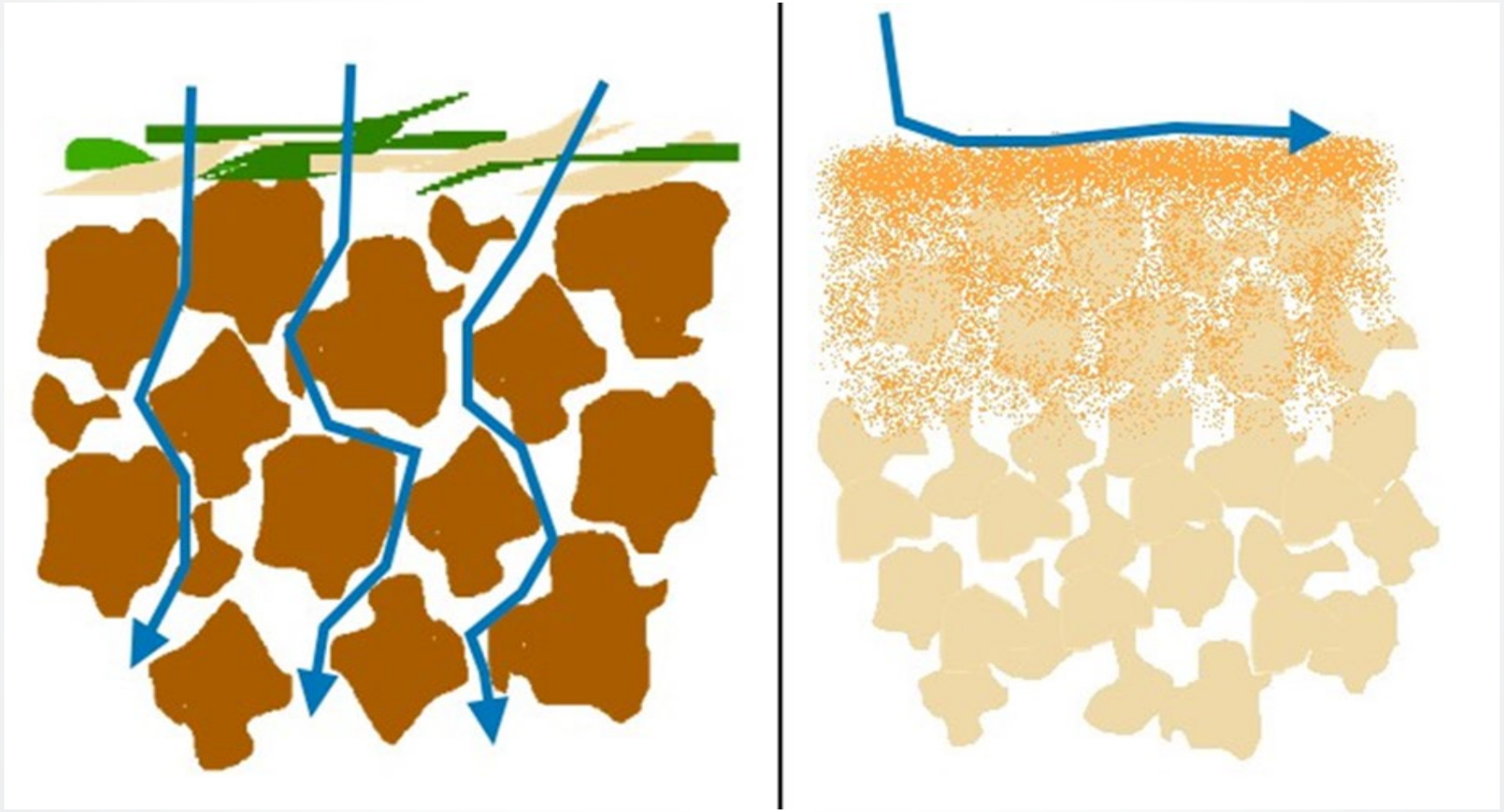


Vadose Zone

- Data inside yellow box corresponds to when spikes in sodium and chloride occurred
- When CAI1 and CAI2 are both positive suggest reverse ion exchange
- Reverse ion exchange loads Na onto particle surface (e.g., clays)
- Reverse ion exchange can lead to:
  - Clogging
  - Diminished infiltration and water movement



