Hydrogeological soil research for green stormwater infrastructure planning and design:
new methods for adapting urban coastal communities

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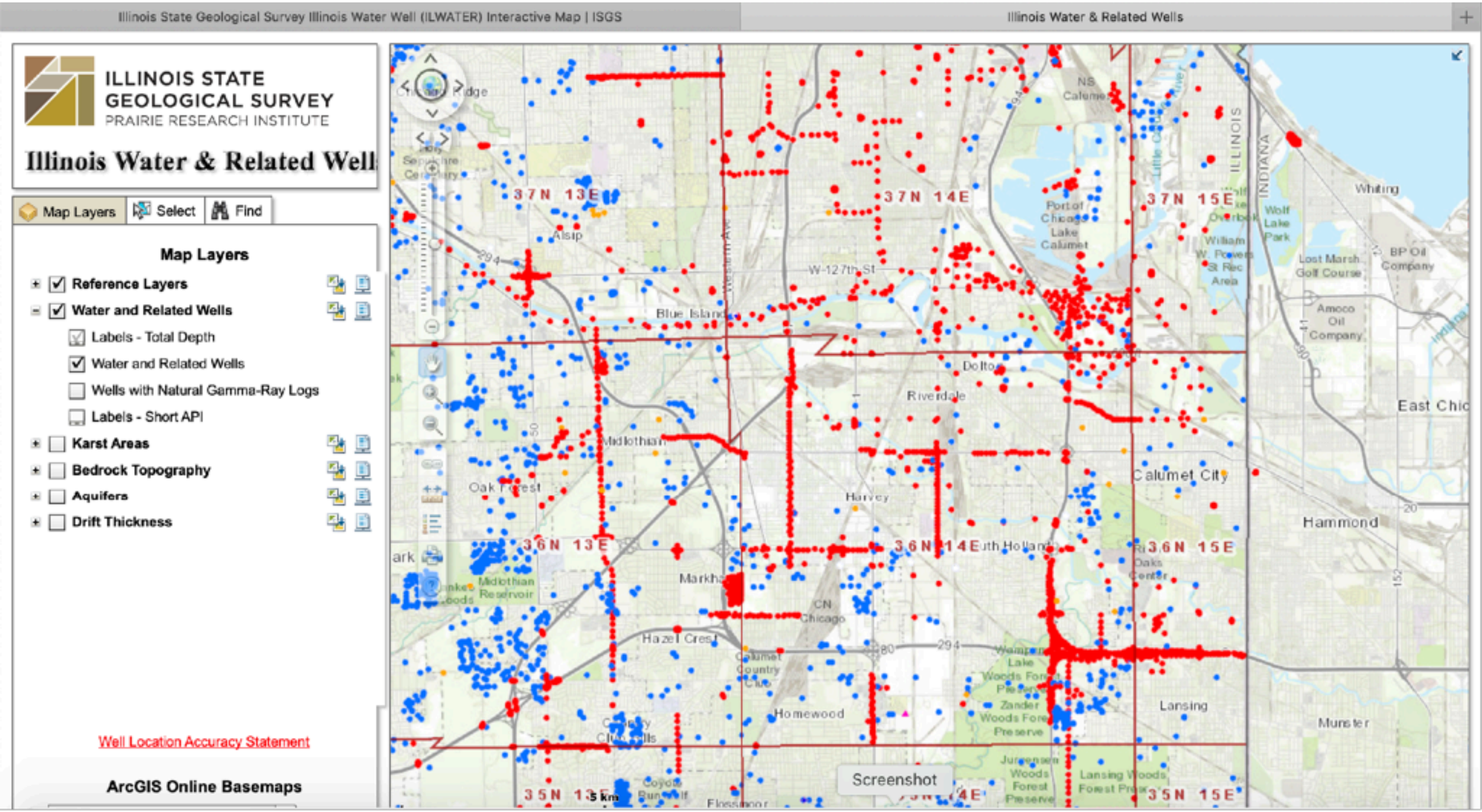
Municipal partners:
Village of Midlothian, coordinated with CMAP LTA project
Calumet City

Other partners:
NRCS, Kristine Ryan and Sarah Smith
CMAP, Kate Evasic
MPC, Sarah Cardona and Bob Newport, multiple
CNT, multiple

