San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission

SEWER SYSTEM IMPROVEMENT PROGRAM
Stormwater Management Toolkit

URBAN WATERSHED PLANNING GAME

June 1, 2013

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TABLE OF CONTENTS

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Grey. Green. Clean.

San Francisco's Urban Watershed Planning Game

On Saturday, June 1, you will get a chance to help plan for San Francisco's sewer system future. The Urban Watershed Planning Game is a collaborative educational exercise in which team members work together to brainstorm solutions to San Francisco's sewer system challenges. Your game day objective is to reduce peak flows and volumes of stormwater entering the combined sewer, thereby reducing strain on the City's aging sewer system. Tools for mitigating both excess stormwater challenges and combined sewer discharges include both green and grey infrastructure. This "Toolkit" describes each stormwater tool and provides details on the siting, performance, benefits, and limitations.

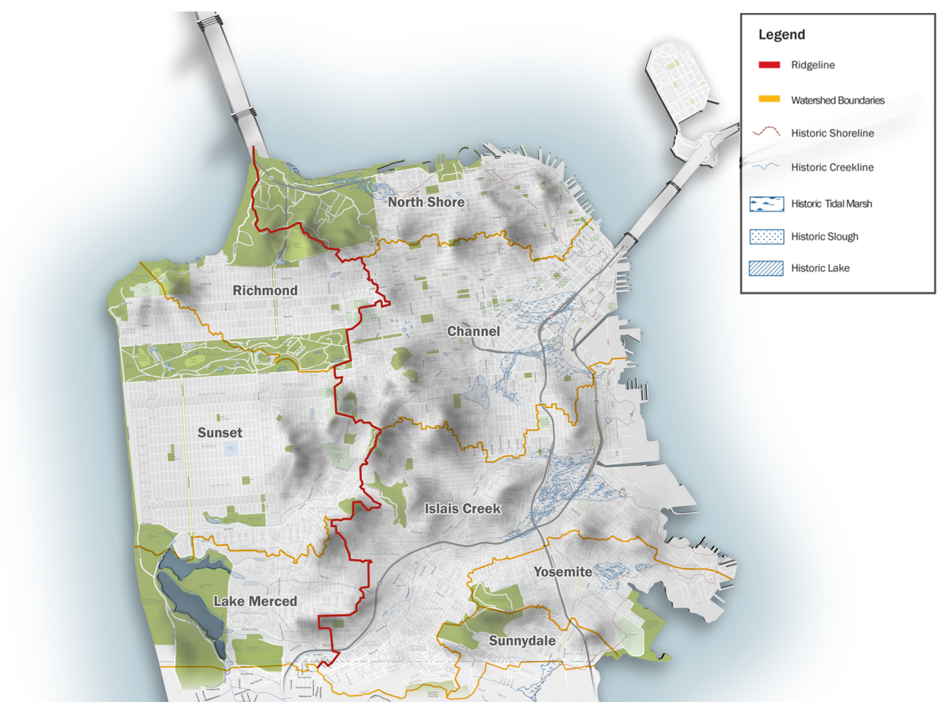
Be Prepared for Game Day! Ideas generated through the game will be analyzed by the SFPUC's planning team and will help us understand community priorities. Below are steps you can take to ensure an educational and effective game day experience.

STEP 1: UNDERSTANDING THE CHALLENGES

San Francisco's Urban Watersheds

Before San Francisco developed into the thriving city it is today, a network of creeks and streams drained surface water from the city's steep rocky interior down to the San Francisco Bay and the Pacific Ocean through marshes and wetlands along its border. The natural hydrologic cycle, working its way through San Francisco's landscape, kept the water clean.

Today, much of the city is paved or built upon and plumbed with a combined sewer which conveys both stormwater and wastewater. The city's stormwater and sewage are collected in a network of pipes, tunnels, and pumps which travel to the City's wastewater treatment facilities where the combined sewage is treated and discharged into the Ocean and Bay. The dramatic increase in impervious surfaces like rooftops and pavement has put increasing pressure on the city's sewer system over time. In San Francisco's urban environment, there are very few places for stormwater to infiltrate into the ground; stormwater has no place to go other than the sewer system. During large storms, the sewer system can be overwhelmed, leading to flooding in low lying areas and combined sewer discharges to the Bay and Ocean. The Urban Watershed Planning Game explores strategies for mitigating both excess stormwater challenges and combined sewer discharges. It is important to understand that the Planning Game explores one subset of challenges facing our sewer system; the game is designed to engage community members in understanding these particular challenges and the types of solutions that can be used to address them.



