

How Effective is Green Infrastructure for Stormwater Management?

Moira Zellner

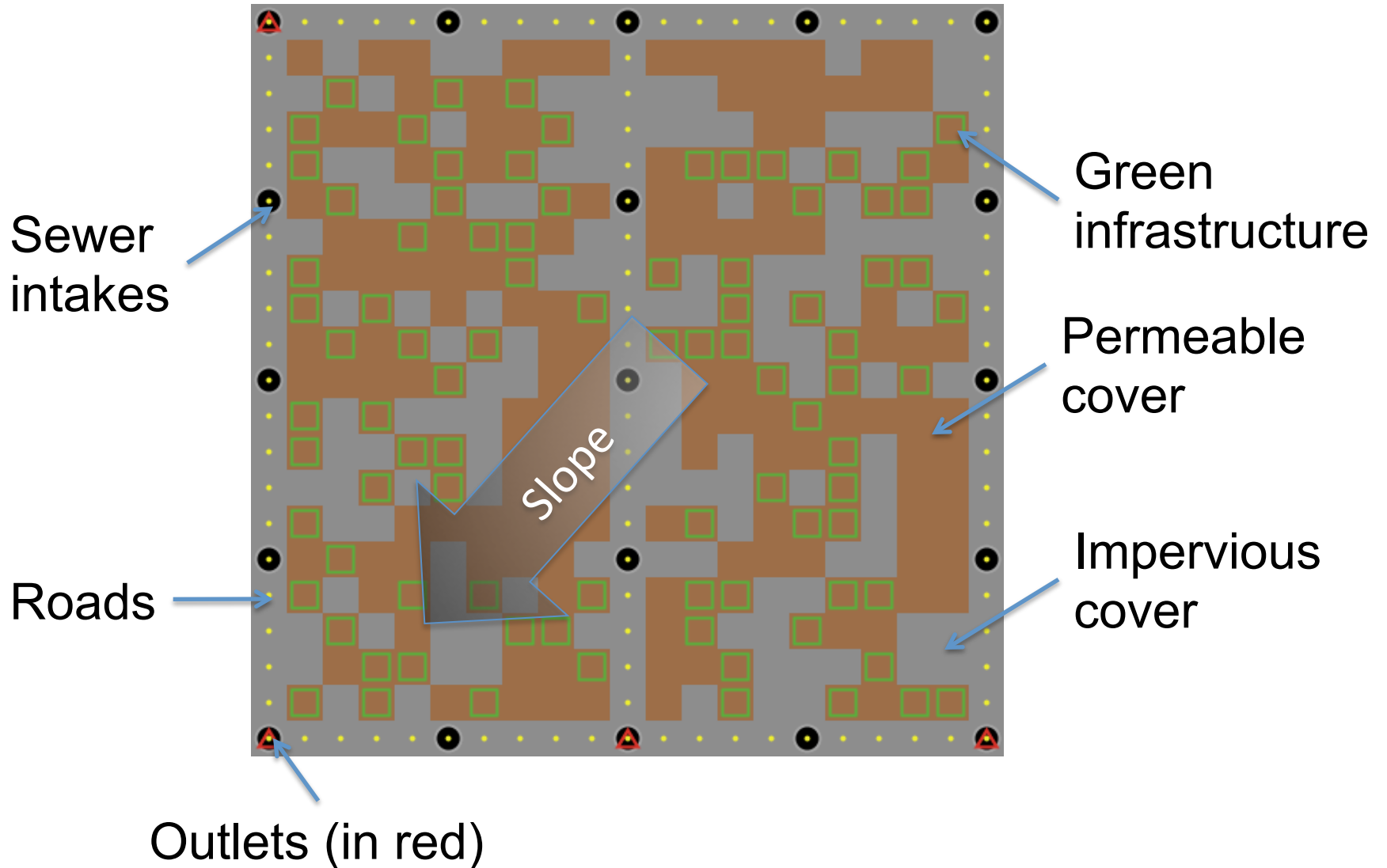
Environment and Natural Resources Committee

CMAP – September 2, 2015

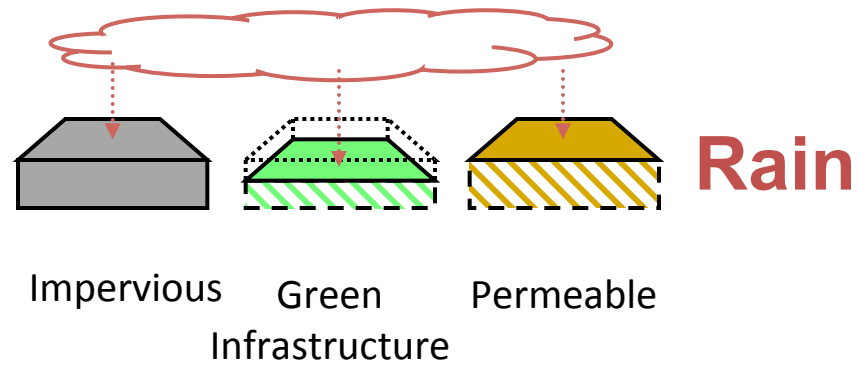
Motivations and questions

- IEPA 2009 – 2010
- Landscape design principles
 - How much?
 - Where?
- Publication:
 - Zellner et al. (in review) “Exploring the Effects of Green Infrastructure Placement on Neighborhood-Level Flooding via Spatially Explicit Simulations”

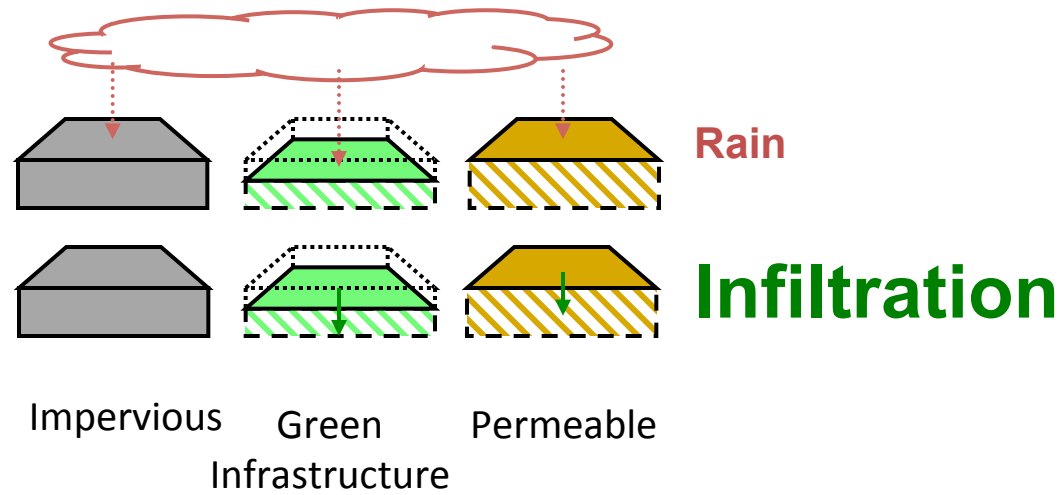
Landscape Green Infrastructure Design (L-Grid)



