Exploring anthropogenic pathways for contaminants to enter aquifers in urban areas

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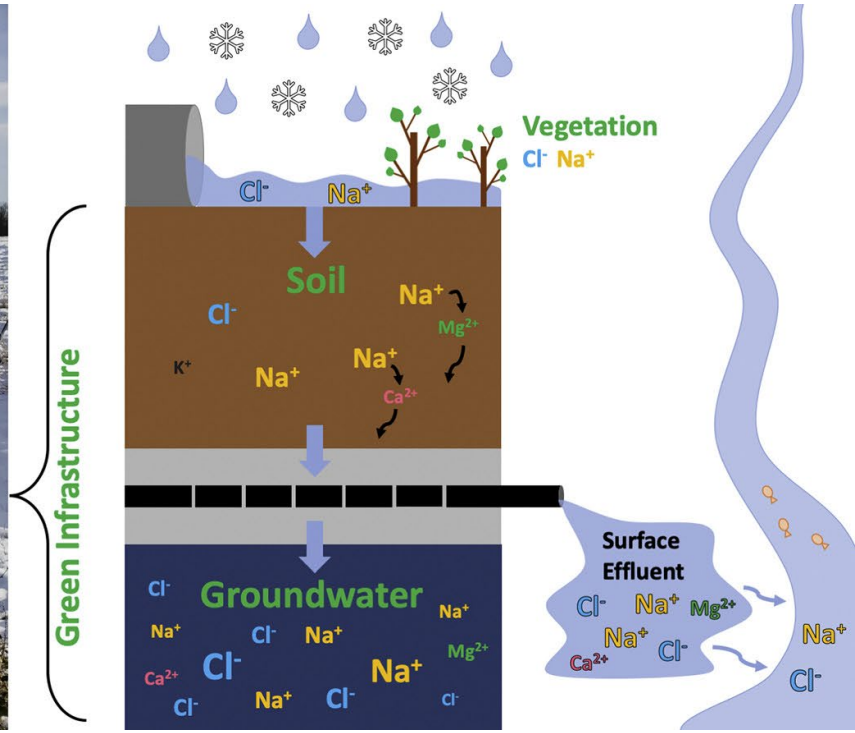
(Burgis et al., 2020)



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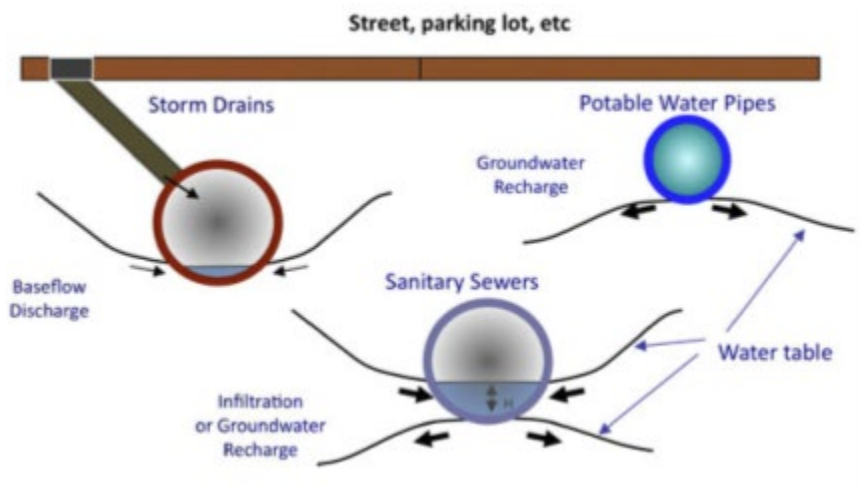
Urban “karst”

- Urban development associated with alterations to soils and complex networks of surface and subsurface pathways for routing stormwater, wastewater, and municipal water supply
- Many have taken to referring to these features as “urban karst”
- Instead of taking centuries to millennia to form through weathering, features are anthropogenic and can happen virtually overnight.