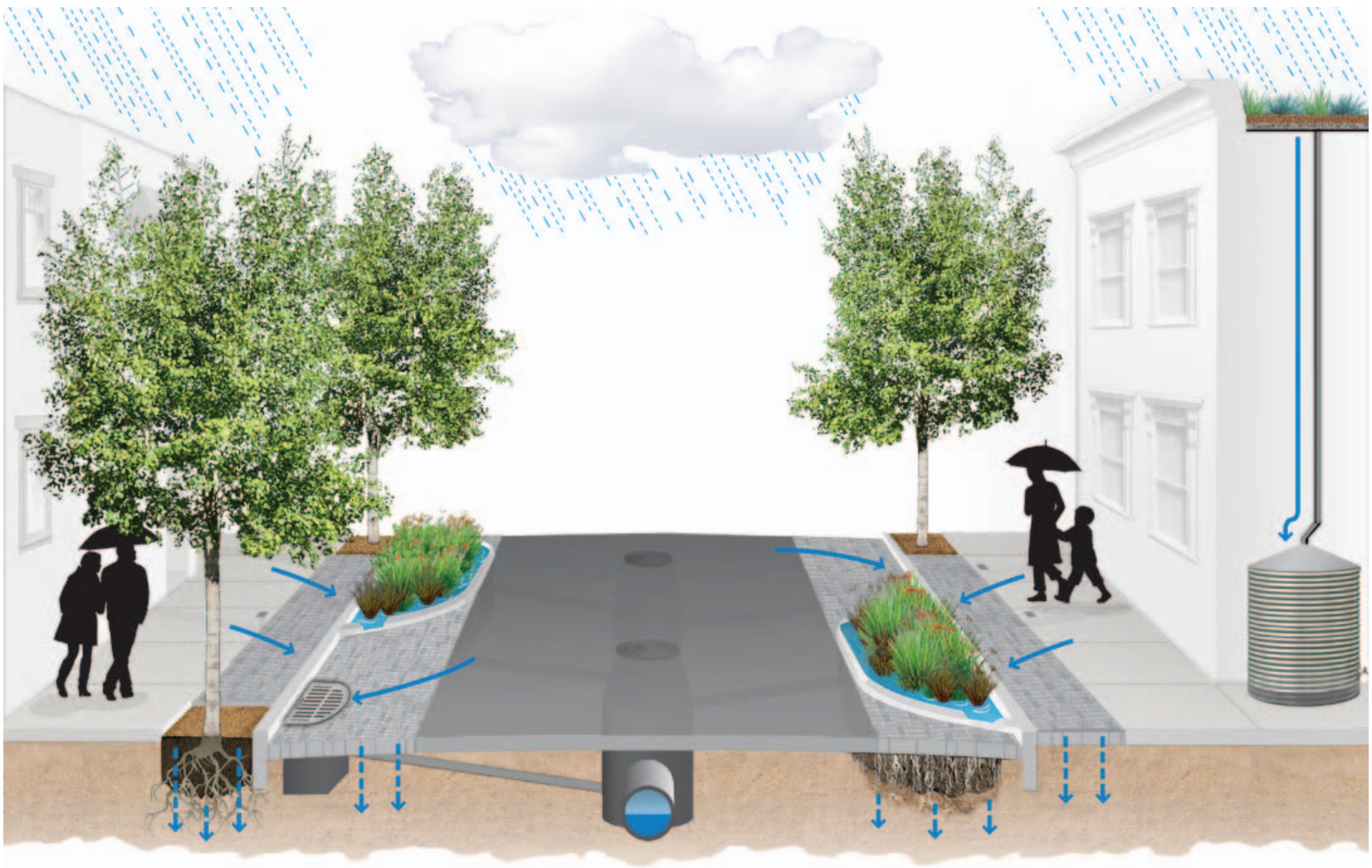
San Francisco Urban Watersheds

A watershed is an area of land that drains water by gravity to a receiving water body such as a river, lake or ocean. San Francisco is divided into eight watersheds, each with unique hydrologic characteristics and sewer system challenges.