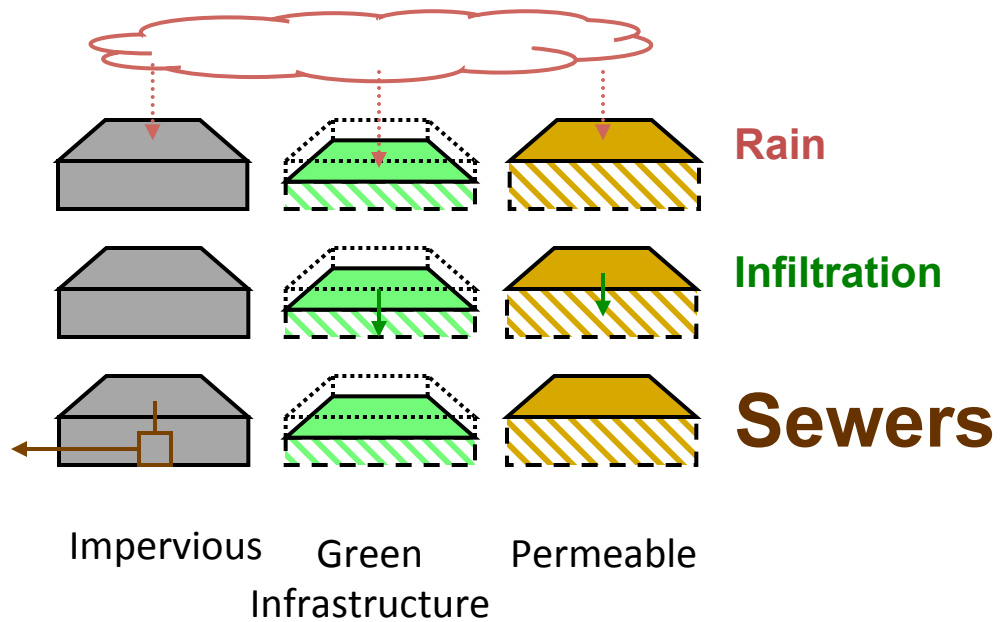
L-GrID processes



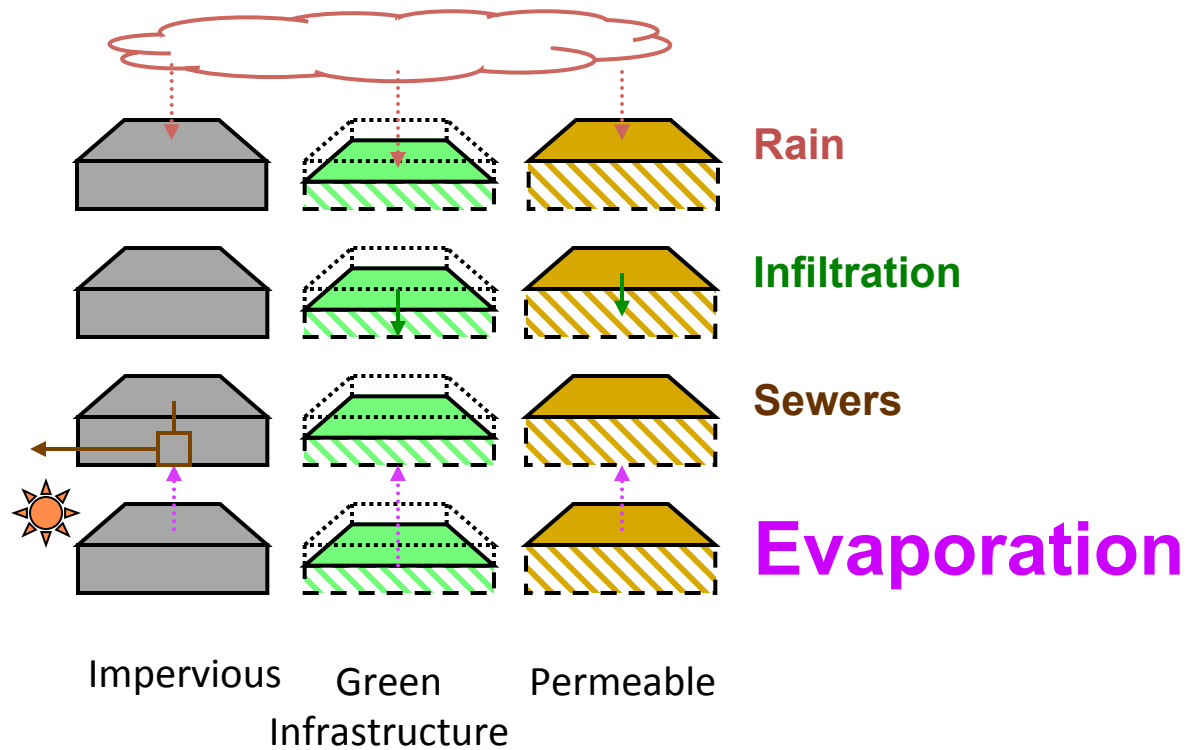
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