City of Philadelphia Green Streets Design Manual

Philadelphia Water Department | Streets Philadelphia

MAYOR'S OFFICE OF TRANSPORTATION AND UTILITIES

2014

Green Street Stormwater Management Practices

chapter 2

2.1 Introduction to Stormwater Management Practices (SMPs) Appropriate for the Right-of-Way

Within this Manual, a variety of designs are presented: Stormwater Planters, Stormwater Bump-outs, Stormwater Trees, Stormwater Tree Trenches, Permeable Pavement. Each of these SMPs is designed to help infiltrate and detain stormwater runoff within the right-of-way.

Any GSI proposed in the right-of-way must consider the effects the SMPs will have on the existing street and all of its users, including motorists, bicyclists, and pedestrians. Well-designed SMPs with rich plantings and quality building materials can be a centerpiece, gateway feature or community enhancement near residences, parks, plazas, bus stops, and in parking areas. Plant material within green stormwater infrastructure facilities can be selected to tolerate salts, drought and temporary inundation, depending on individual site conditions. Additionally, their visibility at the street level provides opportunities for green stormwater infrastructure-related educational and interpretive signage.

Storage and treatment capacity can be increased by connecting green stormwater infrastructure facilities so that they operate as one system along the street. Multiple facilities can treat more runoff, and the total street system must be designed to respond to the many different site conditions that might promote, or negate, the use of certain facilities.

Stormwater management practices are divided into two categories for the purposes of this manual. For those currently in use by the Water Department, typical design and related standards are provided. For those not yet in practice, which will be evaluated through piloting and application in the coming years, standards will be developed and incorporated in a future version of the manual.

2.2 Stormwater Management Practices – Currently Used

Over the past decade, the Water Department has made a significant commitment to the design and construction of GSI demonstration projects throughout the City. By implementing a number of projects aimed at demonstrating the utility of various green stormwater control technologies in highly urbanized areas, the Water Department has helped to raise awareness of GSI among City residents and the regulatory community.

The following practices have been implemented within the City of Philadelphia:

- Stormwater Trees
- Stormwater Tree Trenches
- Stormwater Planters
- Permeable Pavement
- Stormwater Bump-outs (midblock and corner)

2.3 Stormwater Management Practices – Under Development

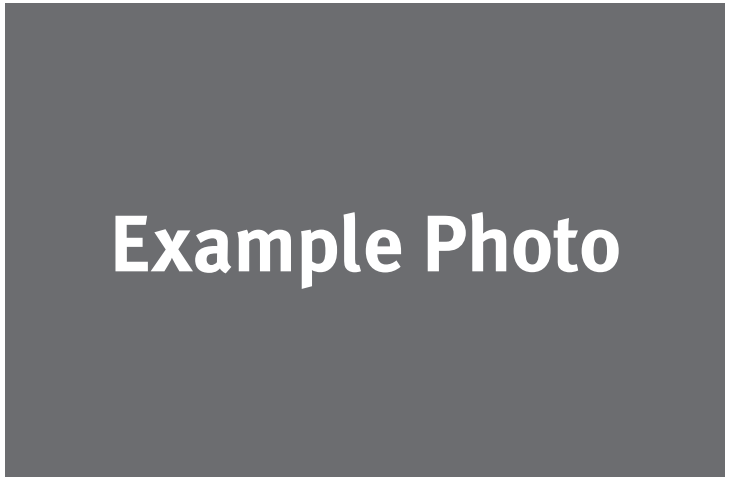
There are a number of stormwater management practices deemed appropriate for use within the right-of-way in other cities, however application of such practices has not yet been piloted within the City of Philadelphia. This section of the manual is intended to be amended as additional stormwater management techniques are identified and proposed for application on Philadelphia streets.

Two such SMPs are currently being piloted, and may become typical SMPs in the future.

- Green Gutters
- Stormwater Drainage Wells

Note that these SMPs are not exhaustive of all types of GSI practices. Other SMPs may be designed and implemented depending on the need or context.

SMP Fact Sheets



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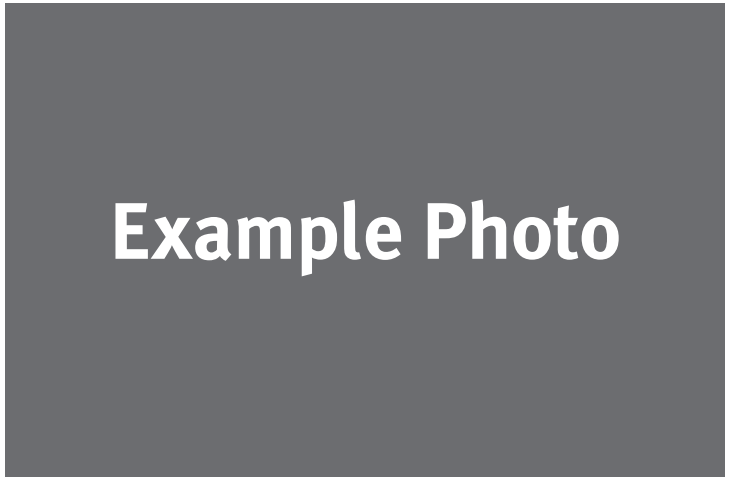


Photo Caption

Overview

A general description of the SMP is provided, including information about its function and aesthetics.

