

Green City, Clean Waters

COMMUNITY ORIENTATION PACKET



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GREEN CITY, CLEAN WATERS

Background

On September 1, 2009, the Philadelphia Water Department (PWD) submitted the *Green City, Clean Waters* plan to the PA Department of Environmental Protection (DEP) and the U.S. Environmental Protection Agency (EPA) to detail how PWD will invest approximately \$1.6 billion over the next 20 years to significantly reduce Combined Sewer Overflows (CSOs) – a combination of sewage and stormwater that overflows into our rivers and streams when it rains (see box below for more information). To ensure this public investment not only results in clean and beautiful waterways, but also provides tangible, additional benefits to our citizens, PWD is dedicating a large portion of this plan to a green stormwater infrastructure (GSI) approach.

Combined sewer overflow episodes and stormwater run-off volumes have increased over time as land development has led to replacement of pervious areas with impervious surfaces, such as roadways and buildings, which are characteristic of urbanized landscapes, like Philadelphia. In turn, this affects Philadelphia's watersheds by impairing water quality and degrading stream habitats. Green stormwater infrastructure contributes to alleviating the CSO problem and its effects, by integrating pervious areas that manage stormwater throughout Philadelphia.

The Vision

The Philadelphia Water Department's (PWD) vision behind the Green City, Clean Waters Plan is to unite the City of Philadelphia with its water environment, creating a green legacy for future generations while incorporating a balance between ecology, economics and equity. The green stormwater infrastructure approach is an essential factor in making this vision a reality.

Green Stormwater Infrastructure

Our definition of green stormwater infrastructure includes a range of soil-water-plant systems that intercept stormwater, infiltrate a portion of it into the ground, evaporate a portion of it into the air, and in some cases release a portion of it slowly back into the sewer system. As a result, less stormwater enters the combined sewer system, ultimately reducing CSOs. Integrating green stormwater infrastructure into a highly developed area like Philadelphia requires a decentralized and creative approach to planning and design. Various tools can be implemented to accomplish this, including stormwater planters, rain gardens and green roofs. Examples of these green stormwater infrastructure tools can be found on p.10. Implementing innovative green stormwater infrastructure (GSI) throughout our City can maximize economic, social, and environmental benefits for Philadelphia.

What Are Combined and Separate Sewer Systems?

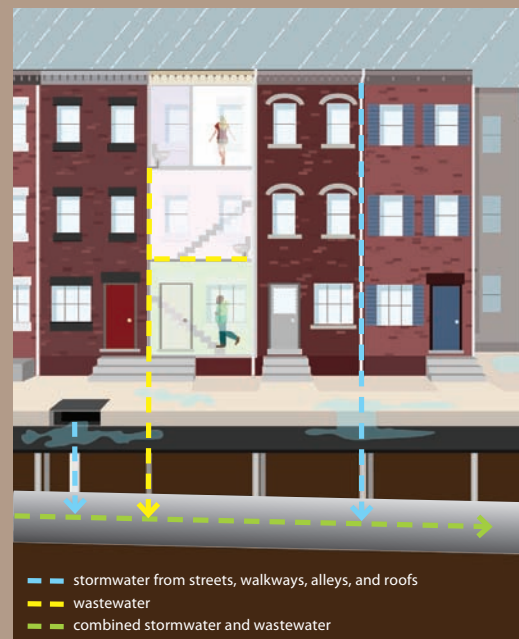
The City of Philadelphia has one of the first sewer systems in the country, with portions dating back to the second half of the 19th century. Much of that original infrastructure is still operational today. PWD's significant commitment to continuously inspect and maintain the 3,000 mile system of pipes, manholes, storm drains, and control chambers will sustain the use by City residents for years to come.

The City of Philadelphia's sewer system is comprised of both combined and separate sewer systems. A combined sewer system (CSS) is simply a single sewer system that carries both sewage and stormwater in one pipe, to a water pollution control plant for treatment before being released to a waterway. During moderate to heavy rainfall events, the system will reach capacity, overflow, and discharge a mixture of sewage and stormwater directly to our streams and rivers from the 164 permitted Combined Sewer Overflow (CSO) outfalls within the City. Sixty percent of the City of Philadelphia, or 64 square miles, is within the combined sewer system drainage area. Four watersheds, generally comprised of the older areas of the City of Philadelphia, receive CSO discharges.

The remainder of the City of Philadelphia's sewer system is drained by what is called a separate sewer system. A separate sewer system collects stormwater in a storm sewer pipe and discharges it directly to a waterway, while the sanitary sewage collected from homes, businesses, and industry is collected in a sanitary sewer pipe and taken to the water pollution control plant for treatment before being released to the waterways.