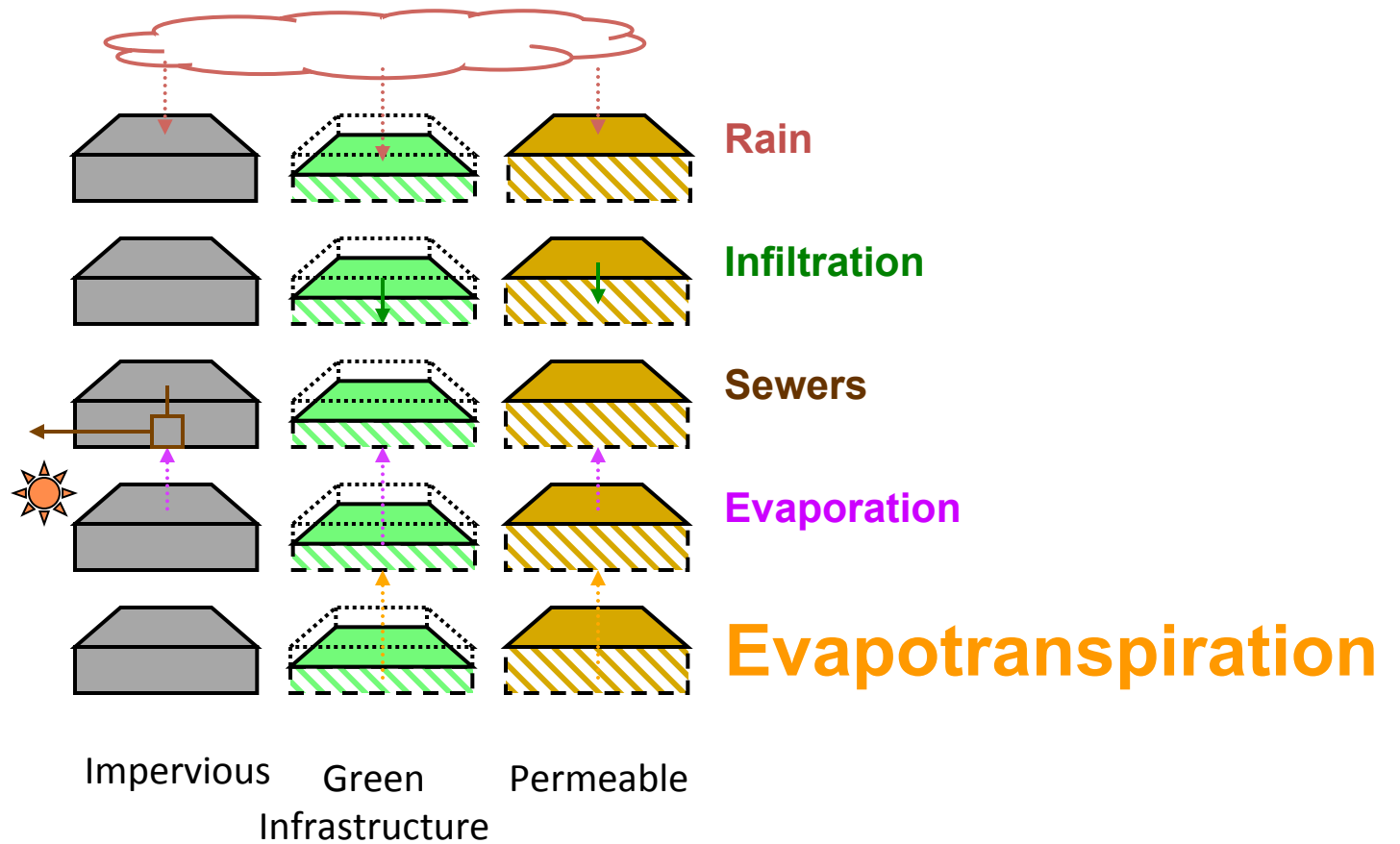
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