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Rooftop Runoff Mitigation Technologies: Bioretention Planters and Green Roofs

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Welcome to Stevens Living Laboratory

Green Roof Water Quality Monitoring Objectives

- Quantify annual and event-based rainfall retention for different engineered media
  - replicated experimental systems
  - natural rainfall
- Characterize discharge quality
  - not well understood in literature
  - nitrogen and phosphorus
  - conventional roof runoff vs green roof
  - supplemental treatment?
- “Best” performance for stormwater retention and nutrient leachate?

Experimental Scale: Green Roof Water Quality

- 26 experimental systems currently in operation
- 9 replicated media & supplemental treatment (“PRB”) configurations
- 2 “ungreened” controls (conventional roofs)

Green Roof Water Quality: Experimental Design

Irrigation

Media: 4'' depth 9.8 ft^2

Downstream "permeable reactive barrier" 0.96 ft^2

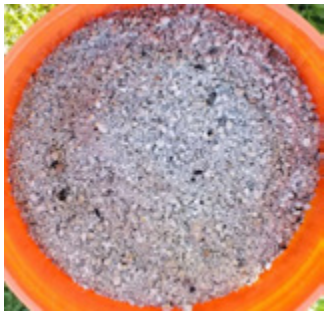
Sample collection & runoff volume measurement

