

# The Landscape Green Infrastructure Design (L-GrID) Model

Metropolitan Planning Council  
Calumet Stormwater Collaborative

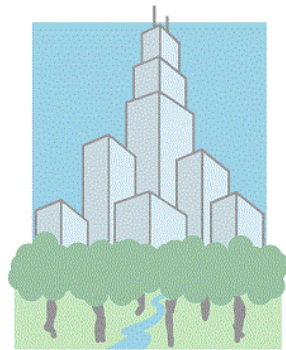
May 3, 2019

Moira Zellner

Dean Massey

University of Illinois at Chicago

THE  
UNIVERSITY OF  
ILLINOIS  
AT  
CHICAGO



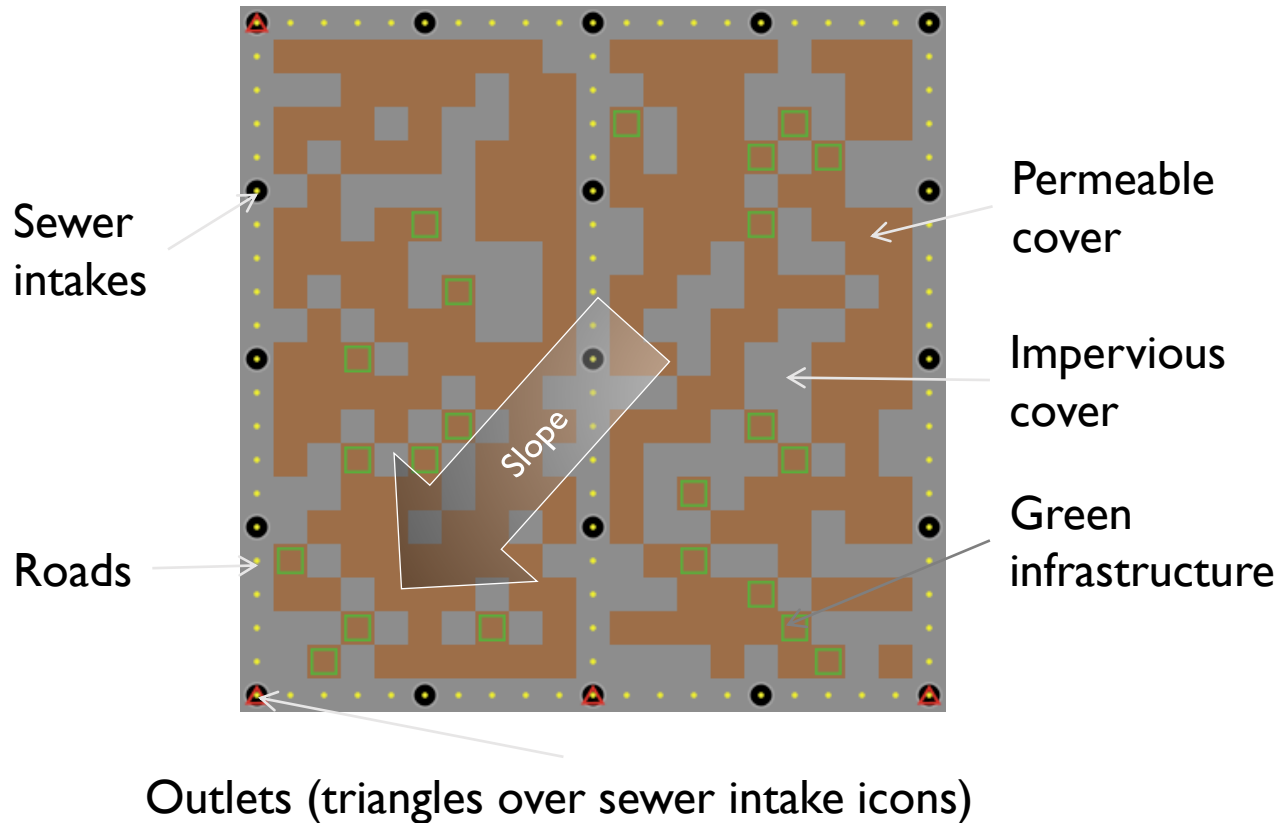
**IESP**  
Institute for Environmental  
Science and Policy