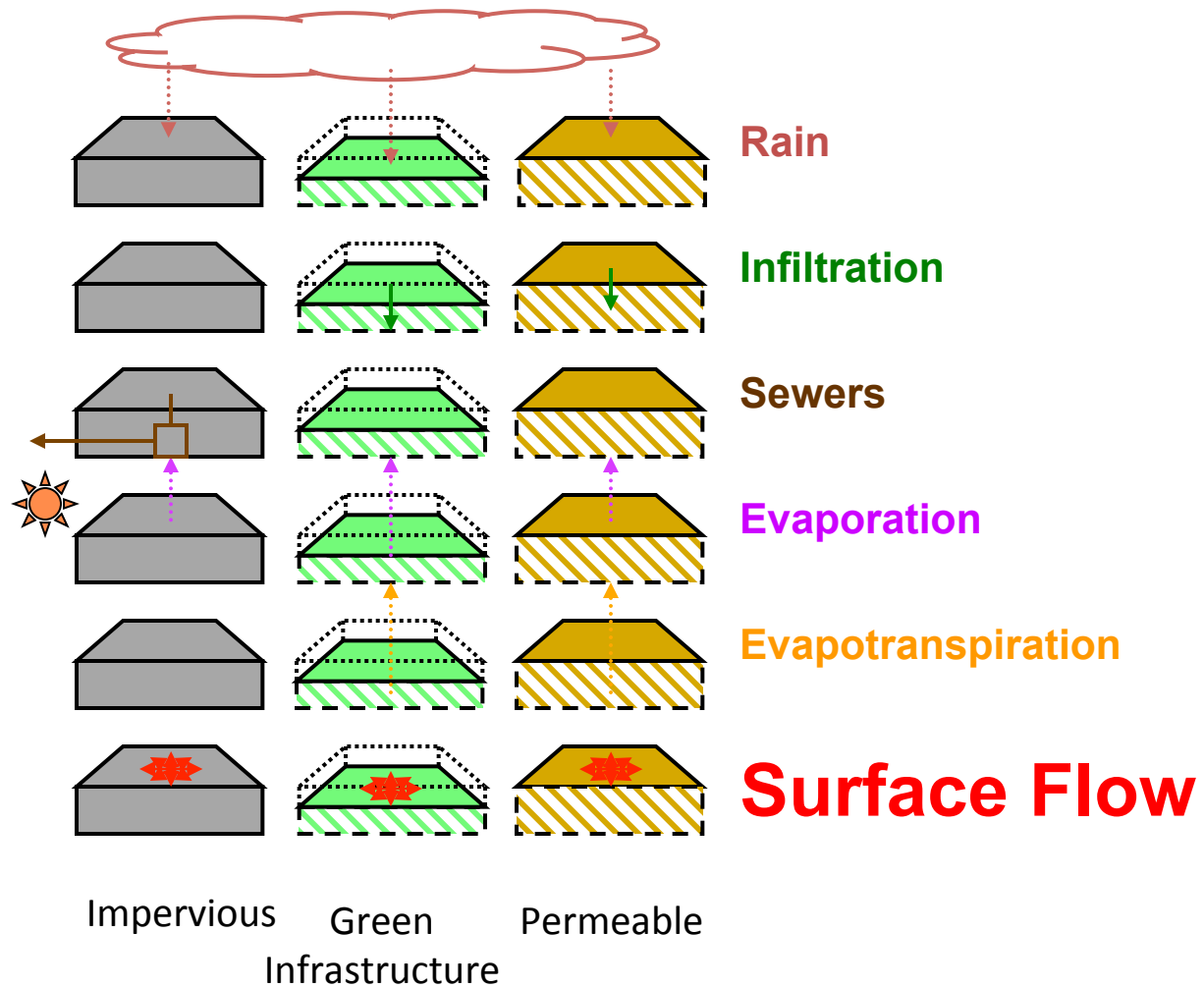
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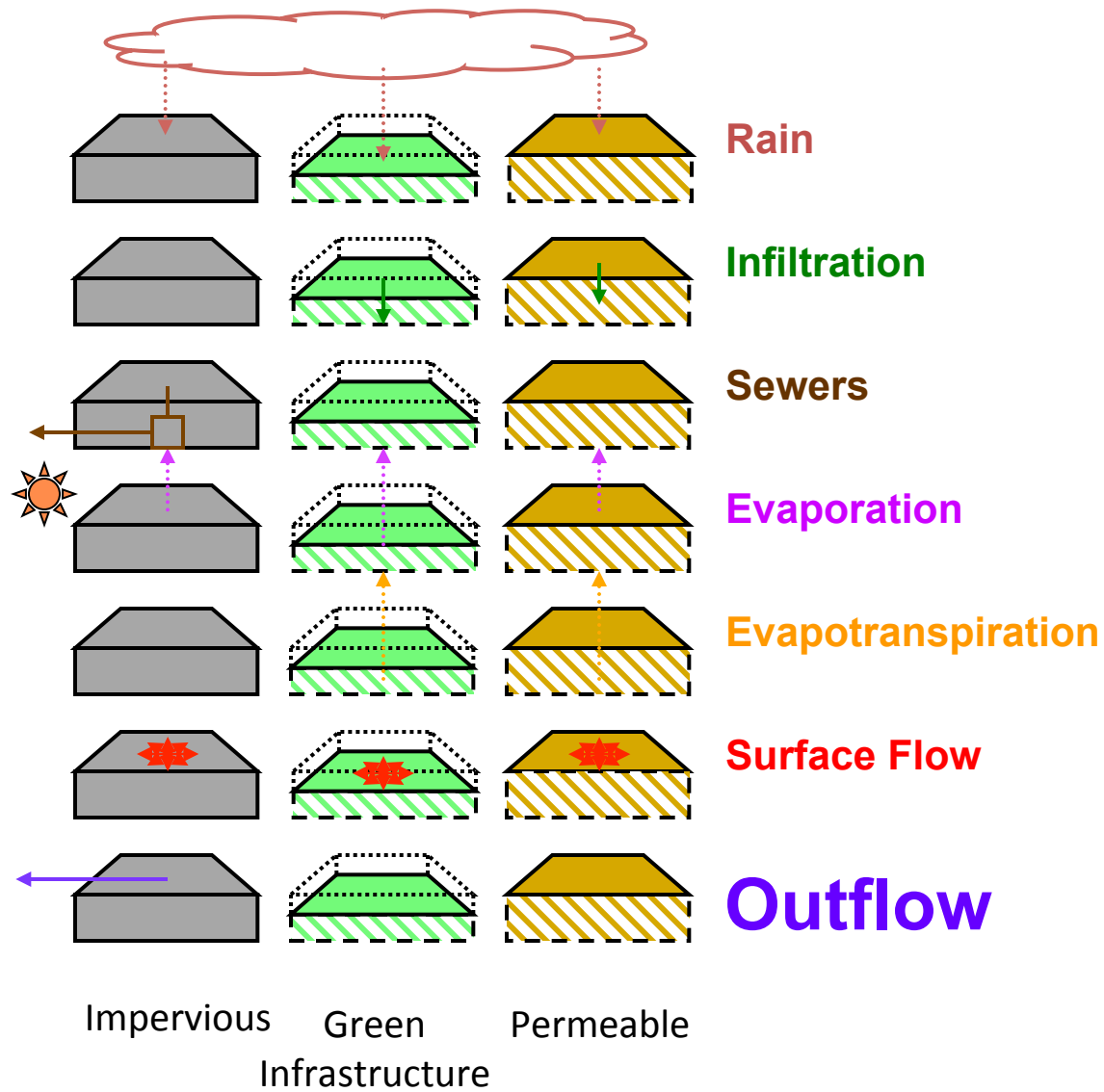
L-GrID processes



