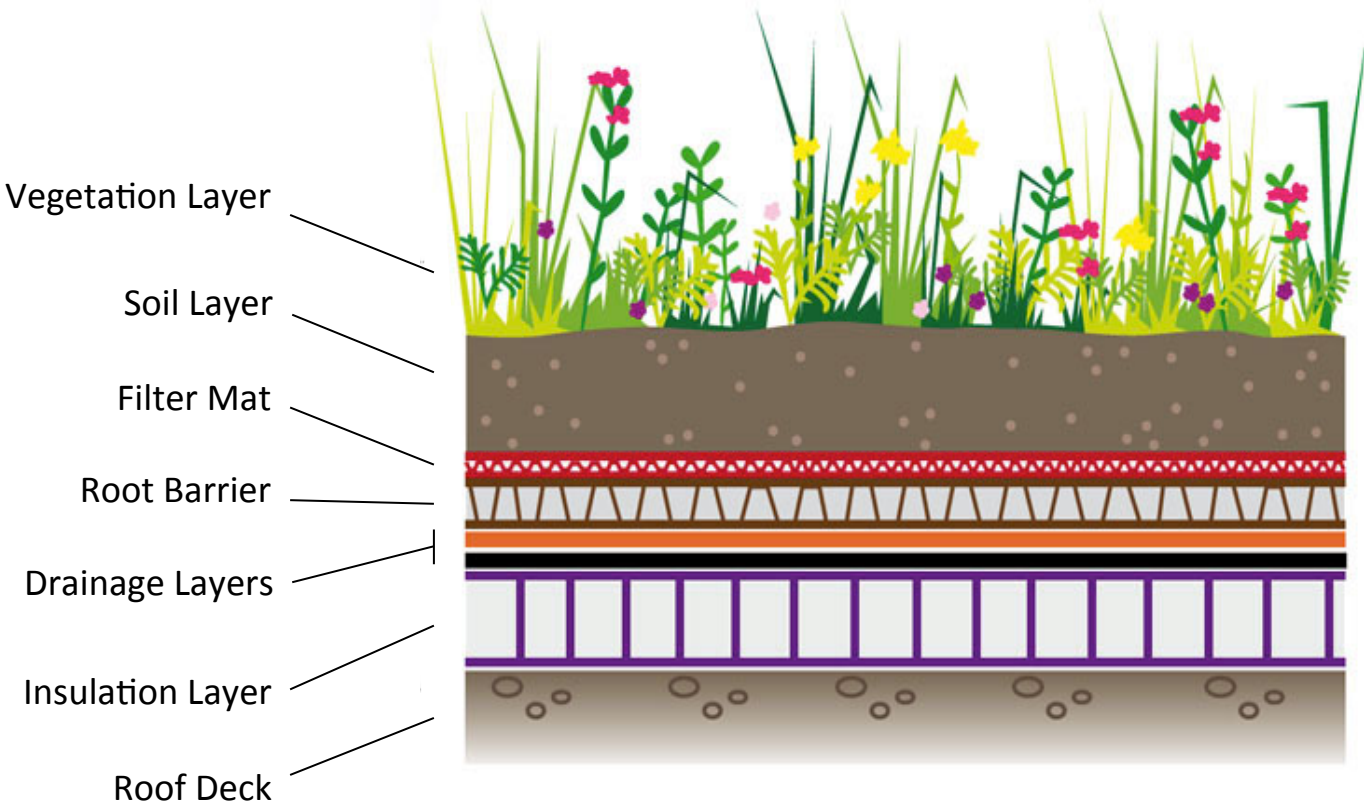# FILTERING OF ATMOSPHERICALLY-DERIVED NUTRIENTS BY AN ESTABLISHED VEGETATED ROOFING SYSTEM

Sarah Mangum
University of Washington, Tacoma

# What is a Green Roof?

Vegetation Layer

Soil Layer

Filter Mat

Root Barrier

Drainage Layers

Insulation Layer

Roof Deck

Green Roof Benefits

- Reduce energy consumption and carbon emissions
- Carbon sequestration in vegetation & soil
- Reduce urban heat islands
- Increase wildlife habitat
- Reduce noise pollution
- Increase longevity of roofing membranes
- Provide esthetically pleasing outdoor spaces

The Minnesota Green Roofs Council

Storm Water Management

- Storm water detention
- Reduced runoff volume through evapotranspiraion
- Reduced runoff speed through infiltration