Watersheds Receiving CSO Discharges	mf drained	served by within Phila.CSS (approx)
Tookany/Tacony-Frankford Creek	19	80%
Cobbs Creek	6	80%
Delaware River	40	71%
Schuylkill River	36	40%

This amounts to 64 square miles of Combined Sewer Service drainage area for potential implementation.



Benefits of Green Stormwater Infrastructure

PWD has undertaken a Triple Bottom Line analysis of the environmental, social, and economic benefits of the *Green City, Clean Waters* plan. This triple bottom line accounting means expanding the traditional financial reporting framework to take into account ecological and social performance so that the total benefits can be evaluated against the financial investment. The figures associated with the following benefits are specific to Philadelphia.

- **Reduced Combined Sewer Overflow events:**
5-8 billion gallons of CSO avoided per year
- **Enhanced Groundwater Recharge:** important for maintaining base flow rates in local rivers and streams.
- **Additional habitat and recreation space:**
increase of over 1 million recreational user-days/year
- **Increased carbon sequestration:** 1.5 billion pounds of carbon dioxide emissions avoided or absorbed
- **Improved air quality:** on average leading to
1–2 avoided premature deaths
20 avoided asthma attacks
250 fewer missed days of work or school/ year
- **Reduced energy and fuel demands:**
reduction of approximately 6 million kW-hr of electricity and 8 million kBtu of fuel used per year
- **Mitigation of Urban Heat Island effect:** trees and vegetation provide shade and naturally cool areas with a dense concentration of surfaces that absorb heat, such as pavement and buildings
- **Higher property values:** increase in property values of 2-5% in greened neighborhoods
- **Creation of jobs:** about 250 people employed in Green Jobs/year

Concerned about basement back-ups?

The Philadelphia Water Department has a program that can help with basement sewer back-ups- the PWD Basement Backup Protection Program: http://www.phila.gov/water/pdfs/bbp_0803.pdf. Additionally, PWD is continually working to increase the efficiency of its collection system.

PWD's Land-Based Green Programs

The Philadelphia Water Department is developing eight Green Programs, each with a number of associated implementation tools – including technical assistance, design services, policy changes, regulatory tools, funding commitments and incentives to manage stormwater.

- **Green Streets**
- **Green Homes**
- **Green Schools**
- **Green Public Facilities**
- **Green Parking**
- **Green Open Space**
- **Green Industry, Business, Commerce and Institutions**
- **Green Alleys, Driveways, and Walkways**

In the initial phases of our Land-Based Green Programs, we are focusing on the Green Streets and Green Homes programs. Please refer to PWD's website, www.phillywatersheds.org, for information about the other programs listed above.

A key to the success of this strategy is that immense opportunity exists for implementation on publicly-owned land, such as City-owned property, streets, and rights-of-way, which constitute 45% of the impervious land area of the City. With this in mind, the initial approach is to focus on Green Streets by implementation in Model Neighborhoods.



Green Streets

Streets and sidewalks are by far the largest single category of public impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer service area. (Note: impervious cover associated with streets in front of parks was not included in this percentage; these streets will be included in the “Green Public Open Space” program).

To mitigate the impact of this impervious area, PWD has developed green street designs to provide stormwater management, while maintaining the primary function of the street for vehicles and pedestrians. A green street uses a combination of vegetated and engineered strategies to manage rain or melting snow, (stormwater runoff), at its source. Green street designs incorporate various green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, stormwater bumpouts, and pervious pavement. Using these tools, a green street captures stormwater runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia’s combined sewer system.

PWD is working to align its green stormwater infrastructure practices with street greening programs associated with GreenWorks’ ambitious greening goals. Coordination of PWD’s program with other city programs will encourage maximum effectiveness. Ultimately, the Green Streets program should result in setting a “green standard” for streets within the City. Partners include PennDOT and the City of Philadelphia Streets Department.



Stormwater Tree Trench



Before



After



A vision of green street implementation.

Green Street Site Selection Process

1. Identification – Sites are identified by a variety of different methods including block petitions, requests by city agencies such as Fairmount Park, School District requests, concurrent projects by private and public partners, and neighborhood greening projects.

2. Screening – Sites are investigated in consideration of the design factors noted below. Existing features, design opportunities, and site limitations are all recorded.

3. Selection – Sites are selected based upon their feasibility and cost-effectiveness, a consideration of any neighborhood planning activities, and the potential to team up with other concurrent projects.

We are always interested in working with civic groups and city agencies that are planning renewal projects. If you know of an opportunity, please contact us: questions@phillywatersheds.org

Green Street Design Factors

To determine if a street is a good candidate for the installation of green infrastructure, PWD designers consider a range of factors. The main site characteristics used for considering a block's green street potential are described below. In addition to these physical features, other important factors such as coordination with other agencies, neighborhood capacity and support, and regulatory challenges can influence selection.

Utilities in Footway or Near Curblines: The presence of utility lines, such as water, sewer, gas, electric, or telecommunication lines, under the sidewalk or near the curblines make our designs more difficult. It is not always possible to build our systems over these lines.