L-GrID processes

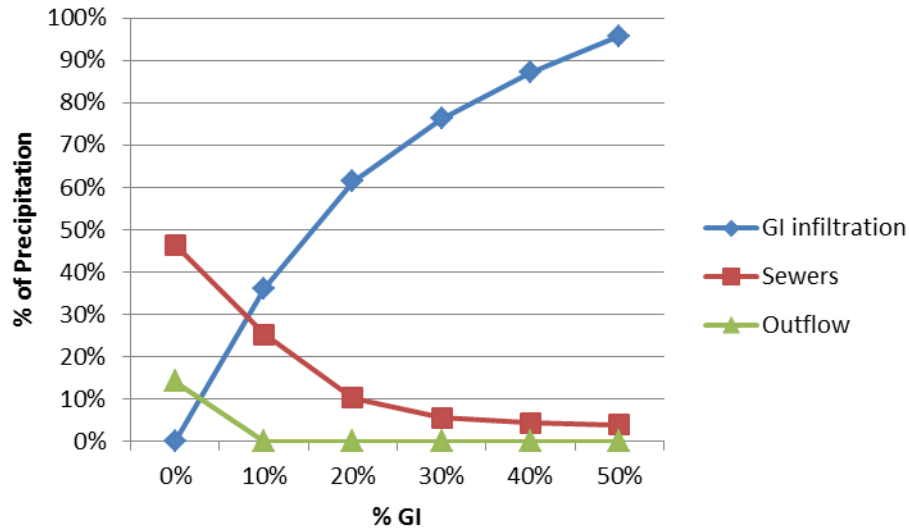


L-Grid processes

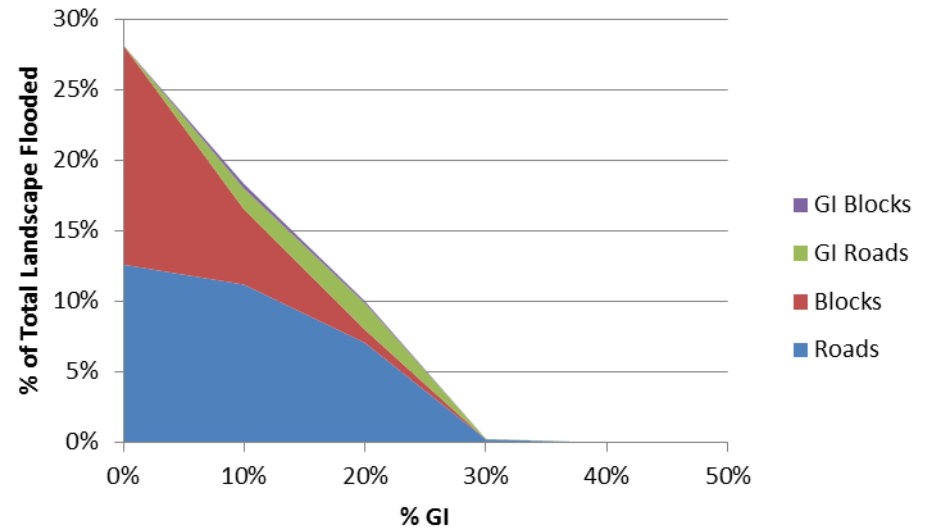
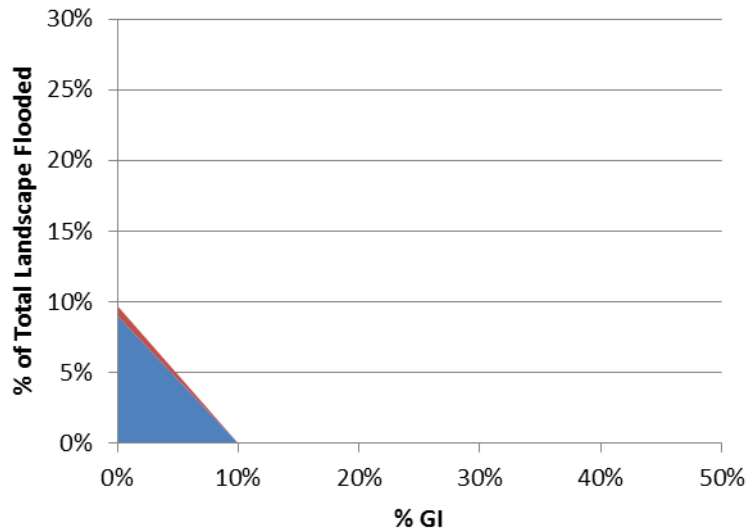
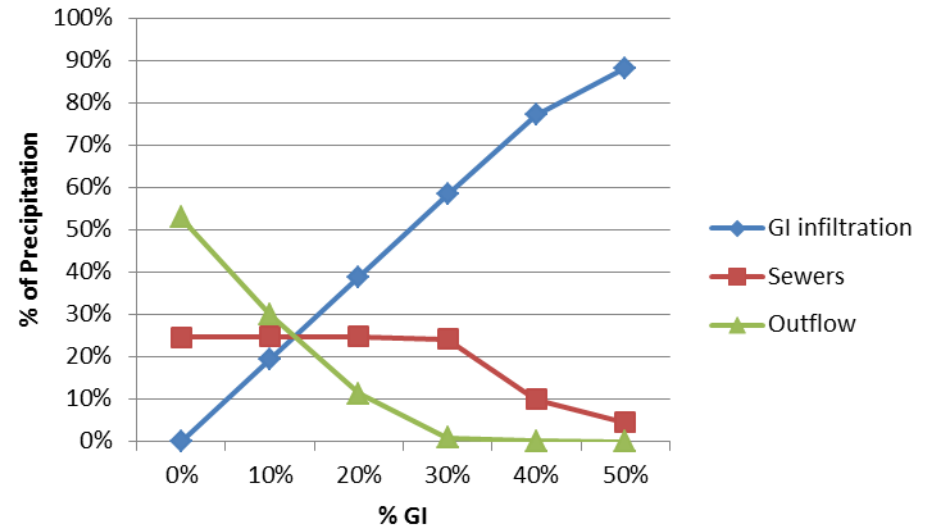


How much?