STEP 2: LEARN ABOUT GREEN AND GREY INFRASTRUCTURE

Green Infrastructure: Green infrastructure is a stormwater management tool that takes advantage of the natural processes of soils, plants, and other innovative technologies in order to slow down, clean, or infiltrate stormwater before it reaches the sewer system, reducing the burden on our aging facilities.

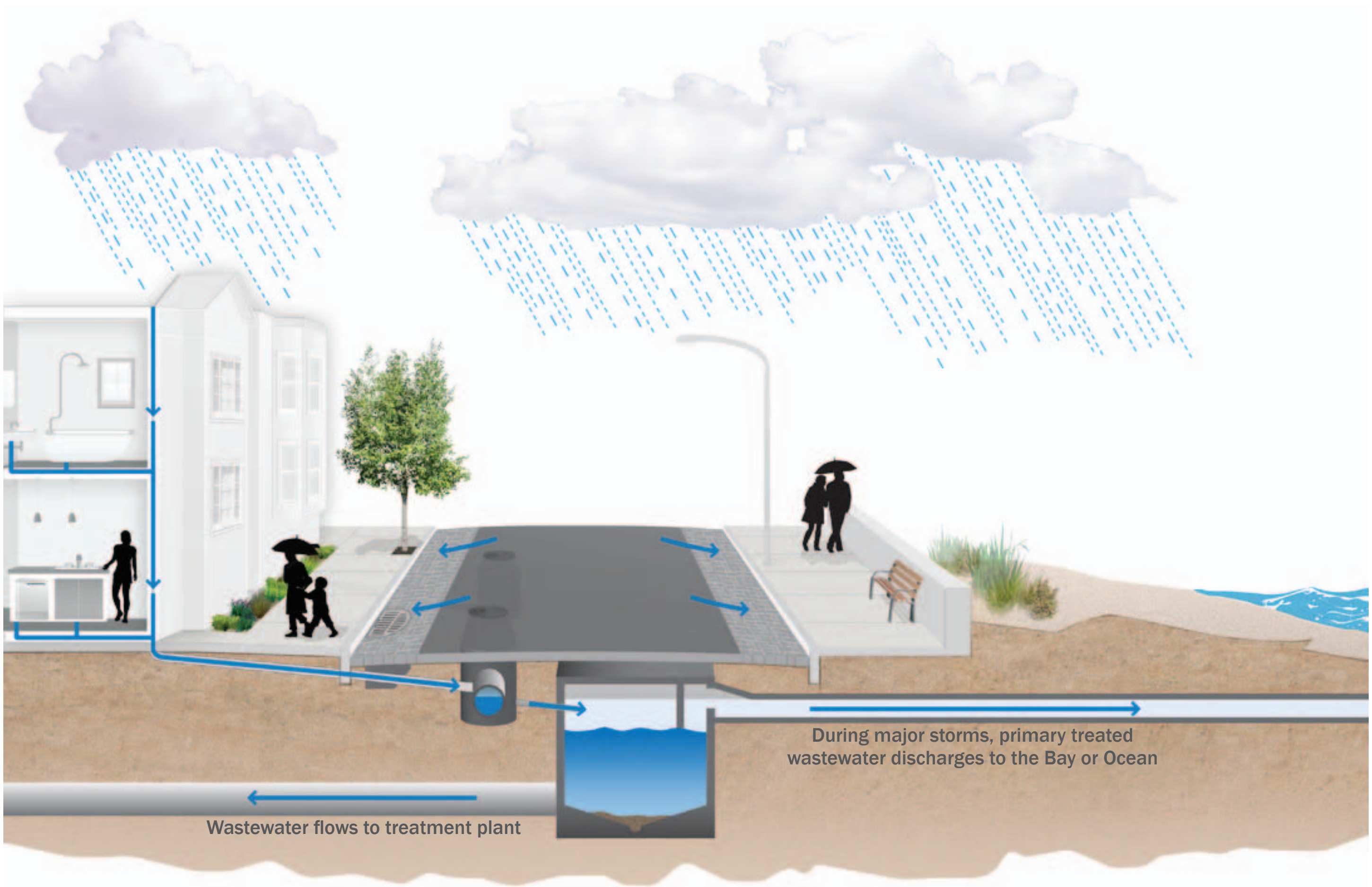
Green Infrastructure has the potential to increase the sewer system's treatment efficiency by reducing or delaying the volume of runoff flowing to the combined sewer, providing stormwater treatment, enhancing environmental protection of receiving waters, and reducing the volume and frequency of combined sewer discharges. These technologies, if properly designed, can also provide ancillary benefits that include neighborhood greening, traffic calming, reduction of potable water demand, and the creation of new open spaces. They can be integrated into the existing urban fabric to create streets, parks, and plazas that both benefit the sewer system and make San Francisco a more livable city.