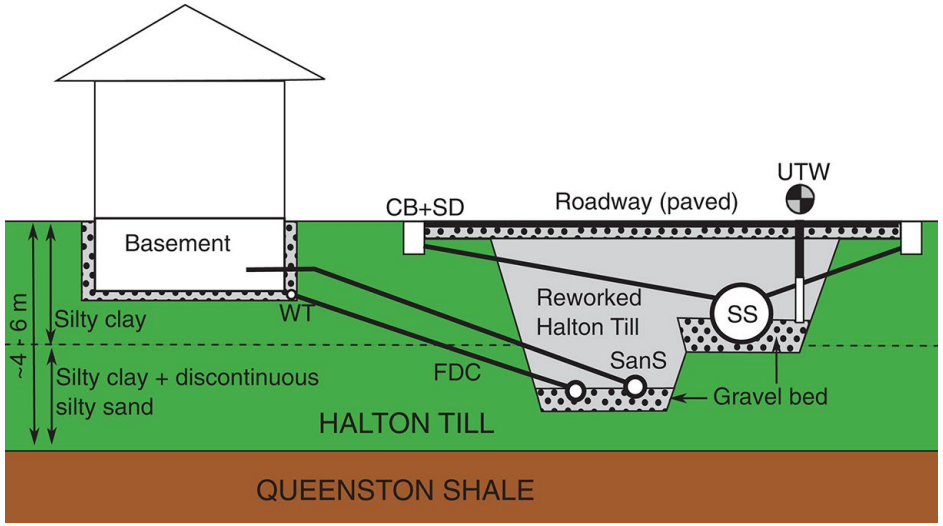
Common types of urban karst

- Water and wastewater pipes



(Kaushal & Belt, 2012)

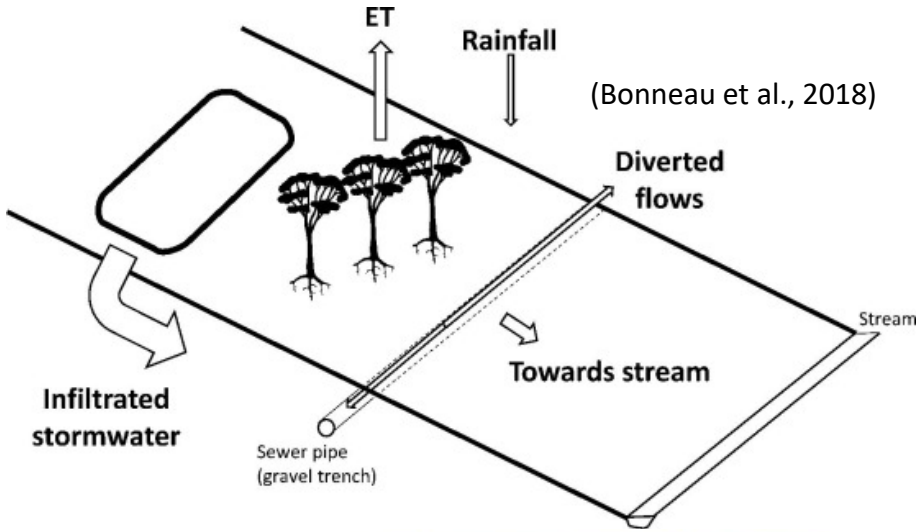
- Manufactured and structural soils, high permeability trenches, etc.