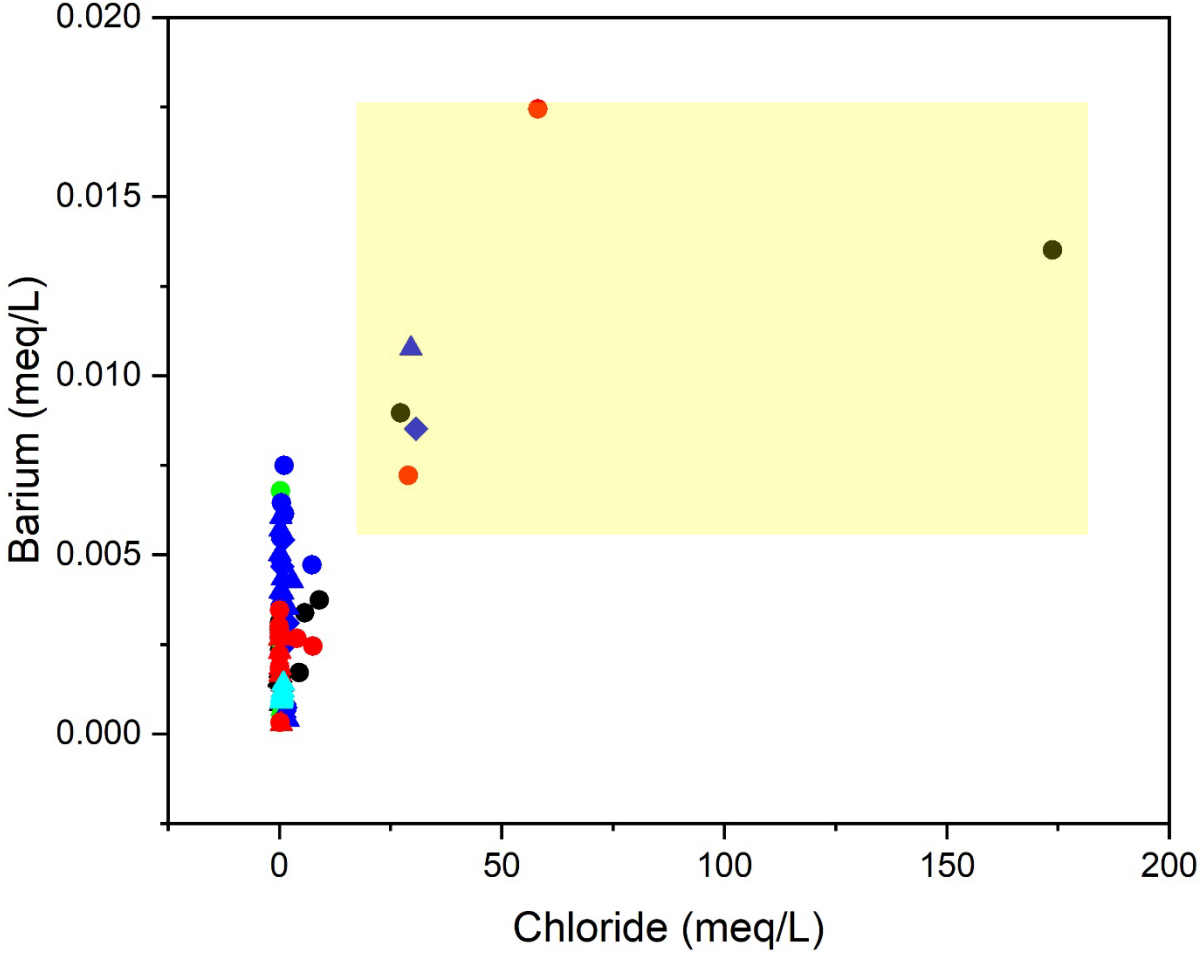
Vadose Zone Continued



Source: Linnburn Station, 2020

Vadose Zone Continued

- Relationship between chloride and barium
- When spikes in chloride occur barium concentrations increase (yellow box)
  - Other metals of concern exhibit similar behavior
  - Enhanced mobility of some metals could be problematic when chloride salts are applied as de-icing agents and stormwater is infiltrated