Sea Grant
ILLINOIS - INDIANA

Updating the IL-Water database: across the Calumet Corridor



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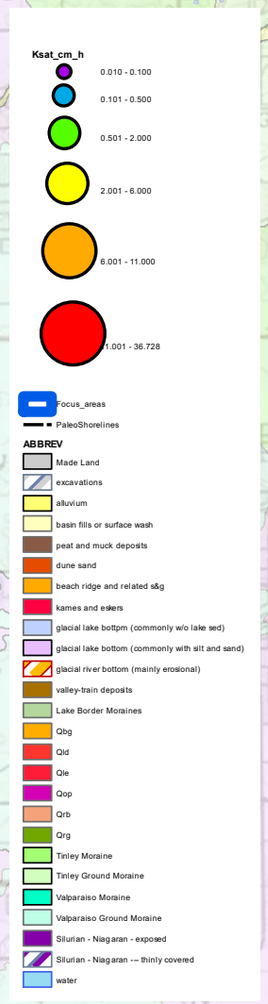
Two municipalities are participating in the soils study: Midlothian and Calumet City.



- Amoozemeter data collected for this project in summer 2018 showed Moderately High to High Ksat (saturated hydraulic conductivity values) in the sandy-textured areas, but were typically Moderately Low in the more clayey, fine-textured area of the Chicago-Calumet Lake Plain.

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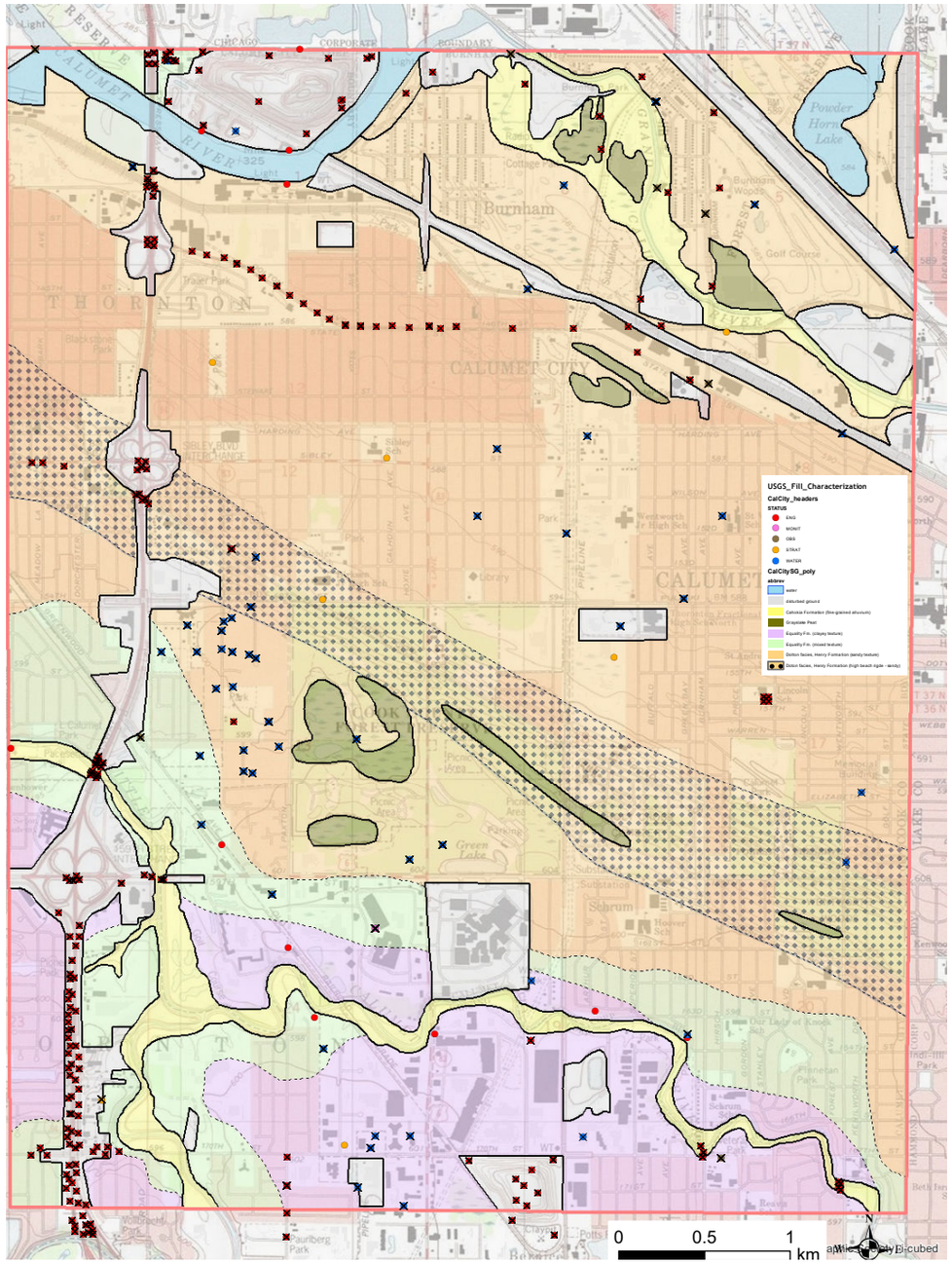
Calumet City Surficial Soils Map: DRAFT, in process - NOT FOR USE