Richmond VA Department of Public Utilities
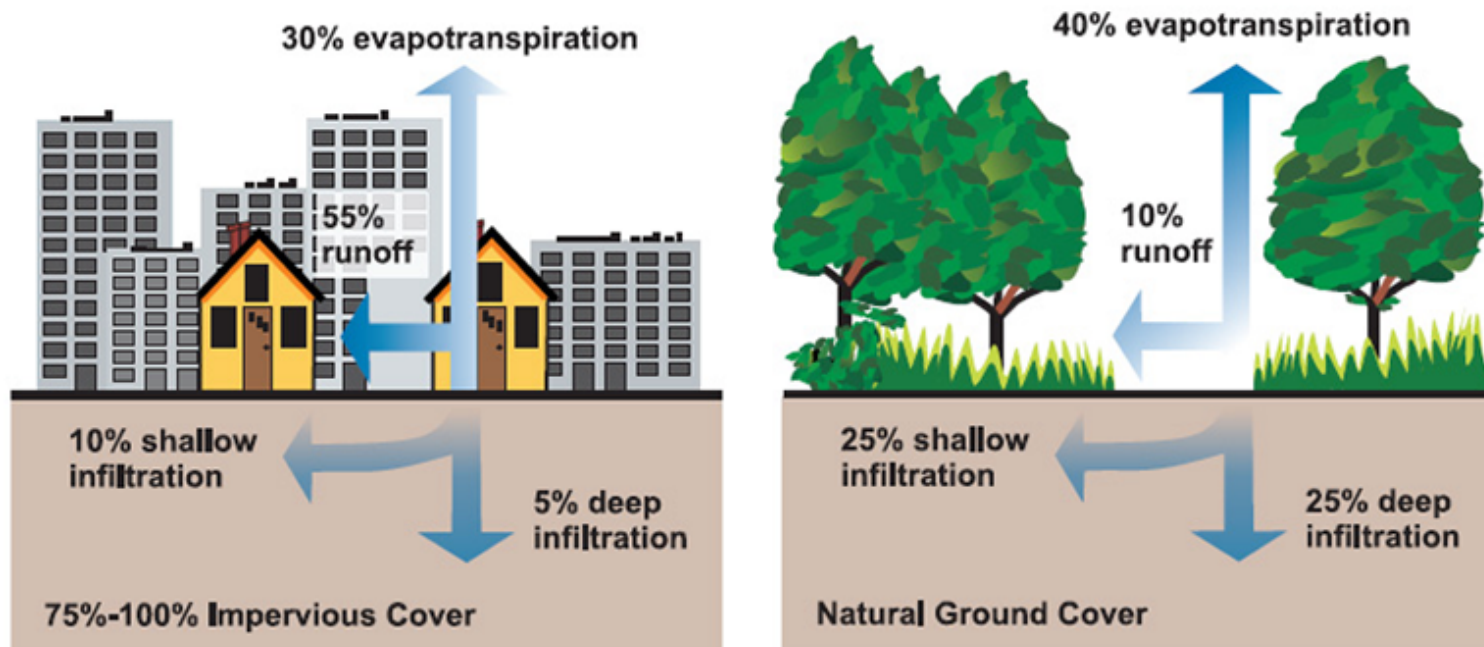
Improved Water Quality?

- Pollution filtration through soil & vegetation

- Toland *et al*:

    - Water soluble phosphorus concentrations from green roof runoff 10 X higher than conventional roofs