# L-Grid Background

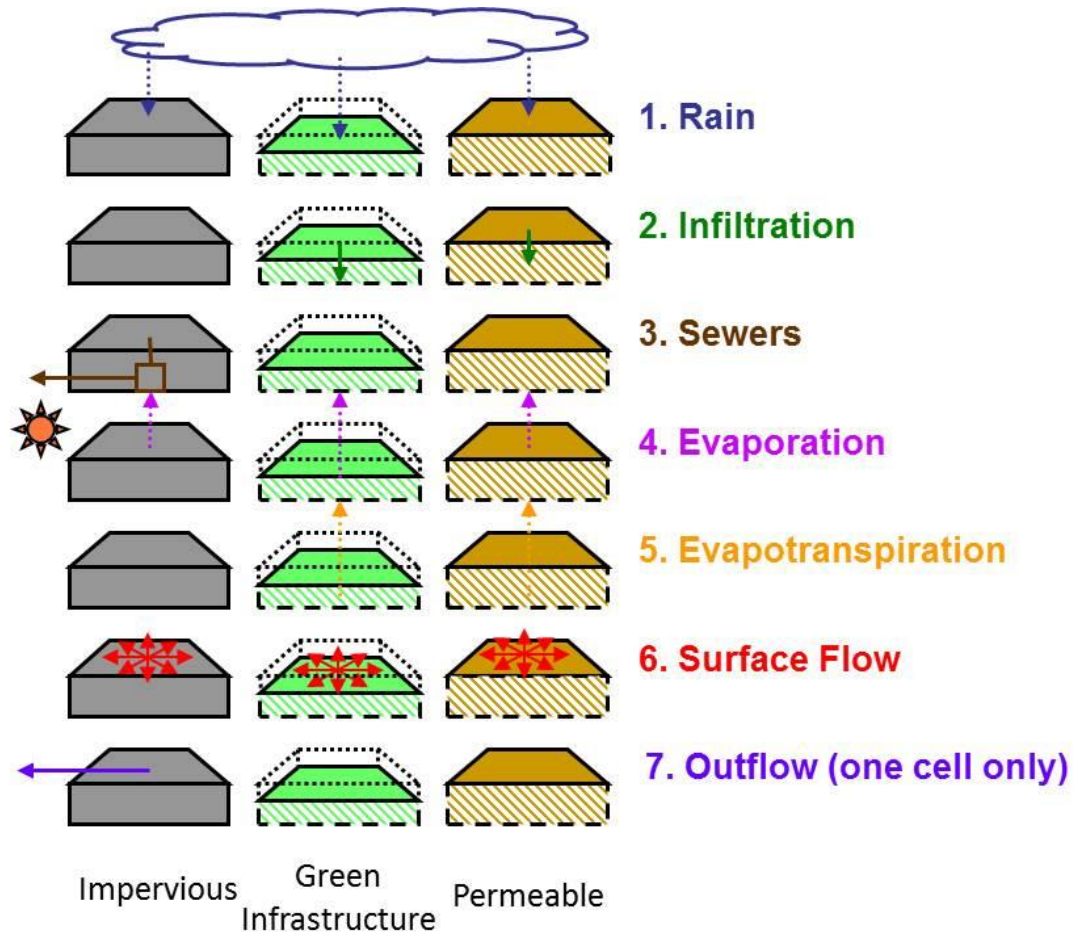
# Motivations and questions

- IEPA 2009 – 2010
- Landscape design principles
  - How much?
  - Where?
- Publication:
  - Zellner, M.; Massey, D.; Minor, E.; Gonzalez-Meler, M. (2016). “Exploring the Effects of Green Infrastructure Placement on Neighborhood-Level Flooding via Spatially Explicit Simulations”. *Computers, Environment and Urban Systems*, 59 (2016): 116-128

# Landscape Green Infrastructure Design (L-GrID)

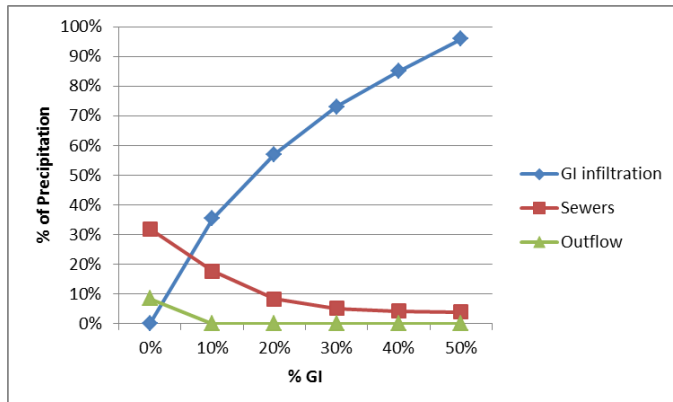


# L-GrID Processes

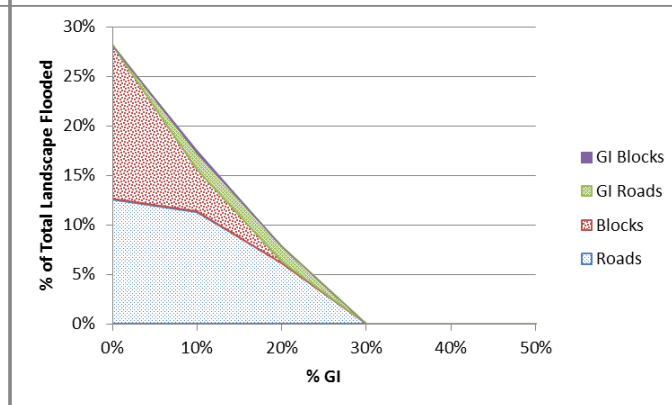
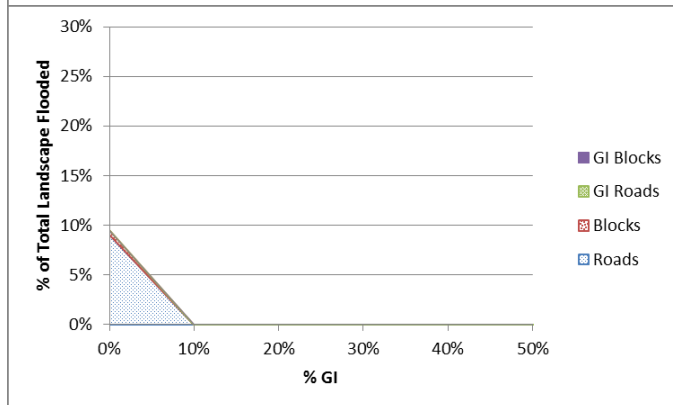
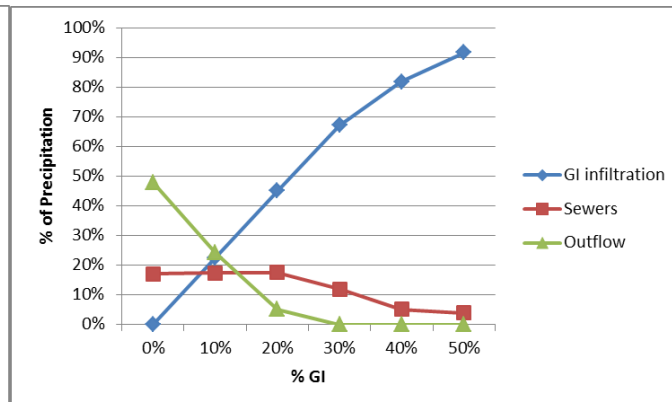


# How much?

## 5-year Storms and % GI Cover

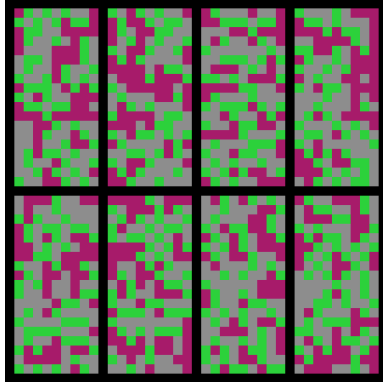


## 100-year Storms and % GI Cover

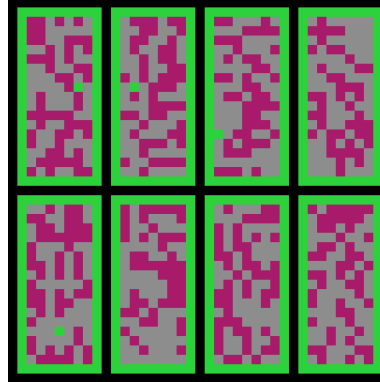


# Where?

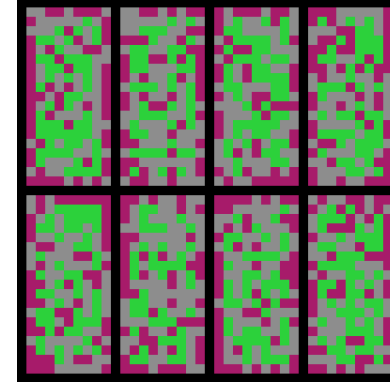
sorted random (baseline)