- Sandy-textured surficial materials (sandy loam, loamy sand, fine sand) occur in more than half of the Calumet City area, in the upper 5 to 10 feet, particularly in areas of ancestral beach ridges (former shorelines of Lake Michigan).

- Mixed-textured (loamy to clay loam) or fine-textured (silty clay loam to silty clay) surficial materials (in upper 5 to 10 feet) occur in some areas, mainly in the southwestern part of the study area in the vicinity of the Little Calumet River. These areas are southwest of the Tolston beach ridge in the Chicago-Calumet Lake Plain. Some localized fine-grained peat and alluvial deposits occur within the sandy-textured areas as well (see attached map).

- Some areas in the Calumet City region have significant fill deposits (landfills, roadways, railroads, former clay pits, and major areas of construction). Many areas in this region have thin deposits of anthropogenic materials (< 2 feet).



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Midlothian Surficial Soils Map:
DRAFT, in process - NOT FOR USE

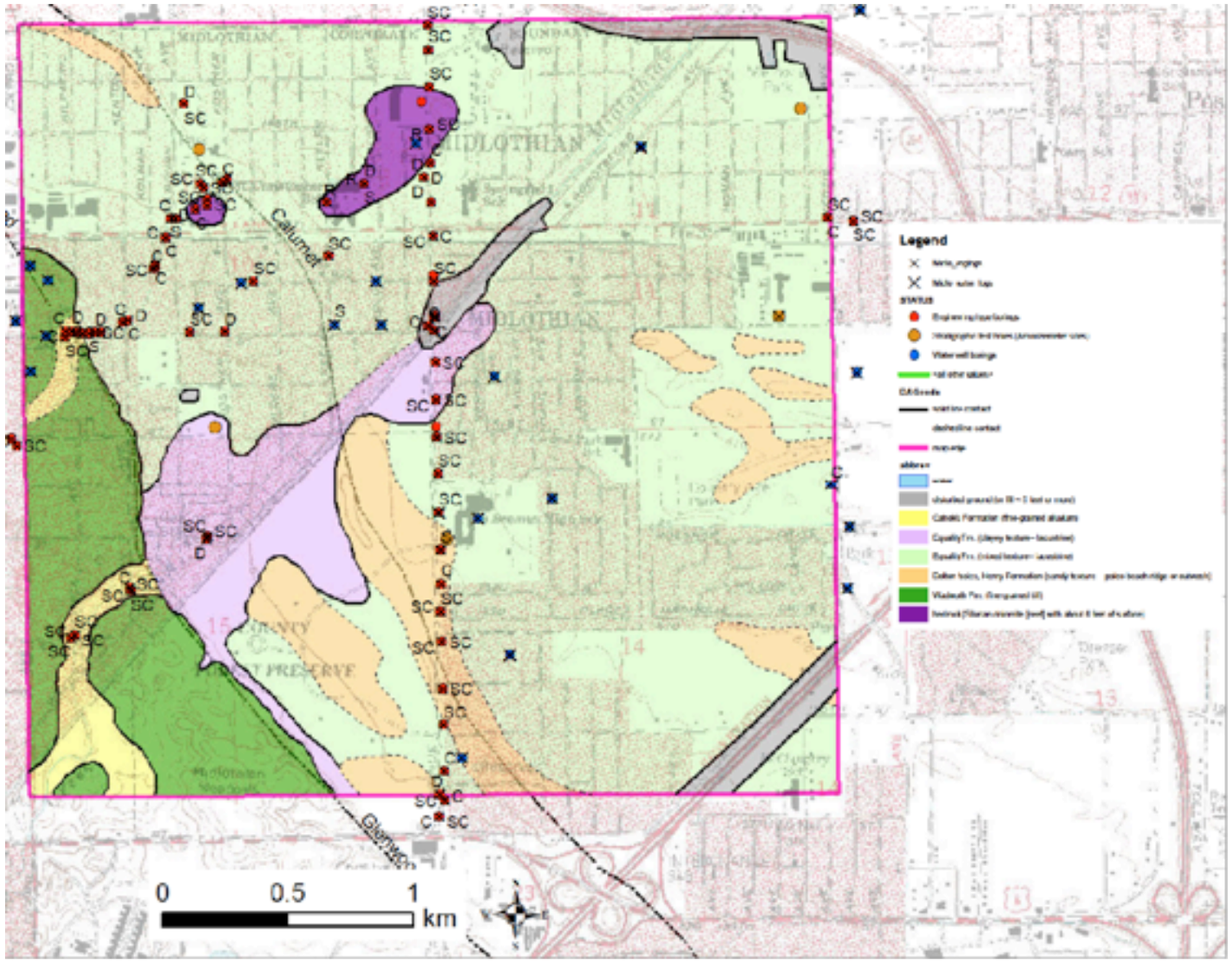
- From preliminary mapping in Midlothian area, the study area is dominated by mixed-texture soils, with some areas of fine-grained soils, and minor amounts of sandy soils in the Calumet beach ridge (which goes through Midlothian area and not Cal City!).