Number of Parcels: Each property, or parcel, has its own utility service laterals that cross the sidewalk. Blocks with fewer parcels therefore have fewer utility conflicts and are thereby pose fewer design limitations.

Street Trees and Obstructions Upslope of Inlets: Construction of our stormwater systems disturbs the sidewalk and surrounding area. We want to manage stormwater as close to the inlet as possible to capture

the largest drainage area. Therefore, any structures upslope of the inlet, especially trees with their large root systems, limit the space in which we can construct.

Sidewalk Width: Wider sidewalks increase the space in which we can safely infiltrate stormwater, allowing us to manage greater volumes of stormwater.

Building Setback: Setback of the building increases the space in which we can safely infiltrate stormwater within the right of way.

Street Slope: Relatively flat streets are favored for our designs. It is more challenging and expensive to construct our systems in steeper streets.

Drainage Area: The larger the drainage area, the more stormwater we can manage. It is more cost-effective to construct systems for larger drainage areas.

Soil Investigation Results: Soil testing provides information about soil infiltration rates, the presence of bedrock or other limiting zones, soil contamination, and other conditions. These factors influence the feasibility and type of designs that can be implemented.

Green Homes

Residential roofs make up 20% of all impervious cover in the City. Success for this program lies in the simplicity of residential scale stormwater management solutions distributed throughout Philadelphia.

Residents can implement the following green stormwater management solutions on their properties:

- Installing rain barrels or flow-through planters to collect roof runoff
- Disconnecting downspouts and using site slopes to direct runoff to pervious areas (rain garden) or small drywells
- Reducing paved areas and replacing them with pervious pavement or gardens
- Planting container gardens to reduce stormwater runoff in areas with space restrictions and no opportunity for pavement removal

By implement these solutions themselves, residents can achieve benefits at a minimal cost. Installation and use of rain barrels have already proven popular through the participation of Philadelphia area residents in the PWD Rain Barrel program, and if implemented on a larger scale, can ultimately affect a significant amount of impervious cover. Additionally, more ambitious (and somewhat more costly) measures are suggested, including the installation of a green roof or capturing stormwater in larger cisterns for reuse.

When implementing any of these green stormwater infrastructure solutions care should be taken to not impact adjacent properties through additional stormwater flow. Precautions include providing a proper safe overflow to the existing combined sewer system in larger storm events, and allowing for appropriate installation distances between any green stormwater infrastructure solutions and the residence, as well as other property lines. Visit our website for more information about the design and installation of these solutions:

http://www.phillywatersheds.org/whats_in_it_for_you



A rain barrel installed in the backyard of a South Philadelphia home.



An example of a newly installed residential rain garden.

Rain Barrels

Rain Barrel Elements

A rain barrel or cistern is a structure that collects and stores stormwater runoff from rooftops. Downspouts lead the stormwater from the roof to into the rain barrel, where it is temporarily stored for various uses. Rain barrels usually consist of a plastic storage container with lid, a system that diverts water into the barrel, an overflow pipe, a screen to keep out debris and mosquitos, and a water spigot to which a hose can attach.

Rain Barrel Benefits

By temporarily holding the stormwater runoff during a rain event, more capacity can be added to the city's sewer system, and reduce pollution and combined sewer overflows to our creeks and rivers, our drinking water source. However, rain barrels and cisterns only serve an effective stormwater control function if the stored water is used or emptied between storms, freeing up storage volume for the next storm. Rain barrels are designed to overflow into the sewer system through the existing downspout connection in large storm events. Although these systems only store a small volume of stormwater, collectively they can be effective at preventing large volumes of runoff from entering the sewer system and nearby creeks and rivers, as well as reducing CSOs. Rain barrels promote water conservation by saving, on average, 1,300 gallons of water during the summer. This can add up to significant savings. Storing stormwater for garden and lawn use helps recharge groundwater naturally.