Green infrastructure technologies include permeable paving, rain gardens, and rain harvesting systems.

Grey Infrastructure: Grey infrastructure includes the traditional technologies that collect, store and convey a combination of stormwater and sewage to our treatment plants. These technologies include pipes, tunnels, tanks, and pump stations and are the backbone of the sewer system.

The Urban Watershed Planning Game includes green infrastructure game pieces such as rain gardens, flow-through planters, vegetated roofs, constructed wetlands, permeable paving, and creek daylighting. Grey infrastructure game pieces include detention tanks, storage pipes, and conveyance pipes.



Grey infrastructure includes the traditional technologies that collect, store and convey a combination of stormwater and sewage to our treatment plants.

STEP 3: LEARN HOW TO PLAY THE GAME

Each team member will be asked to "play" different stormwater management tools within the boundaries of one of San Francisco's eight watersheds. Each watershed game board has a set of stormwater management goals for excess stormwater and combined sewer discharge volume reduction. Each tool provides different stormwater management benefits and has different costs. These values have been quantified based on studies and modeling that has been calibrated for San Francisco.

This booklet introduces and describes the benefits and limitations of each stormwater management tool in the Planning Game. Your job is to identify appropriate locations for the tools to address the surface water management goals in your watershed. During your turn you will place a tool on the game board and a scorekeeper will help tally the benefits and costs.

The game piece tools fall into four main categories based on their performance type:

SINK IT (Retention): Holds stormwater and infiltrates it

SLOW IT (Detention): Holds stormwater flow and slowly releases to sewer system after the storm

REUSE IT (Storage and Reuse): Holds stormwater and uses it to meet non-potable water demands (eg. toilet flushing, irrigation, etc)

MOVE IT (Conveyance): Directs flow to a downstream area for storage

Be sure to look for opportunities for partnerships, multi-purpose projects, and synergies on adjacent or nearby developments. Throughout the game, your scorekeeper will calculate the benefits and costs and determine how closely your team meets your stormwater management goals and stays within your budget. Keep in mind that the Planning Game is a brainstorming exercise and a time to learn and explore new ideas.

About the Urban Watershed Assessment

In 2010, the San Francisco Public Utilities Commission (SFPUC) made a commitment to watershed-based planning and launched the Urban Watershed Assessment process, which is part of the City's larger Sewer System Improvement Program (SSIP). Faced with aging facilities, regional seismic activity, and a changing climate, the goal of the Urban Watershed Assessment is to implement an objective, transparent process that will result in a recommended plan for collection system projects across all of the watersheds to bring the Combined Sewer System up to the adopted SSIP Levels of Service. The Urban Watershed Assessment will proactively identify both green and grey infrastructure solutions to help address the challenges in each of the city's watersheds.

