

INTRODUCTION TO GREEN INFRASTRUCTURE ELEMENTS

Green Infrastructure Information and Case Studies: What is Green Infrastructure?

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Section 502 of the Clean Water Act defines green infrastructure as "...the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspire stormwater and reduce flows to sewer systems or to surface waters." ¹

Stormwater runoff is a major cause of water pollution in urban areas. When rain falls on our roofs, streets, and parking lots in cities and their suburbs, the water cannot soak into the ground, as it would in a natural environment. Stormwater drains through gutters, storm sewers, and other engineered collection systems and is discharged into nearby water bodies.

Conventional piped drainage and water treatment systems are designed to quickly move urban stormwater away from the built environment, increasing the amount, speed and force of the water and the trash, bacteria, heavy metals, and other pollutants carried from the urban landscape to waterways.

Higher flows resulting from heavy rains also can cause erosion and flooding in urban streams, damaging habitat, property, and infrastructure.

Green infrastructure is designed to store water as close as possible to where the rain falls. Like rain that falls in natural, undeveloped areas, the water is absorbed and filtered by soil and plants allowing water delivered to lakes and streams to create healthier urban environments.

At the neighborhood or site scale: green infrastructure stormwater systems manage wet weather impacts by mimicking one or more characteristics of natural drainage systems.

At the city or county scale: green infrastructure can form a patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water.

Green infrastructure Benefits include: reduced stormwater volumes and pollutants, increased environmental, social, and economic benefits cost-effectiveness, resilience to changing stormwater flow and intensity.

Community scale benefits: recreational, health, habitat, cooling, infiltration, groundwater recharged, and less flash flooding.

This information is to help inform a discussion about common green infrastructure elements implemented on a neighborhood-scale and relationships to sites and larger scale elements spanning a watershed.

Individual Elements combine to make a "Green Infrastructure Stormwater System"

¹ <https://www.epa.gov/green-infrastructure/what-green-infrastructure> . This presentation incorporates information from the EPA Green Infrastructure website.

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DOWNSPOUT DISCONNECTION

This simple practice reroutes rooftop drainage pipes from draining rainwater into the storm sewer to draining it into rain barrels, cisterns, or permeable areas. Uses: store stormwater, infiltration to soil. It can be especially beneficial to cities with combined sewer systems. Water from the roof flows from this disconnected downspout into the ground through a filter of pebbles.



- [Milwaukee Downspout Disconnection](#) [EXIT](#)
- [Portland, OR, Downspout Disconnection Program](#)

RAINWATER HARVESTING



Rainwater harvesting systems collect and store rainfall. Uses: slows and reduce runoff and provide a source of water. This practice could be particularly valuable in arid regions, where it could reduce demands on increasingly limited water supplies.

- [New York City Rain Barrel Giveaway Program](#)
- [Arizona Municipal Water Users Association](#)

RAIN GARDENS

Rain gardens can be installed in almost any unpaved space. Also known as bioretention, or bioinfiltration, cells, they are shallow, vegetated basins that collect and absorb runoff from rooftops, sidewalks, and streets. This practice mimics natural hydrology by infiltrating, and evaporating and transpiring—or “evapotranspiring”—stormwater runoff.

- [Burnsville, MN, Stormwater Retrofit Study \(PDF\)](#) (18 pp, 2.7 MB, [About PDF](#)) [EXIT](#)
- [12,000 Rain Gardens in Puget Sound](#) [EXIT](#)



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PLANTER BOXES



Planter boxes are an attractive tool for filtering stormwater as well as reducing the runoff that goes into a sewer system. Planter boxes are urban rain gardens with vertical walls and either open or closed bottoms. They collect and absorb runoff from sidewalks, parking lots, and streets and are ideal for space-limited sites in dense urban areas and as a streetscaping element.

- [Michigan Avenue Streetscape EXIT](#)
- [Philadelphia Water Department EXIT](#)

BIOSWALES



Bioswales are vegetated, mulched, or xeriscaped channels that provide treatment and retention as they move stormwater from one place to another. Vegetated swales slow, infiltrate, and filter stormwater flows. They are particularly well suited to being placed along streets and parking lots.

[Wisconsin Department of Natural Resources Technical Standard](#)

PERMEABLE PAVEMENTS



Permeable pavement is a good example of a practice that catches water where it falls. Permeable pavements infiltrate, treat, and/or store rainwater where it falls. They can be made of pervious concrete, porous asphalt, or permeable interlocking pavers. Particularly cost effective where land values are high and flooding or icing is a problem.

- [Use of Pervious Concrete Eliminates over \\$260,000 in Construction Costs in Sultan, WA EXIT](#)
- [Designing Impervious: A Minnesota city eschews storm drains for pervious streets EXIT](#)

(Shoreville, MN).

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Green infrastructure can capture stormwater that would usually flow into the sewer system

GREEN STREETS AND ALLEYS



Green streets combine more than one feature to capture and treat stormwater. Green streets and alleys are created by integrating green infrastructure elements (Permeable pavement, bioswales, planter boxes, and trees) into their design to store, infiltrate, and evapotranspire stormwater.

- [Los Angeles Green Street: Elmer Ave](#) [EXIT](#)
- [The Chicago Green Alley Handbook \(PDF\)](#)(24 pp, 3.7 MB, [About PDF](#)) [EXIT](#)

- [EPA Region 3 Green Streets, Green Jobs, Green Towns \(G3\) Program](#)
- [Seattle Public Utilities GSI Projects](#)
- [Syracuse Green Street: Concord Place \(PDF\)](#)(2 pp, 220 K, [About PDF](#)) [EXIT](#)

GREEN PARKING



Many green infrastructure elements can be seamlessly integrated into parking lot designs. Permeable pavements can be installed in sections of a lot and rain gardens and bioswales can be included in medians and along the parking lot perimeter. Benefits include mitigating the urban heat island and a more walkable built environment.

- [Ipswich River Watershed Demonstration Project in Wilmington, MA](#)

- [Toronto Design Guidelines for “Greening” Surface Parking Lots \(PDF\)](#)(40 pp, 9.6 MB, [About PDF](#)) [EXIT](#)

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GREEN ROOFS



A green roof system atop a building helps manage stormwater and reduce energy costs for cooling. Green roofs are covered with growing media and vegetation that enable rainfall infiltration and evapotranspiration of stored water. They are particularly cost-effective in dense urban areas where land values are high and on large industrial or office buildings where stormwater management costs are likely to be high.

Examples

- [King County, WA, Green Roof Case Study Report \(PDF\)](#) (31 pp, 1 MB, [About PDF](#))
- [Green Roof and Wall Projects Database](#) [EXIT](#)

URBAN TREE CANOPY



City trees soak up stormwater, provide cooling shade and help to slow traffic. Trees leaves and branches reduce and slow rain and reduce stormwater. Many cities have set tree canopy goals to restore some of the predevelopment benefits of trees. Homeowners, businesses, and community groups can participate in planting and maintaining trees.

- [Chicago Trees Initiative](#) [EXIT](#) [Water Department: Stormwater Tree Trench](#) [EXIT](#)

LAND CONSERVATION



Land conservation is another good tool for communities to use for reducing the risks of stormwater runoff and sewer overflows. The water quality and flooding impacts of urban stormwater also can be addressed by protecting open spaces and sensitive natural areas within and adjacent to a city while providing recreational opportunities for city residents. Natural areas that should be a focus of this effort include riparian areas, wetlands, and steep hillsides.

- [Green Seams: Flood Management in Milwaukee](#) (8 pp, 233 K,