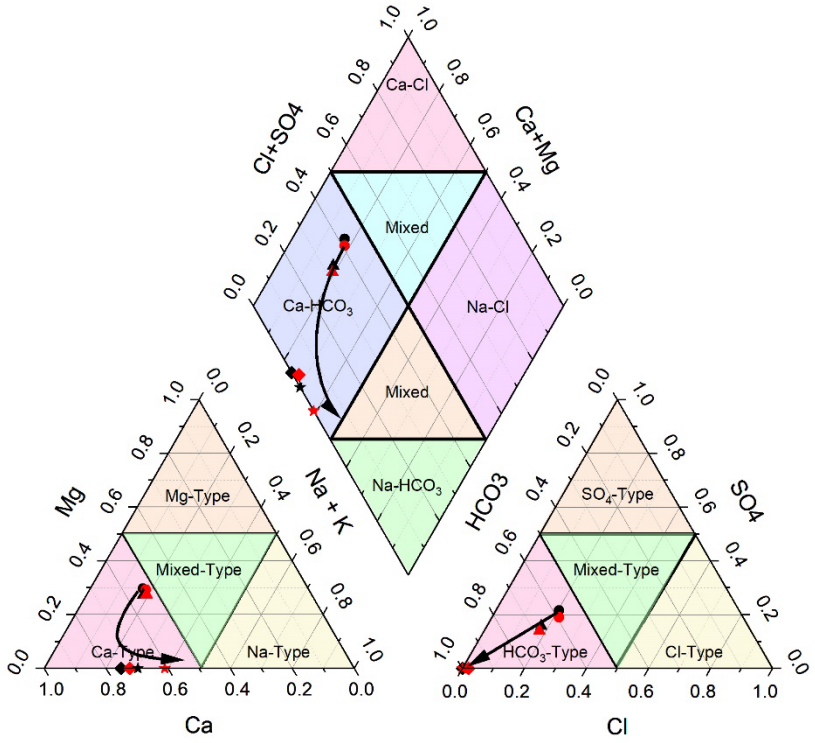


Groundwater

- In all case studies there were changes to groundwater quality
- Traditional stormwater contaminants do not pose a concern
- There was increasing phosphate concentration that was related to GI at two of the study locations.