(Shepley et al., 2019)

Common types of urban karst

- Stormwater routing and detention
- Quarries
- Wells and bores

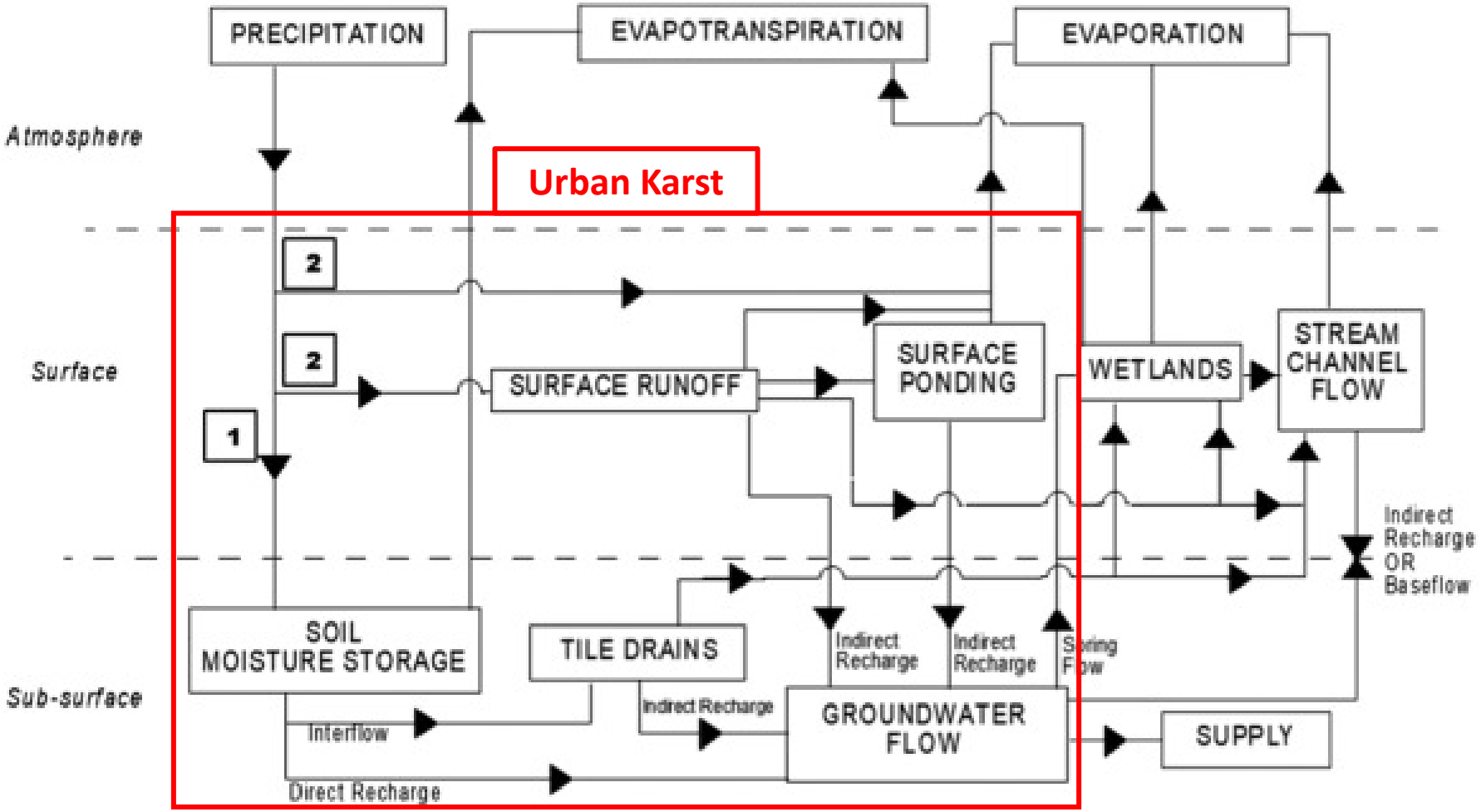


(Bonneau et al., 2018)

Figure 2. *A unique way of utilizing an abandoned well (Courtesy of Geary Schindel of EAA). The white paper on and around the well is a toilet paper.*

(Saribudak et al., 2017)