Rain Barrel Uses

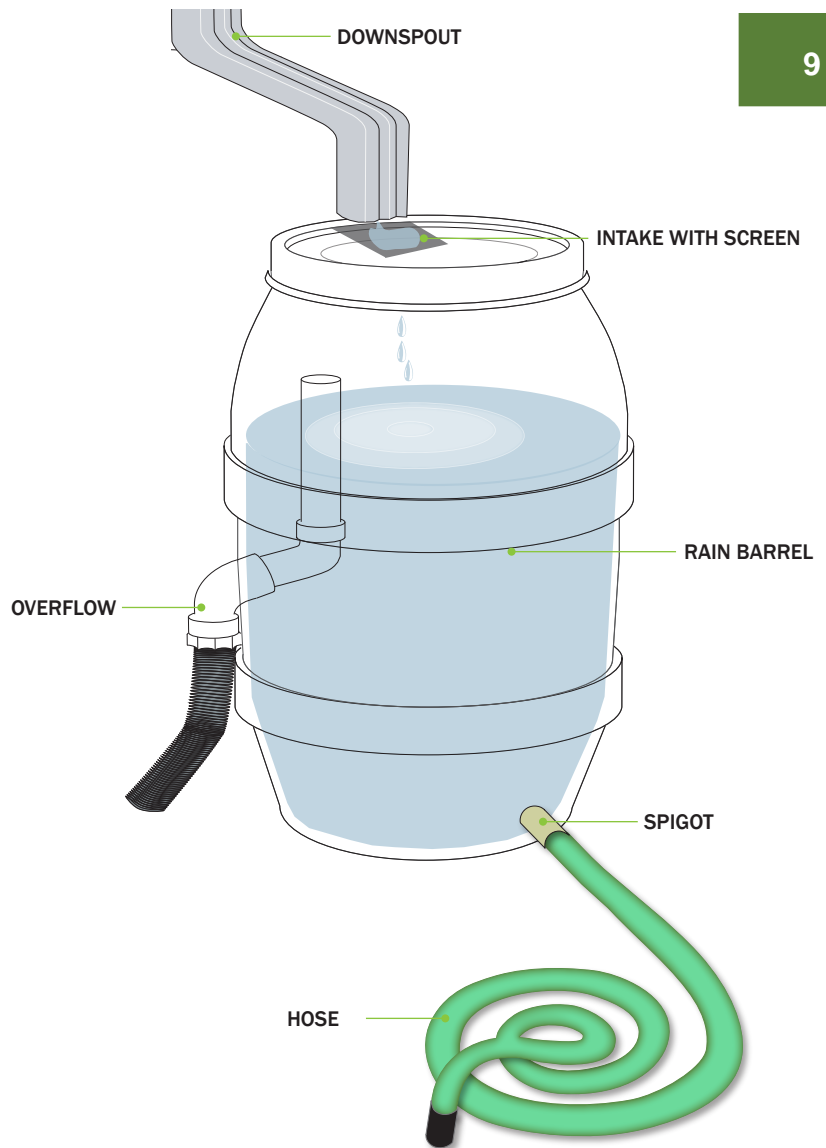
The collected rain water can be used:

- to water lawns, gardens, window boxes or street trees
- to wash down patio furniture
- to fill a bird bath
- to wash cars

How can I get a Rain Barrel?

The Philadelphia Water Department is distributing a limited supply of rain barrels to residents located within the watersheds of Philadelphia free of charge, in an effort to promote the reduction of stormwater runoff impacts. In order to receive a rain barrel, it is mandatory to attend a rain barrel workshop to be educated on the installation and use of the rain barrel. There is a one-per-household limit. Rain barrel workshops are held in locations around the city throughout the year. The workshops are organized on a watershed-basis, meaning you can only attend a workshop organized for your watershed.

http://www.phillywatersheds.org/whats_in_it_for_you/rainbarrel



IMPORTANT: Water stored in rain barrels needs to be used or emptied between storms to free up storage volume for the next storm.

How can I make my own Rain Barrel?

Instructions for building and installing a rain barrel can be found in PWD's Homeowner's Guide to Stormwater Management. This guide also lists resources where rain barrels can be purchased, and how to implement other stormwater management solutions around the home.

http://www.phillywatersheds.org/doc/Homeowners_Guide_Stormwater_Management.pdf

GREEN STORMWATER INFRASTRUCTURE TOOLS

PWD's Land-Based Green Programs will each utilize a unique mix of green stormwater infrastructure tools. The majority of these examples have been implemented locally, demonstrating the use of green stormwater infrastructure in Philadelphia. The additional examples are located in Portland, Oregon, as noted.



A stormwater tree trench is a system of trees that is connected by an underground infiltration structure. On the surface, a stormwater tree trench looks just like a series of street tree pits. However, under the sidewalk, there is an engineered system to manage the incoming runoff. This system is composed of a trench dug along the sidewalk, lined with a permeable geotextile fabric, filled with stone or gravel, and topped off with soil and trees. Stormwater runoff flows through a special inlet (storm drain), leading to the stormwater tree trench. The runoff is stored in the empty spaces between the stones, watering the trees and slowly infiltrating through the bottom. If the capacity of this system is exceeded, stormwater runoff can bypass it entirely and flow into an existing street inlet.

Mill Creek Tree Trench
Philadelphia, PA

Stormwater Tree Trench



A stormwater bump-out is a vegetated curb extension that protrudes into the street either mid-block or at an intersection, creating a new curb some distance from the existing curb. A bump-out is composed of a layer of stone that is topped with soil and plants. An inlet or curb-cut directs runoff into the bump-out structure where it can be stored, infiltrated, and taken up by the plants (evapotranspiration). Excess runoff is permitted to leave the system and flow to an existing inlet. The vegetation of the bump-out will be short enough to allow for open site lines of traffic. Aside from managing stormwater, bump-outs also help with traffic-calming, and when located at crosswalks, they provide a pedestrian safety benefit by reducing the street crossing distance.