Benefits

- Information regarding benefits associated with the given SMP are listed.

Potential Constraints and Considerations

- Potential constraints and considerations associated with the use of a particular SMP in a given street context are highlighted.

Interaction with Bicyclists and Pedestrians

- Potential for an SMP to have implications on bicyclists and/or pedestrians are highlighted

Urban Design Context

- A description of how this SMP fits in with or complements the urban design context is provided.

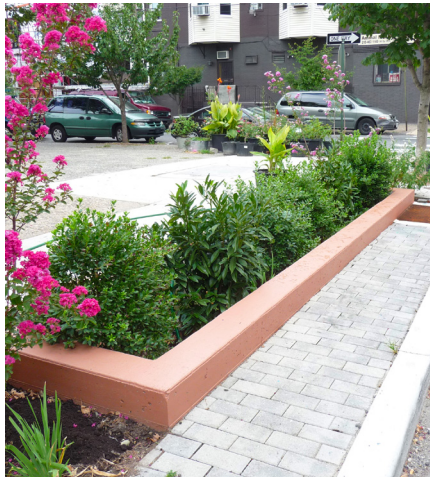
Maintenance

- A general overview of maintenance tasks associated with a given SMP are noted.

Examples

- Examples of projects in Philadelphia where this SMP has been implemented are provided.

Stormwater Planter



Columbus Square

The Philadelphia Navy Yard

Overview

A stormwater planter is a specialized, landscaped planter installed in the sidewalk area and designed to manage stormwater runoff. Runoff is routed to the planter by setting the top of the planting media in the planter lower than the street's gutter elevation and connecting the planter to one or more inlets (types vary), allowing stormwater runoff from the street to flow into the planter. Runoff from the adjacent sidewalk can flow directly into the stormwater planter from the surface. Plantings are incorporated within the facility to provide uptake of water and pollutants. Though stormwater planters can be designed in a variety of shapes and sizes, they are typically rectangular in form with vertical sidewalls on all four sides and an open bottom.

Benefits

- Water filters through the planting soil, improving water quality.
- Provides a physical buffer between pedestrians and the street.
- Creates aesthetic improvements to streetscape.
- Can be sized and placed to fit between existing surface features such as driveways, signs, street furnishings, and street trees.
- Provides an area within the right-of-way for smaller plantings in addition to street trees.

Potential Constraints and Considerations

- Requires adequate sidewalk width to accommodate both the planter and pedestrian circulation; refer to the Complete Streets Design Handbook, Section 4.3.2
- Can sometimes be challenging to limit interior depth of planter depending on surrounding surface grades.
- Must consider step-out areas for on-street parking or vehicle stopping.

Interaction with Bicyclists and Pedestrians

- Provides a separation between pedestrians and moving traffic.
- May intrude into the walking zone a maximum width of two feet, maximum length of 10 feet, and a minimum spacing of 30 feet. Refer to the Complete Streets Design Handbook, Section 4.3.2.

Urban Design Context

- Provides a formal streetscape element.
- Edge treatment may contribute to streetscape design (i.e., a perimeter wall could be designed to function as a seat wall, a perimeter fence could be an aesthetic feature, or the edging may include artistic elements).
- Stormwater Planters are designated as a priority design treatment for all street types by the Complete Streets Design Handbook.

Maintenance

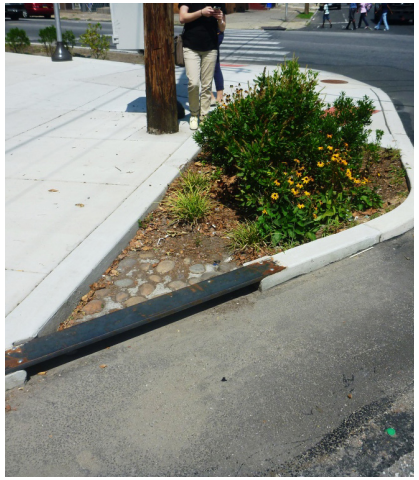
- Routine landscape maintenance needed, such as trimming, watering during droughts, weeding, and litter removal, etc.
- Routine cleaning of inlets and pipes is required.