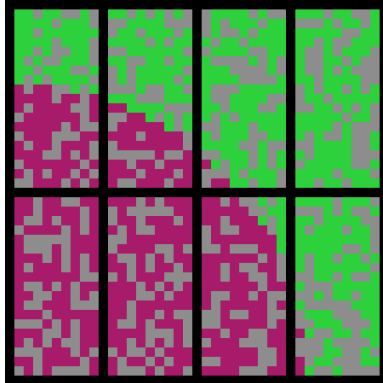
adjacent to roads



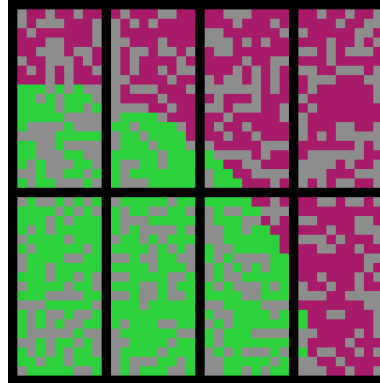
away from roads



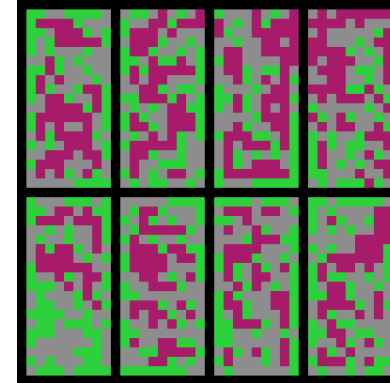
upstream



downstream



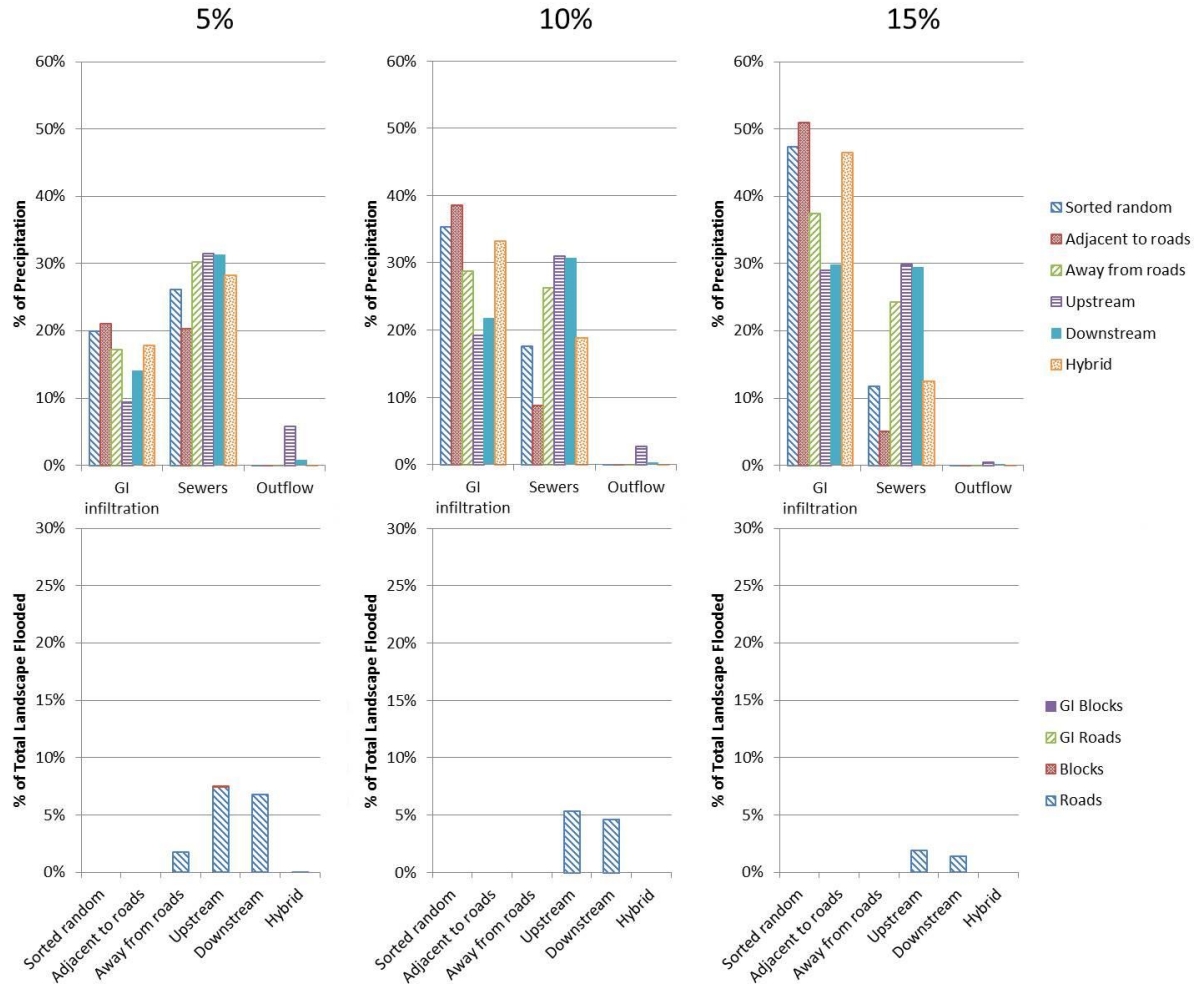
hybrid



■ = road   ■ = impermeable block   ■ = permeable block   ■ = green infrastructure