cityoftacoma.org

wastormwatercenter.org

Nitrogen & Phosphorus Effects

- Eutrophication

- Loss of biodiversity

- Loss of habitat

- Increased turbidity
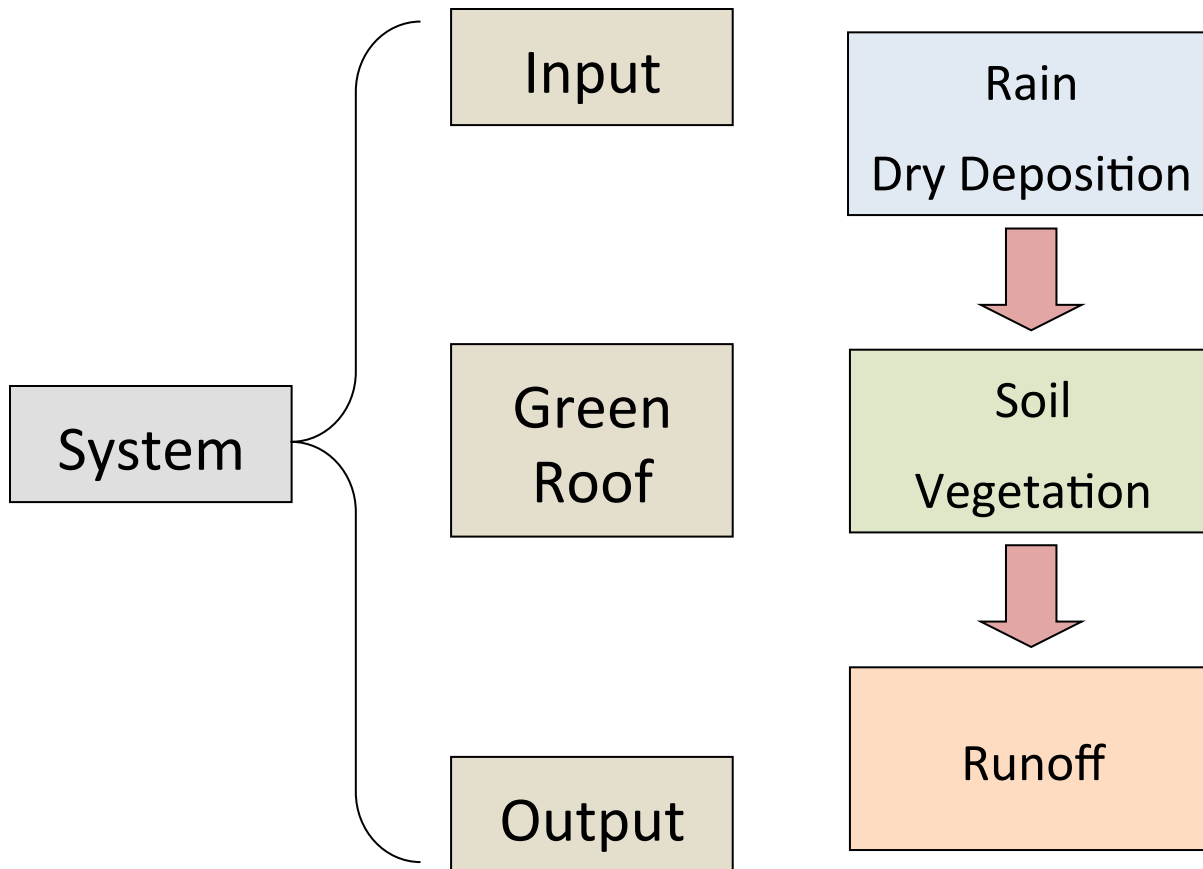

noordzeeloket.nl

cost869.alterra.nl

britannica.com

Project Intent

- Conduct mass-balance of nitrogen and phosphorus species

- Evaluate effectiveness of nutrient filtration

- Compare runoff from green roof & conventional roof

- Establish methodology for long-term monitoring

Mass Balance

Input

System

Green
Roof

Output

Rain

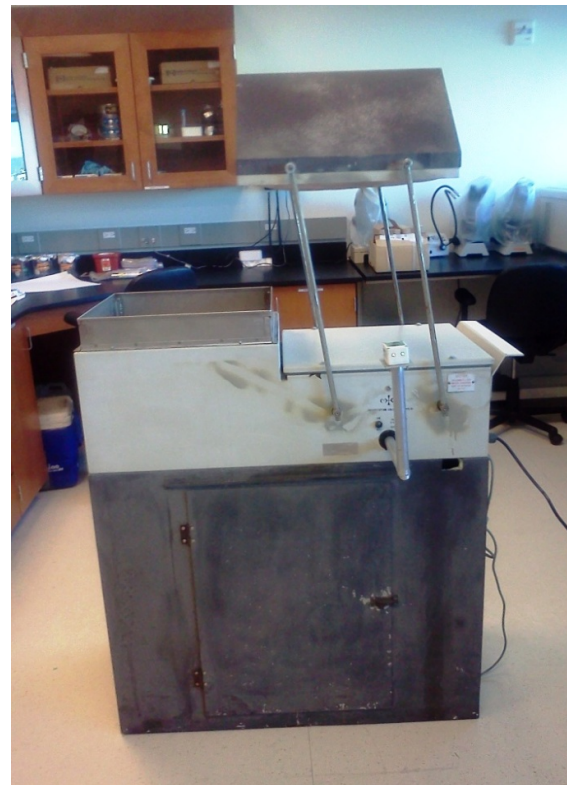Dry Deposition

Soil

Vegetation

Runoff

Experimental Plan

- Rainwater:
  - Event-based sampling with an auto-sampler
- Dry Deposition:
  - Passive sampling
- Vegetation:
