WORKSHOP I:
Green Infrastructure Overview
Construction, Inspection, and Maintenance

- Stormwater BMP Maintenance
  DPW Staff and Municipal
  Stormwater Managers
- 10.31.17

Horsley Witten Group, Inc.

MASSACHUSETTS OFFICE OF COASTAL ZONE MANAGEMENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SEAL OF THE TOWN OF BARNSTABLE, MASS. 1639. ADOPTED MAY 4, 1889

BARNSTABLE CLEAN WATER COALITION

APCC Association to Preserve Cape Cod

PRESENTATION OUTLINE

- **8:15 - 8:45 Green Infrastructure Practice Overview**
- Why Green Infrastructure (GI)
- Overview of GI BMPs and how they work
- Using the right GI in the right places (will cover this as we go)

Bioretention at Heritage Museum and Gardens, Sandwich, MA

Many Cape Estuaries Impaired by Excess Nitrogen and Bacteria

Negative Effects on the Environment and Community

- Algal blooms from excessive nutrient delivery; loss of aquatic grasses (eelgrass); low dissolved oxygen; and fish kills
- Impacts human uses (swimming, boating, fishing); aesthetics; and property values

What is Green Infrastructure?

- An approach to land development/ redevelopment that mimics nature i stormwater runoff
- A term that is used differ ent disciplines and in di ts
  - GI / GSI / LID
- Stormwa hat infiltrate, evap est and re-use stormwater e to its source as possible
  ts, shallow depressions, and vegetation minimize runoff and closely reflect natural conditions

MULTIPLE BENEFITS

Green Infrastructure Principles

Bioretention at HYA, Hyannis, MA

- Treats stormwater as a *resource* rather than a waste product
- Preserves and/or recreates natural landscape features
- Minimizes the effects of impervious cover
- Implements stormwater practices that rely on natural systems to manage runoff

Green Infrastructure Benefits

- **WATER**
  - Runoff volume reduction and less flooding
  - Natural recharge to groundwater
  - Pollutant reduction and cleaner water
- **ENERGY**
  - Reduced urban heat island effect
  - Less energy used for cooling
- **AIR QUALITY**
  - Natural uptake of pollutants from air

Bioretention at BSU, Bridgewater, MA

Green Infrastructure Benefits

- **COMMUNITY AND HABITAT**
  - Increased wildlife habitat
  - More recreational space
  - Increased property values
  - Increased public awareness
- **COSTS**
  - Reduced landscaping costs
  - Less wastewater treatment costs
  - Less life-cycle costs
- **REGULATORY COMPLIANCE**
  - Compliant with permit requirements