About the Sewer System Improvement Program

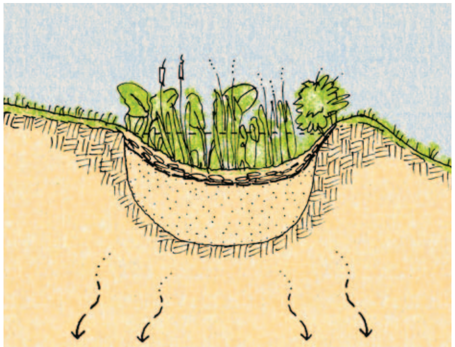
The Sewer System Improvement Program (SSIP) is a 20-year, multi-billion dollar citywide investment to improve our aging sewer infrastructure and protect public health and the environment. The SFPUC will use innovative strategies to bring aging pipelines, pump stations, and treatment facilities into a state of good repair, ensure system reliability, and maintain compliance with environmental requirements. All proposed improvements will meet the adopted SSIP Level of Service Goals:

+ Provide a Compliant, Reliable, Resilient, & Flexible System that can Respond to Catastrophic Events
+ Integrate Green & Grey Infrastructure to Manage Stormwater
+ Provide Benefits to Impacted Communities
+ Modify the System to Adapt to Climate Change
+ Achieve Economic & Environmental Sustainability
+ Maintain Ratepayer Affordability

Rain Garden

Sink It (Retention)

(also known as: bioretention cell, bioretention planter, curb-side planter, above-ground planter, flow-through planter, and stormwater planter)



Schematic Diagram

Description

A rain garden is a stormwater facility that relies on vegetation and either native or engineered soils to capture, infiltrate and transpire water, and remove pollutants from runoff. It reduces stormwater volume, attenuates peak flow, and improves stormwater quality. Rain gardens feature vegetation that can tolerate periodic inundation and contain soils with high organic content. If designed properly, they can be an aesthetic and habitat amenity as well as a stormwater treatment facility.

Siting

- Rain gardens can be used in a variety of contexts, including residential yards, office and commercial storefronts, parks, and rights-of-way, parking lots, and other landscaped areas
- Rain gardens can be easily integrated into retrofits of existing sites
- Rain gardens can be integrated into the building's foundation walls either at grade using an in-ground planter or above ground using a contained planter
- Ideally, rain gardens should be situated in areas with less than 5 percent slope, but they can be effective at up to 20 percent slopes with proper flow control designs

Bioretention planter at Glencoe Elementary School in Portland, OR

Performance

Pollutant Removal

●

Target Pollutants

Sediment	● ⊛
Nutrients	◒
Organics	●
Trash	○ ⊛
Metal	●
Bacteria	●
Oil/Grease	●

Volume Reduction

●

Peak Flow Reduction

◒

○ Low
◒ Moderate
● High
⊛ Requires Pre-treatment

Benefits:

- Easy and inexpensive to install
- Wide range of scales and site applicability
- Reduces runoff volume where infiltration is feasible and attenuates peak flows
- Improves water quality and air quality
- Increases effective permeable surfaces in highly urbanized areas
- Creates habitat and increases biodiversity in the city (with appropriate vegetation)
- Provides aesthetic amenities
- Facilitates groundwater recharge (infiltration-based systems only)
- Facilitates evapotranspiration

Limitations:

- Requires relatively flat site

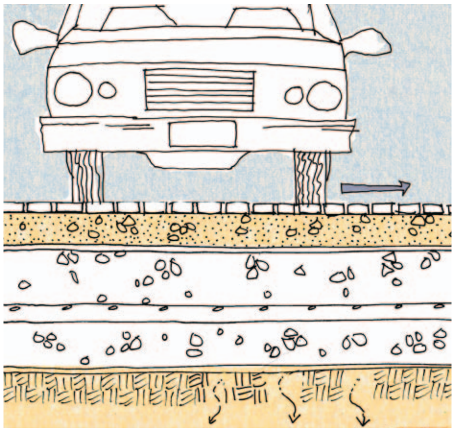
Rain garden in Mint Plaza, San Francisco, CA

Boardwalks provide access across waterfront rain gardens in Seattle, WA

Permeable Paving

Sink It (Retention)

