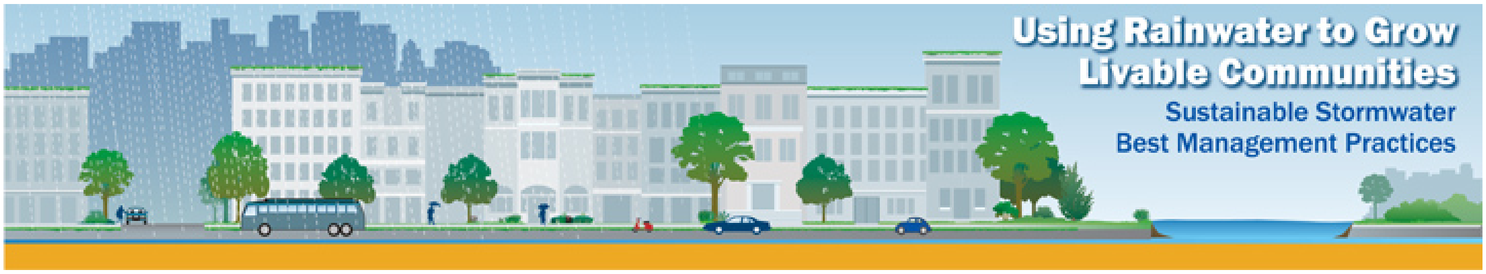

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Green Streets Basics and Design

BMPs to Programs

The evolution from centralized stormwater management to greener, more sustainable BMPs necessitates a progression from installing individual practices to implementing broader water quality programs. Conventional end-of-pipe management practices are often installed myopically, focused primarily on collecting runoff from one drainage area. The first applications of stormwater BMPs were similarly applied, focused on addressing runoff from a small area. However, rather than installing a single rain garden or green roof disconnected from a larger network of management practices, stormwater BMPs can be components of broad program initiatives intended to address significant sources of pollution.

Green streets are an example of how individual stormwater BMPs are used as elements of a broader program aimed at mitigating a significant source of stormwater pollution. Urban roads, along with sidewalks and parking lots, are estimated to constitute almost two-thirds of the total impervious cover in urban areas and contribute a similar ratio of runoff. Green streets use combinations of stormwater BMPs to enhance water quality and improve the design and function of urban roads. WERF defines green streets as those that:

- Mimic local hydrology prior to development
- Provide multiple benefits including
  - Stormwater management and volume reductions
  - Providing a key link in the green infrastructure network
  - Enhancing aesthetics
  - Improving local air quality by intercepting airborne particulates and providing shade
  - Enhancing economic development
  - Improving the pedestrian experience

The use of green streets allows stormwater BMPs to act in a broader environmental capacity than solely managing stormwater. For example, Chicago's Green Alley program, by using light-colored permeable and recycled concrete, addresses urban heat island and material disposal issues simultaneously with stormwater management.

Common Elements of Green Streets

Green streets can incorporate a wide variety of design elements including street trees, permeable pavements, bioretention, and swales. Although the design and appearance of green streets will vary, the functional goals are the same. Green streets techniques will encourage the interaction of stormwater with soil and vegetation to promote infiltration and retention.

Narrower Street Widths

One reason that streets constitute such a significant source of stormwater volume and pollution is the impervious area associated with them. Green streets first reduce stormwater impacts by eliminating unnecessary impervious area. Many urban and suburban streets are sized to meet code requirements for emergency service vehicles, on-street parking, and free flow of traffic. These code requirements often result in streets being oversized for their typical everyday functions. The Uniform Fire Code requires that streets have a minimum 20 feet of unobstructed width; a street with parking on both sides would require a width of at least 34 feet. In practice, many suburban and urban streets may be much wider than this as local design practices have increased street widths to 40 and 50 feet. There is often a large percentage of street impervious area that serves no practical purpose other than generating stormwater runoff. In addition to stormwater concerns, wide streets have many detrimental effects on neighborhood livability, traffic conditions, and pedestrian safety.

Many communities have adopted narrower street width standards while also accommodating emergency vehicles by developing alternative street parking configurations, prohibiting parking near intersections, providing vehicle pullout space, and using smaller block lengths. A key to identifying and successfully codifying narrow street widths is coordination amongst departments, including fire, transportation, and public works.