Mill River Park Taunton, MA

Resilience

- Flood mitigation
- Drought mitigation
- Adaptability


Before: Contamination, flood, blight


After: Multipurpose space, flood storage

East End Veteran's Memorial Park, Peabody, MA

GREEN INFRASTRUCTURE PRACTICES

Bioretention and Green Street Practices

Permeable/Porous/Pervious Pavements

Infiltration Practices

Swales and Channels

Constructed Wetlands

Rainwater Harvesting

Green and Blue Roofs

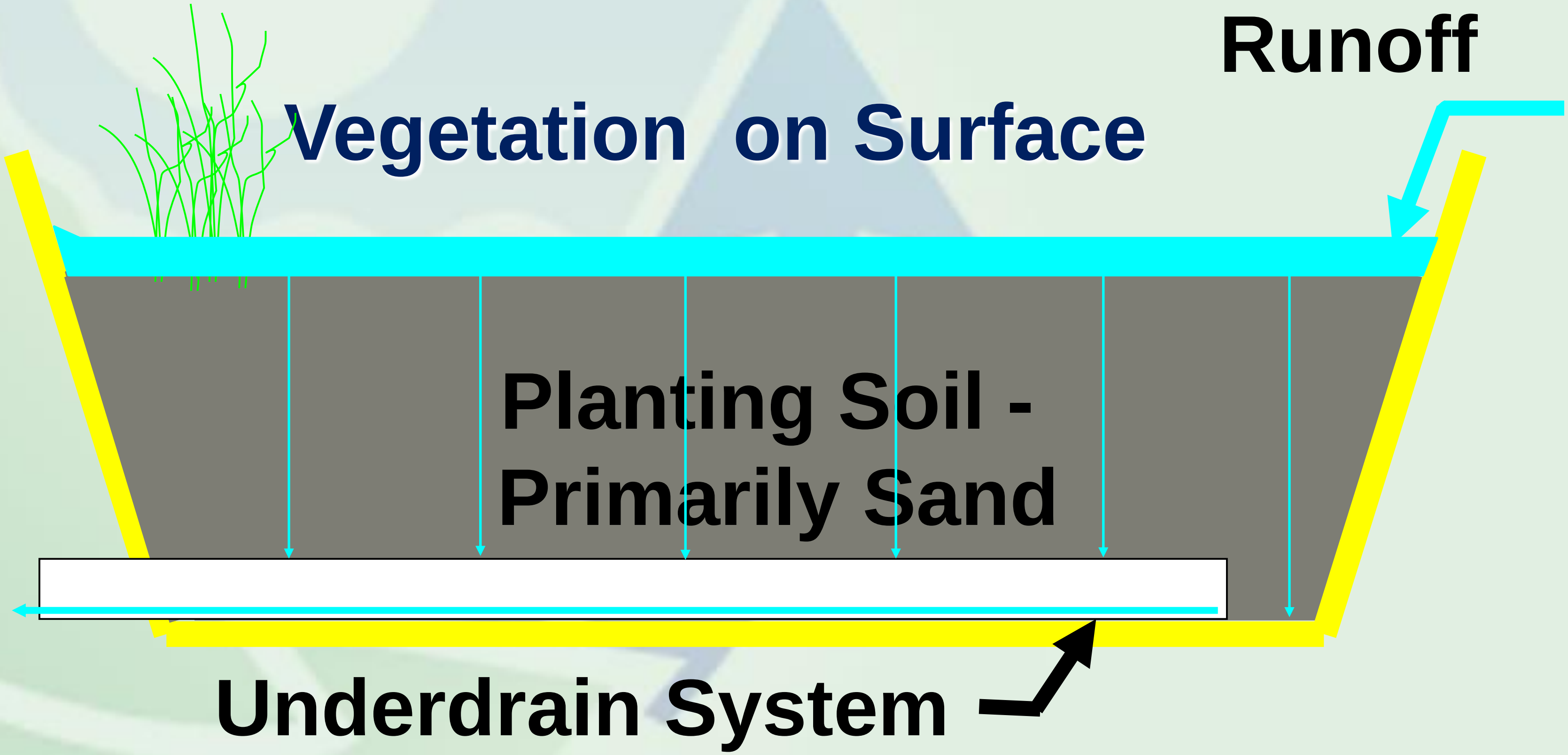
Non-Structural Practices

Bioretention and Green Streets

Shallow landscaped depression designed to capture stormwater runoff for treatment and/or infiltration through natural processes.

- Practice Variants:
  - Bioretention
  - Tree Filters
  - Stormwater Planters
  - Rain Gardens