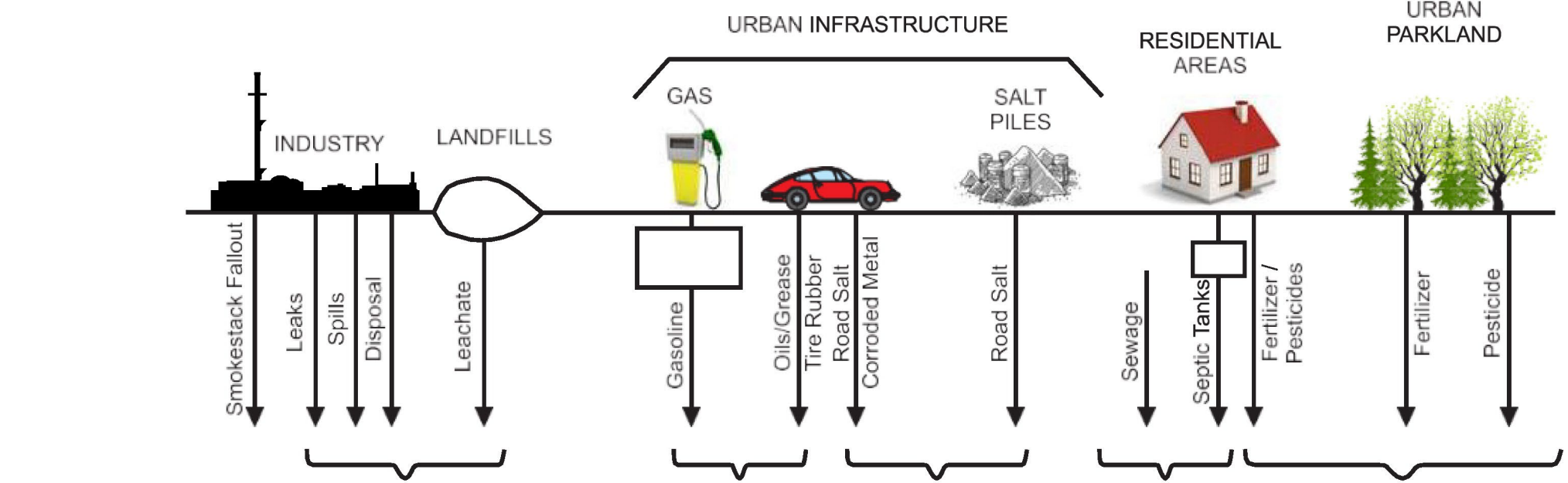
Urban karst in the water cycle



(Howard and Gerber, 2018)

Influence of urban karst

- Significant contributor to urban recharge in many areas
  - In some cases, net groundwater “recharge” increases following urban development
    - Pipe leakage
    - Stormwater infiltration
    - Cracks in “impervious” surfaces
    - Green infrastructure
    - Irrigation return flows
- However, some of these sources are undesirable, containing existing anthropogenic contamination and altering subsurface chemistry