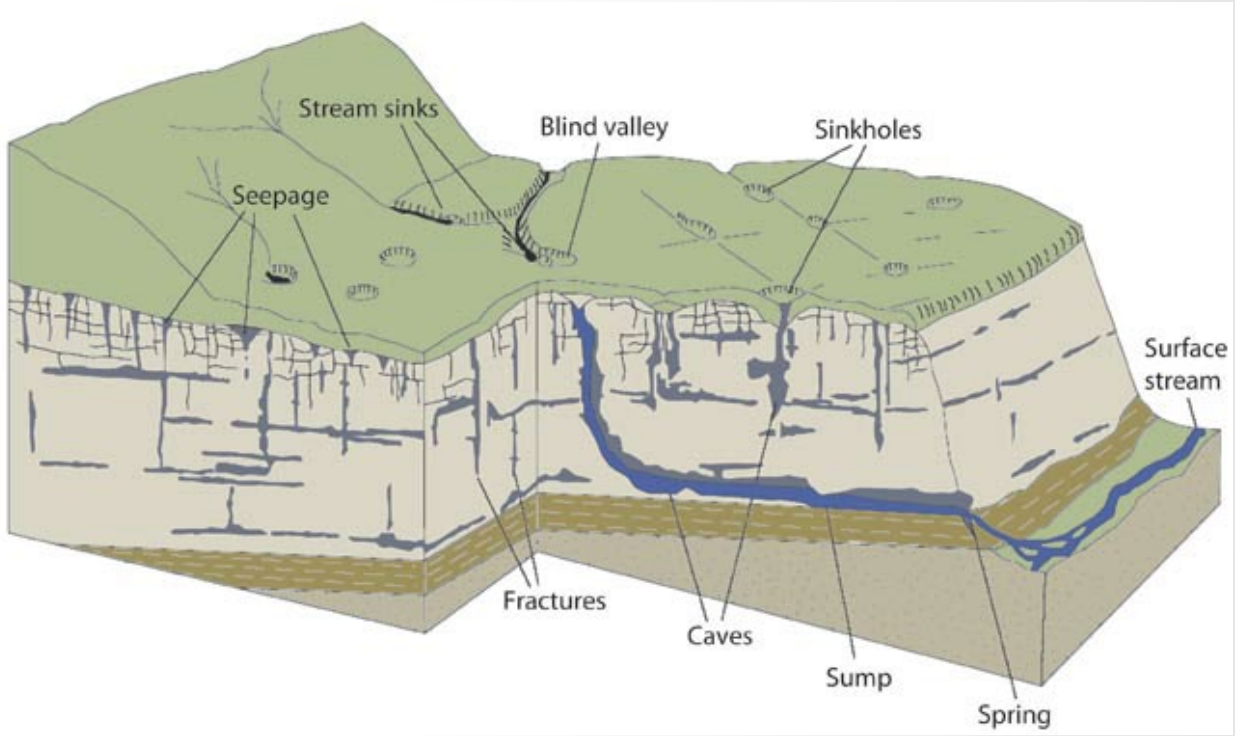
Groundwater

- Mixing and dilution of infiltrated water with groundwater caused changes to groundwater quality
- Major anion and cations concentrations in stormwater <<< groundwater
  - Except when de-icing agents applied
- If groundwater is used for drinking water:
  - Dilution can cause water type changes
  - Impacts to drinking water treatment are possible



Karst Geology

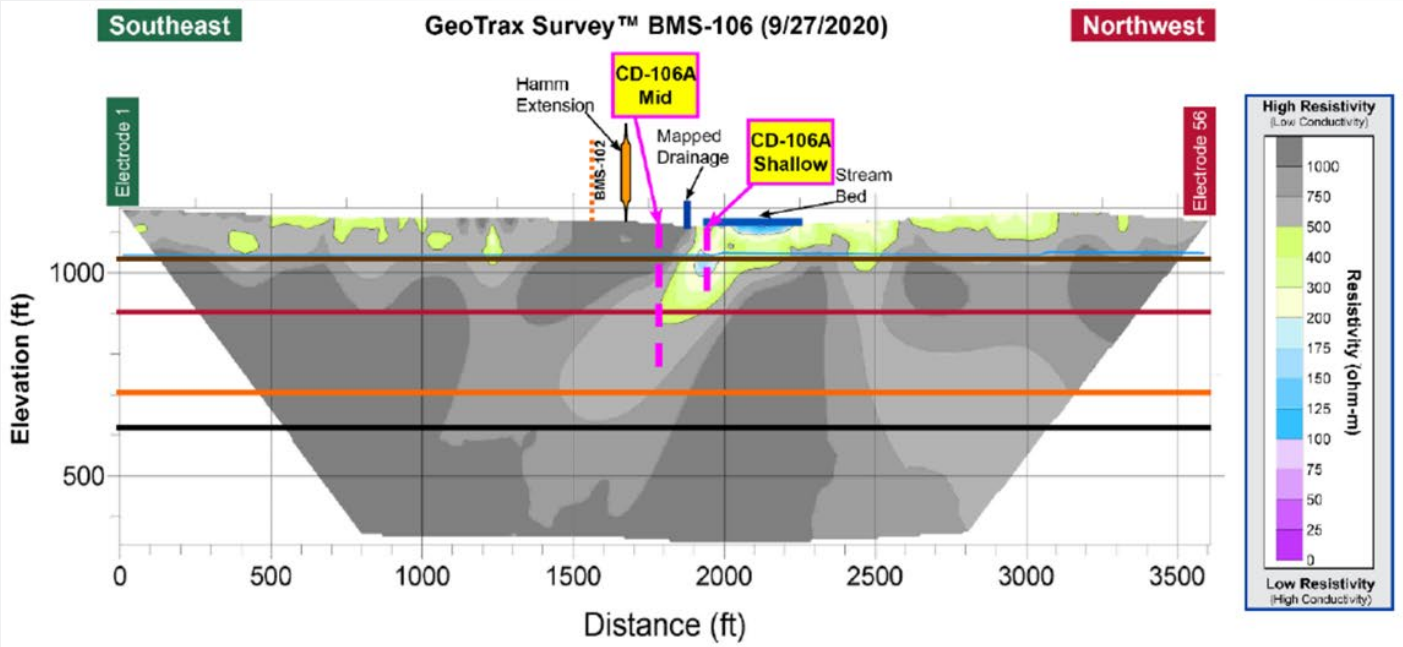
- Water-soluble units (e.g., carbonates and sulfates) with dissolution features in the subsurface.
- Groundwater moves through preferential flow paths - fractures, fissures, bedding planes.
- Groundwater in a karst aquifer is prone to contamination (Kaufmann et al., 2019).
- Important drinking water aquifers:
  - Edwards (TX), Biscayne (FL), **Arbuckle-Simpson** (OK)