# Where? 5-year storms

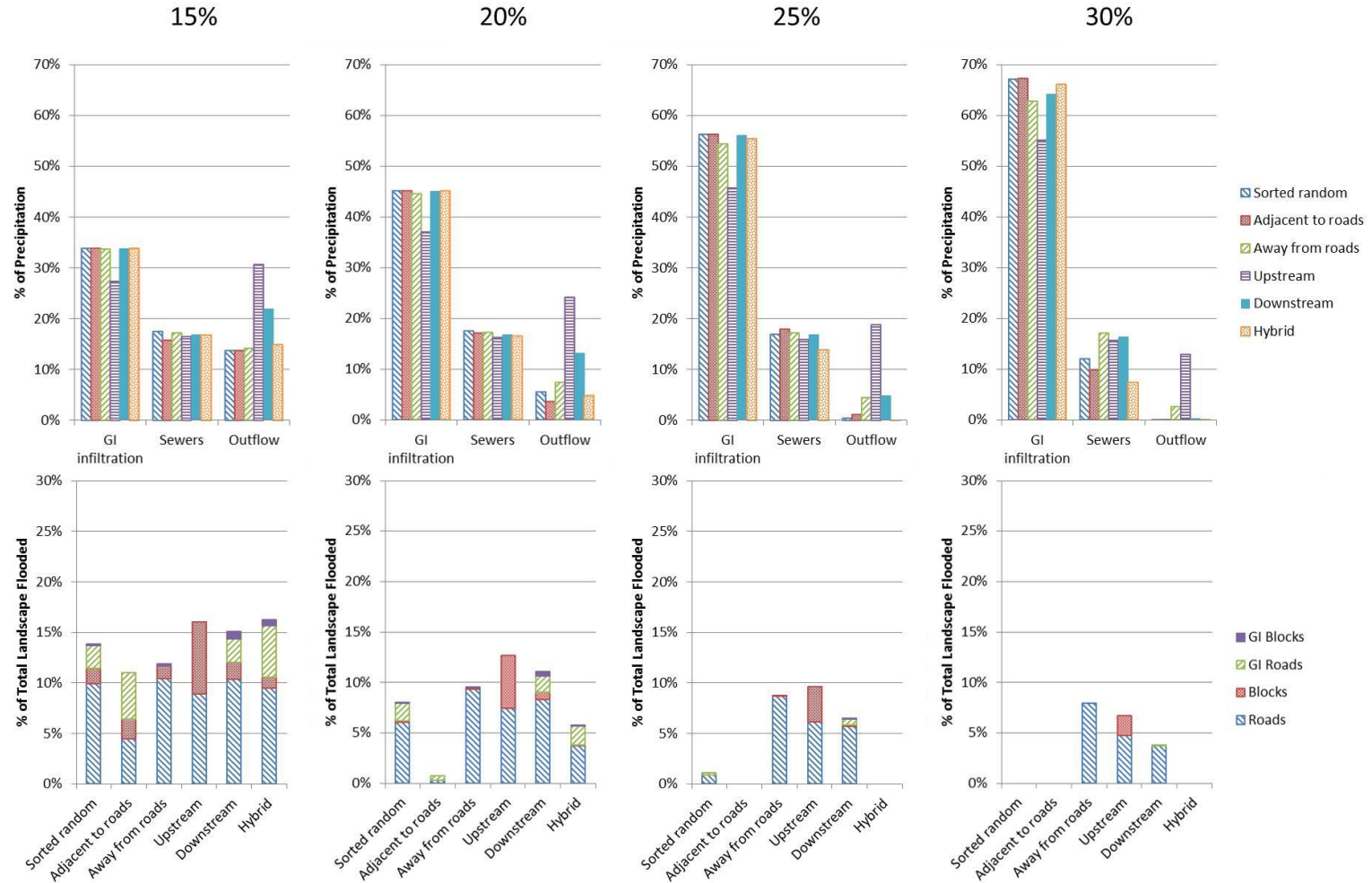
## % Green Infrastructure





# Where? 100-year storms

## % Green Infrastructure



# Design principles

- Thresholds
- Dispersed over clustered
- Advantage of curb cuts
  - Keep water in roads
  - Detention
  - Installation in public property and maintenance
- Hybrid in larger storms
  - Build on curb cut layout
- When all else fails, try random
- Other layouts?