- There are also a couple localized areas with shallow bedrock (Silurian dolomite reefs within 5 feet of ground surface).

- Our amoozemeter sites were fairly representative of the soil types with mostly mixed-texture, some clayey, and some sandy.

- There is also a fair bit of disturbed ground or fill material, but not as much as in Cal City area. And much less sandy textured soils than in Cal City area.

- There are areas between Midlothian and Cal City that are more dominated by the fine-grained soils (such as Harvey area).



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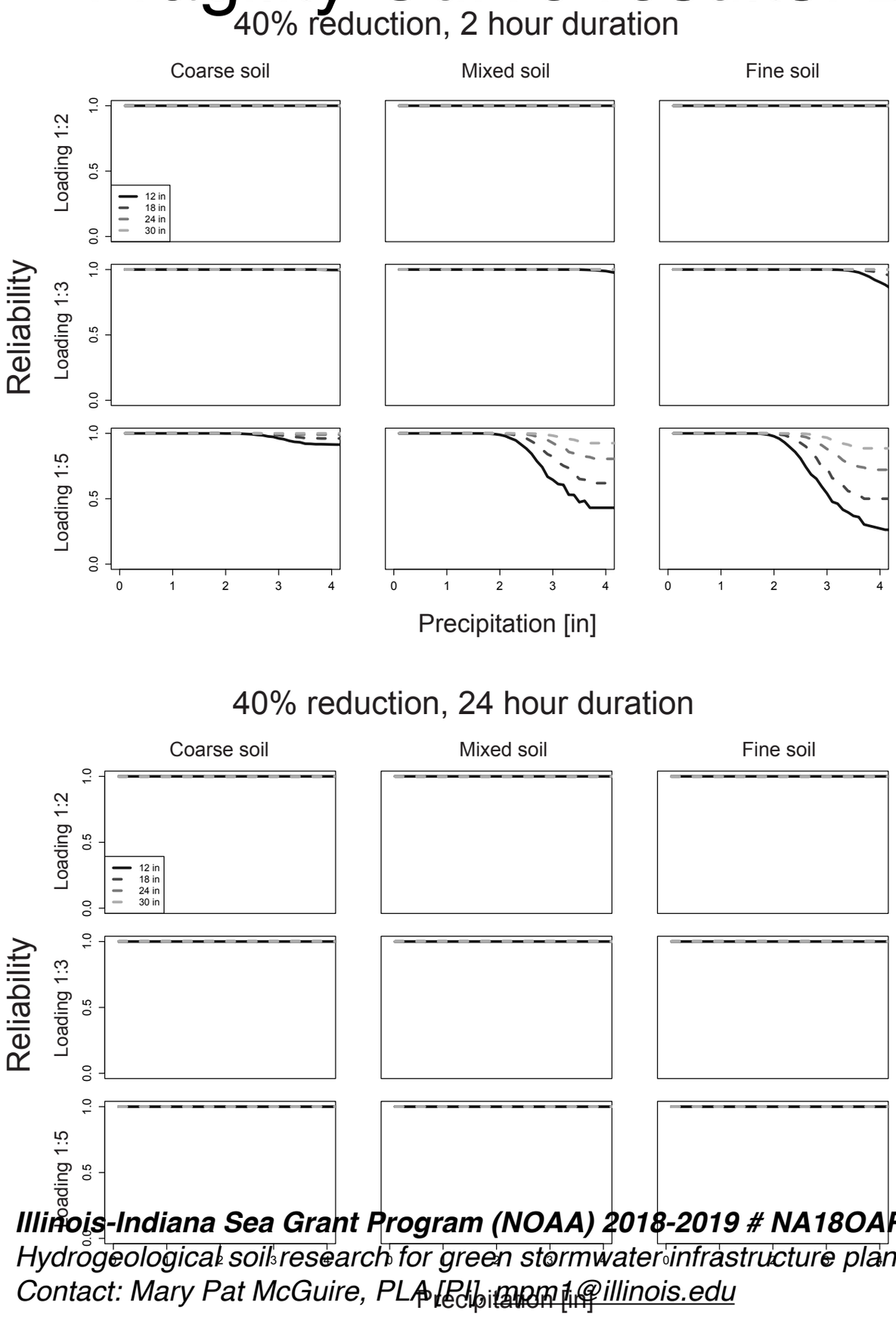
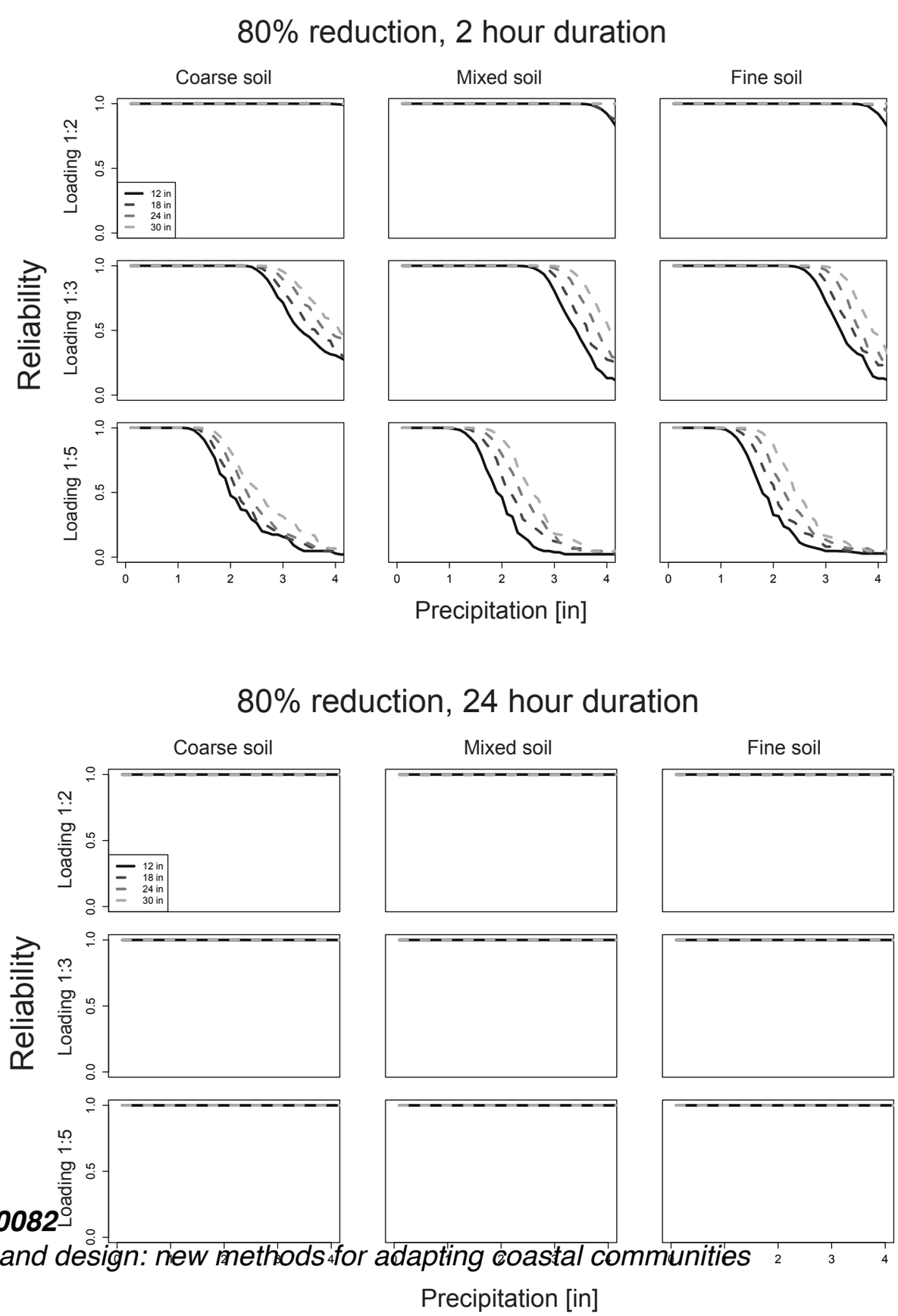
Fragility Curve results: DRAFT - NOT FOR USE