Bioretention Schematic



Bioretention at Steamship Auth, Palmer Ave, Falmouth, MA

Green Streets

Bioretention Benefits

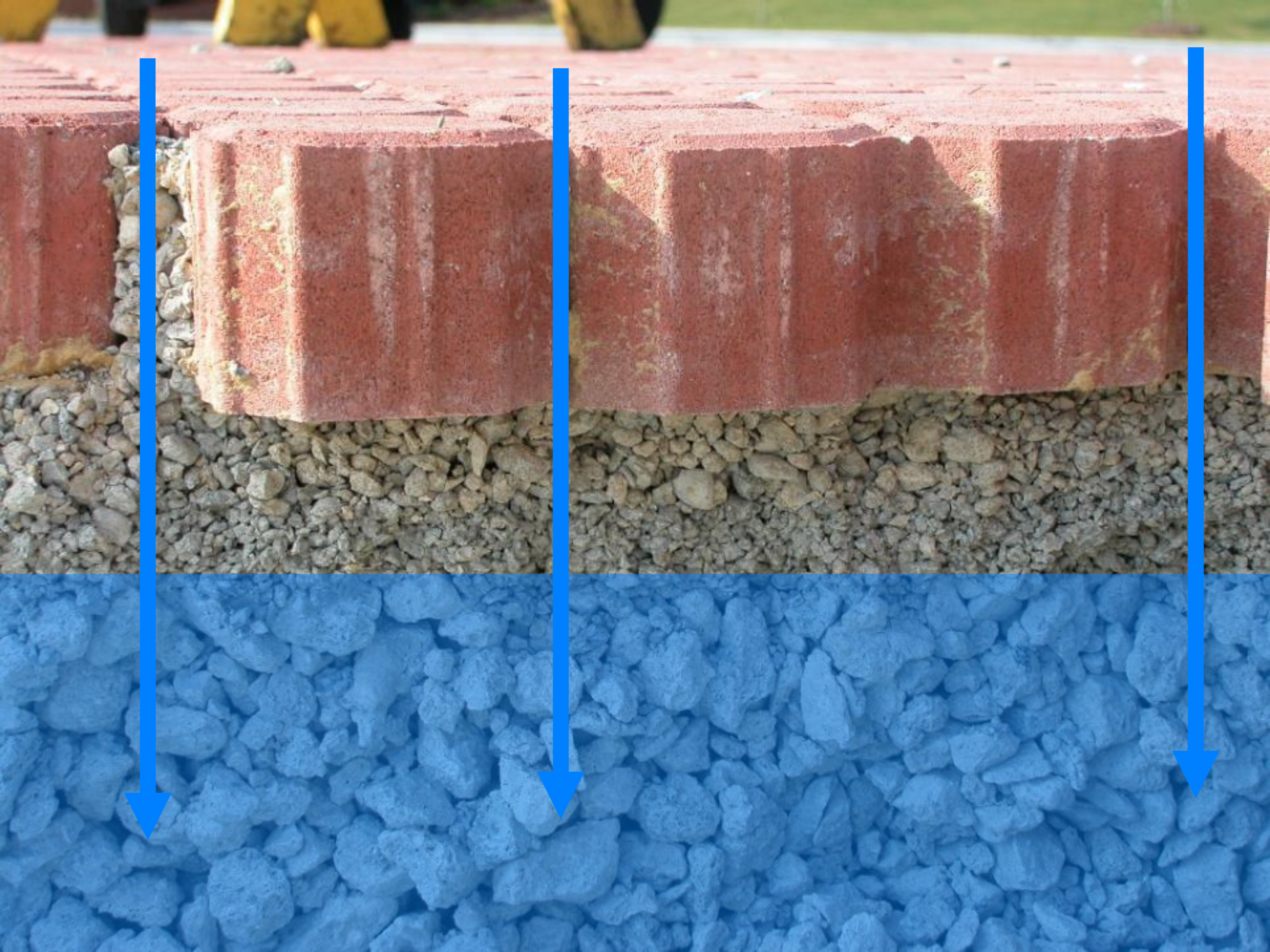
- Benefits:
  - Versatile practice
  - Runoff reduction, promotes recharge
  - Good pollutant removal (> 80% of sediment)
  - Aesthetics (combine with site landscaping)
  - Modest space consumption
  - Natural approach, affecting air quality, temperature, & habitat

Permeable/Porous/Pervious Pavements

Permeable surface material that allows rainfall to percolate through the media into underlying soils or drainage collection system.