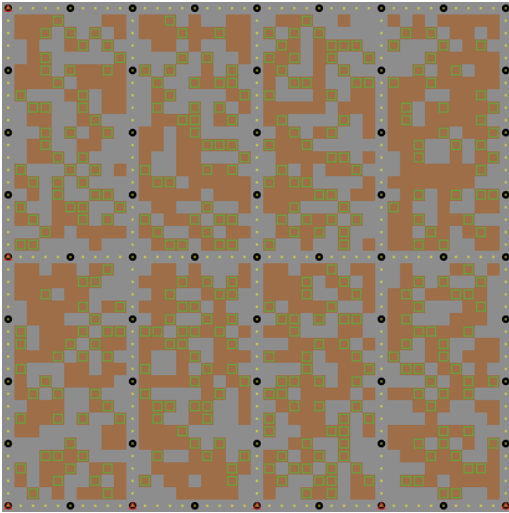
5-year storms



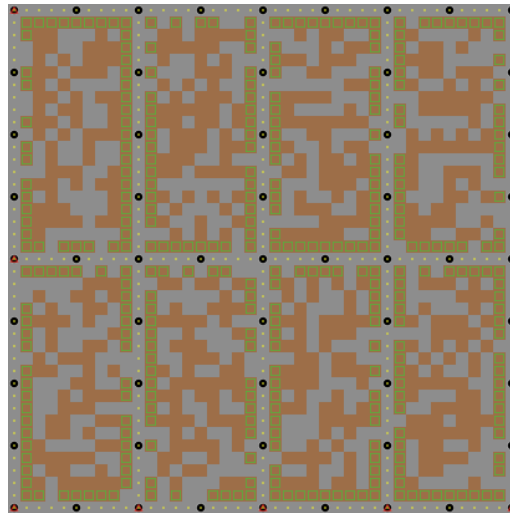
100-year storms



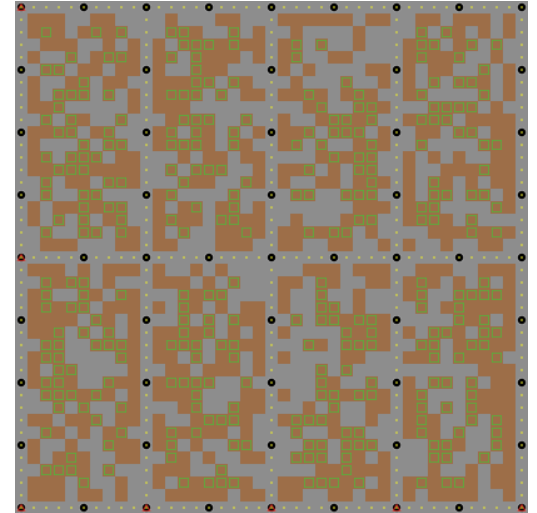
Where?



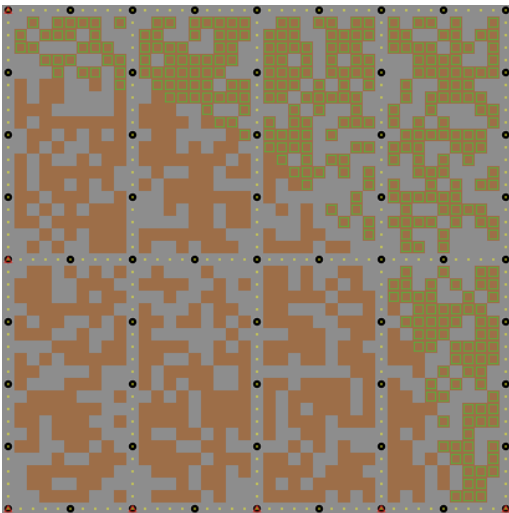
random



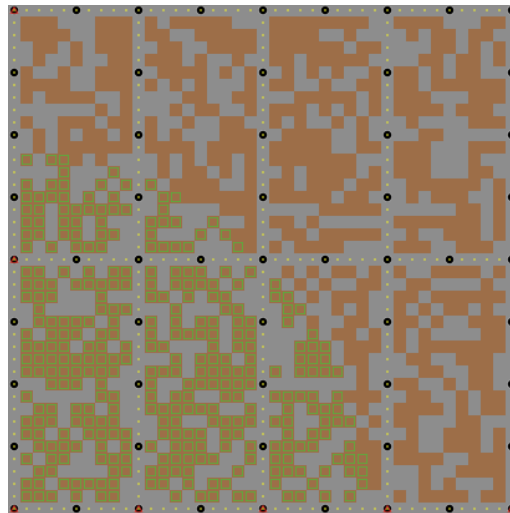
adjacent to roads



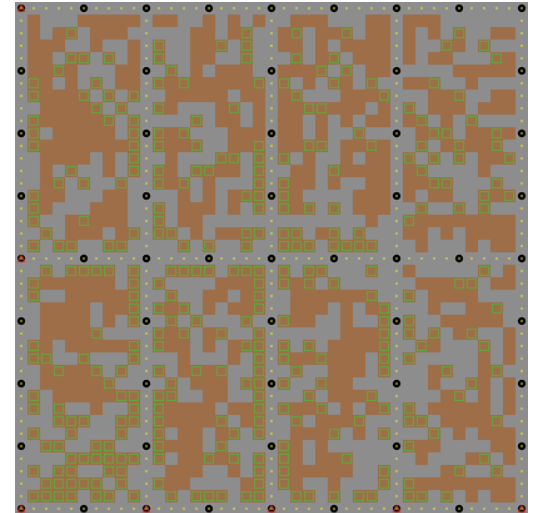
away from roads



upstream



downstream

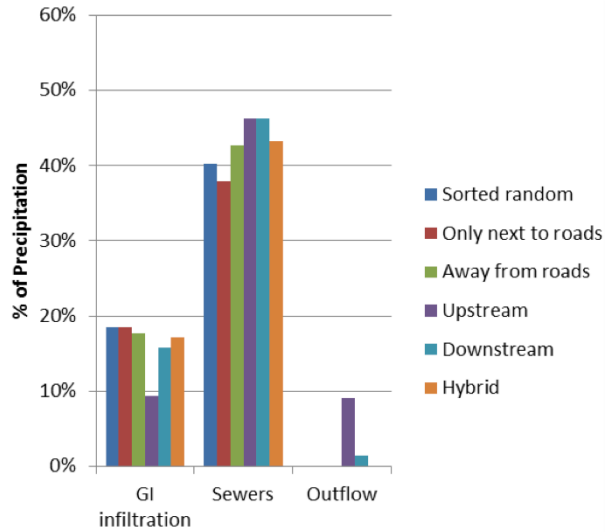


hybrid

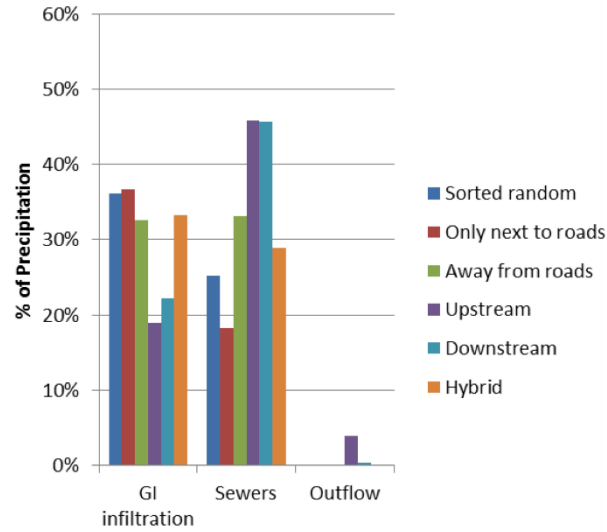
Where?