Examples of Adopted Narrow Street Widths

Jurisdiction	Street Width (in feet)	Parking Condition
Phoenix, AZ	28	parking both sides
Santa Rosa, CA	30 26-28 20 20	parking both sides, <1000ADT parking one side no parking neck downs at intersection
Orlando, FL	28 22	parking both sides, res. Lots>55' wide parking both sides, res. Lots>55' wide
Birmingham, MI	26 20	parking both sides parking one side
Howard County, MD	24	parking unregulated
Kirkland, WA	12 20 24 28	alley parking one side parking both sides - low density only parking both sides
Madison, WI	27 28	parking both sides, <3DU/AC parking both sides, 3-10 DU/AC

ADT: Average Daily Traffic; DU/AC: dwelling units per acre

Bioretention

Bioretention offers an effective multi-purpose green street stormwater management strategy. Bioretention features can be tree boxes that collect stormwater runoff from the street (similar to conventional tree boxes), planter boxes, curb extensions, or bioswales. To adapt to street configurations, grades, soil conditions, and space availability, a range of shapes, sizes, and layouts can be used. This design flexibility, while a positive, has also slowed the incorporation of street bioretention into municipal Department of Transportation (DOT) construction specifications and standards. A few municipal DOT programs have instituted green street requirements in roadway projects, but widespread incorporation is still lacking.

Bioretention can be used to create a green street by managing street and sidewalk runoff (Source: Abby Hall, US EPA)

Selecting plants that are suitable for vegetated stormwater management is also important for bioretention. Appropriate plants are typically natives that flourish in the regional climate conditions, adapted to periodic flooding, low maintenance, and, if in cold climates, salt tolerant. Plant selection should also consider plant height with regard to driver visibility, safety, and security.

Permeable Pavement

Of all the green streets practices, municipal DOTs have been arguably most cautious about implementing permeable pavements, even though some DOTs have, for decades, specified open-graded asphalt for low use roadways because of lower cost; to minimize vehicle hydroplaning; and to reduce road noise. The reluctance to implement permeable pavements on a large-scale, however, is often because of a lack of experience with them as a stormwater management BMP.

A bioswale and permeable concrete are used for stormwater management and to enhance neighborhood aesthetics (Source: Abby Hall, US EPA)

The greatest concern for permeable pavements seems to be a perceived lack of long-term performance and maintenance data. Universities and DOTs began experimenting with permeable pavements in parking lots, maintenance yards, and pedestrian areas as early the late 1980s in the U.S. Over time, monitoring of these applications have created a large amount of data on the success of permeable pavements in nearly every climate region of the country. In recent years, municipal and private roadway pilots have demonstrated the successful use of permeable pavements.

Freeze/thaw cycles and snow plows are the major concerns for permeable pavements in cold climate communities. However, these concerns have proven to be generally unfounded when appropriate design and maintenance practices are employed. A well-designed permeable pavement structure will always drain and never freeze solid. The air voids in the pavement allow plenty of space for moisture to freeze and ice crystals to expand. Also, rapid drainage through the pavement eliminates the occurrence of freezing puddles and black ice. Municipalities in cold climates will need to make adjustments to deicing programs for permeable pavement areas—sand should not be applied because it fills the air voids. Permeable concrete and asphalt and certain permeable concrete pavers also comply with the requirements of the Americans with Disability Act.

Street Trees

Street trees provide multiple benefits to the urban landscape by reducing the urban heat island effect, reducing stormwater runoff, improving the urban aesthetic, and improving air quality. Correspondingly, they are also a critical component of green streets. Street trees are even good for the economy; customers spend 12 percent more in shops on streets lined with trees than on those without trees. However, urban environments are often inhospitable for tree growth. Trees are often given little space to grow, the soil around street trees often becomes compacted during the construction of paved surfaces, and underground utilities encroach on root space.

If tree roots are surrounded by compacted soils or are deprived of air and water by impervious streets and sidewalks, their growth will be impaired, their health will decline, and their expected life span will be cut short. By providing adequate soil volume and a good soil mixture, the benefits obtained from a street tree multiply. To obtain a healthy soil volume, install larger tree boxes or use structural soils, root paths, or "silva cells" used under sidewalks or other paved areas. These options allow tree roots the space they need to grow to full size.

Street trees lining a sidewalk (Source: Casey Trees)

Silva cell structures support the sidewalk while providing root space for street trees (Source: Deep Root Partners, LP)

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Water Environment Research Foundation 635 Slaters Lane, Suite G-110 Alexandria, VA 22314 Tel: 571-384-2100 Fax: 703-299-0742