Established July 2017

Media Configurations

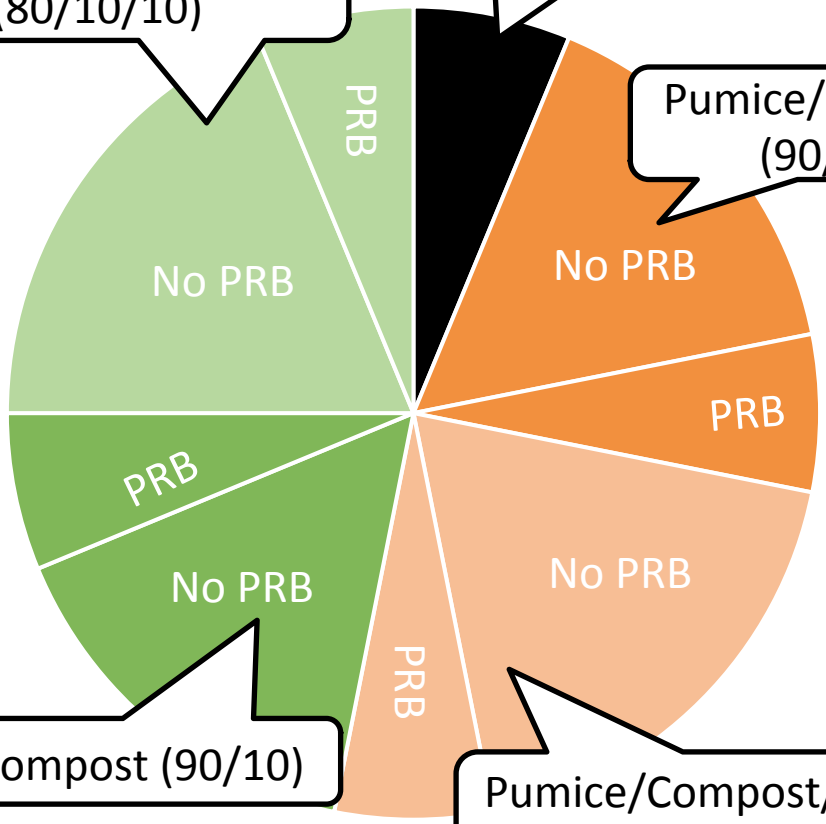
Expanded Clay

Zeolite PRB



Pumice

No PRB

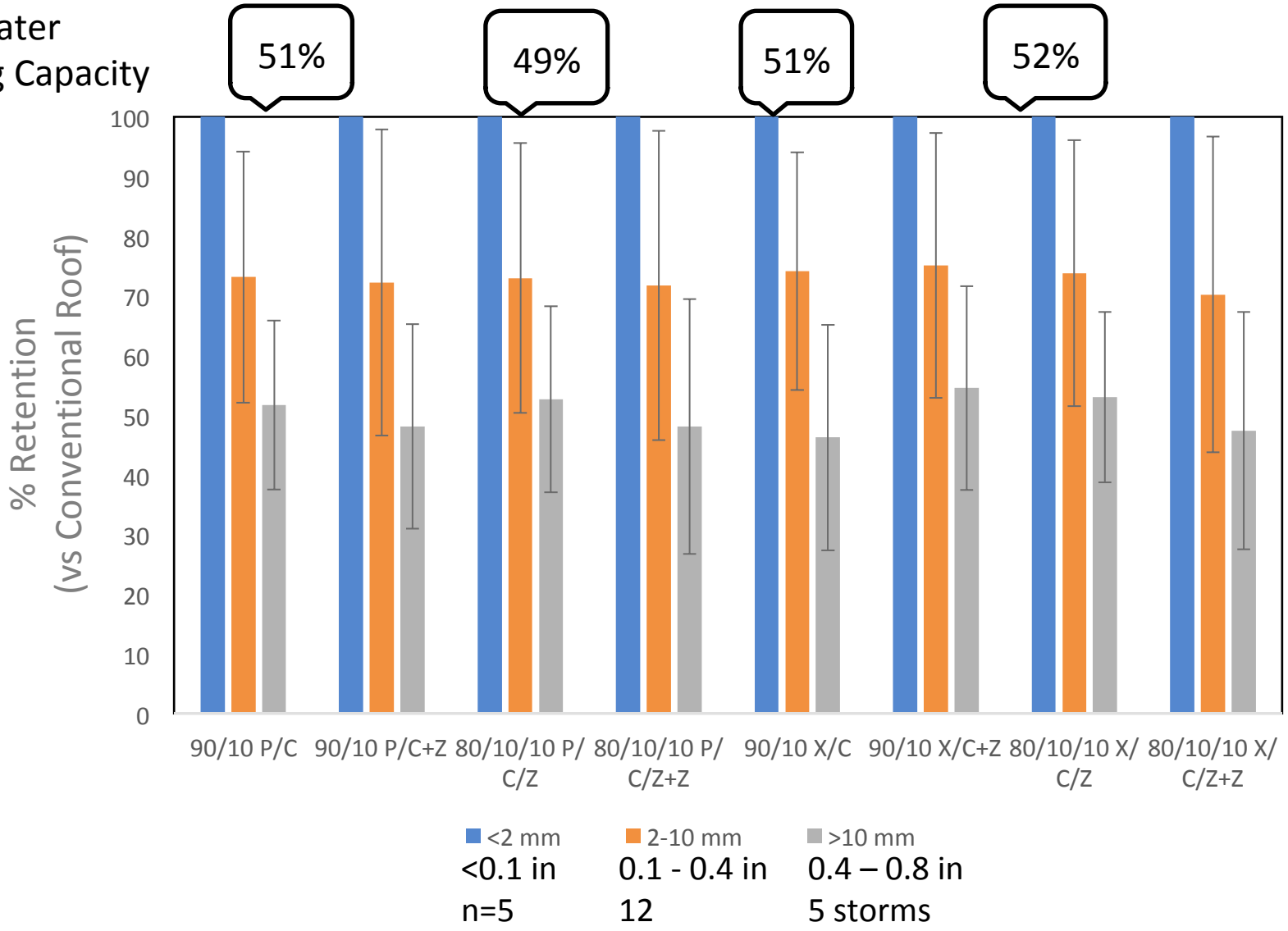


Data Collection and Sampling

- Water volume collected in buckets = stormwater retention
- Water quality sampling:
  - 9 configurations across 26 trays, including replication
  - Nitrogen Species: Total Nitrogen; TKN, NO_3; Total Inorganic Nitrogen
  - Phosphorus Species: Total Phosphorus, Orthophosphate