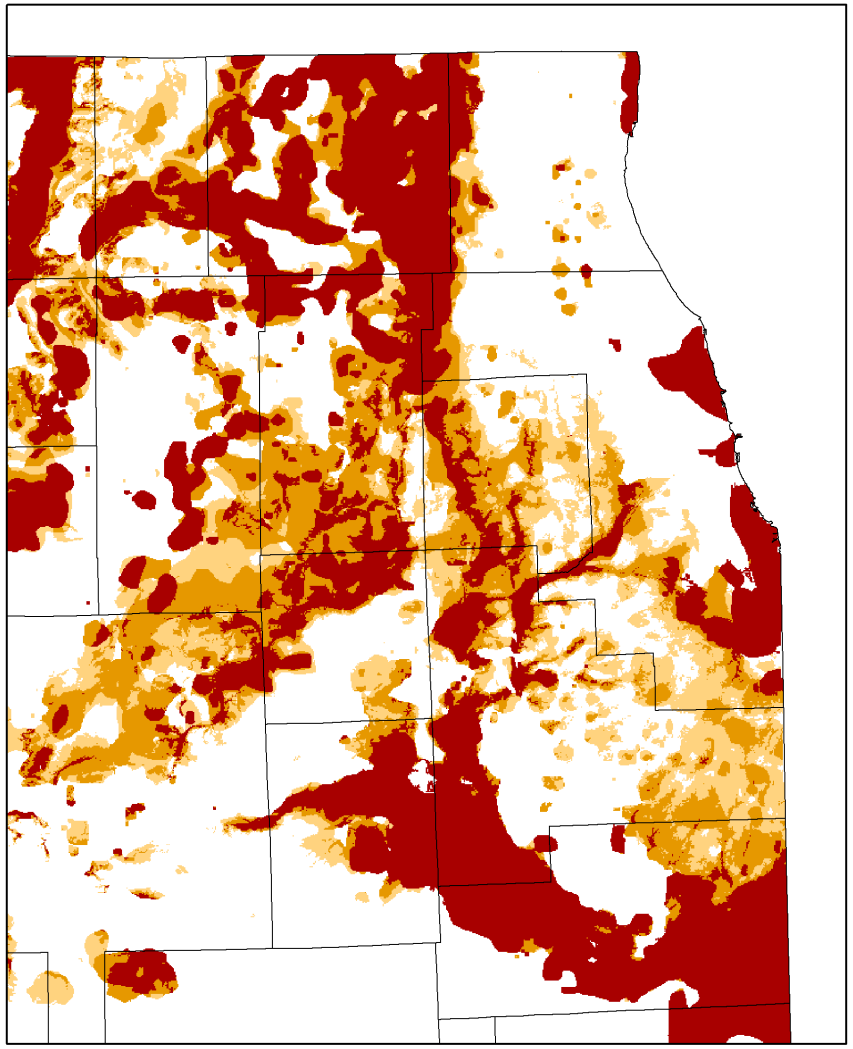
Contaminant Category	Sulphate and Nitrogen Compounds	Solvents/Degreasers Dyestuffs/Inks Petroleum Hydrocarbons Pesticides Paints, Acids, Alcohols VOC's/PAH's/PCB's	Petroleum Hydrocarbons (LNAPL's)	Rock Salt Heavy Metals	Nitrogen compounds Detergents Bacteria	Nitrogen compounds Herbicides Insecticides Fungicides
Common Contaminants	Nitrate Sulphate Heavy Metals	Chlorinated alkenes/alkanes Carbon tetrachloride Tetrachlorethane Dichloromethane 1-1-1-trichloroethane Trichloromethane Trichloroethene 1,1-dichloroethene 1,2 -dichloroethane Phenols/Chlorophenols Organic acids Aromatic Hydrocarbons Benzene Toluene Ethylbenzene Xylenes Soluble inorganics incl. heavy metals & cyanide	Aromatic Hydrocarbons Benzene Toluene Ethylbenzene Xylenes	Sodium Chloride Lead Copper Arsenic	Nitrate/Nitrite Ammonia Coliforms Chloride Trichloroethylene Benzene Heavy Metals Dichlorobenzene Dichloromethane	Nitrate/Nitrite Ammonia Atrazine/Deethylatrazine Aldrin/Dieldrin Chlordane Heptachlor Alachlor/Metalochlor Lindane