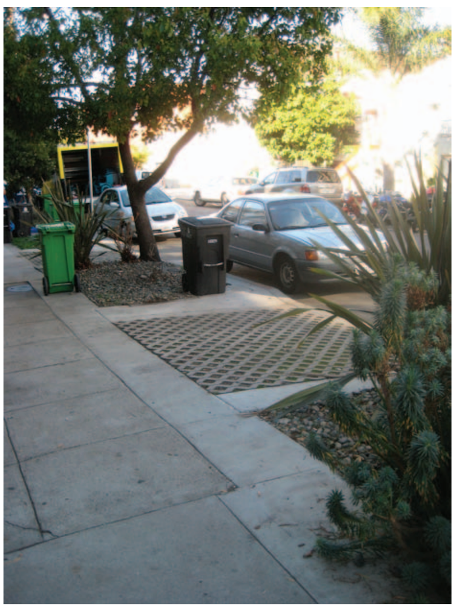
(also known as: pervious paving, porous pavement, grass pavers, green parking, pervious concrete, porous asphalt, turf blocks, unit pavers, ungrouted brick/stone, crushed aggregate)



Schematic Diagram

Description

Permeable paving is any porous load-bearing surface that temporarily stores rainwater in an underlying aggregate layer until it infiltrates into the soil below. Permeable paving reduces annual runoff volumes, slows down peak flows, and improves water quality by removing oil and grease, metals, and suspended solids. It does not typically remove nutrients. Infiltration rates of permeable surfaces may decline over time to varying degrees depending on design and installation, sediment loads, and consistency of maintenance. Common materials for the paving surface include porous asphalt, pervious concrete, interlocking block pavers, and plastic grid systems.



Permeable paving used for driveway aprons on Shotwell Street in San Francisco, California

Siting

Areas with low-speed travel and light to medium-duty loads, such as:

- parking lots
- low-traffic streets
- parking lanes
- driveways
- bike paths
- patios
- plazas
- sidewalks

Site conditions, including native soil infiltration rate, depth to groundwater, depth to bedrock, slope, and adjacent land uses, should be assessed to determine whether infiltration is possible beneath permeable pavement and to ensure that off-site sediment and pollutants are not directed onto the permeable surface. The mimimum recommended setback of permeable pavement from building foundations is 10 feet if receiving run-on from adjacent surfaces and no setback if there is no run-on.

Performance

Pollutant Removal

◒

Target Pollutants

Sediment	● ⊛
Nutrients	○
Organics	◒
Trash	○ ⊛
Metal	●
Bacteria	●
Oil/Grease	●

Volume Reduction

●

Peak Flow Reduction

◒

○ Low
◒ Moderate
● High
⊛ Requires Pre-treatment

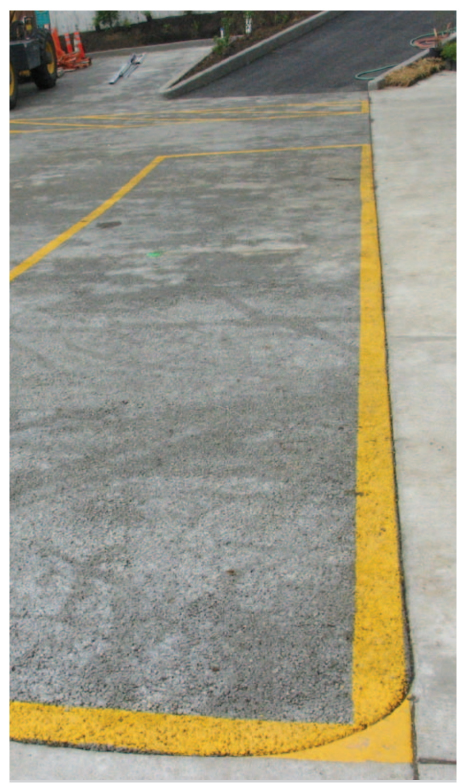
Benefits:

- Reduces runoff volume and attenuates peak flows
- Improves water quality by reducing fine-grained sediment, organic matter, and trace metals
- Reduces the heat island effect
- Facilitates groundwater recharge
- May increase safety for persons with disabilities by providing textured, non-slip surfaces and reducing ponding
- Can be used as a design element to provide aesthetic benefits

Limitations:

- Limited to paved areas with slow traffic and low traffic volumes
- Limited to sites with slopes that do not exceed 5%
- Difficult in compacted soils: infiltration rates must be at least 0.5 inch per hour
- Depth to bedrock and groundwater must be greater than 4 feet for infiltration based systems