Portland, OR

Stormwater Bump-out



A stormwater planter is a specialized planter installed into the sidewalk area that is designed to manage street and sidewalk runoff. It is normally rectangular, with four concrete sides providing structure and curbs for the planter. The planter is lined with a permeable fabric, filled with gravel or stone, and topped off with soil, plants, and, sometimes, trees. The top of the soil in the planter is lower in elevation than the sidewalk, allowing for runoff to flow into the planter through an inlet at street level. These planters manage stormwater by providing storage, infiltration, and evapotranspiration of runoff. Excess runoff is directed into an overflow pipe connected to the existing combined sewer pipe.

Portland, OR

Stormwater Planter



Pervious pavement is a specially designed pavement system that allows water to infiltrate through the pavement and prevents it from becoming runoff. This system provides the structural support of conventional pavement, but is made up of a porous surface and an underground stone reservoir. The stone reservoir provides temporary storage before the water infiltrates into the soil. There are many different types of porous surfaces including pervious asphalt, pervious concrete, and interlocking pavers. Interlocking pavers function in a slightly different way than pervious concrete and asphalt. Rather than allowing the water to penetrate through the paving, pavers are spaced apart with gravel or grass in between the pavers that allows for infiltration.

Mill Creek Basketball Court
Philadelphia, PA

Pervious Pavement

Plants and Stormwater Management

Trees, shrubs, and flowers help manage rain, or stormwater, through catching rain drops on their leaves and branches before the stormwater becomes runoff, as it hits the ground. The stormwater collected on these surfaces can easily evaporate into the air. Additionally, plants help manage stormwater runoff not only by allowing water to infiltrate into the soil, but also by a process called evapotranspiration, in which water is taken up by plant roots and transpired through their leaves. Plants and soil also help in filtering stormwater runoff.

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A green roof is a roof or section of roof that is vegetated. A green roof system is composed of multiple layers including waterproofing, a drainage layer, an engineered planting media, and specially selected plants. Green roofs can be installed on many types of roofs, from small slanting roofs to large commercial flat roofs. Two basic types of green roofs have been developed, extensive and intensive. An extensive green roof system is a thin, (usually less than 6 inches), lighter-weight system planted predominantly with drought-tolerant succulent plants and grasses. An intensive green roof is a deeper, heavier system designed to sustain more complex landscapes. A green roof is effective in reducing the volume and velocity of stormwater runoff from roofs by temporarily storing stormwater, slowing excess stormwater release into the combined sewer system, and promoting evapotranspiration.

Green Roof

Fencing Academy of Philadelphia
Philadelphia, PA



A rain barrel or cistern is a structure that collects and stores stormwater runoff from rooftops. The collected rain water can be used for irrigation to water lawns, gardens, window boxes or street trees. By temporarily holding the stormwater runoff during a rain event, more capacity can be added to the city's sewer system. However, rain barrels and cisterns only serve an effective stormwater control function if the stored water is used or emptied between most storms so that there is free storage volume for the next storm. Rain barrels are designed to overflow into the sewer system through the existing downspout connection in large storm events. Although these systems only store a small volume of stormwater, collectively, they can be effective at preventing large volumes of runoff from entering the sewer system.

Rain Barrel/Cistern

Residential Rain Barrel
Philadelphia, PA



A rain garden is a garden designed to collect runoff from impervious surfaces such as roofs, walkways, and parking lots, allowing water to infiltrate into the ground. The garden is typically moderately depressed (lower than the surrounding ground level), with the bottom layer filled with stone, so runoff can collect and pond within it. The site is graded appropriately to cause stormwater to flow into the rain garden area from the nearby impervious area. The water ponds on the surface, is used by the vegetation in evapotranspiration, and infiltrates into the subsurface stone storage and soil. Rain gardens can be connected to sewer systems through an overflow structure, but usually they are sized to infiltrate the collected stormwater runoff within 72 hours. Flexible and easy to incorporate into landscaped areas, rain gardens are suitable for many types and sizes of development and retrofits. Rain gardens are effective at removing pollutants and reducing stormwater runoff volume.