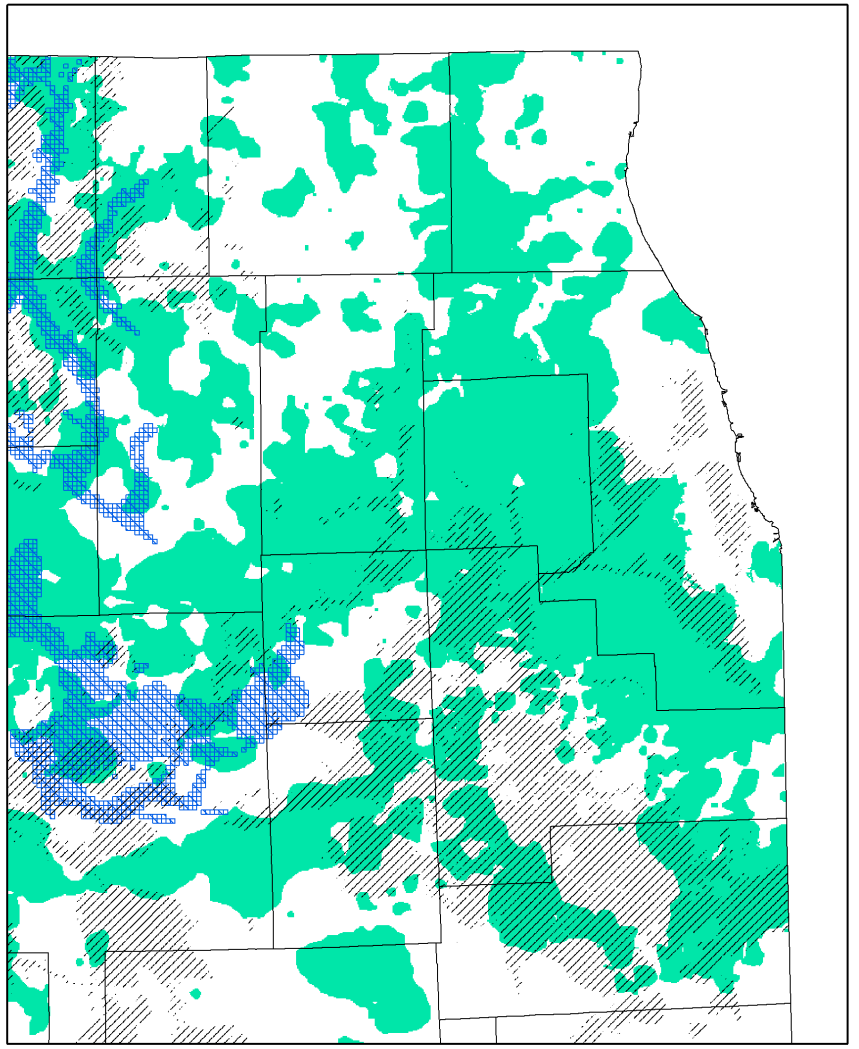
+PFAS

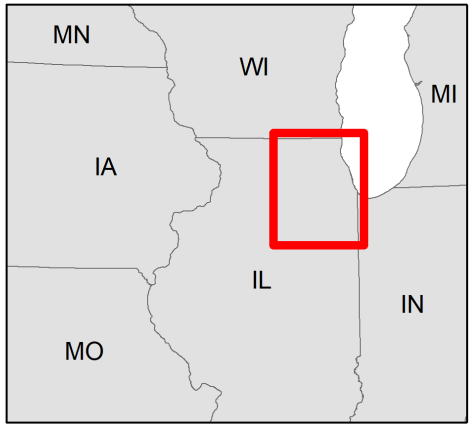
(from Warner et al., 2016; modified after Howard, 1997)

- Hypothesis:

While areas with highly permeable materials near the surface are inherently vulnerable to contamination from urban development, areas with native low-permeable soil and glacial materials might also be vulnerable to urban development through replacement of native soils with fill, addition of urban karst features, green infrastructure, etc.