# UIC Campus Application

# UIC capital plan



# UIC West Campus



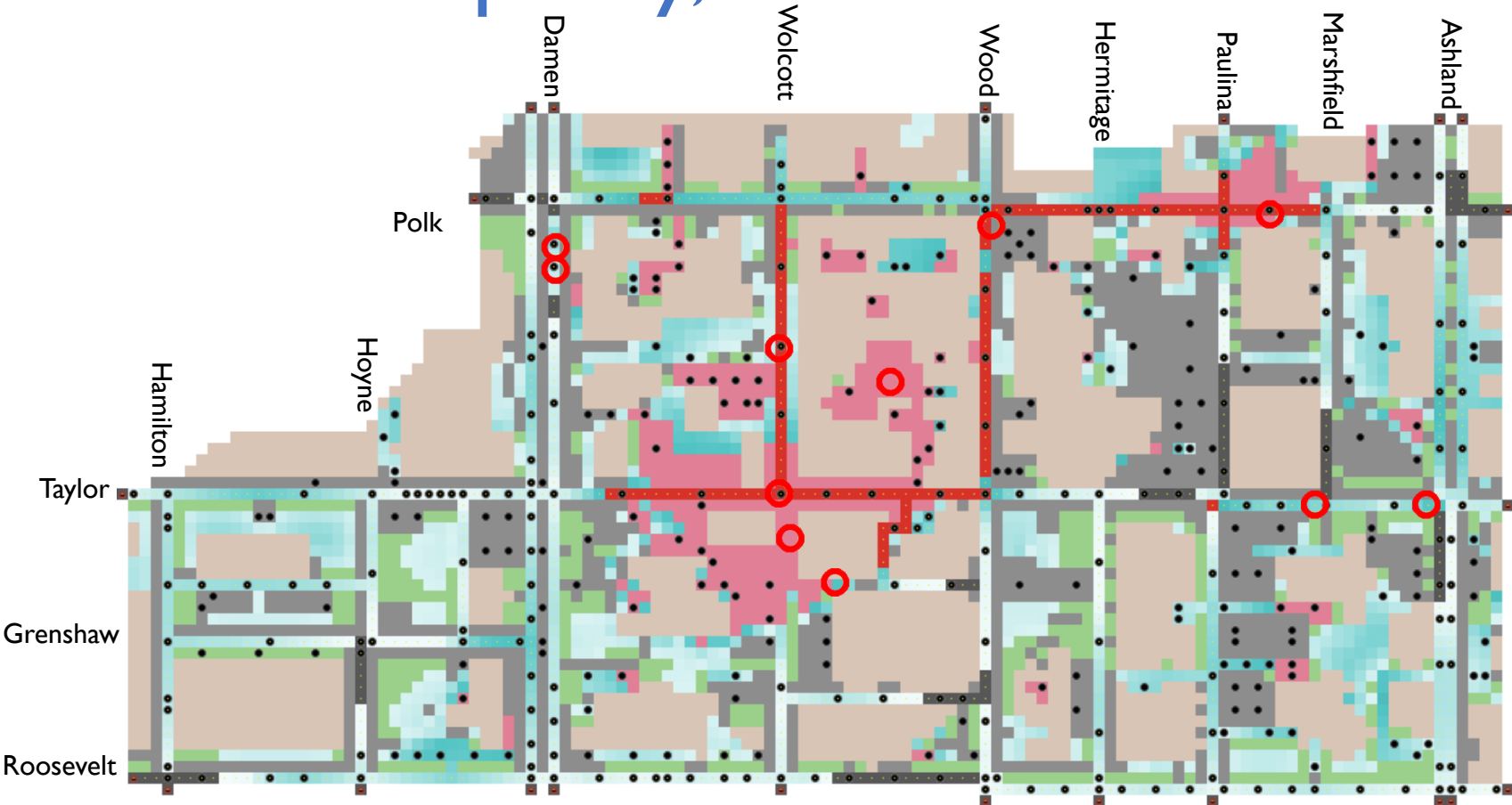


# Baseline 1: (2-year, 6-hour storm)

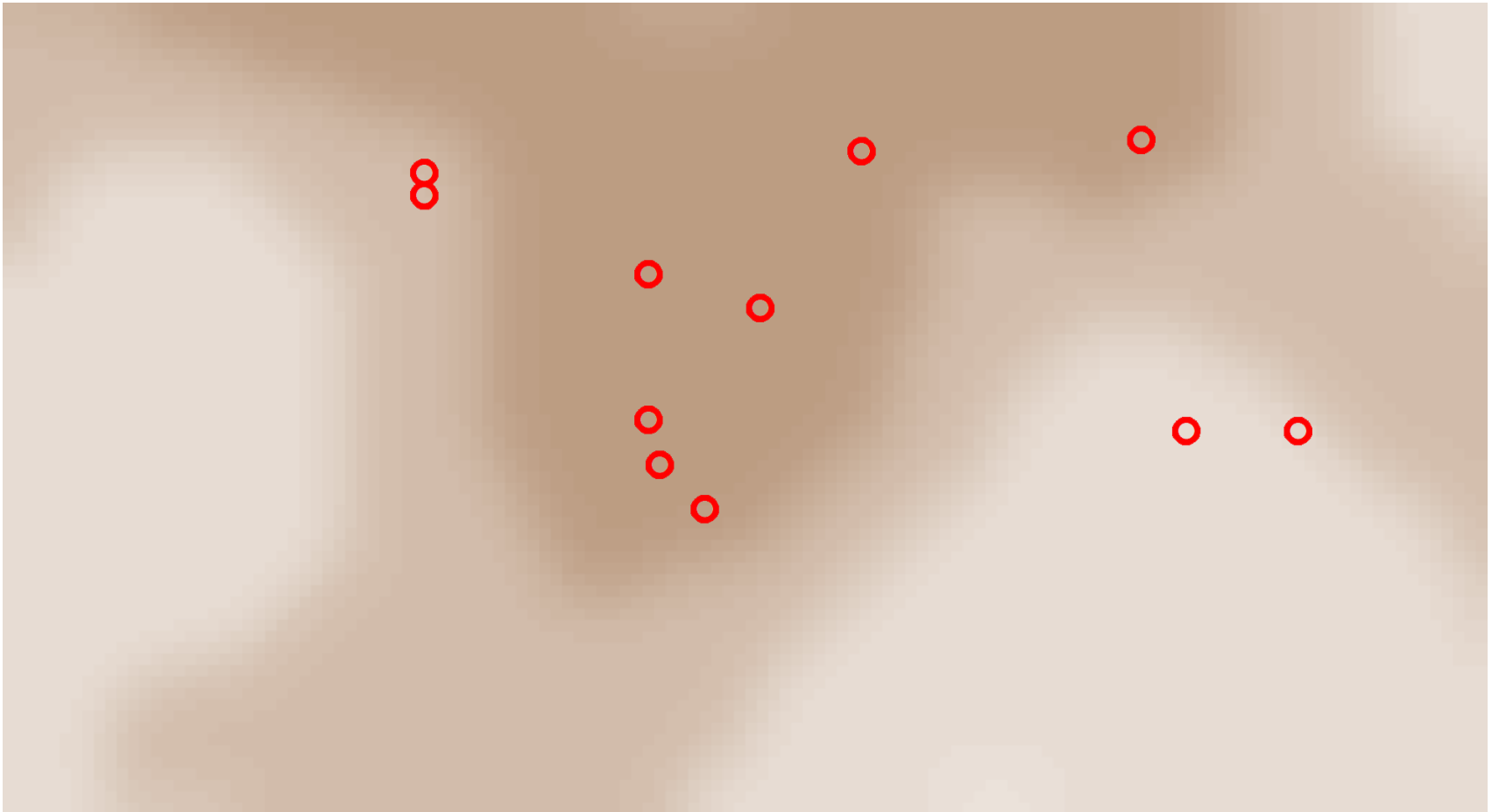
Standing water levels during and immediately after the storm