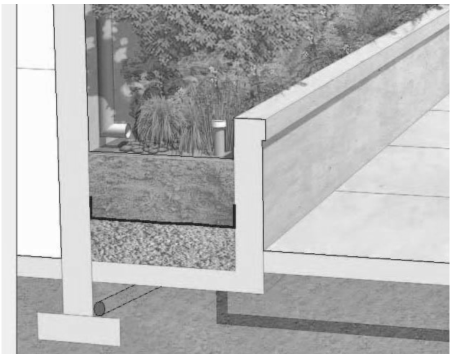
Permeable paving used for parking areas in Germany



Porous asphalt in Portland, OR

Flow-Through Planter

Slow It (Detention)



Schematic Diagram

Description

Flow-through planters are structural landscaped planters that collect stormwater* and filter out pollutants as the water percolates through the vegetation, growing medium, and gravel and then is slowly released to the sewer system.

Tree box filters are flow-through planters with a concrete “box” that contains filtering growing media and a tree or large shrub.

* runoff from adjacent impervious surfaces (streets, sidewalks, parking lots)

Siting

- Flow-through planters are appropriate where soils do not drain well or there are site constraints.
- A liner may be required when located adjacent to buildings, over contaminated soils, and on unstable slopes. Excess stormwater collects in a perforated pipe at the bottom of the flow-through planter and drains to an approved discharge point.
- Tree box filters are used singly or in multiples, often adjacent to streets where runoff is directed into them for treatment before it enters a catch basin.

PSU Stephen Epler Hall, Portland, Oregon

Performance

Pollutant Removal

High

Target Pollutants

Sediment	High	Requires Pre-treatment
Nutrients	Moderate	
Organics	High	
Trash	Low	Requires Pre-treatment
Metal	High	
Bacteria	High	
Oil/Grease	High	

Volume Reduction

High

Peak Flow Reduction

Moderate

Low
Moderate
High
Requires Pre-treatment

Benefits:

- With appropriately amended soils a flow-through planter can serve numerous benefits: detention; increased physical/chemical/microbial pollution reduction; and reduced erosion potential.
- Planted vegetation helps to attenuate stormwater flows and break down pollutants by interactions with bacteria, fungi, and other organisms in the planter soil. Vegetation also traps sediments, and reduces erosion. Appropriate and carefully considered plantings enhance the aesthetic and habitat value of a flow-through planter.

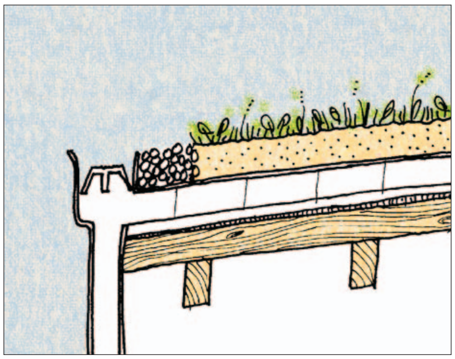
Rose Quarter parking structure, NE Portland

Aloha Dog and Cat Clinic, Washington County

Vegetated Roof

Slow It (Detention)

(also known as: eco-roof, green roof)



Schematic Diagram

Description

Vegetated roofs are roofs that are entirely or partially covered with vegetation and soils. These roofs improve water quality by filtering out contaminants including suspended solids, metals, and polycyclic aromatic hydrocarbons (PAHs) as the runoff flows through the growing medium or through direct plant uptake. The engineered soils absorb rainfall and release it slowly, thereby reducing the runoff volumes and delaying peak flows. Vegetated roofs include engineered soils as a growing medium, subsurface drainage piping, and a waterproof membrane to protect the roof structure.

Siting

- Can be installed on most types of commercial, multifamily, and industrial structures, as well as on single-family homes, garages, and sheds
- Can be used for new construction or to re-roof an existing building
- Roof must have sufficient structural support to hold the additional weight of the vegetated roof (generally a minimum of 10 to 25 pounds per square foot)
- Roof slopes between 5 and 20 degrees are most suitable

The Academy of Sciences building in San Francisco, CA has a nearly 2.5-acre vegetated roof

Performance

Pollutant Removal

High

Target Pollutants

Sediment	High
Nutrients	High
Organics	High
Trash	Low
Metal	High
Bacteria	High
Oil/Grease	High