Examples

- Columbus Square
- The Philadelphia Navy Yard

Figure 2.1: Three-Dimensional View of a Stormwater Planter

Stormwater Bump-out



Shepard Recreation Center Corner Bump-out

Queen Lane Mid-Block Bump-out

Overview

A stormwater bump-out is a landscaped curb extension that extends the existing curb line into the cartway. It is designed to manage stormwater runoff by setting the top of the planting media in the bump-out lower than the street's gutter elevation and connecting the bump-out to one or more inlets (types vary), which allows stormwater runoff from the street to flow into the bump-outs. Runoff from the adjacent sidewalk can flow directly into the stormwater bump-out from the surface. They are designed to capture, slow, and infiltrate stormwater within a planted area or subsurface stone bed. Landscape plantings within the curb extension effectively take up some of the stormwater through their root systems. The remaining stormwater is temporarily stored within the curb extension until it either infiltrates or drains back to the sewer. In mid-block bump-outs, overflow exits through an opening on the downstream side, and flows into a nearby storm drain inlet.

Benefits

- Water filters through the planting soil, improving water quality.
- Provides a physical buffer between pedestrians and the street.
- Does not require encroachment into sidewalk area.
- Encourages slower vehicle speeds by physically and visually narrowing the street.
- Reduces pedestrian crossing distances when used at intersections.
- Provides an area within the right-of-way for smaller plantings in addition to street trees.

Potential Constraints and Considerations

- Must consider existing on-street parking conditions, street width, and vehicle turning radii.
- Alteration of existing curb line will directly impact existing street drainage patterns and bump-out design must ensure existing street drainage is not negatively impacted.
- Vegetation must accommodate adequate sight distances at intersections.

Interaction with Bicyclists and Pedestrians

- Placement should avoid rerouting bicyclists.
- If placed near an intersection, care may be taken to accommodate pedestrian passage through the curb extension, which can limit its stormwater treatment capacity.
- Mid-block bump-outs should not encourage unwanted mid-block pedestrian crossings.

Urban Design Context

- May be integrated with a pedestrian seating area or transit shelter.
- The Complete Streets Design Handbook refers to these practices as Curb Extensions. Curb extensions are designated as a priority design treatment at local / local and local / major street intersections, as well as intersections wth complex geometry, by the Complete Streets Design Handbook.

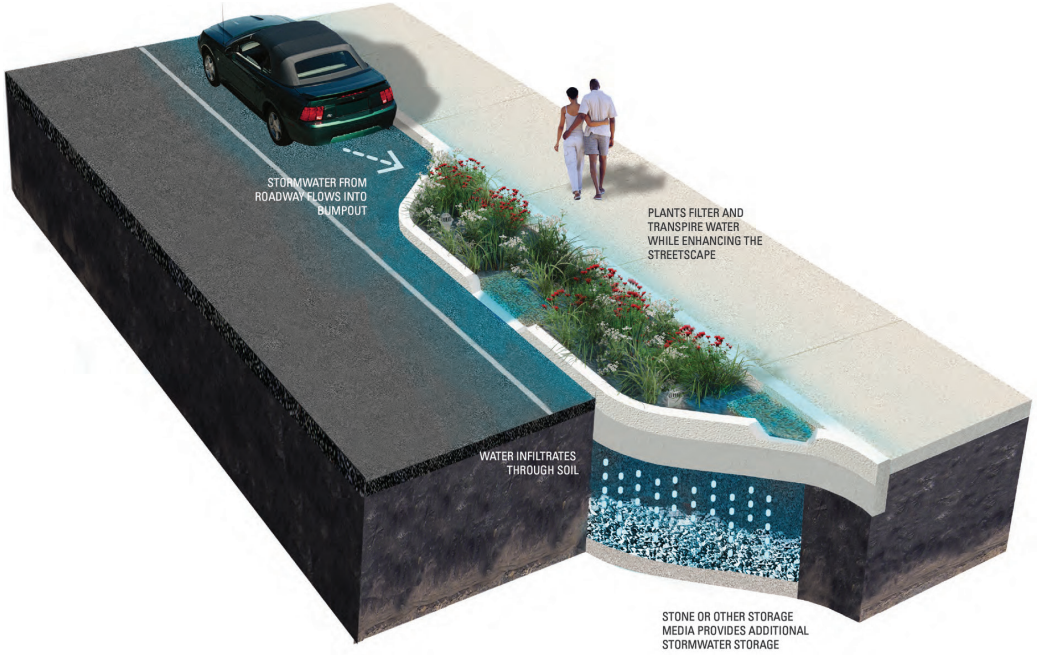
Maintenance

- Routine landscape maintenance, such as trimming, watering during droughts, weed and litter removal, etc.
- Routine cleaning of inlets and pipes is required.