Storm Water Retention

Max Water Holding Capacity

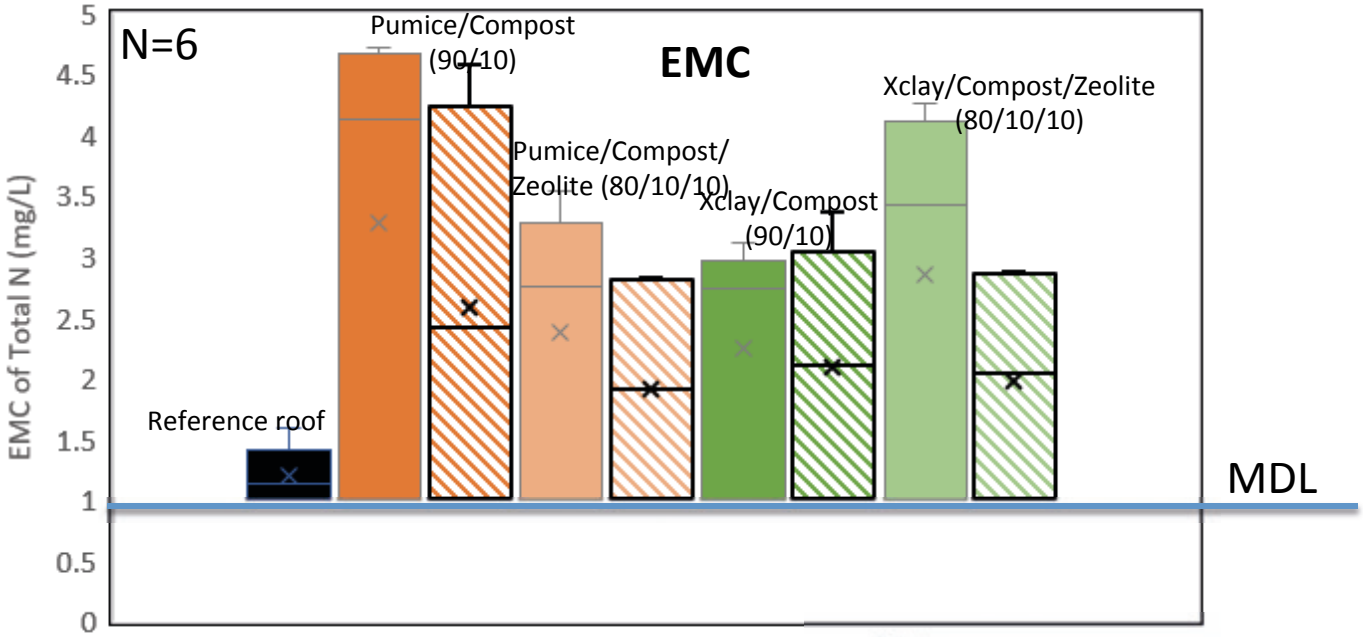


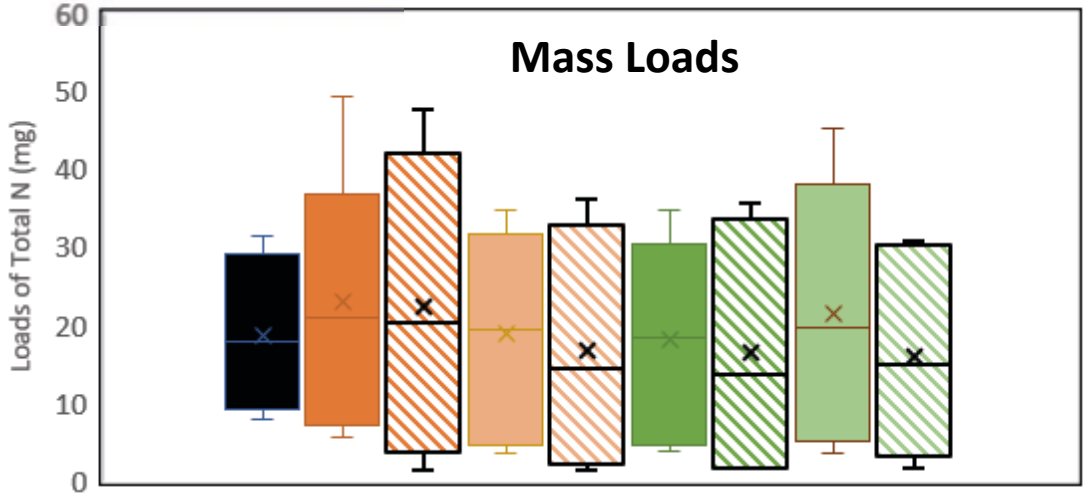
<0.1 in n=5

0.1 - 0.4 in 12

0.4 – 0.8 in 5 storms

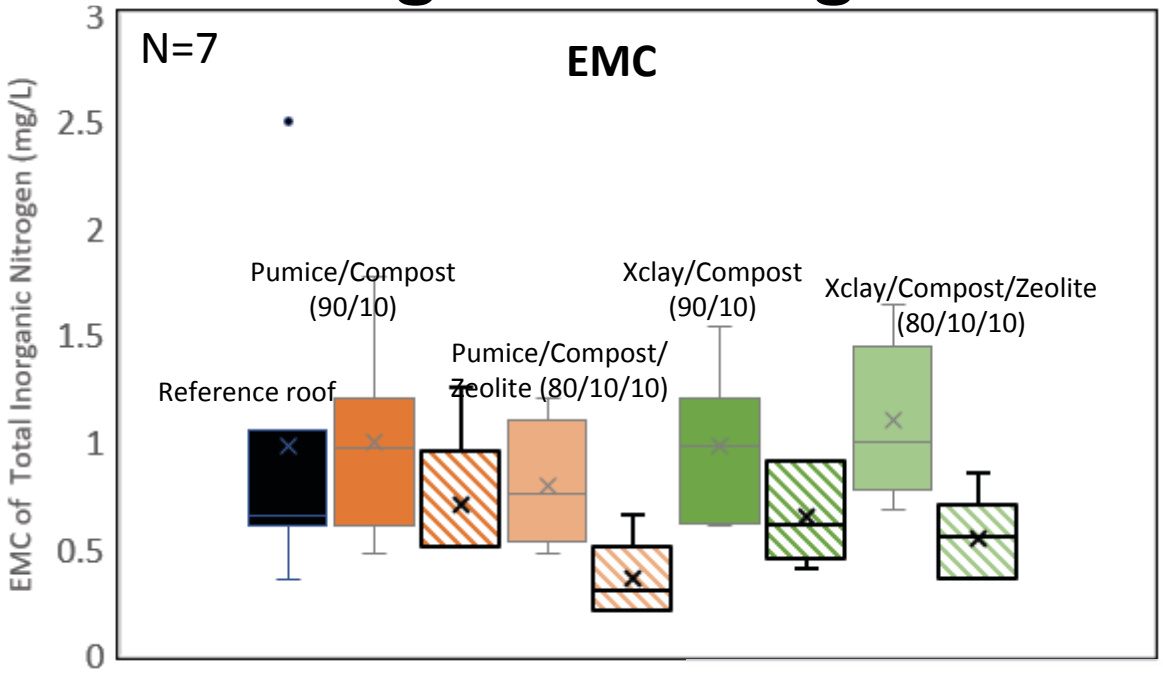
Total Nitrogen

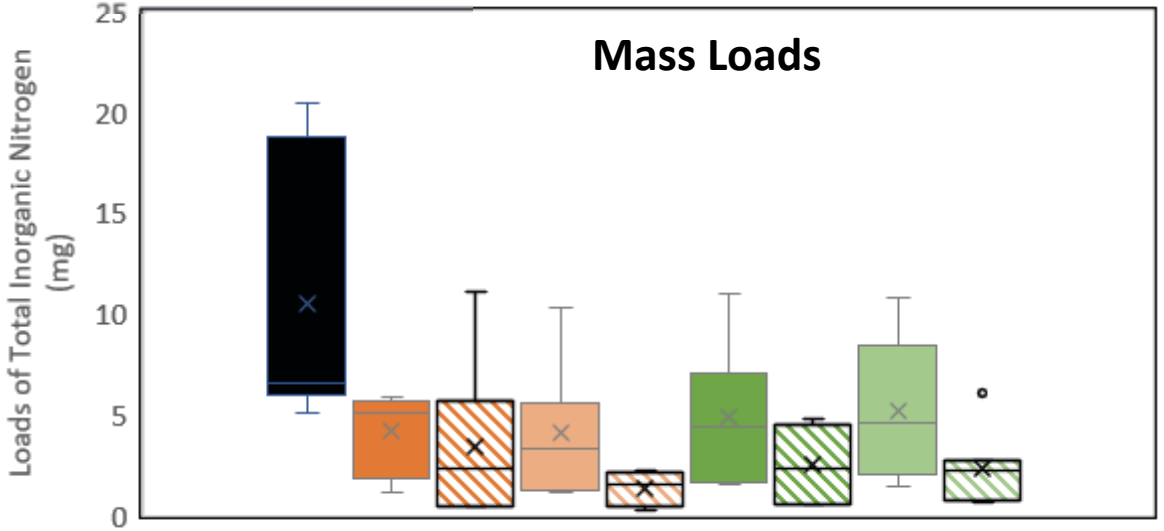




Box with stripes indicates PRB

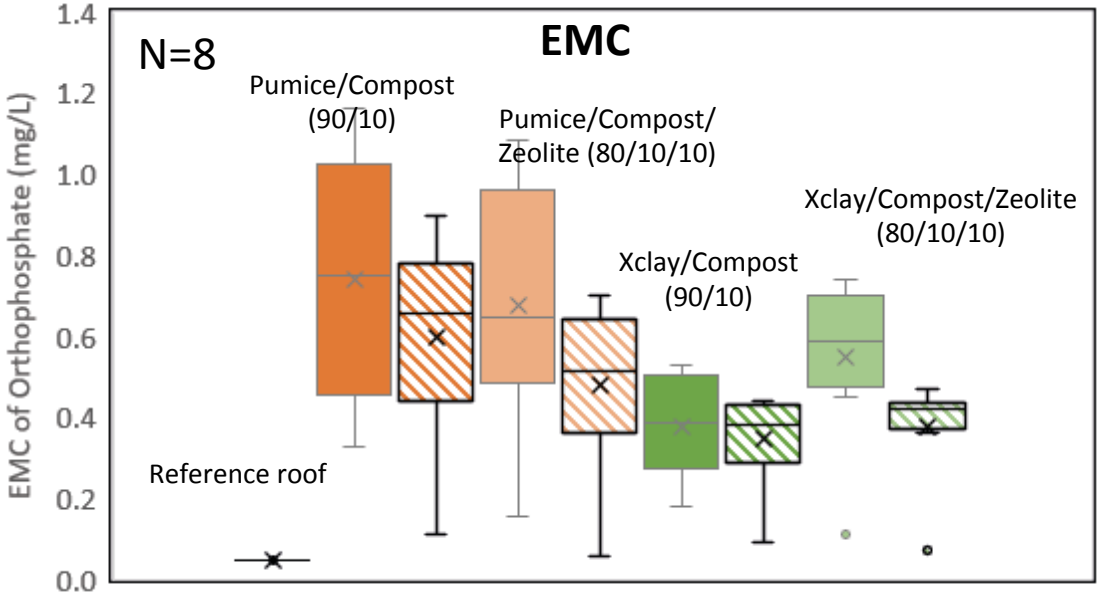