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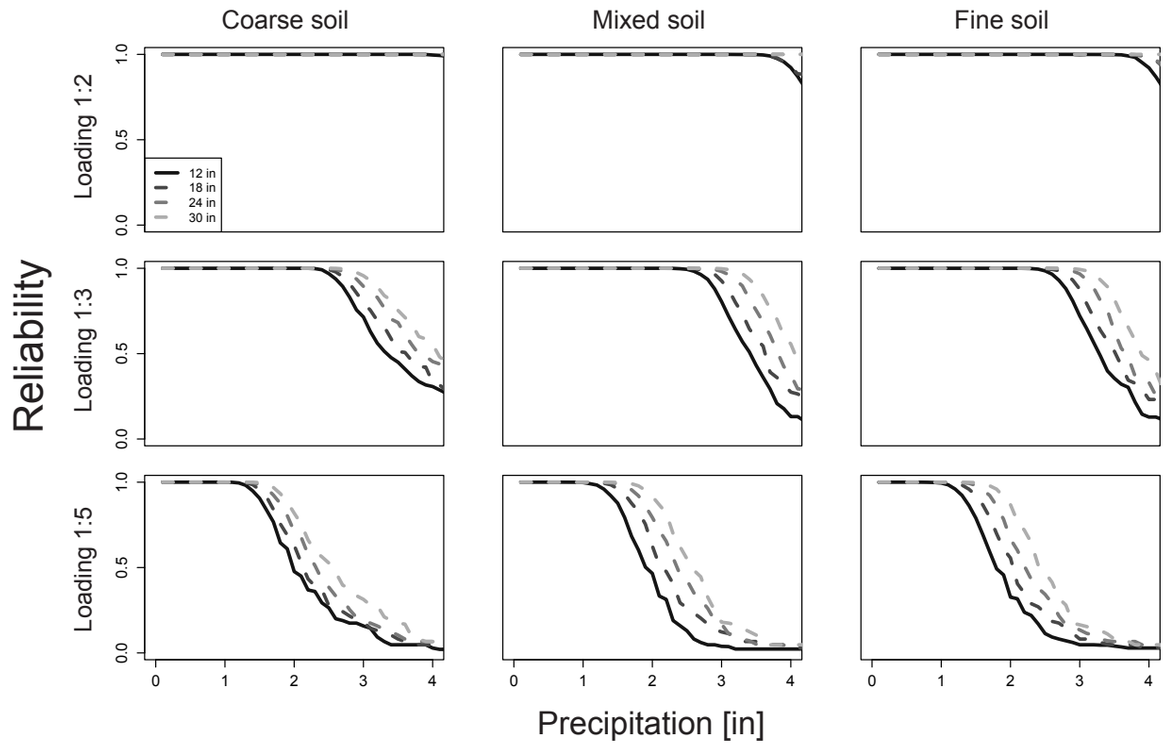
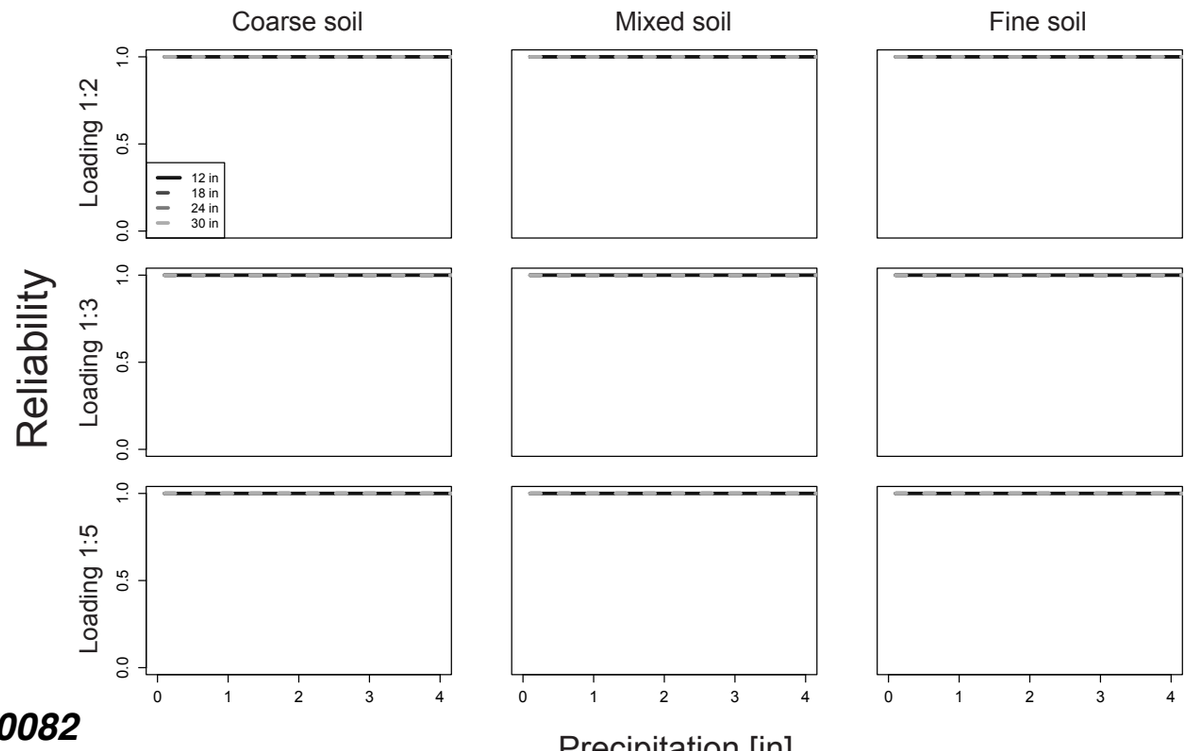
Fragility Curve results: DRAFT - NOT FOR USE