Examples

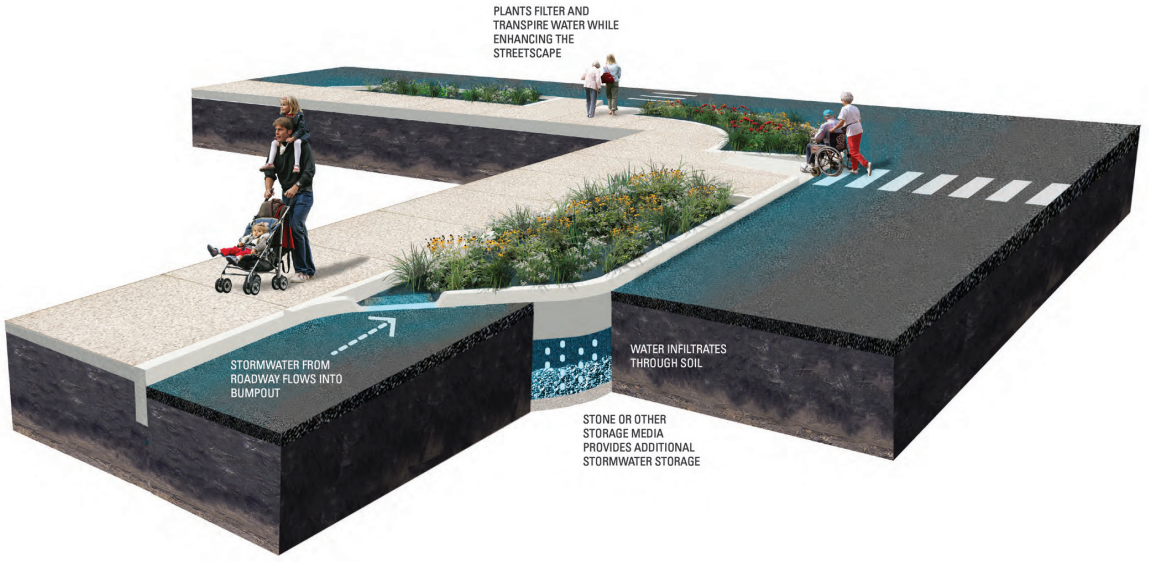
- Midblock Bump-outs: Queen Lane
- Corner Bump-outs: Shepard Rec Center at 56th and Vine; Daroff School at 57th and Haverford; 3rd and Fairmount

Figure 2.2: Three-Dimensional View of a Stormwater Bump-out



Mid-block Stormwater Bump-out

Corner Stormwater Bump-out



Stormwater Tree

Stormwater Tree Precedent

Overview

A stormwater tree is a street tree planted in a specialized tree pit installed in the sidewalk area. It is designed to manage stormwater runoff by placing the top of the planting media in the tree pit lower than the street's gutter elevation and connecting the tree pit to an inlet (types vary), which allows stormwater runoff from the street into the tree pit. Runoff from the adjacent sidewalk can flow directly into the tree pit from the sidewalk surface. Multiple tree pits can be designed in series to maximize the potential for stormwater capture and treatment. Stormwater will either infiltrate or drain to a connection to the storm sewer network. If the stormwater tree is at capacity, runoff can bypass the stormwater tree inlet and enter other downstream SMPs or a downstream storm drain.

Benefits

- Adds street trees to the streetscape.
- Requires only a small footprint and can therefore fit within a constrained site.
- Can accommodate steep topographic changes.
- Can fit between existing street furnishings such as signs, benches, hydrants and lights.

Potential Constraints and Considerations

- Limited stormwater management capacity.
- Recessed elevation of tree pit requires consideration for protecting pedestrians from step down to surface of planting media.

Interaction with Bicyclists and Pedestrians

- Street trees provide the benefit of shade and a vertical separation between pedestrians and moving traffic.
- May intrude into the walking zone a maximum width of two feet, maximum length of five feet, and minimum spacing at 30 feet. Refer to the Complete Streets Design Handbook, Section 4.3.2.

Urban Design Context

- Enhances streetscape with street trees.