Total Inorganic Nitrogen



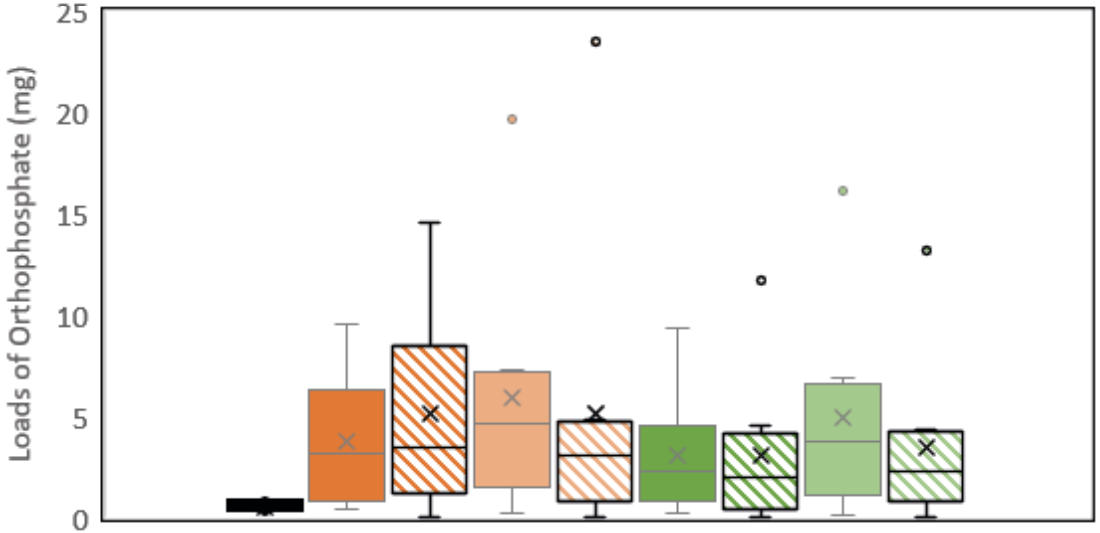


Box with stripes indicates PRB

Orthophosphate



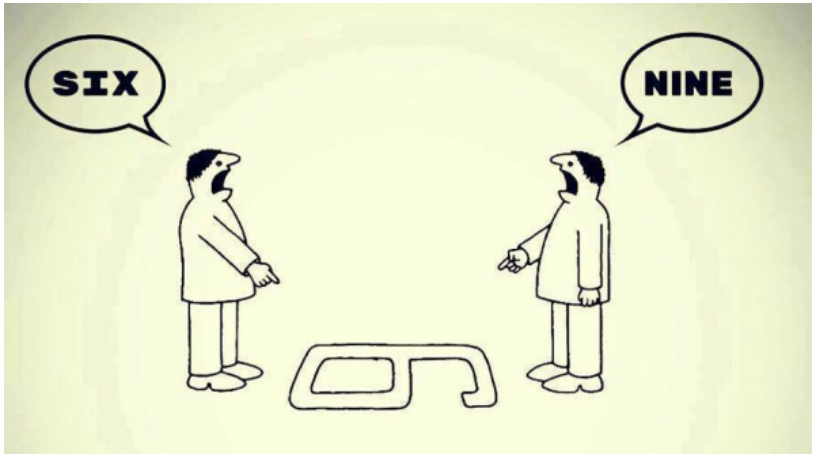
Average Mass Loads



Box with stripes indicates PRB

Perspective

- Collect more data
  - Highly variable storm size
  - New/establishing plants
- Aging and seasonal variations?