5-year storms

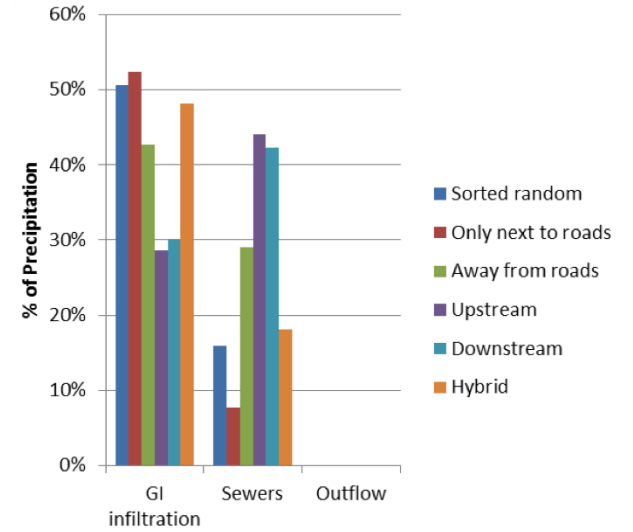
5%



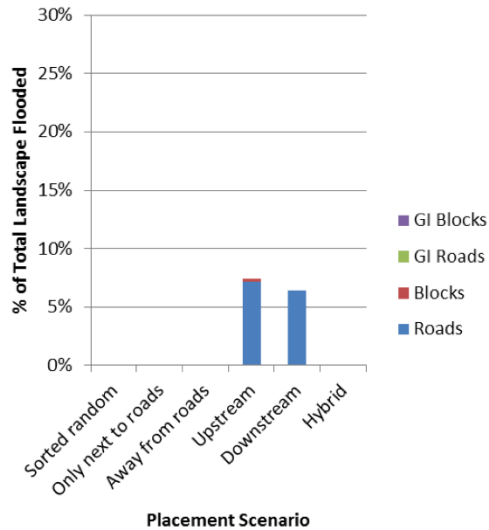
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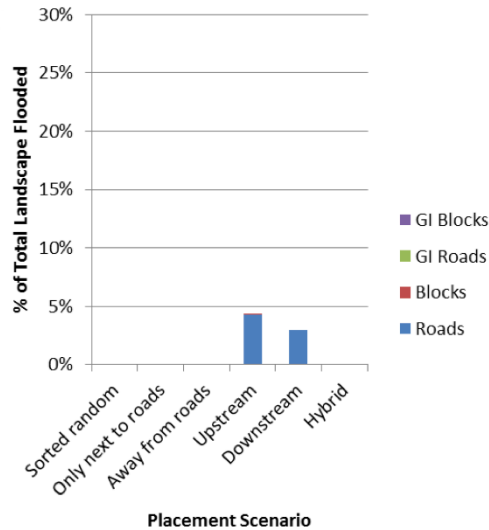
15%



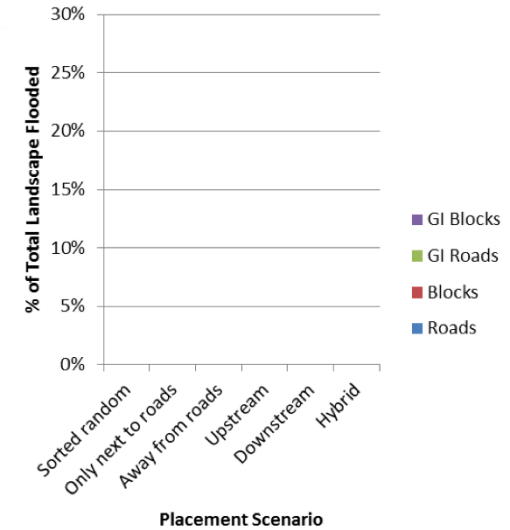
Water Outcome



Water Outcome



Water Outcome



Where?

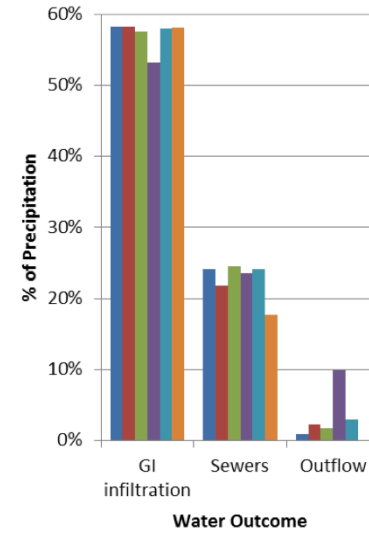
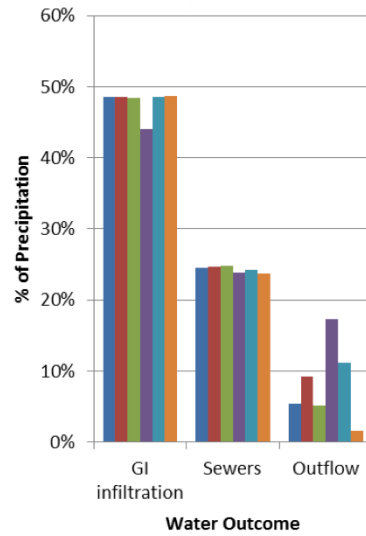
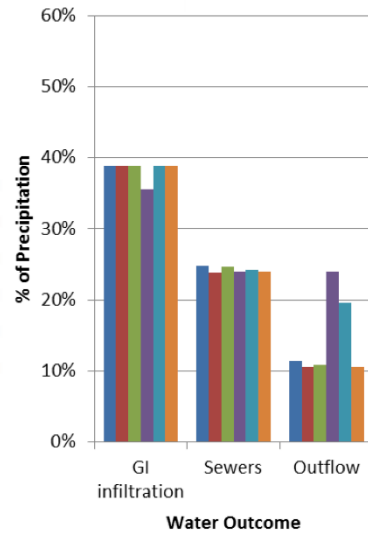
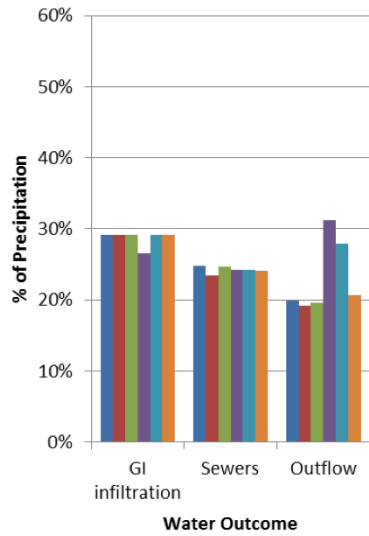
100-year storms