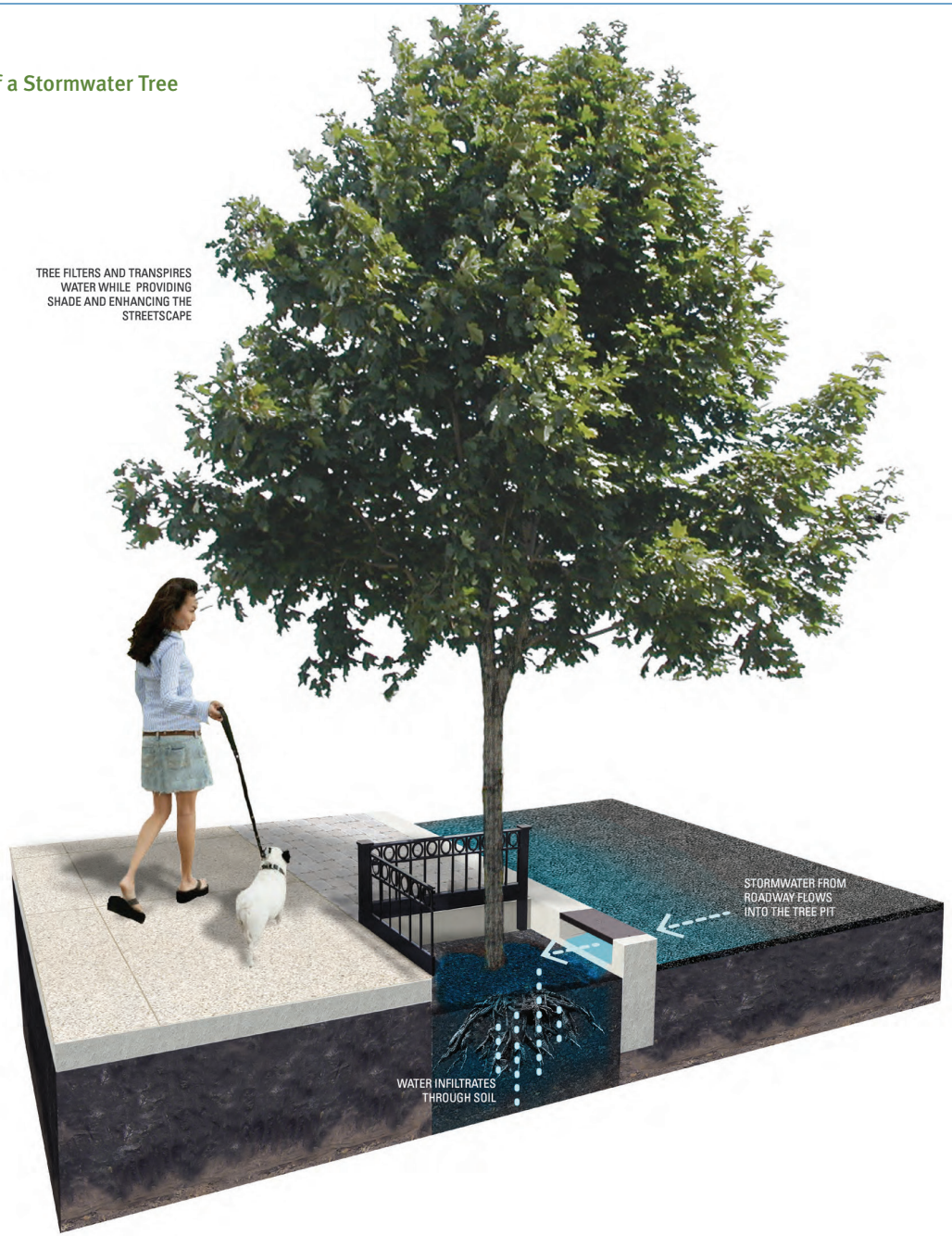
Maintenance

- Routine tree maintenance and litter removal.

Examples:

- Norris Street
- Sepviva Street
- Shissler Recreation Center

Figure 2.3: Three-Dimensional View of a Stormwater Tree



Stormwater Tree Trench

Ben Franklin Parkway

Shissler Recreation Center

Overview

A stormwater tree trench is a subsurface trench installed in the sidewalk area that includes a series of street trees along along a section or the total length of the subsurface trench. It is designed to manage stormwater runoff by connecting the subsurface trench to one or more inlets (types vary), which allows runoff from the street and sidewalk to flow into the subsurface trench. The runoff is stored in the empty spaces between the stones or other storage media in the trench, watering the trees and slowly infiltrating through the trench bottom. If the capacity of the system is exceeded, stormwater runoff can bypass the storm drain entirely and flow into an existing inlet downstream or through an underdrain system connected to the storm drain network. The surface above the trench and surrounding the street trees is restored to the elevation of the surrounding surfaces.

Benefits

- Ability to store a large volume of stormwater
- Adds street trees to the streetscape.
- Impact to existing sidewalk width, use, and surface features is similar to that of typical street tree planting because sidewalk surface is restored to grade.

Potential Constraints and Considerations

- Because flow is directed to the subsurface of the system, special attention should be paid to pretreatment.

Interaction with Bicyclists and Pedestrians

- Does not impede bicycle or pedestrian movement.

Urban Design Context

- Enhances streetscape with some or all of the following: street trees, tree grates, unit pavers.