- Practice Variants:
  - Permeable pavers
  - Porous asphalt
  - Pervious concrete
  - Proprietary materials (pre-cast pervious slabs, recycled tires/glass)

Permeable Paver Options



Permeable Pavement Benefits

- Benefits:
  - Several design options
  - Runoff reduction, promotes recharge
  - Excellent pollutant removal (> 90% of sediment)
  - Aesthetics (mostly applies to pavers)
  - No additional space consumption
  - Reduces need for sand and salt for winter snow/ice management

Infiltration

Stormwater control practices designed to infiltrate runoff into the underlying soils and ultimately recharge the groundwater.

- Practice Variants:
  - Infiltration basins
  - Infiltration trenches
  - Underground chambers
  - Dry wells

Infiltration Benefits


Buckman Heights courtyard with infiltration garden

- Benefits:
  - Versatile practice
  - Runoff reduction, promotes recharge
  - Excellent pollutant removal (> 90% of sediment)
  - Aesthetics (combine with site landscaping)
  - Modest space consumption
  - Possible to manage a range of storms from small to large

Swales and Open Channels

- Removes pollutants through particle settling and filtration.
- Infiltration typically occurs as water flows across the surface.
- Compost amendments can increase infiltration and water storage, and improve plant health.

Design variants:

Dry swale, wet swale, bioswale, grass channel

Swales and Open Channels

Bioswale , New York, NY

Bioswale at Heritage Museum & Gardens,
Sandwich, MA

Swale/Channel Benefits

Wet Swale at Roger Williams Park, Providence, RI

- Benefits:
  - Linear practice (good for roads/highways)
  - Runoff reduction, can promotes recharge
  - Mixed pollutant removal (possible bacteria source – birds/pets/other wildlife)
  - Aesthetics (combine with site landscaping)
  - Modest space consumption
  - Best in flatter slopes; design variants allow for use in places with high gw/poor soils

Regenerative Conveyance System (aka, Step-pool Bioretention)

- Channel that both conveys flows and promotes infiltration and groundwater recharge
- Good for steep sloping areas with land area constraints

RCS at Sawmill Pond, N. Kingstown, RI

Constructed Stormwater Wetlands

- Wet vegetated treatment systems incorporating natural wetland elements
- Combines detention and retention elements that can manage a wide range of storm events (WQ to Q_{100})

Design variants:

- Shallow Marsh Wetland (aka, surface wetland)
- Ext. det. Wetland
- Gravel Wetland
- Wet Swale

Const. Wetland at Scouting Way, Peabody, MA

Constructed Stormwater Wetland Benefits

Gravel Wetland at Maine Mall, S. Portland, ME

- Benefits:
  - Can manage a range of storms (WQ to 100 yr)
  - Versatile practice; good in high gw conditions
  - Good pollutant removal (especially nitrogen)
  - Natural Aesthetics and provides wildlife habitat
  - Lower maintenance
  - Typically more cost effective than smaller “on-site” GI