# Baseline 1: 2-year, 6-hour storm, 50% initial soil saturation, 70% initial sewer capacity, no CSOs



# Baseline 1: (2-year, 6-hour storm)

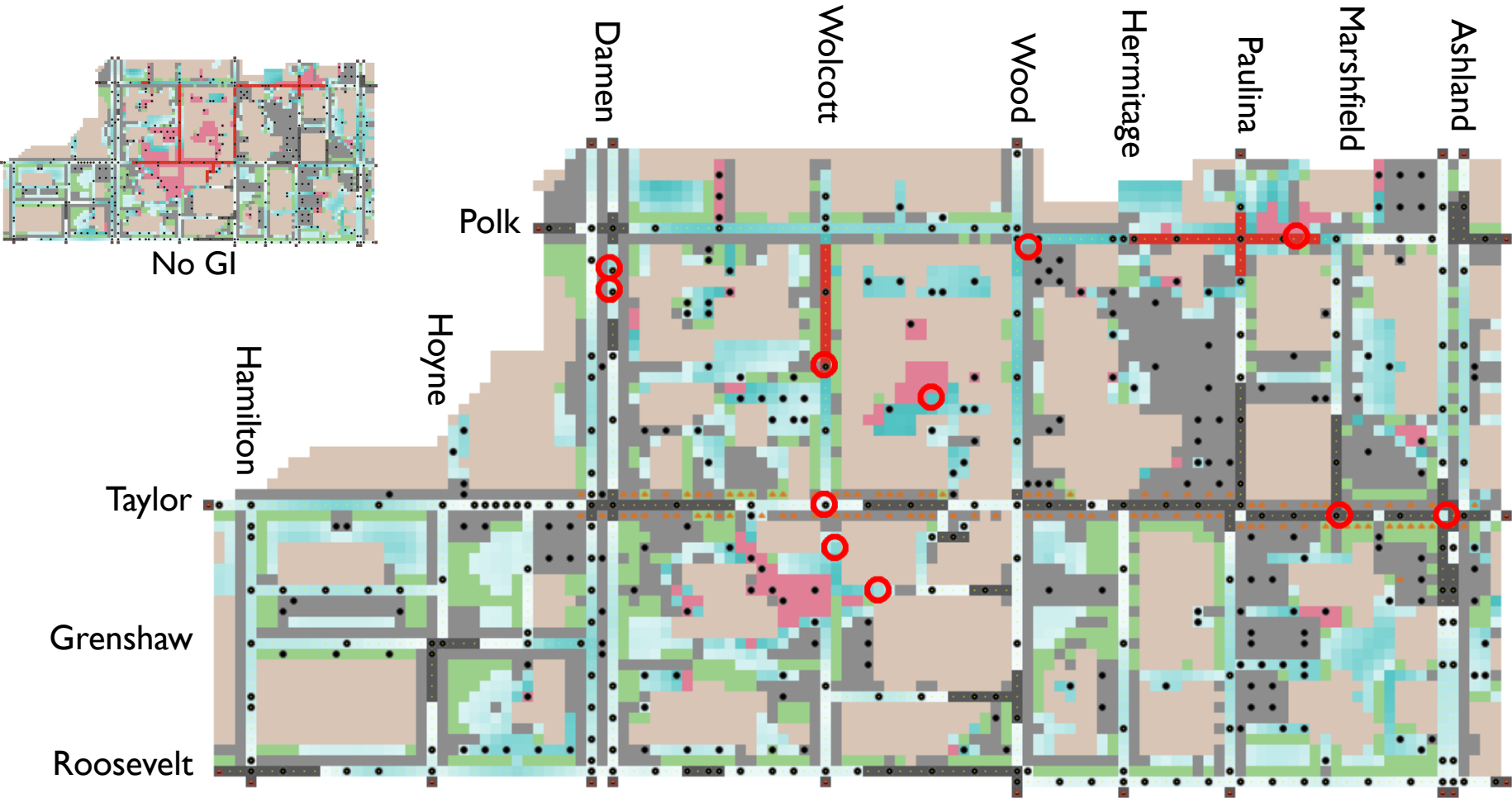




# Baseline 1: 2-year, 6-hour storm, 50% initial soil saturation, 70% initial sewer capacity, no CSOs

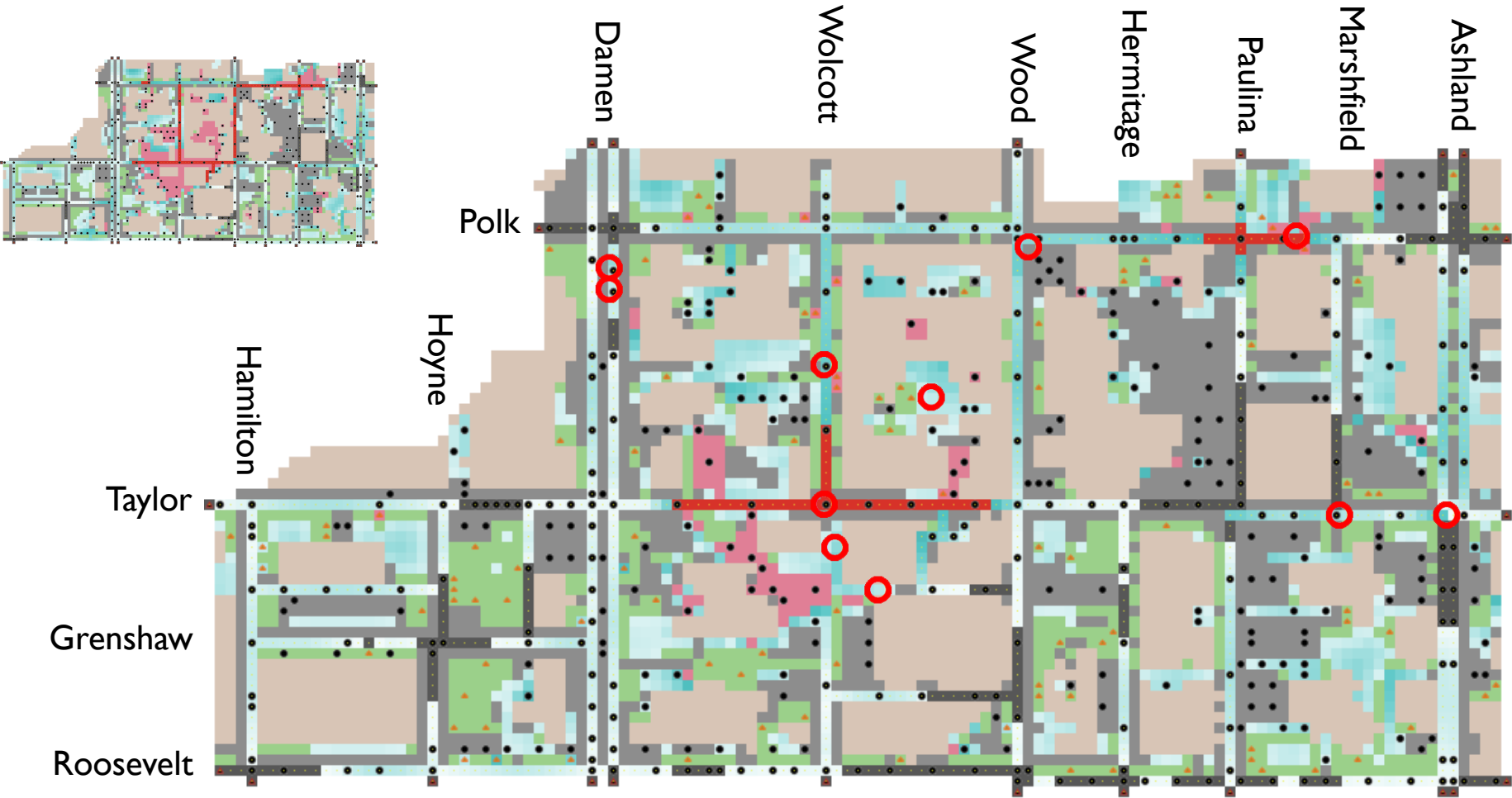


# Scenario 1a: swales along Taylor Street





# Scenario 1c: random



# How well do scenarios perform?

			For normalized values, 1 is worse, 0 is better							
			Baseline 1 (2yr, 6hr)		Scenario 1a: Taylot St		Scenario 1b: flowpath		Scenario 1c: random	
Ranking 1	Ranking 2	Metric	Value	Normalized Value	Value	Normalized Value	Value	Normalized Value	Value	Normalized Value
3	5	Present value cost: installation + maintenance (20 years)	NA	NA	\$1,439,300	1.00	\$1,439,300	1.00	\$1,439,300	1.00
2	2	\$ per gallon runoff captured by GI	NA	NA	\$1.65	1.00	\$1.23	0.00	\$1.63	0.95
1	1	GI capacity used	NA	NA	67.94%	1.00	90.82%	0.00	68.84%	0.96
5	6	Sewer capture (% of precipitation)	84.28%	NA	79.04%	0.47	77.81%	0.00	80.42%	1.00
6	4	Outflow to downstream area (% of precipitation)	6.91%	NA	4.18%	1.00	2.56%	0.00	3.34%	0.48
4	3	Area flooded (% of area ever flooded)	7.88%	NA	2.47%	0.99	0.86%	0.00	2.48%	1.00
			<b>SCORES</b>							
			Ranking 1		5%		81%		5%	
			Ranking 2		3%		90%		10%	

# Things to consider

- Simulations alone are not enough
  - Tradeoffs
  - Costs and distribution
  - Spatial constraints
  - Diverse stakeholder interests
- Solution-building AND compromise
- Awareness of preferences
  - Addressing diverse needs
    - metrics, evaluation, exploration

# Participatory Modeling

# Workshop structure

## Participatory Modeling Protocol





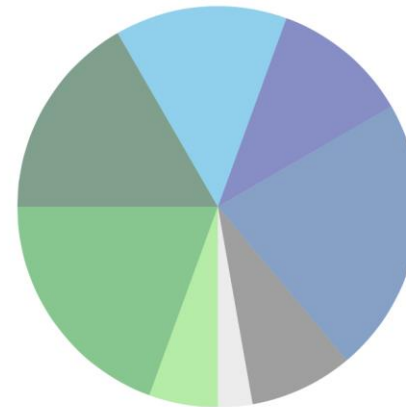
# I: Concern profile

iPad

12:03 PM

100%

Sort the items based on how important they are to you