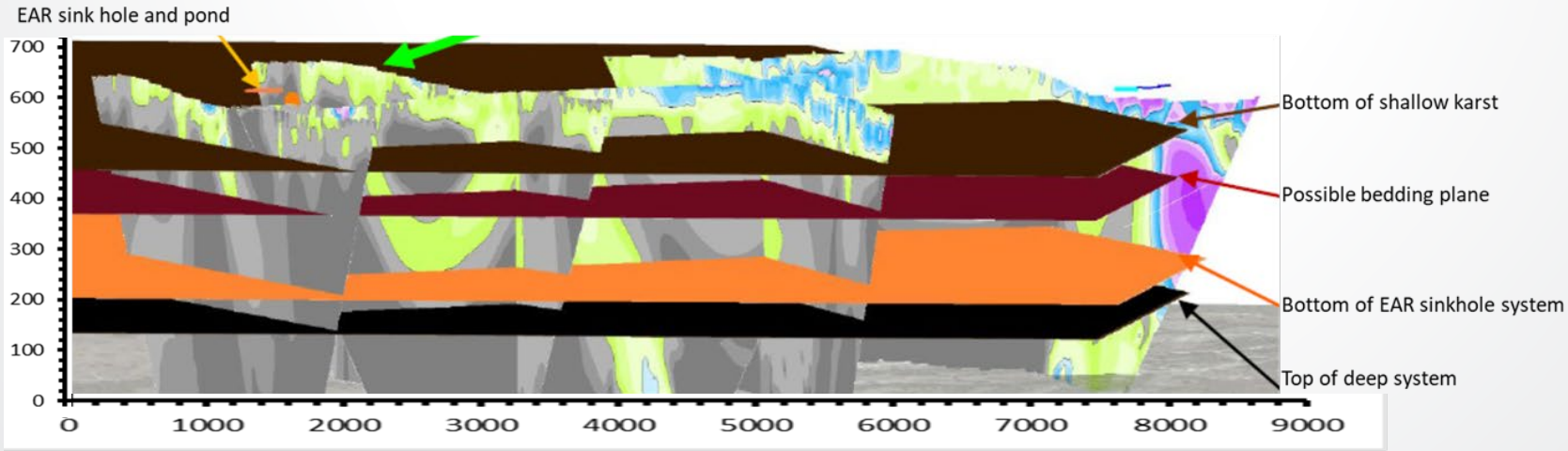
Source: Wisconsin Geological and Natural History Survey, 2021

Electrical Resistivity Imaging (ERI)