- Quantify the effects of PRB in hydrologic behavior and nutrient reduction
- Explore more PRB materials such as biochar

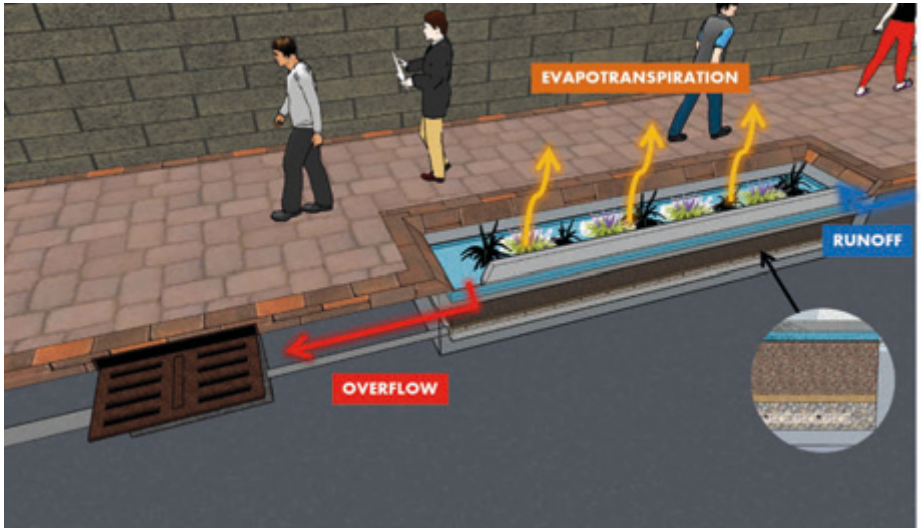


The Living Laboratory Bioretention Planters

In collaboration with Michael Borst
US EPA Office of Research and Development, Edison, NJ

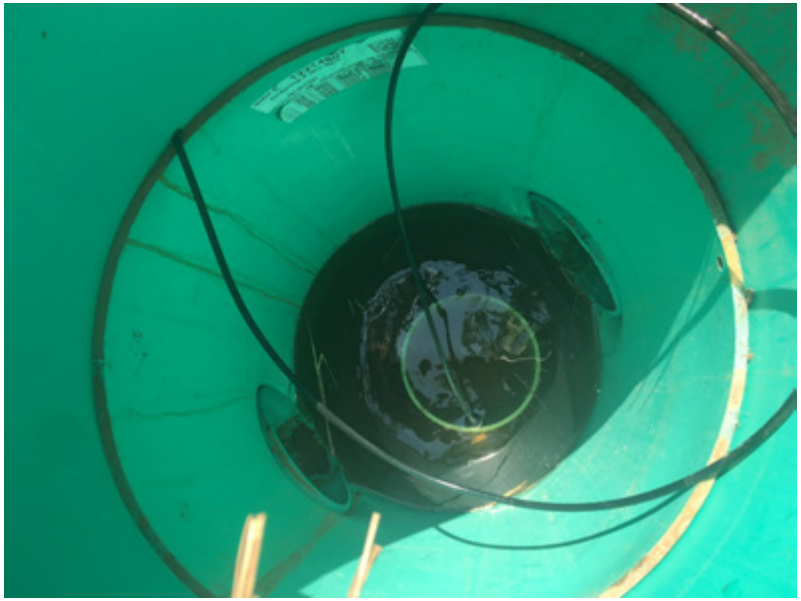
- 4 planters – replicated field experiments
- 2 different engineered media recipes
- Inflow from ~ 4800 ft² roof through gutters.
- Measure detention (flow) mitigation

Objectives and Applications of Bioretention Planters



- Similar layers to a rain garden, but much smaller system.
- Runoff detention for low volume, frequent storms.
- CSO mitigation opportunity?
- Low footprint, inconspicuous devices → easy retrofit?