Enter Username

Profile Unlocked  Profile Locked

## Definitions

**Investment:** Cost to install and maintain new green infrastructure on both city and private property. Maintenance costs are in Present Value (PV) over 20 years, at 3% discount rate.

**Damage Reduction:** The amount of property damages reduced by the investment.

**Efficiency of Intervention: (\$/Gallon)** The amount of money spent per gallon of rainwater stored or infiltrated by green infrastructure installations.

**Capacity Used:** The percentage of capacity used by interventions over their total available capacity.

Your Survey

Guidebook

Simulation Results

Comparison Viewer

## 2: Interactive placement of tokens



# 3: L-GrID Simulations

## Landscape Green Infrastructure Design Model (L-GrID)

This model is designed to compare different green infrastructure layout scenarios at the subwatershed scale.

Setup of Landscape and Processes

Go until Stop Conditions Met

go

data-visualized

flooding definitions-highest water

color-patches

Time in run (military time)

0

when-sewers-full

no-CSO

Initial-soil-saturation 50 %

Initial-sewer-capacity 70 %

Storm-duration

6-hour

Storm-type

2-year

Rainfall-distribution

hyetograph

Sample Rainfall totals (24-hour only listed)

- 1-year = 2.43 inches
- 2-year = 2.95 inches
- 5-year = 3.77 inches
- 10-year = 4.45 inches
- 100-year = 7.2 inches

GI-Import-scenario

Blank.txt

Remove GI

export-gi

Place Green Infrastructure

Type-to-place

Swales

Run only with no GI (Blank.txt). Overrides neighbor-option and has no inflows; records outflows.

Must be run after outflow calibration; again, with no GI (Blank.txt).

On Off Sewer-calibration-run?

On Off Outflow-calibration-run?

On Off Infiltration-calibration-run?

On Off Normalization-calibration-run?