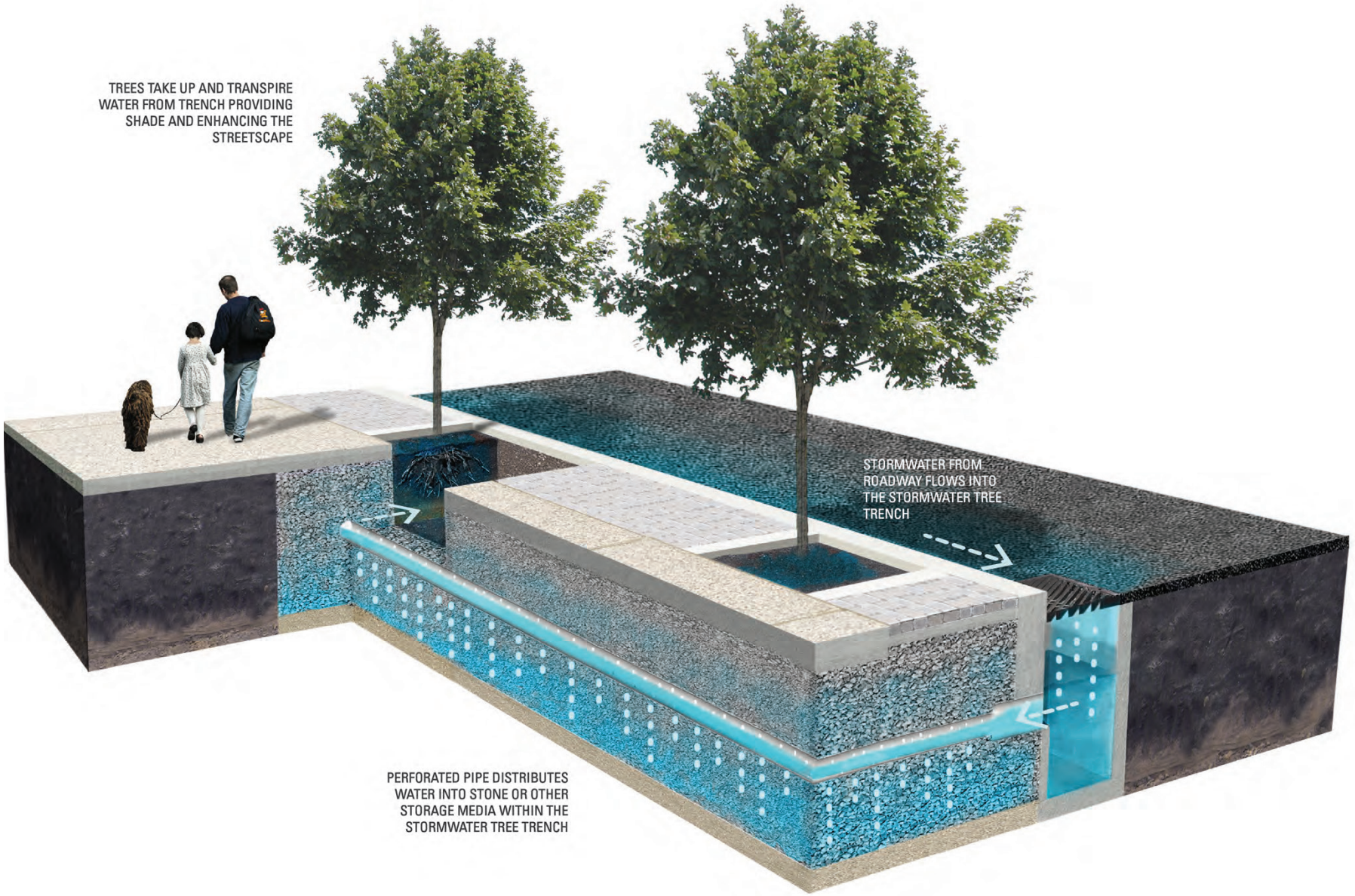
Maintenance

- Routine landscape maintenance of street trees.
- Routine cleaning of inlets and pipes is required.

Examples

- Waterview Recreation Center
- 16th and Snyder
- Ben Franklin Parkway
- Shissler Recreation Center

Figure 2.4: Three-Dimensional View of a Stormwater Tree Trench



Permeable Pavement

Percy Street

Waterview Recreation Center

Overview

Permeable pavement is a hard pavement surface consisting of materials that allow water to pass freely through the surface, thereby eliminating or reducing runoff compared to impervious paving. Permeable pavement surfaces typically include a storage media such as stone beneath the permeable surface that provides the structural support of conventional pavement and also provides temporary storage of stormwater. Permeable pavement, sometimes referred to as pervious or permeable paving/pavement, includes different types of permeable surfaces such as permeable asphalt, permeable concrete, and permeable pavers. While permeable asphalt and permeable concrete materials allow water to pass through the surface of the asphalt or concrete, permeable pavers typically allow water to pass through the joint spacing between the pavers.

Benefits

- Provides stormwater management while maintaining paved and other hardscape surfaces.
- Can be implemented in lieu of traditional pavement replacement projects.

Potential Constraints and Considerations

- Many streets in Philadelphia include an impervious concrete sub-base which would have to be removed for permeable pavement to be effective.
- Design must consider traffic loading and volume conditions.
- Designs may not allow stormwater to drain onto permeable pavements from other areas without approval by the Water Department.

Interaction with Bicyclists and Pedestrians

- Interlocking pavers should not be used in bike lanes.

Urban Design Context

- Alternating permeable paving types can help differentiate surfaces by modal use.