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County Boundary

Sand and gravel contamination potential

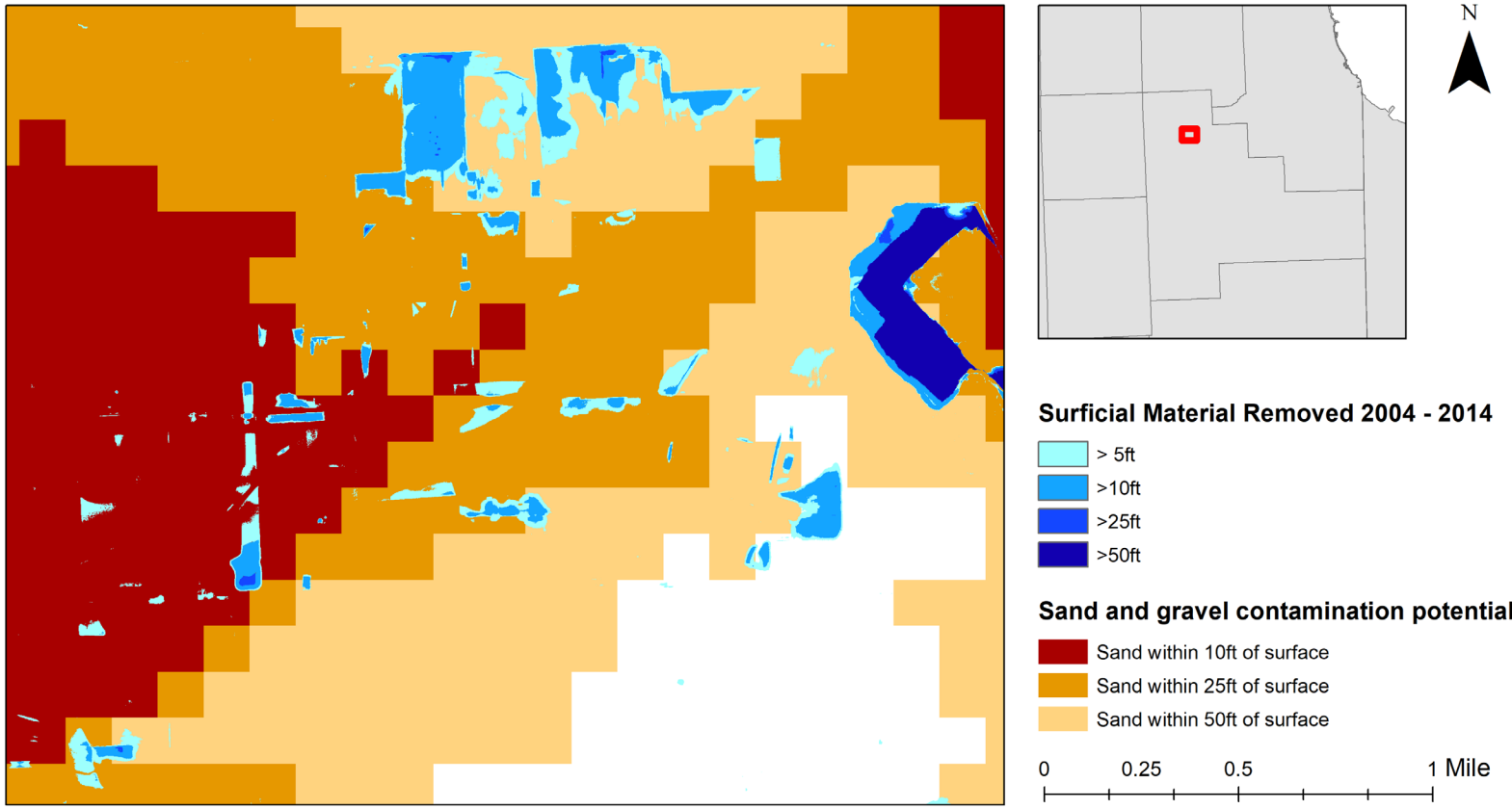
- Sand within 10ft of surface
- Sand within 25ft of surface
- Sand within 50ft of surface