  - Random sampling
- Soil:
  - Random sampling
- Runoff from simulated rain events:
  - Grab samples OR collection of entire runoff stream

Rainwater

AUTO-SAMPLER

Closed
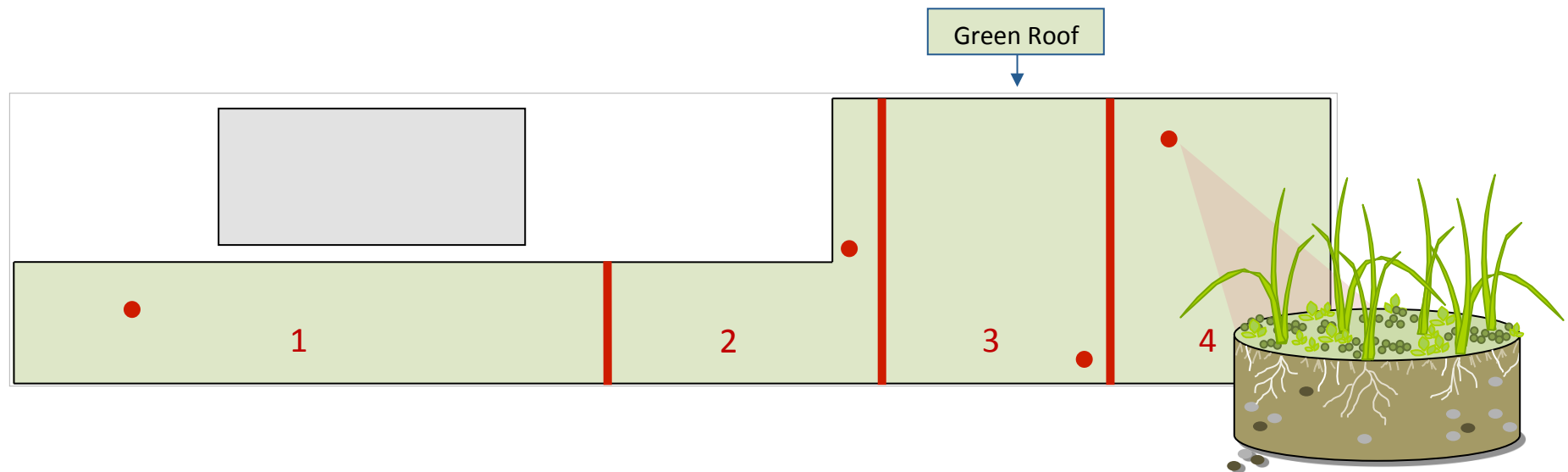

Open

Dry Deposition

- 3-4 glass plates attached to solar panel mounts
- Remove after 1 week
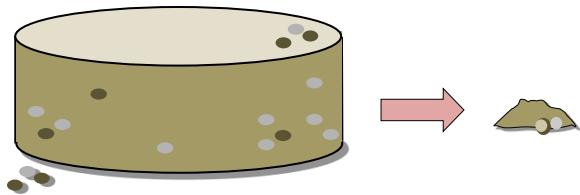- Rinse plates and treat solution as water sample

Vegetation

- ☐ Divide green roof into zones
- ☐ 1 random sample from each zone
- ☐ Separate plants from soil
- ☐ Separate into sub-samples by species

Green Roof

1   2   3   4

Soil

- Will collect at the same time as plant samples
- Return majority to roof
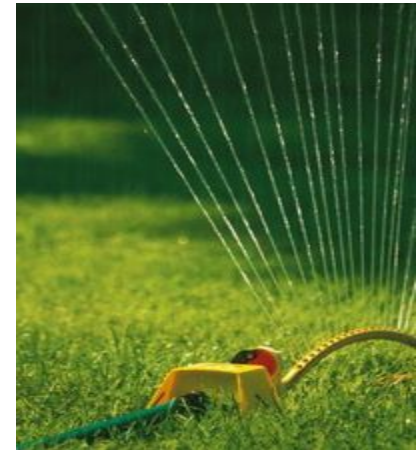- Analyze soil from installation as a comparison