Maintenance

- Periodic clean out or vacuuming of surface is required.
- Ensure that no sediment builds up on the pavement. Remove sources of sediment such as erodible soils in nearby landscaped areas.

Examples:

- Percy Street (Permeable Asphalt)
- Waterview Recreation Center (Permeable Concrete)
- Queen Lane (Permeable Pavers)

Figure 2.5: Three-Dimensional View of Permeable Pavement

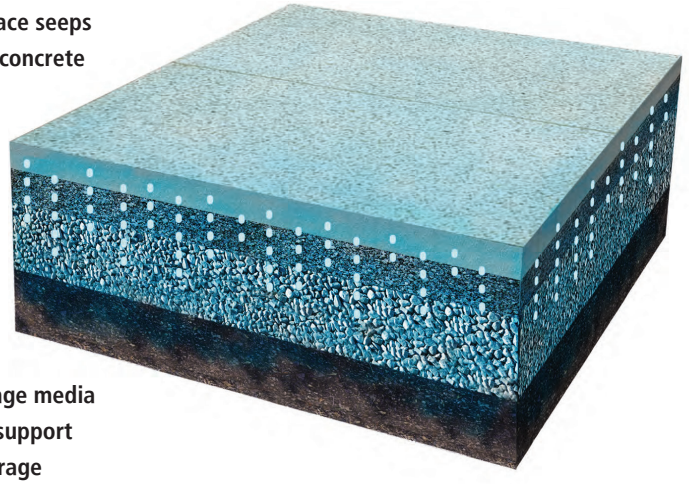
Permeable Asphalt

Stormwater on surface seeps through permeable asphalt

Stone or other storage media provides structural support and stormwater storage

Permeable Concrete

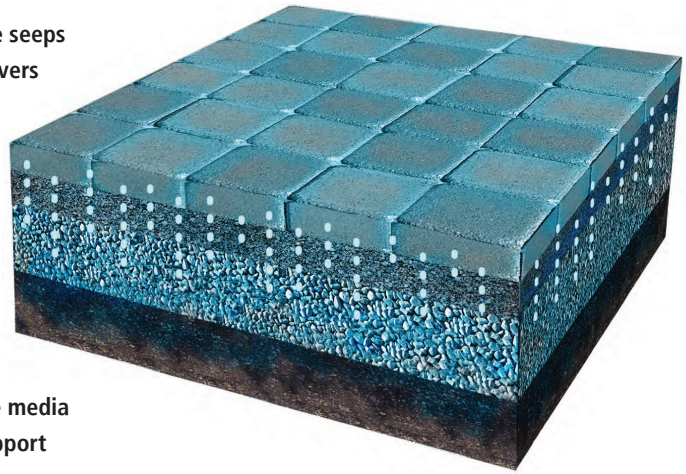
Stormwater on surface seeps through permeable concrete



Stone or other storage media provides structural support and stormwater storage

Permeable Paver

Stormwater on surface seeps through permeable pavers



Stone or other storage media provides structural support and stormwater storage

Green Gutter

Portland, OR precedent

Overview

A green gutter is a narrow and shallow landscaped strip along a street's curb line. It is designed to manage stormwater runoff by placing the top of the planting media in the green gutter lower than the street's gutter elevation allowing stormwater runoff from both the street and sidewalk to flow directly into the green gutter. An elevated curb can be used along the street side of the green gutter with openings along its length to allow runoff to flow into the green gutter. Green gutters can be designed to infiltrate and/or flow to the existing storm sewer. The system attenuates storm-water flows, provides storage and, in some cases, infiltration and evapotranspiration. In flow-through green gutters, overflow runoff can be conveyed to the existing storm drain system, either through an underdrain tied to the existing storm drain system, or as shallow concentrated flow that is conveyed downstream to an existing inlet.

Benefits

- Provides a physical buffer between pedestrians and the street when an elevated street side curb is used.
- Does not require encroachment into sidewalk area.
- Provides an area within the right-of-way for smaller plantings.

Potential Constraints and Considerations

- Must consider existing on-street parking conditions and street width.
- Landscape materials must accommodate direct impact of gutter flow velocity.

Interaction with Bicyclists and Pedestrians

- Edge treatments should prevent pedestrian and bicyclists from stepping into the green gutter area.
- Placement should occur outside of bike lanes.