- **While green stormwater infrastructure typically has large variability, we have quantified the runoff reduction performance of rain gardens and permeable pavement (on-going) in response to different rainfall events.**
- **Rain gardens can effectively reduce runoff (~80% runoff reduction) even with clayey native soils.**
- **Loading ratio (ratio of green infrastructure surface area to directly connected impervious surface area) is an important design consideration for increasing reliability of green infrastructure runoff reduction.**





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VERTICAL INTERFACE = (Depth + Material)
SURFACE PERFORMANCE = (site (w/context)+ weather/climate)

Weather / Climate Scenarios (4th dimension temporal)

PLANTED
rain garden

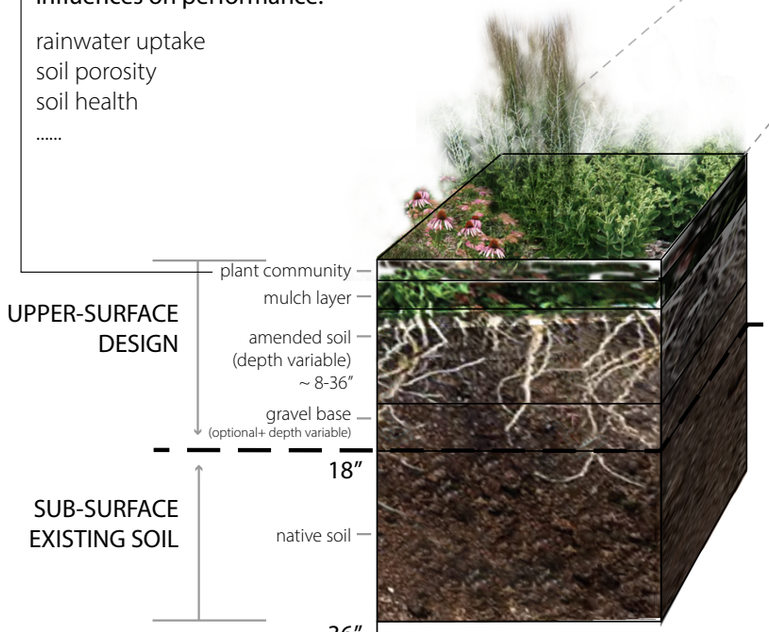
PAVED
unit-paver/porous lot

Loading Ratio, aka the site
(3th dimension spatial)