Monitoring Stations



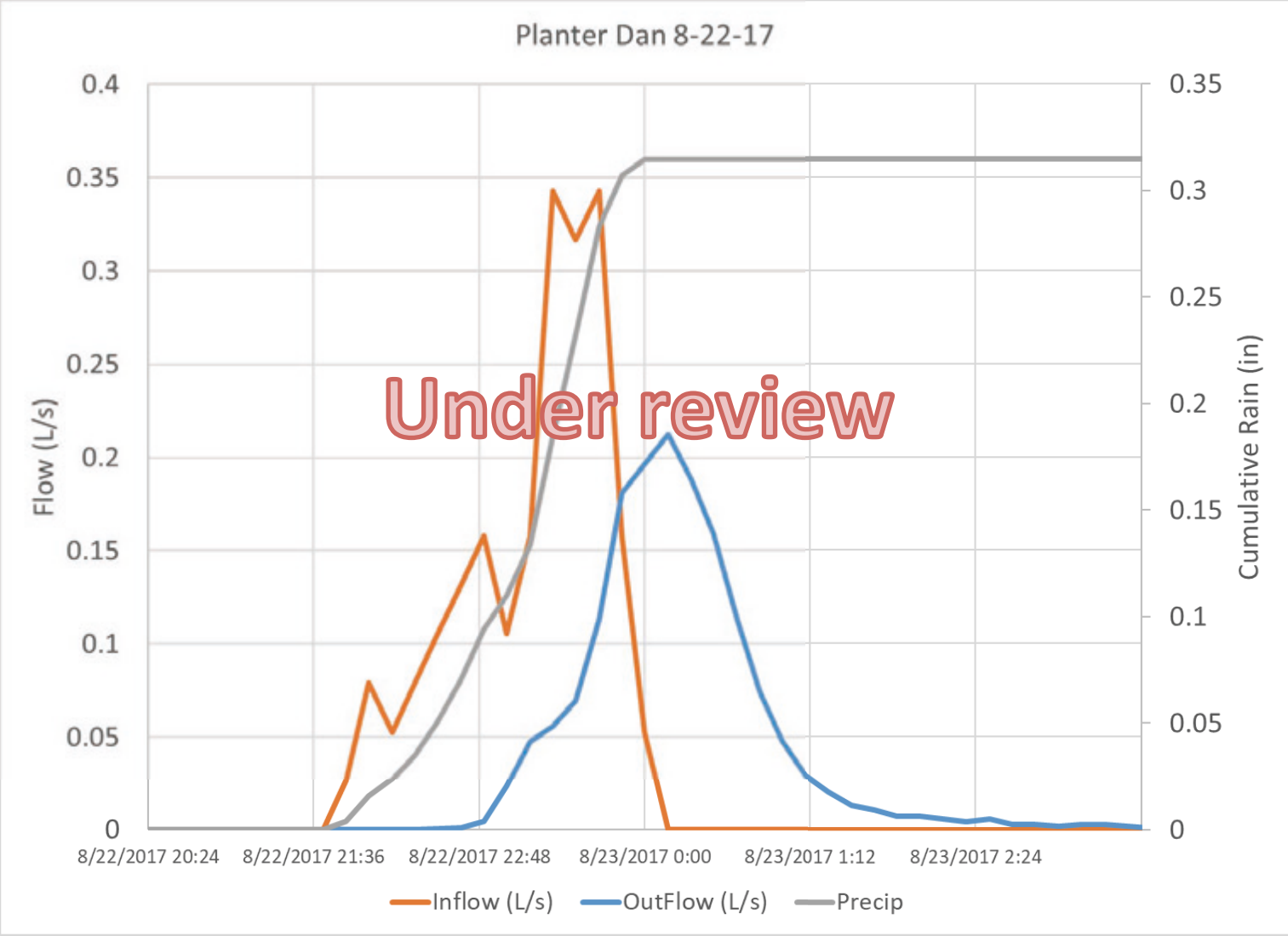
- Inflow
- Internal filling & draining
- Outflow
- Soil moisture