Constructed Stormwater Wetlands

WVTS in Chepachet Village, Glocester, RI

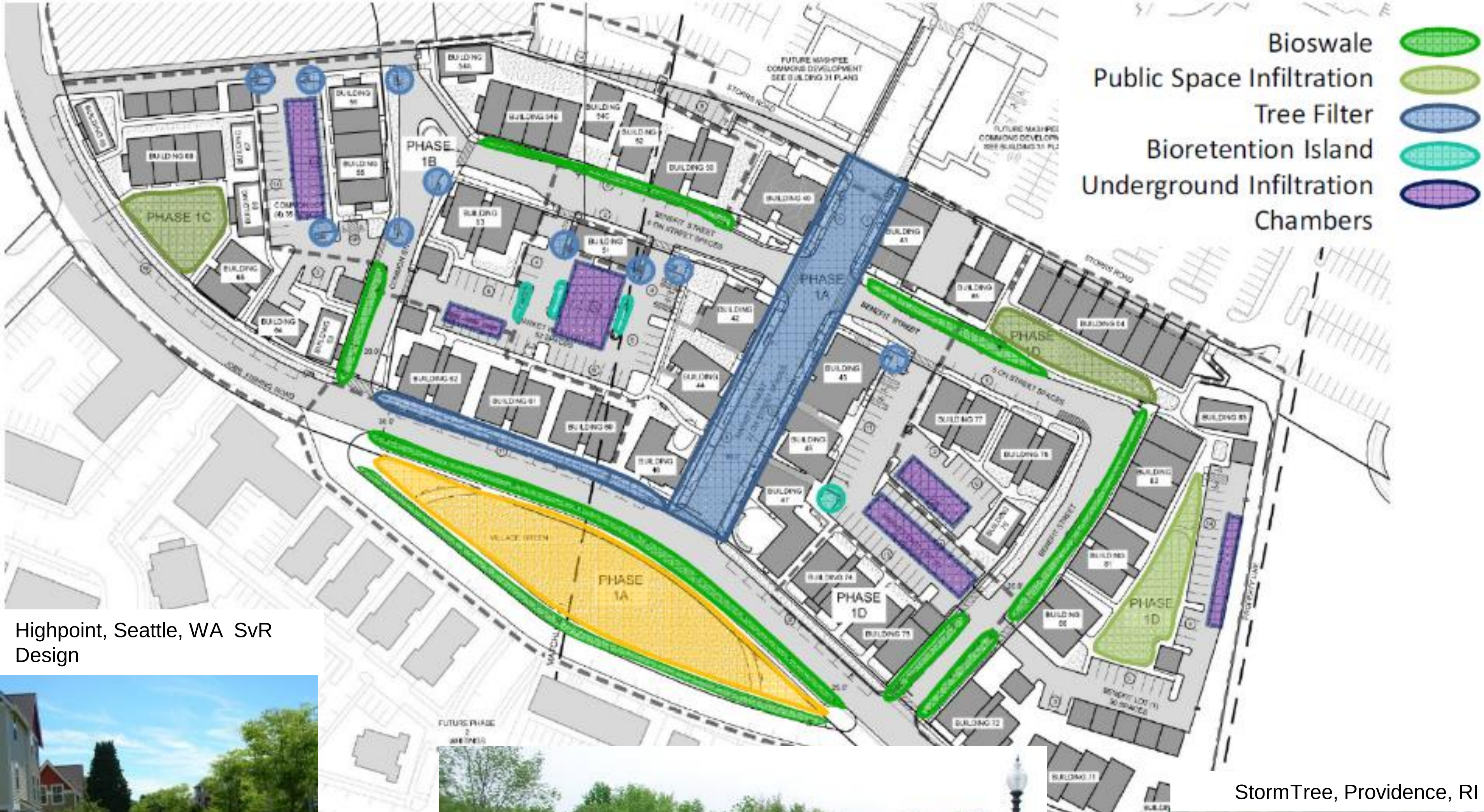
Constructed Stormwater Wetlands

Gravel Wetland at Sawmill Pond, N. Kingstown, RI

Wet Swale at Roger Williams Park, Providence, RI

Mashpee Commons – Mashpee, MA

Mashpee Commons – Opportunities



Highpoint, Seattle, WA SvR Design

n Group,

StormTree, Providence, RI

A Few Challenges to GI

- Contaminated soils
  - Avoid excavation and infiltration in contaminated soils
- Areas with high potential pollutant load or discharges to sensitive resources (e.g., Zone II)
  - Infiltration prohibited or higher pretreatment standards
- Class V well registration
  - Infiltration practices that are deeper than they are wide
- Conflicts with local development codes
  - Subdivision rules may require curbs, two sidewalks, wide roads, stormwater catch basins and pipes, and prescribed street trees, which all can limit flexibility for GI

In Summary….

- Green Infrastructure is a useful tool for maintaining, mimicking and restoring natural hydrology and protecting water quality in the developed landscape.

- It is flexible, effective, and achieves multiple other benefits.