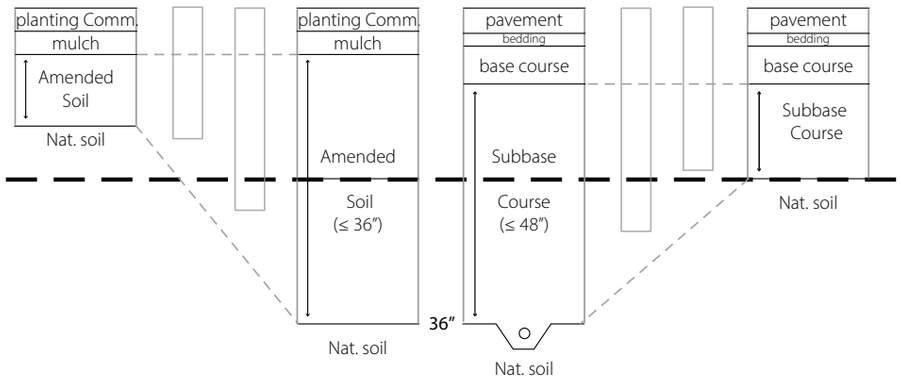
- slope
- shape / flow path
- edge condition

planting design/
influences on performance:

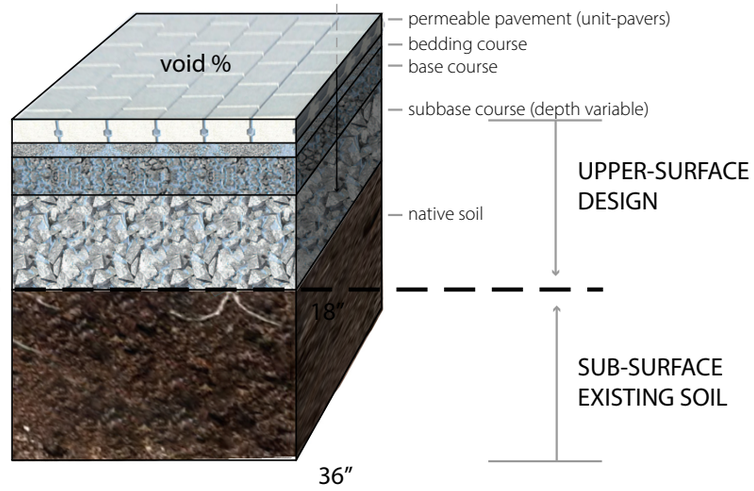
rainwater uptake
soil porosity
soil health
.....



coarse design ⟷ fine design ⟷ coarse design



Raindrop
(2th dimension interface)



GI Design Prototype - Concept Methodology

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Green Stormwater Infrastructure Design, based on underlying soils

key principles:
- intercept water directly (or, as close as possible)
- create underlyng layers of material (organic and/or open-graded) to further capture water
- reduce energy and erosion (make capture very direct)
- convey water downward through soils, through gravity and/or soil properties
- use planting to uptake (everywhere possibe)

GI Surfaces
(e.g. parking lots)

- designed to handle water directly through the surface
- optional to receive from adjacent surfaces
- lower loading ratio

GI Features
(e.g. bioswales)

- designed to receive water from adjacent surfaces
- higher loading ratio

Surfaces vs Features - Concept Methodology
Loading ratio plays a key role in performance

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Identifying retrofit sites

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Schedule

Late-Spring-early Fall 2018*
Digitizing soil archives and soil drilling/augering
Amoozameter data, characterizing soils
First municipal partnership meeting

Fall 2018
Design concepts and prototyping
Fragility curve analysis, modeling results 2D, 3D, 4D
Sharing preliminary soil data and modeling results
Calumet City - Dec 20 and Village of Midlothian - early January
Choose urban areas for design

Winter-Spring 2019
Apply the findings to select areas - Feb - March
Climate modeling - April
“Proof of concept”?
Review results with communities - late April

Summer 2019
Identify pilot projects
Share with other Calumet Corridor communities

Fall 2019
Create decision toolkit for wider use

*Ongoing soil database development

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