Rain Garden

Wissahickon Charter School
Philadelphia, PA

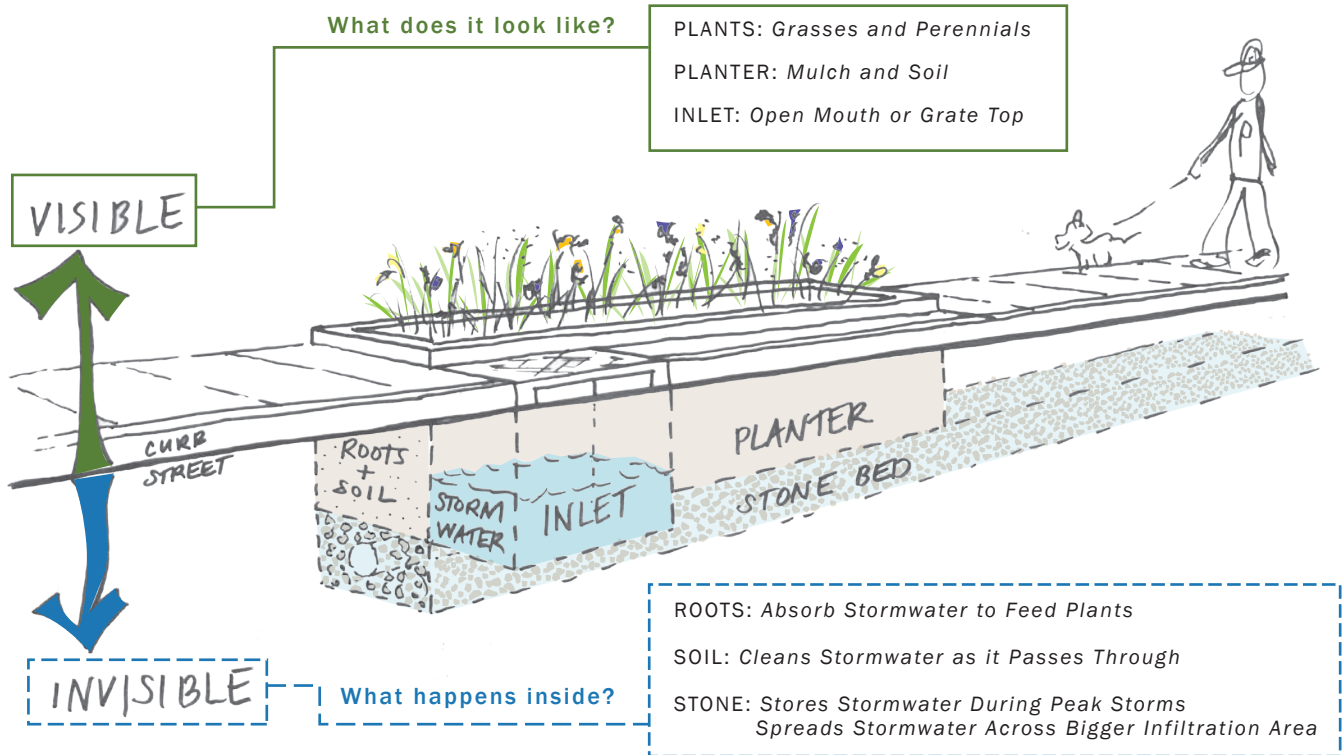


A flow-through planter is a structure that is designed to allow stormwater from roof gutters to flow through and be used by the plants. Flow-through planters are filled with gravel, soil, vegetation and a connection to the roof downspout to let water flow in. They temporarily store stormwater runoff on top of the soil and filter sediment and pollutants as water infiltrates down through the planter. They are typically waterproofed, and the bottom of the planter is normally impervious. Thereby, planters do not infiltrate runoff into the ground, rather they rely on evapotranspiration and short-term storage to manage stormwater. Excess water can overflow into the existing downspout connection. Flow-through planters can be constructed in many sizes and shapes, and with various materials, including concrete, brick, plastic lumber or wood.