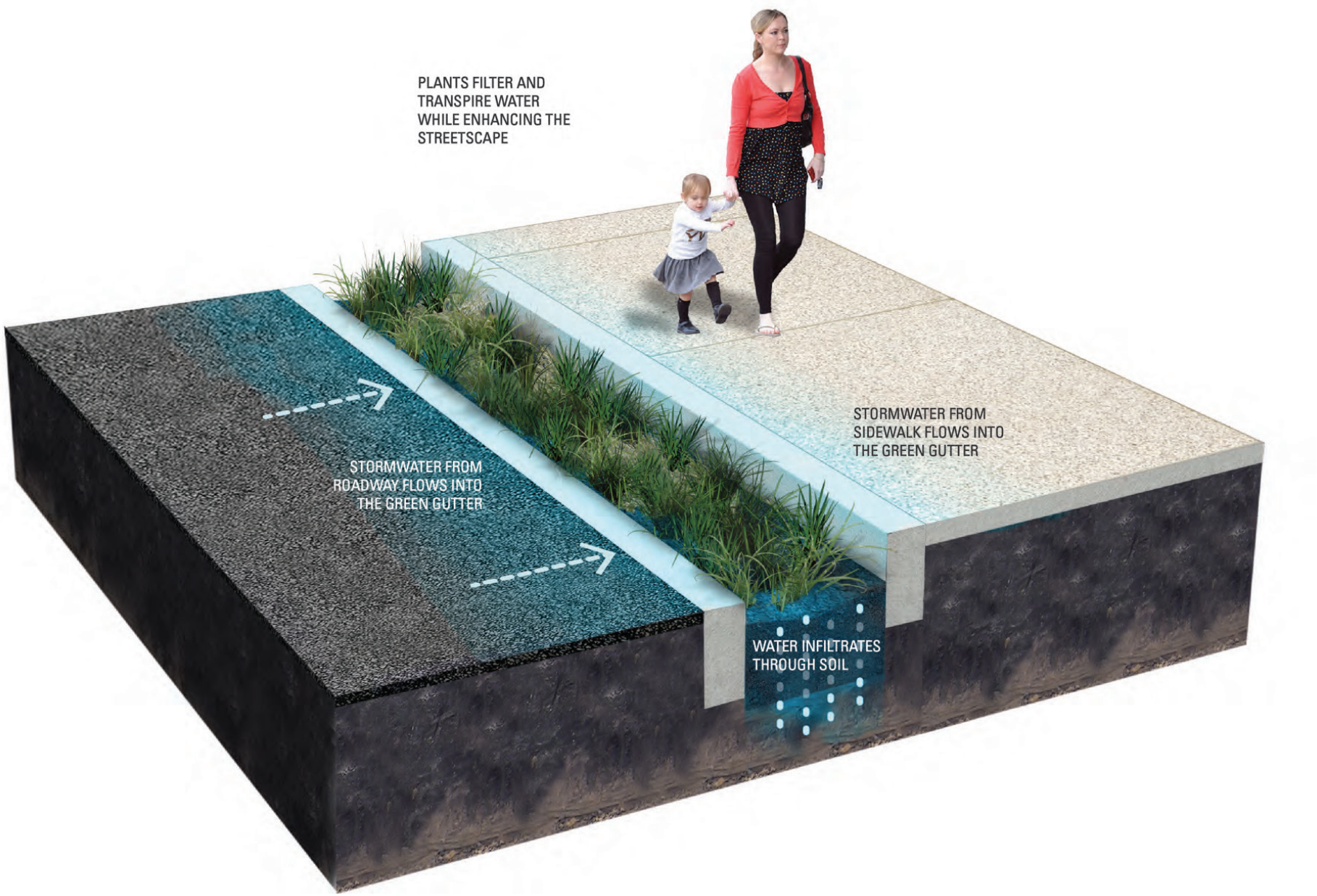
Urban Design Context

- Consider opportunities where there is no on-street parking and/or wide shoulders.
- May not be appropriate in high volume pedestrian areas.

Maintenance

- Routine landscape maintenance.

Figure 2.6: Three-Dimensional View of a Green Gutter



Stormwater Drainage Well

Overview

A stormwater dainage well is designed to manage stormwater runoff by receiving stormwater from upstream collection and pretreatment systems and then discharging the stormwater into the surrounding soils through perforations in the manhole.

Benefits

- Small footprint with potentially large storage volume.
- Potential option where other SMPs are not applicable.

Potential Constraints and Considerations

- The minimum allowable separation between the bottom of the stormwater drainage well and seasonal high ground water is two feet.
- The minimum allowable separation between the bottom of the stormwater drainage well and the top of bedrock is three feet.
- The minimum allowable separation between the stormwater drainage well and building foundations is 20 feet.
- Design sizing may be based on methods other than static storage of the runoff volume. Consult PWD for guidance.

Interaction with Bicyclists and Pedestrians

- Stormwater drainage wells would not impact bicyclists or pedestrians any differently than a normal manhole cover.

Urban Design Context

- These stormwater management practices are completely below ground with only a manhole cover on the surface; as such, stormwater drainage wells do not impact the urban design context any differently than a normal manhole.
- These SMPs can be used in combination with other SMPs to increase the stormwater management and aesthetic benefits.

Maintenance

- Designed such that stormwater introduced to the stormwater drainage well has already passed through a system that provides a high level of pretreatment, stormwater drainage wells themselves require relatively little maintenance. However, maintenance of the upstream pretreatment system, which varies, will be required.