15%

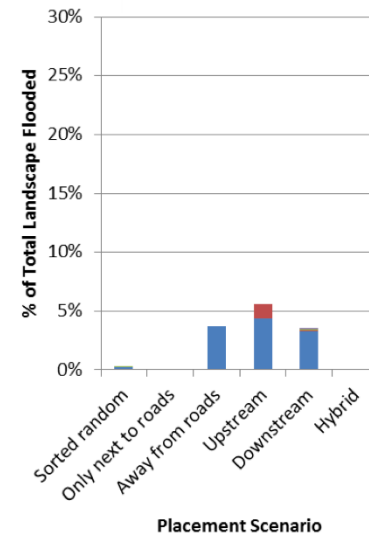
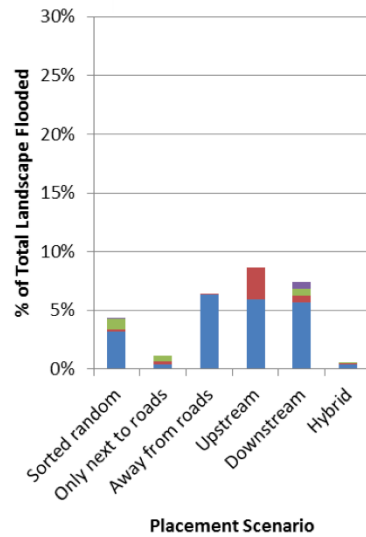
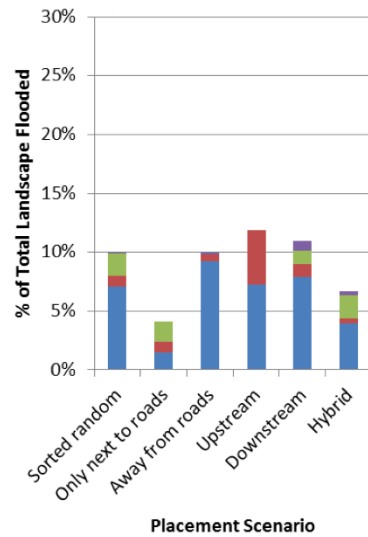
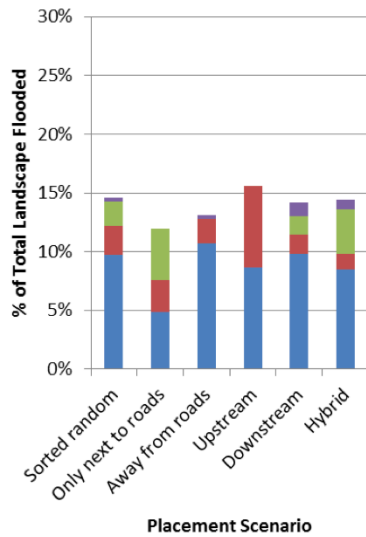
20%

25%

30%



- Sorted random
- Only next to roads
- Away from roads
- Upstream
- Downstream
- Hybrid



- GI Blocks
- GI Roads
- Blocks
- Roads

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

Things to consider

- First you model, then you monitor...
- Variable landscapes and GI types
- Simulation alone cannot give best solution
 - Tradeoffs
 - Costs and distribution
 - Spatial constraints
 - Diverse stakeholder interests

Seeing water flow, seeking compromise

- Solution building AND compromise
- Awareness of preferences
 - elicitation, recognition, point of departure
- Addressing diverse needs
 - metrics, evaluation, exploration
- Publication:
 - Zellner et al. (in progress) “A Participatory Simulation Protocol for Stormwater Management and Planning”

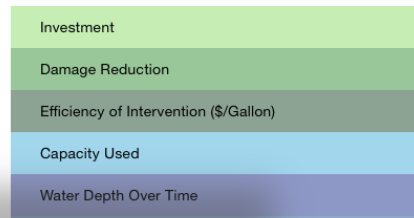
Participatory modeling



Mobile interfaces

Carrier 6:50 PM 100%

Sort the items based on how important they are to you



Investment: Cost to install and maintain new green infrastructure on both city and private property.

Damage Reduction: The amount of 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 amount of intervention capacity used

Water Depth Over Time: The amount of rainwater in the streets and on property over the course of the entire storm.

Groundwater Infiltration: The percentage of rainwater that is

Carrier 11:31 AM 100%

Simulation Results Sorted By Your Priorities

Map and Score	Intervention Efficiency	Puddle Depth Viewer	Private Cost
Trial 1 Score: 27 / 100 Broken down by source:	<ul style="list-style-type: none"> Rain Barrels Swales Perm. Paviers Green Roofs 		Installation Cost: \$0 Rain Damage: \$88,276 Maintenance Cost: \$0
Trial 2 Score: 30 / 100 Broken down by source:	<ul style="list-style-type: none"> Rain Barrels Swales Perm. Paviers Green Roofs 		Installation Cost: \$247,216 Rain Damage: \$55,162 Maintenance Cost: \$6,988
Trial 3 Score: 30 / 100 Broken down by source:	<ul style="list-style-type: none"> Rain Barrels Swales Perm. Paviers Green Roofs 		Installation Cost: \$247,216 Rain Damage: \$37,978 Maintenance Cost: \$6,988

Each color in the score breakdown is linked to an outcome measure to the right of it. Explore how the puddle depth and intervention capacity change over time.

Unacceptable Flooding Depth Hours after storm

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

Your Survey Guidebook Simulation Results

Facilitation

- Canonical profiles before their own
- Accompanying worksheets and boards
- Strategies for exploration
- Opportunity for synthesis
- Connection to region

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

Opportunities

- First you model, then you monitor...
 - Design principles
 - Rapid evaluation
 - Field experiments
- ... then you act!
 - Participatory modeling as a point of entry
 - to the problem,
 - to other tools,
 - to diverse interests
 - Collaboration
 - Funding

Acknowledgments

- Leilah Lyons, Charles Hoch, Josh Radinsky, Max Dieber, Andy Johnson, Emily Minor, Jen Weizeorick, Dan Milz, Carl Kunda, Ethan Brown, Lissa Domoracki, April Schneider, Kelsey Pudlock, Curtis Witek, Tia Shelley, Brian Slattery, Lisa Cotner, Ben O'Connor
- Chicago region stakeholders
- John Watson, MWRD
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Thank you!

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