9 sensors per planter

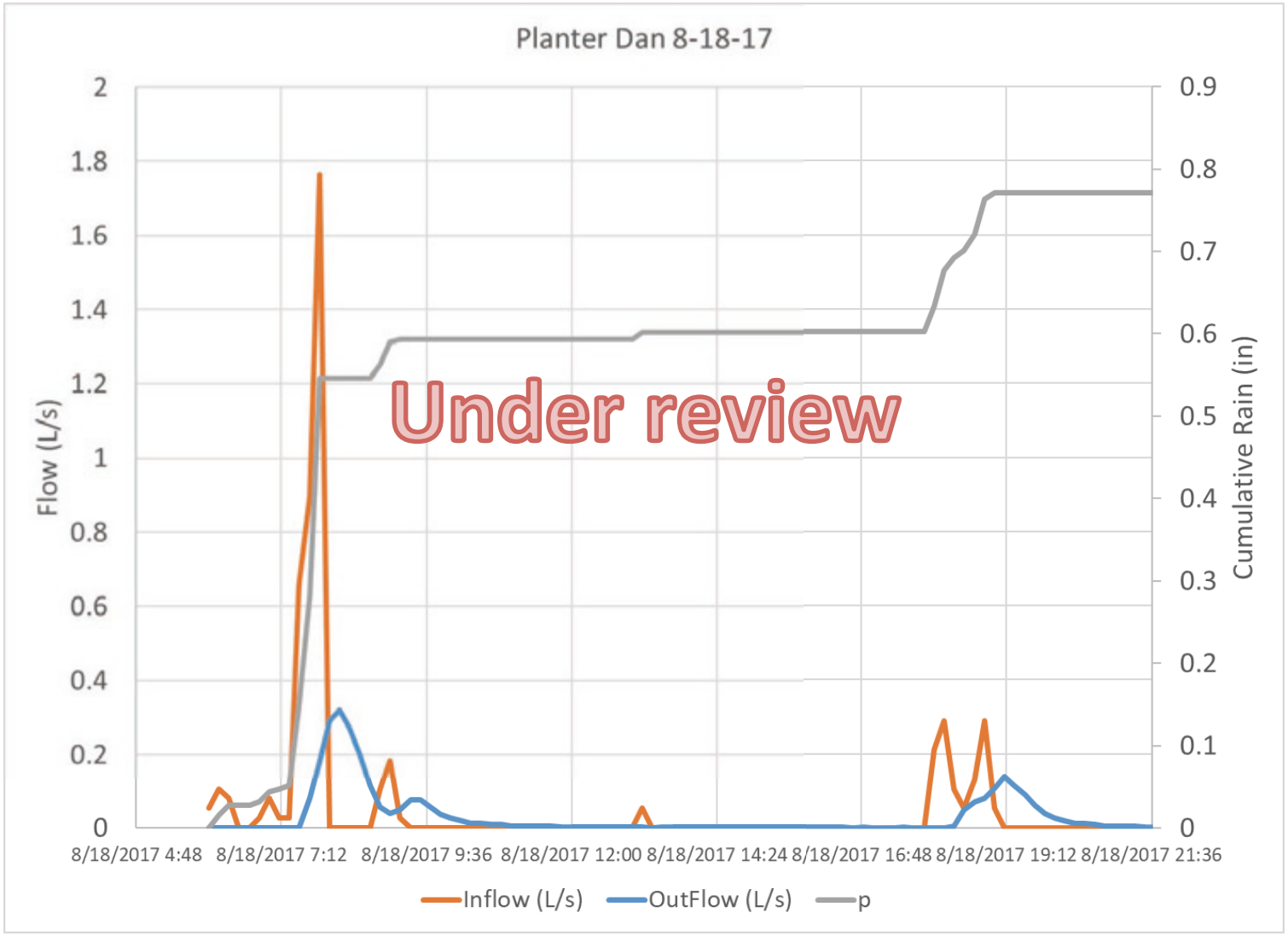
Monitoring Challenges

Downspout scuppers

Representative small storm performance



Representative performance



What happens next?

Future of the Living Laboratory Planters

- Continue monitoring
  - Quantify performance for varied storm conditions
  - How much and how long can water be detained in the system?
  - Is retention (volume reduction) significant?
  - Effect of media recipe?
- Map how water flows through the system → modeling

Acknowledgements

The project would have been impossible without Birgitte Gisvold Johannessen, Samantha Conte, Sarah Chan, Dylan Wash and Daniel Rosenberger who built this experimental set up, Professor Fassman-Beck, Stevens Facilities Management, Stevens Pinnacle Scholars, Stevens Innovation & Entrepreneurship Scholar.

Special thanks to Michael Borst, US EPA Office of Research & Development, Edison, NJ.

With thanks to these folks for materials' support…

GREEN ROOF PLANTS

STANCILLS CUSTOM SOIL BLENDING

st. cloud innovation through zeolite

Thank you!

Questions?

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