Flow-through Planter

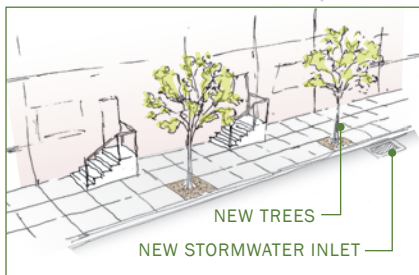
Portland, OR

GREEN STREETS: STORMWATER PLANTER

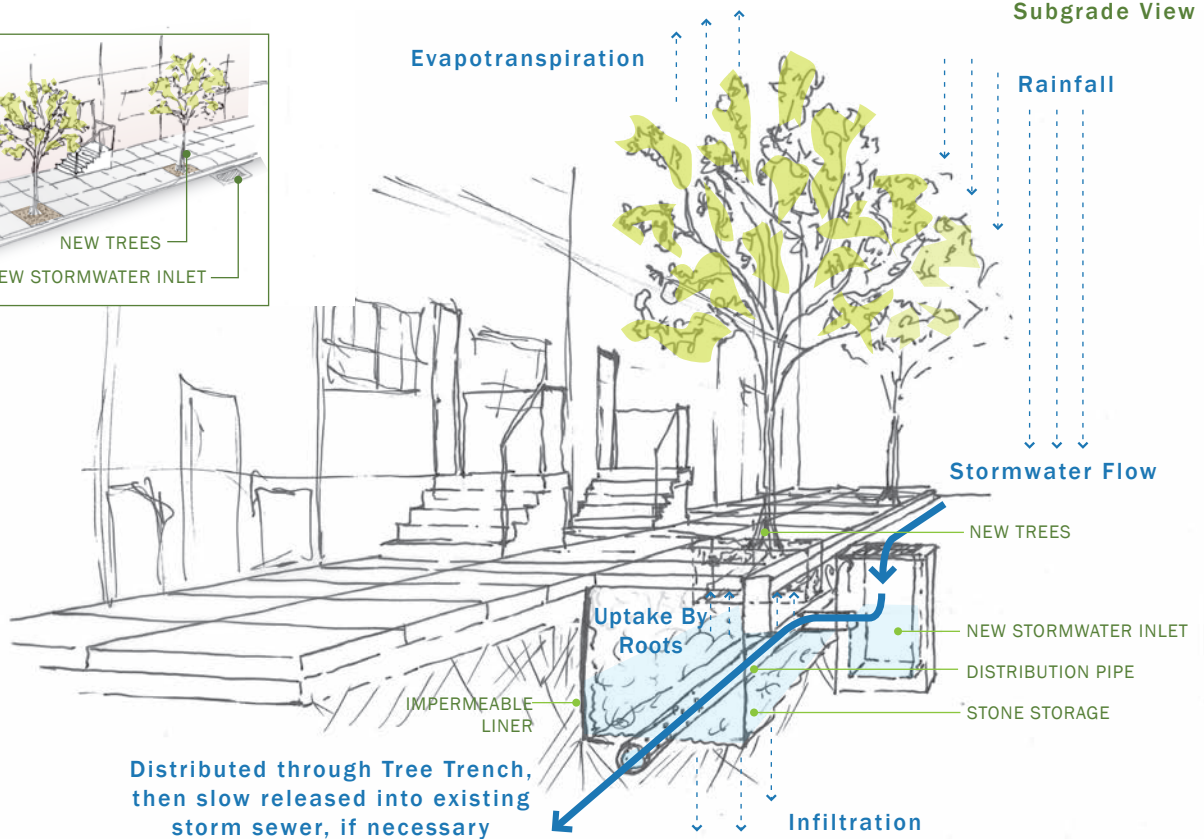


GREEN STREETS: STORMWATER TREE TRENCH

Street View

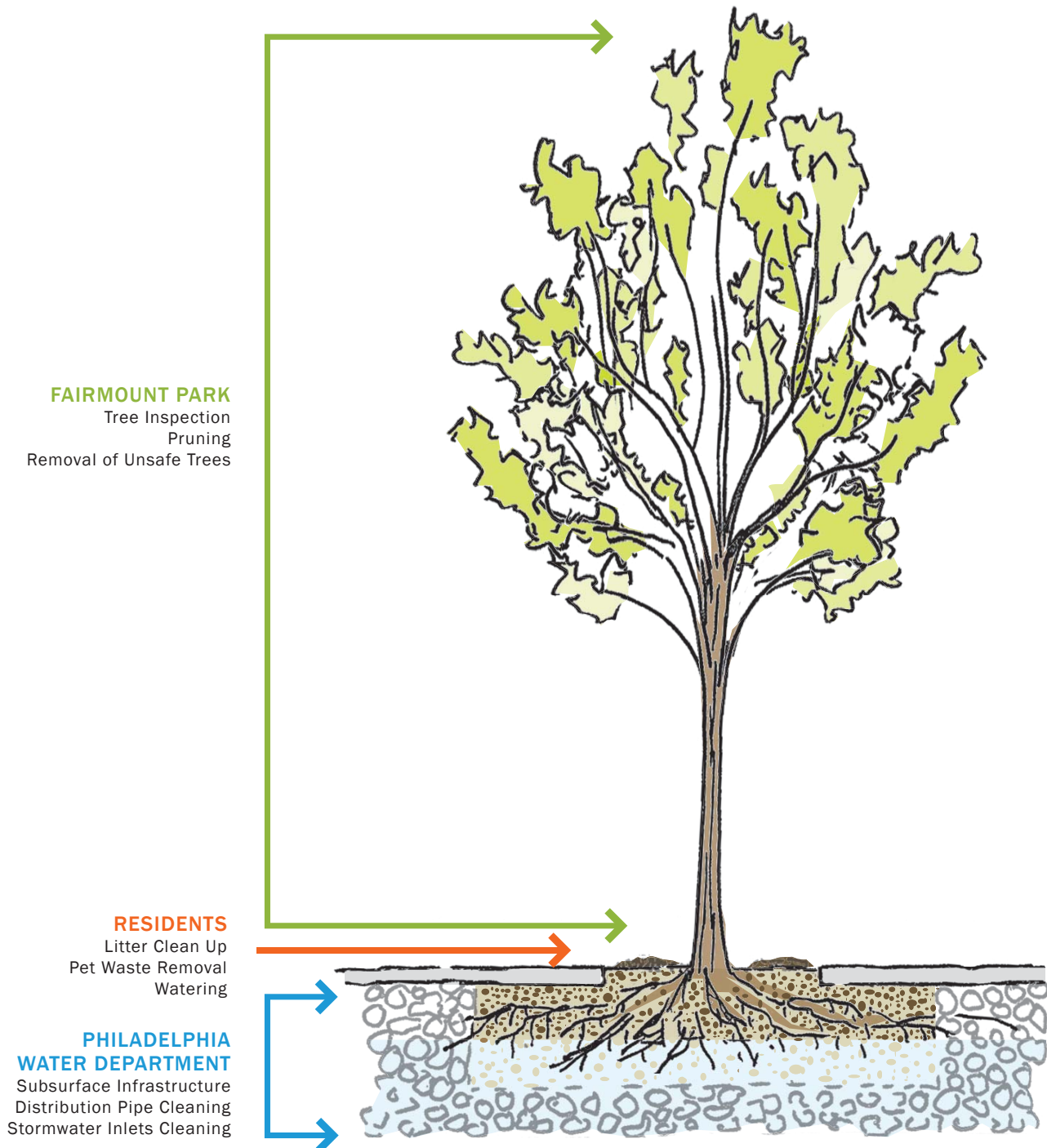


Subgrade View



Stormwater Tree Trench: Maintenance Responsibilities

Responsibility for maintenance of green stormwater infrastructure will be shared by various partners. Green stormwater infrastructure implemented on streets or the right-of-way will be maintained through PWD in-house staff, other City department staff, such as Fairmount Park, and contractors. Fairmount Park maintenance responsibilities for street trees include tree inspection, pruning, and tree removal. PWD will specifically be responsible for subsurface green stormwater infrastructure, distribution pipe cleaning, and stormwater inlet cleaning. Property owners and residents are responsible for minimal routine maintenance, including litter clean up, pet waste removal, and, most importantly, watering of trees and vegetation, during their 1-2 year establishment period, as indicated below.



Resources

Philadelphia Water Department (PWD) Office of Watersheds

<http://www.phillywatersheds.org>

The Philadelphia Water Department offers several resources:

- Green Street planning, design and implementation
- Rain Barrel Workshops
<http://www.phillywatersheds.org/rainbarrel/>
- Green stormwater infrastructure implementation educational materials for homeowners, business owners, and community groups:
http://www.phillywatersheds.org/whats_in_it_for_you
- Events calendar
http://www.phillywatersheds.org/whats_in_it_for_you/events
- Facebook page
<http://www.facebook.com/green.cities.clean.waters>
- Twitter
<http://twitter.com/Green4CleanH2O>

Fairmount Park Commission (FPC)

<http://www.fairmountpark.org/>

