Green Infrastructure Overview

Presented at ANJEC Congress
October 14, 2022
Christopher C. Obropta, Ph.D., P.E.
obropta@envsci.rutgers.edu
Impervious Surfaces

More development → More impervious surfaces → More stormwater runoff
The Urban Water Cycle

- **Precipitation**
- **Sublimination**
- **Condensation**
- **Limited Transpiration**
- **Roof Runoff**
- **Stormwater Runoff**
- **Limited Infiltration**
- **Road Runoff**
- **Increased Stream Volumes & Erosion**
- **Evaporation**

**Unfiltered Storm Sewer Discharge**
What is stormwater?

Stormwater is the water from rain or melting snows that can become “runoff,” flowing over the ground surface and returning to lakes and streams.
Water Quality
Water Quantity (flooding)
More Flooding
And even more flooding
Is Green Infrastructure a solution?

...an approach to stormwater management that is cost-effective, sustainable, and environmentally friendly.

Green Infrastructure projects:

- capture,
- filter,
- absorb, and
- reuse

stormwater to maintain or mimic natural systems and treat runoff as a resource.
Green Infrastructure

Stormwater management practices that protect, restore, and mimic the native hydrologic condition by providing the following functions:

- Infiltration
- Filtration
- Storage
- Evaporation
- Transpiration
Green Infrastructure Practices

Bioretention Systems
- Rain Gardens
- Bioswales
- Stormwater Planters
- Curb Extensions
- Tree Filter Boxes

Permeable Pavements

Rainwater Harvesting
- Rain barrels
- Cisterns

Dry Wells

Rooftop Systems
- Green Roofs
- Blue Roofs
TYPES OF BIORETENTION

Larger Bioretention Systems
  – Single-family lots
  – Commercial areas
  – Parking lots

Rain Gardens
  – Single-family lots
  – Small commercial areas

Bioretention Swales/Bioswales/Vegetated Swales
  • Typically in right-of-way

Planters & Planter Boxes
  – Highly urban areas
  – Right-of-way and adjacent to buildings

Vegetated Curb Extensions
  – Bioretention incorporated into right-of-way in urban and suburban areas
Rain Gardens

BERM
The berm is constructed as a barrier to control, slow down, and contain stormwater.

PONDING AREA
The ponding area is the lowest, deepest visible area of the garden. When designed correctly, this area should drain within 24 hours.

NATIVE PLANTS
A rain garden is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions.

DRAINAGE AREA
This is the area of impervious surface that drains stormwater runoff to the rain garden.

INLET
This is the area where stormwater enters. The inlet is often lined with stone to slow water flow and prevent erosion.

CURB CUT
This curb cut and concrete flow pad are designed to help redirect stormwater runoff to the rain garden system and out of the storm drain.
Lots of Rain Gardens
**Bioswale**

**Native Plants**
A bioswale is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions. The vegetation helps filter stormwater runoff as it moves through the system.

**Conveyance**
Unlike other systems, the bioswale is designed to move water through a vegetative channel as it slowly infiltrates into the ground.

**Slope**
The slope is designed at a maximum of 3:1. These slopes often require erosion control materials for stabilization.

**Inflow**
This is the area where stormwater enters.
Stormwater Planters

NATIVE PLANTS
A stormwater planter is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions.

CURB CUT
This curb cut and concrete flow pad are designed to help redirect stormwater runoff to the rain garden system and out of the storm drain.

INLET
This is the area where stormwater enters. The inlet is often lined with stone to slow water flow and prevent erosion.

CONCRETE WALL
Concrete walls are installed to match the existing curb. These walls create the frame for the stormwater planter and continue to function as a curb.

SUBGRADE
Stormwater planter systems are unique because of their subgrade structure. This structure is layered with bioretention media, choker course, compact aggregate, and soil separation fabric.
Permeable Pavement

Porous Asphalt
It is common to design porous asphalt in the parking stalls of a parking lot. This saves money and reduces wear.

DRAINAGE AREA
The drainage area of the porous asphalt system is the conventional asphalt cartway and the porous asphalt in the parking spaces. Runoff from the conventional asphalt flows into the porous asphalt parking spaces.

Subgrade
Porous pavements are unique because of their subgrade structure. This structure includes a layer of choker course, filter course, and soil.

Underdrain
Systems with low infiltration rates due to soil composition are often designed with an underdrain system to discharge the water.

Asphalt
This system is often designed with conventional asphalt in areas of high traffic to prevent any damage to the system.
Permeable Pavements

- Underlying stone reservoir
- Porous asphalt and pervious concrete are manufactured without "fine" materials to allow infiltration
- Grass pavers are concrete interlocking blocks with open areas to allow grass to grow
- Permeable pavers systems are concrete pavers with infiltration between the spaces of the pavers
- Ideal application for porous pavement is to treat a low traffic or overflow parking area
ADVANTAGES

• Manage stormwater runoff
• Minimize site disturbance
• Promote groundwater recharge
• Low life cycle costs, alternative to costly traditional stormwater management methods
• Mitigation of urban heat island effect
• Contaminant removal as water moves through layers of system

COMPONENTS

Design Guidelines for Porous Asphalt with Subsurface Infiltration

- Uncompacted subgrade is critical for proper infiltration
- Uniformly graded stone aggregate with 40% void space for stormwater storage and recharge
- Filter fabric lines the subsurface bed
- Riverjacks open into recharge bed

- Porous asphalt pavement
Porous Asphalt
Pervious Concrete
Grass Pavers
Rainwater Harvesting Systems

- **Drainage Area**: This is the area of impervious surface that is captured in the rainwater harvesting system. In this case, it is a structure like a rooftop.

- **Gutter**: This captures runoff from the rooftop and carries it to the rainwater harvesting system.

- **First Flush Diverter**: This mechanism is installed to bypass the first several gallons of runoff which tend to be the dirtiest water before it enters the tank.

- **Cistern Tank**: This tank is designed in different sizes to accommodate the runoff from a designated drainage area.

- **Overflow**: This mechanism is designed to act as a discharge for the water when the cistern is full or when it is winterized.

- **Spigot**: A spigot is installed near the base of the cistern tank to allow water to be removed for use without an electronic pump system.

- **Sediment**: Sediment and other pollutants that enter the tank will settle to the bottom.
Rain Barrels
Cisterns
Let’s get back to flooding – bioretention is an option but does it take up too much space?
Design Guidelines for Porous Asphalt with Subsurface Infiltration

RIVERJACKS OPEN INTO RECHARGE BED

POROUS ASPHALT PAVEMENT

UNCOMPACTED SUBGRADE IS CRITICAL FOR PROPER INFILTRATION

FILTER FABRIC LINES THE SUBSURFACE BED

UNIVERSALLY GRADED STONE AGGREGATE WITH 40% VOID SPACE FOR STORMWATER STORAGE AND RECHARGE
What if …

every time we repave a parking lot in New Jersey, we convert it into a stormwater management system. For every acre of parking lot, we can capture stormwater runoff from the 100-year storm from four to five acres of impervious surfaces. When we include a rain garden, we can further increase the benefits.
In the meantime, do your part and install a rain garden.
Questions?

Chris Obropta: obropta@envsci.rutgers.edu
Hollie DiMuro: hdimuro@envsci.rutgers.edu