# 4: Sorted simulation results

iPad

2:30 PM

Not Charging

## Simulation Results Sorted By Your Priorities

The Performance score is broken down into colors corresponding to the outcomes on the right

Sort by <input type="text" value="Trial Number"/>	Water Flow	Max Depth of Flooding	Damage Reduction	Impact on
	0 hrs <span style="float:right">48 hrs</span> Storm Playback: 21 hours			
<p><b>Trial 1</b></p> <p>Performance: Broken down by source: </p> <p>Best for me  Worst for me </p>			Rain Damage: \$27,978 Damaged Reduced by: 13% Sewer Load: 22.58% Storms like this one to recoup investment cost: 0	100.00% flowed
<p><b>Trial 2</b></p> <p>Performance: Broken down by source: </p> <p>Best for me  Worst for me </p>			Rain Damage: \$18,475 Damaged Reduced by: 61% Sewer Load: 18.74% Storms like this one to recoup investment cost: 147	75.50% flowed
<p><b>Trial 3</b></p> <p>Performance: Broken down by source: </p> <p>Best for me  Worst for me </p>			Rain Damage: \$0 Damaged Reduced by: 100% Sewer Load: 18.74% Storms like this one to recoup investment cost: 49	7.84% c flowed

You can revise your profile by returning to the "Your Survey" tab below

# 5: Social viewer

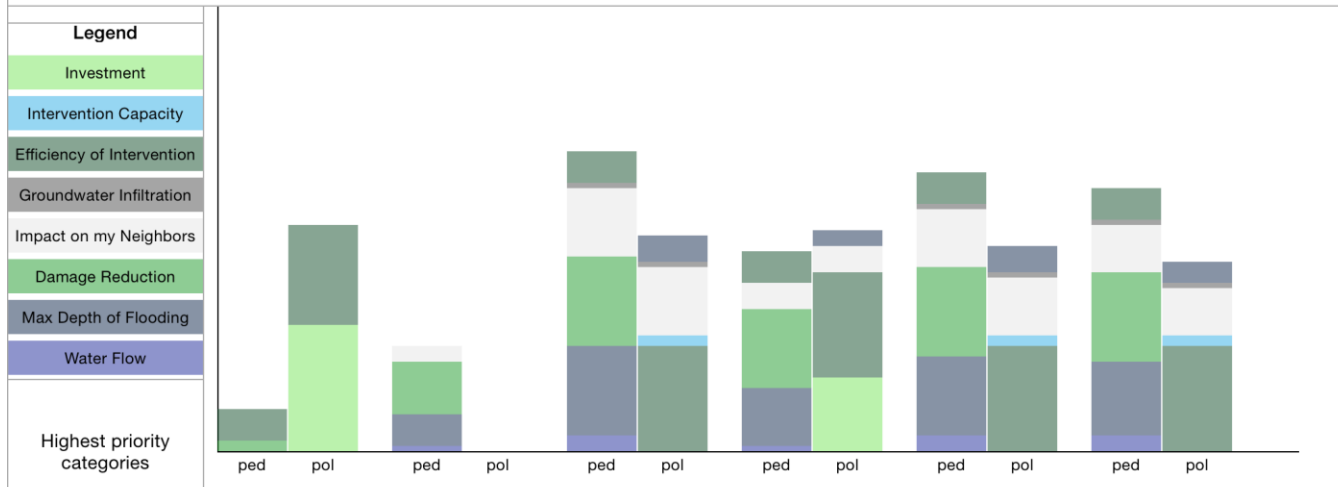
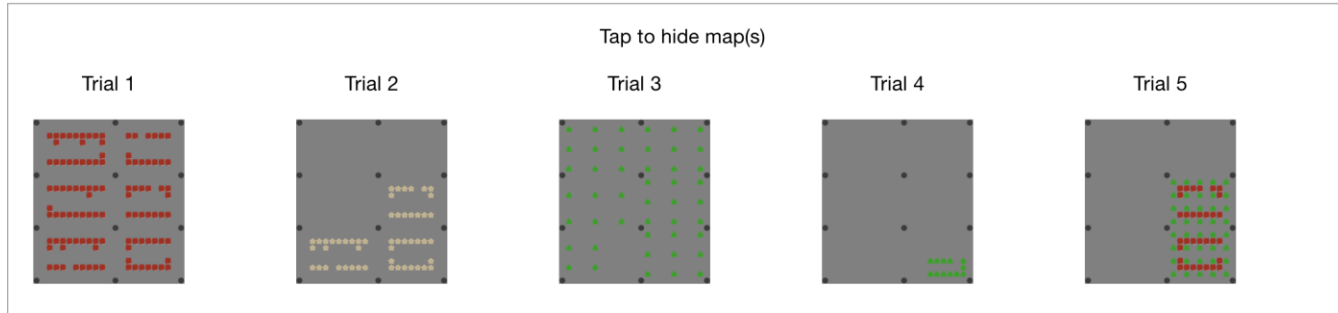
iPad

2:30 PM

Not Charging

## Simulation Results of Yours and Other Users Priorities, Sorted By Your Priorities

Each color in the score breakdown is linked to an outcome measure to the left of it



You can revise your profile by returning to the "Your Survey" tab below

Condensed  Expanded

# Iterative structure

## Participatory Modeling Protocol



# Learning, innovation, compromise

- **Transparency of assumptions and tradeoffs**

*Jo: "Oh wow, that's much better...for you."*

*Nina: "I guess it matters what your priorities are!"*

*Kevin: "Damage was reduced by 87%...but we were over budget by 1.2 million."*

- **Systematic exploration**

*"Let's start by going crazy, putting a lot of stuff on here, and then pare back from there."*

*"We can run multiple simulations, so let's run this one and then try that"*

- **Gesturing and mental modeling**

*Following the flow*

*Imagining different performance*

- **Green infrastructure cannot locally solve the problem**

*"Perhaps we need to think of moving the houses out of there"*

*Green AND gray infrastructure*

*Coordination with other communities*

# Takeaways

- Collaborative design
- Facilitation for synthesis
- Consensus or compromise?
- Participatory modeling as a point of entry
  - to the problem,
  - to other tools,
  - to diverse interests
  - to other problems
- Zellner, ML, Lyons, L, Milz, D, Shelley, J, Hoch, C, Massey, D and Radinsky, J. n.d. "Participatory complex systems modeling for environmental planning: Opportunities and barriers to learning and policy innovation." In: Porter, WF, Zhao, J, Schmitt Olabisi, L and McNall, M (eds.), *Innovations in collaborative modeling*. East Lansing, USA: Michigan State University Press. In Press.



# Thank you!

Moira Zellner [mzellner@uic.edu](mailto:mzellner@uic.edu)

Dean Massey [dmasse2@uic.edu](mailto:dmasse2@uic.edu)