Soil from vegetation sampling

Bag of unused soil from green roof installation

Simulated Rain Events

- To measure mobilization of nutrients in soil
  - Municipal water supply, oscillating sprinkler
  - 3-4 hours long, 3-5 separate events
 - 7.5L/min flow over 1200 ft^2
- Penthouse roof watered separately

Comstock/Comstock/Getty Images

Scupper

Penthouse Roof

Green Roof

Filter Access Panel

OR
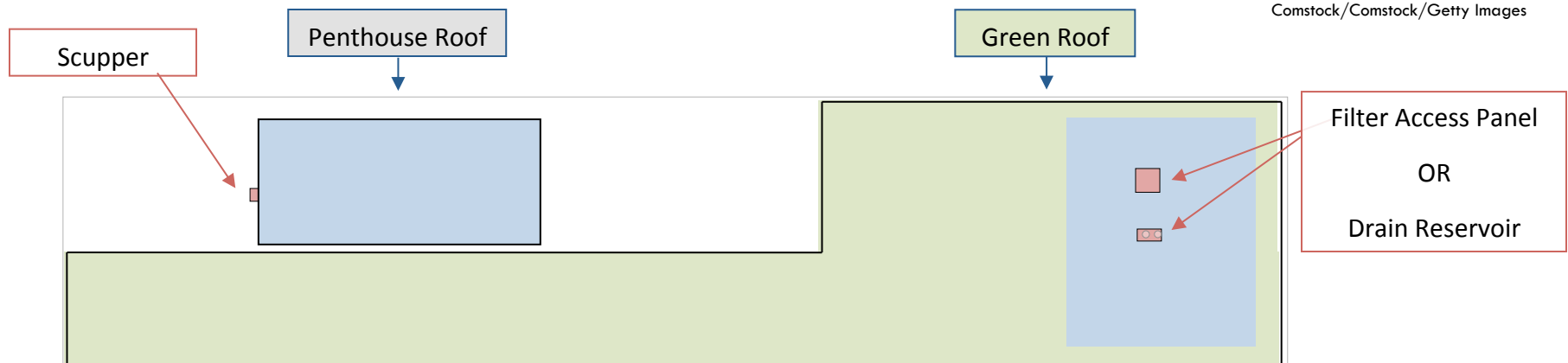
Drain Reservoir

Runoff

- **Entire runoff stream**
  - Plug one drain in reservoir
  - Collect into carboy with peristaltic pump, switch carboys when full
  - Draw off sample, dump the rest
- **Flow-weighted grab samples**
  - Several samples over duration of flow
  - Taken from filter access panel
  - Must know flow rate for each sample
- **Penthouse roof: collect all runoff**
- **Municipal water also collected**
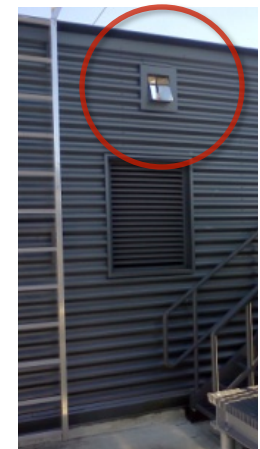
Sampling Plan

	Total N	NO$_3^-$	NO$_2^-$	NH$_3$	Total P	Plant Extractable P	Water Soluble P	Ortho-P
GREEN ROOF								
Soil (n=4)	X				X	X	X	
Vegetation (n=4)	X				X			
Runoff (n=3 to 5)		X	X	X	X			X
Dry Deposition (n=3 to 5)		X	X	X	X			X
PENTHOUSE ROOF								
Runoff (n=3 to 5)		X	X	X	X			X
MISCELLANEOUS								
Rainwater (n= 3 to 5)		X	X	X	X			X
Municipal Water (n=1)		X	X	X	X			X
Unused Soil (n=1)	X				X	X	X	

Expected Outcomes

- Higher nutrient concentrations in green roof runoff that Penthouse runoff or rain initially

- Decreasing concentrations with increased precipitation

- Long-term nutrient concentrations?

Acknowledgements

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Questions?

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