Bedrock contamination potential

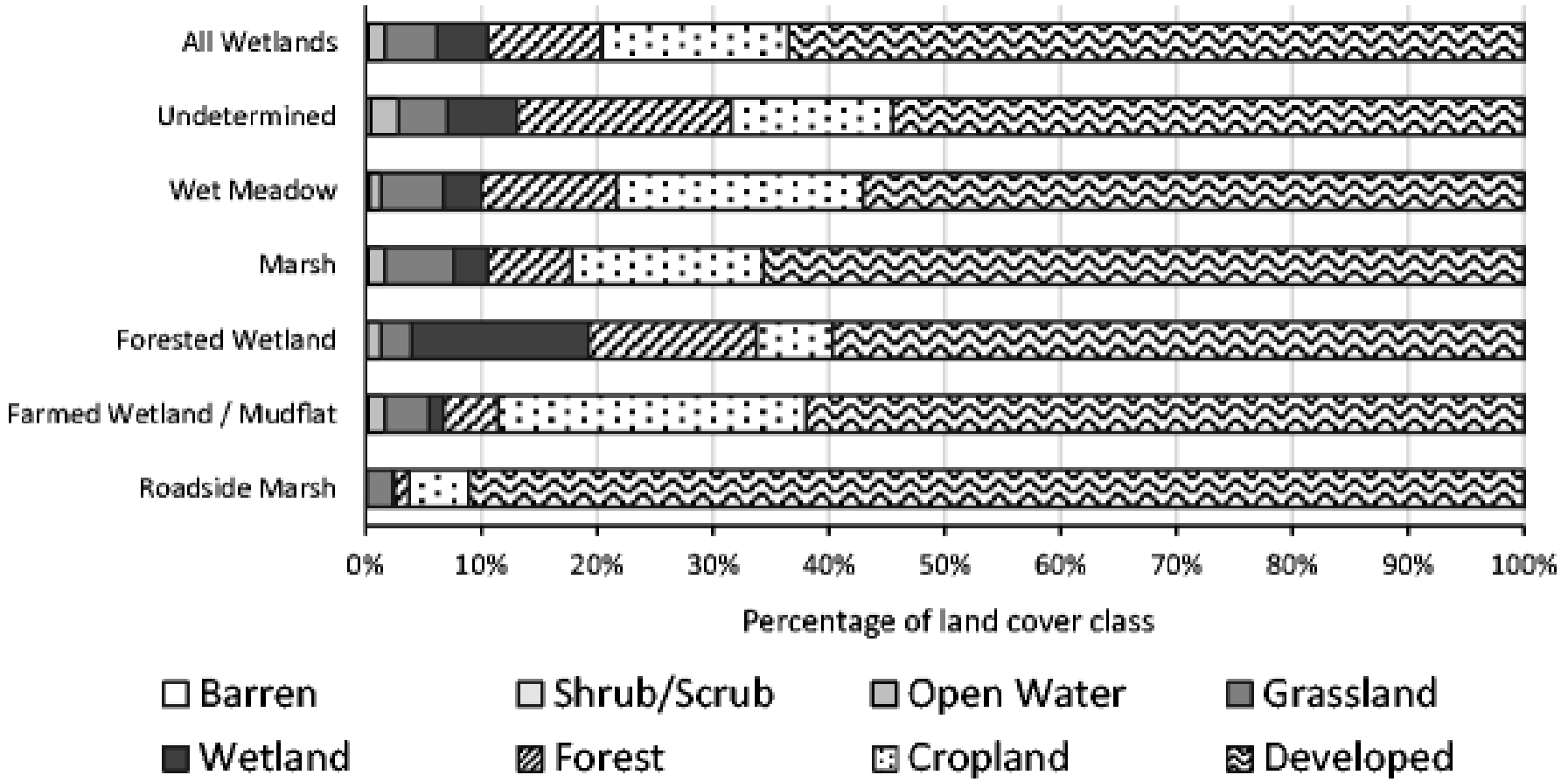
- Drift thickness < 50 ft
- St. Peter at bedrock surface
- Sand at bedrock surface

0 10 20 40 Miles

Example of retention basin installation and land development in Will County



Land use surrounding wetlands in Chicago Metropolitan Area



(Skutely and Matthews, 2018)

Questions?

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