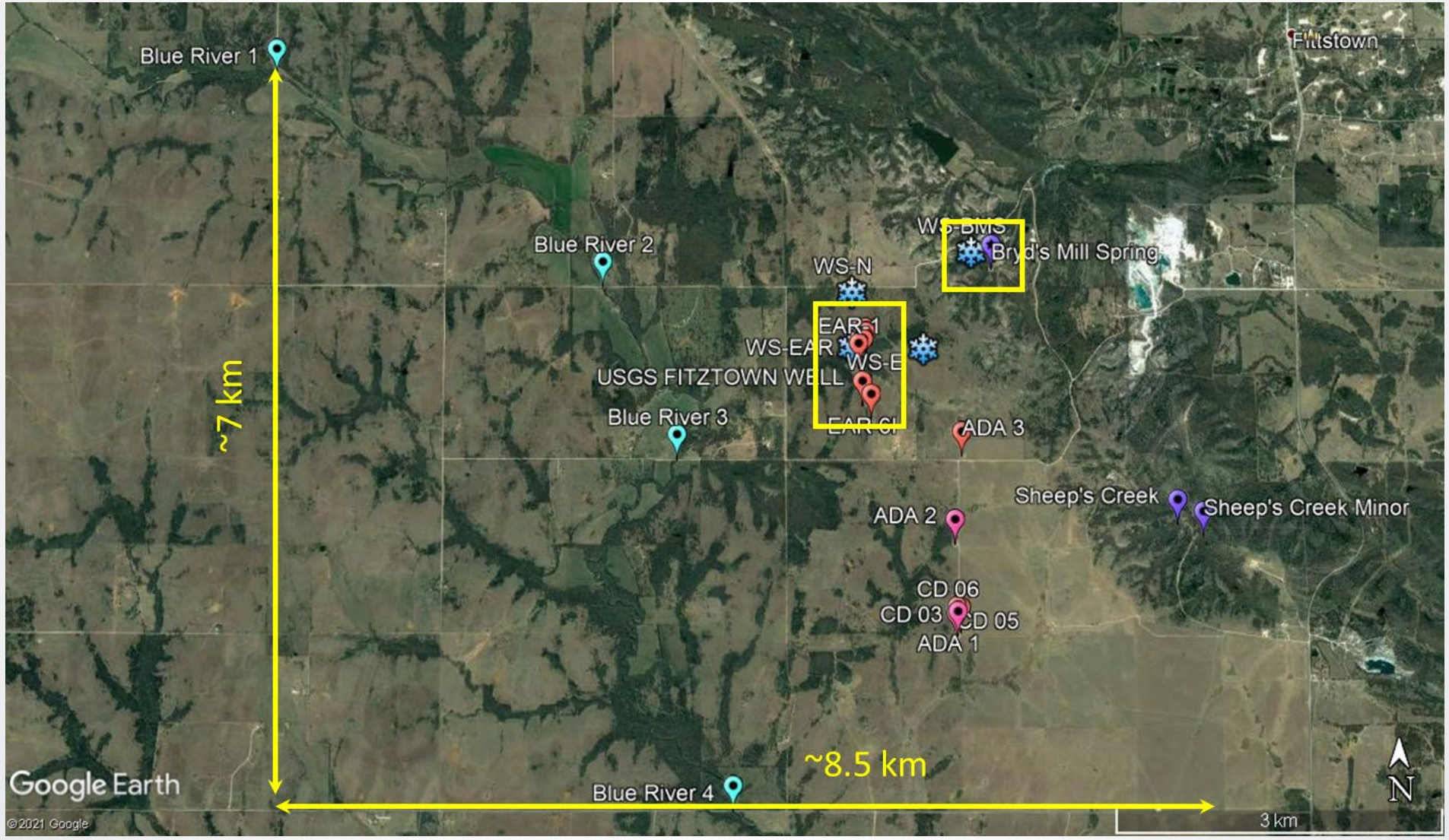
ERI for understanding Deep Geology



Figures from Aestus, Inc., 2020

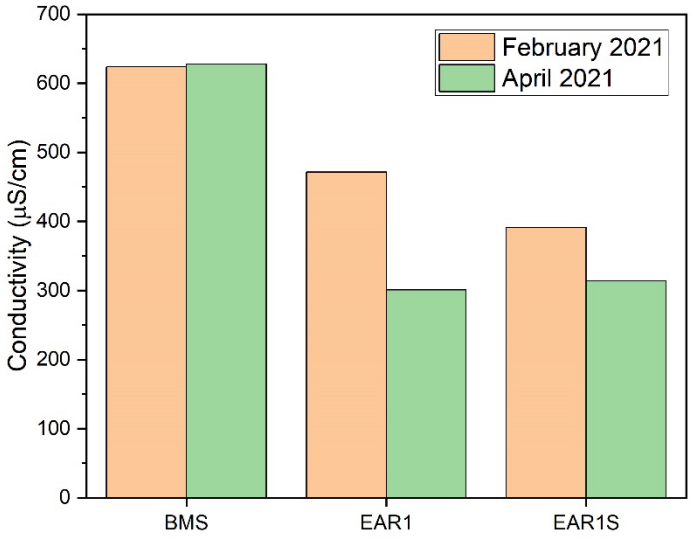


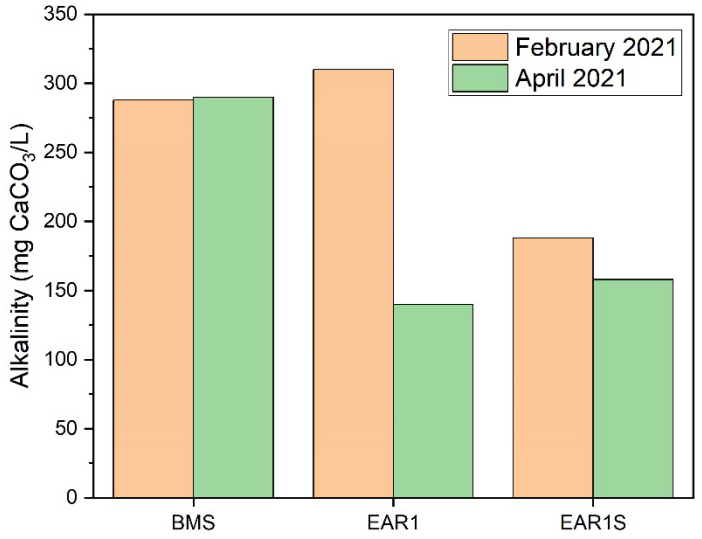
Enhanced Aquifer Recharge Study

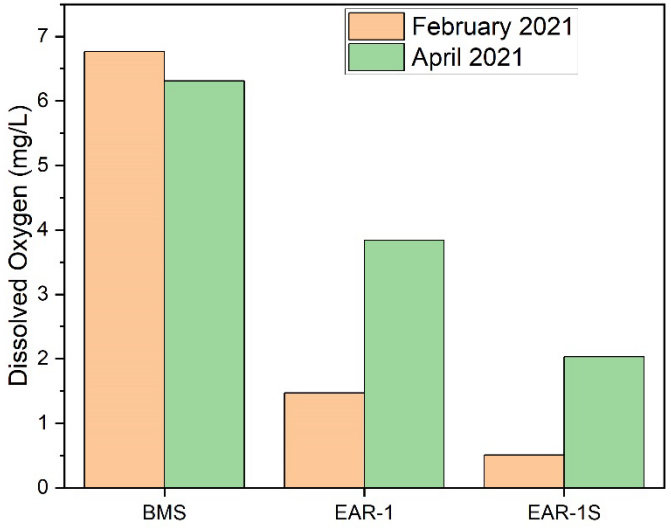


EAR Infiltration Site

April 2021 Overland Flow Event

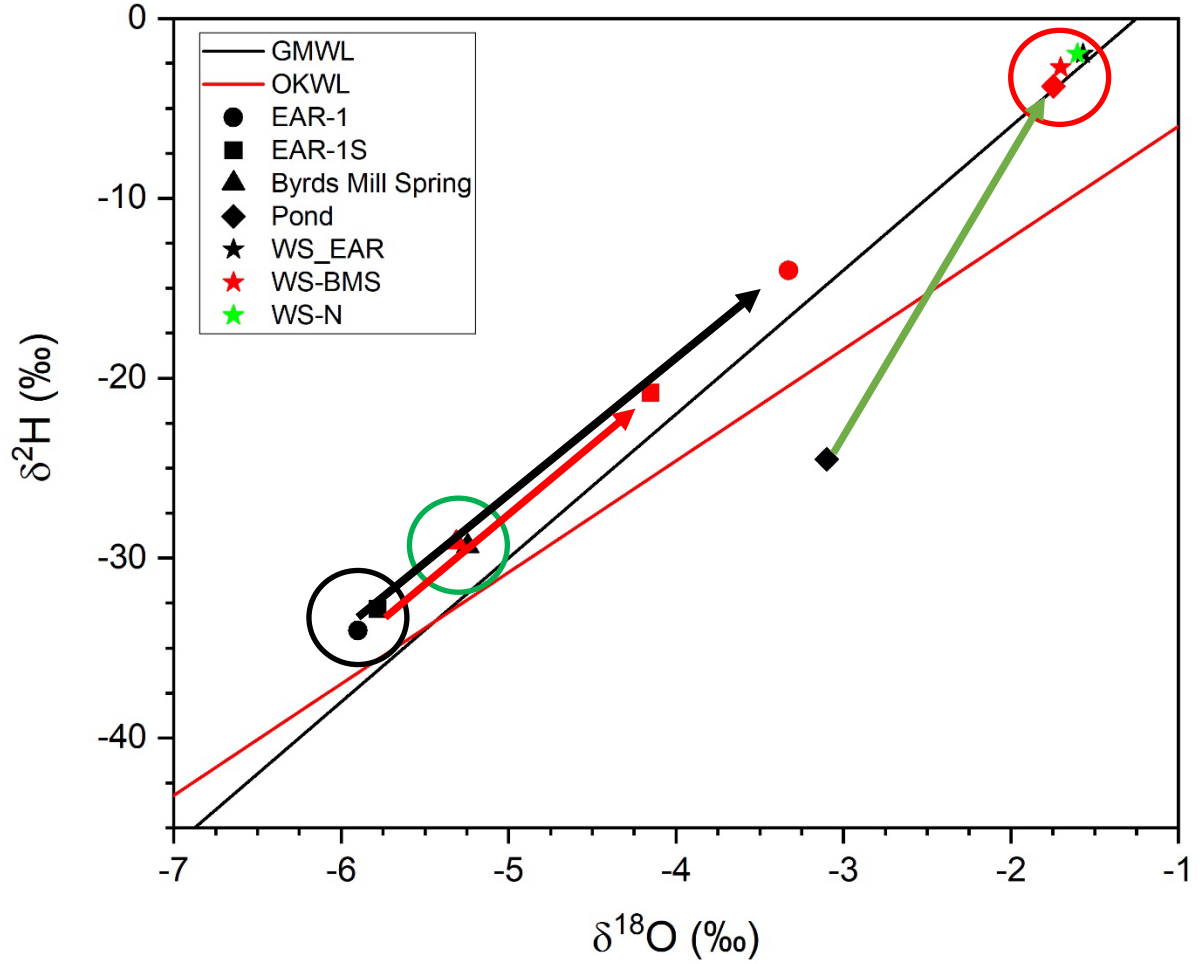






April Overland Flow Event

- Water isotopes also show mixing of:
  - Aquifer water (black highlighted area)
  - Precipitation (red highlighted area)
- BMS did not show changes (green highlighted area)
- EAR-1 and EAR-1S from aquifer water towards precipitation
- Pond appears to be composed mainly of precipitation



Evolving Project

- Infiltration appeared to change GW chemistry
- Questions:
  - Where does the infiltrated water go?
  - Are the changes observed to GW chemistry permanent or transient?
  - Is the GW monitoring network robust enough?

Summary

- De-icing agents are potentially problematic in vadose zone in GI systems
  - Increased sodium in vadose zone could lead to:
    - Dispersion of fine-grained materials
    - Clogging
    - Diminished infiltration/ water movement
  - Potential of metal mobility with chloride spikes
- Karst systems
  - Dilution of groundwater during infiltration of stormwater runoff
  - Water isotopes demonstrate precipitation mixing with ambient groundwater
  - Water isotopes maybe useful in tracking movement of infiltrated water


Questions?