The Fairmount Park Commission manages all Park and street trees in the City of Philadelphia. So, if you observe a problem with your tree or if you'd like your tree inspected for removal, pruning, or would like to have a tree planted, please call the Fairmount Park Street Tree Management Division Office.

Street Tree Management Division Office
Frances Piller, District Manager
Tel 215-685-4363
Fax 215-685-4364
E-mail fpc.streettree.info@phila.gov

- Street tree maintenance request form:
http://www.fairmountpark.org/pdf/FPC_tree_request.pdf

- Tree care:

<http://www.fairmountpark.org/TreeCare.asp>

Pennsylvania Horticultural Society (PHS)

<http://www.phsonline.org>

The Pennsylvania Horticultural Society designs and builds green projects throughout the greater Philadelphia area, in collaboration with a variety of partners including PWD. Additionally, PHS offers training and guidance to the community including the following resources:

- Tree Tenders class:

In support of TreeVitalize, PHS, in partnership with Penn State Cooperative Extension, offers nine hours of hands-on tree care training for residents of the five-county Philadelphia region. The free training will cover tree biology, identification, planting, proper care and working within your community.

<http://www.pennsylvaniahorticulturalsociety.org/phlgreen/tree-training.html>

- Tree Planting:

<http://www.pennsylvaniahorticulturalsociety.org/phlgreen/current-trees.html>

- Garden Tenders class: Philadelphia Green's Garden Tenders is a self-help training course for community groups and non-profit organizations within the city of Philadelphia that are interested in starting community gardens on vacant lots in parks, around schools and churches. The responsibility for creating and maintaining a garden belongs to each group.

<http://www.pennsylvaniahorticulturalsociety.org/phlgreen/gardentenders.html>