Volume Reduction

Moderate

Peak Flow Reduction

Moderate

Low
Moderate
High
Requires Pre-treatment

Benefits:

- Provides insulation and can lower heating and cooling costs for the building
- Extends the life of the roof – a green roof can last twice as long as a conventional roof, saving replacement costs and materials
- Provides noise reduction
- Reduces urban heat island effect
- Lowers the temperature of stormwater runoff, which maintains cool temperatures for fish and other aquatic life
- Creates habitat and increases biodiversity in the city
- Provides aesthetic amenities

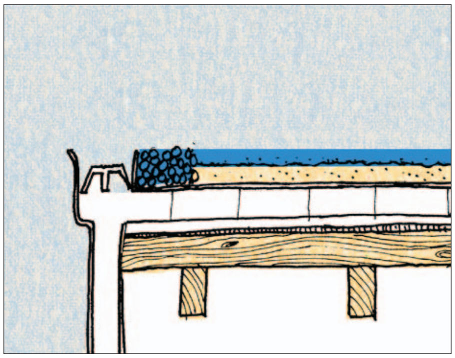
Limitations:

- Limited to roof slopes less than 20 degrees (5-in-12 pitch)
- May Require additional structural and seismic support to bear the added weight
- Irrigation may be needed to establish plants and maintain them during extended dry periods (depending on plant types)

Vegetated roofs can be designed to be visible from the street to add unique textures and colors to building design

Blue Roof

Slow It (Detention)



Schematic Diagram

Description

Blue roofs are non-vegetated roofs that control the roof's downspouts to temporarily store rainfall on the roof surface. Blue roofs can also be used to capture and route rainfall for irrigation and other non-potable demands. Weirs at the roof drain can create temporary storage and gradual release back into the roof drainage system. A blue roof captures rainfall, allows some evapotranspiration, and releases the remaining rainfall slowly, thereby reducing the runoff volumes and delaying peak flows. There are a number of blue roof types, retrofitting the roof drain to control flow, installation of check dams to detain rainfall and slowly release to the roof drain, and roof trays to detain rainfall and slowly release to the existing roof drainage.

Siting

- Most effective in highly urbanized areas where rooftop occupies most of the site.
- Can be installed on most types of commercial, multifamily, and industrial structures, as well as on single family homes, garages, and sheds
- Can be used for new construction or to retrofit an existing building
- Roof must have sufficient structural support to hold the additional weight of the water
- Flat roofs are most suitable, less than 2 percent

Blue roof next to a vegetated roof (foreground)

Performance

Pollutant Removal

◒

Target Pollutants

Sediment	●
Nutrients	○
Organics	○
Trash	●
Metal	○
Bacteria	○
Oil/Grease	○

Volume Reduction

◒

Peak Flow Reduction

●

○ Low
◒ Moderate
● High
⊛ Requires Pre-treatment

Benefits:

- Less expensive than subsurface storage or green roofs
- Reduces strain on the sewer system during the peak of rainfall events

Limitations:

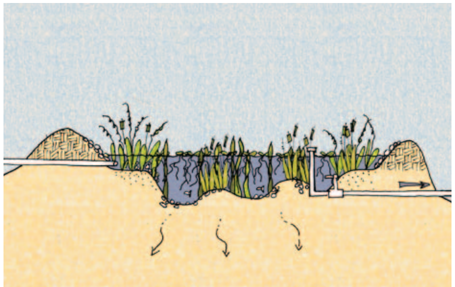
- Most effective on flat roofs with slopes less than 2 percent

Blue roof in New York City, New York

Constructed Wetland

Slow It (Detention)

(also known as: stormwater wetland, treatment wetland, stormwater marsh)



Schematic Diagram

Description

Constructed wetlands are man-made wetlands designed to collect and purify stormwater through microbial transformation, plant uptake, settling, and adsorption. Water is stored in shallow vegetated pools that are designed to support wetland plants. Constructed wetlands have many of the same ecological functions as natural wetlands and are beneficial for flood control and water quality improvement.

Siting

- Wetlands must be sited on a relatively flat area with less than 2 percent slope, but can receive drainage from upstream slopes of up to 15 percent
- Wetlands typically occupy 1 to 3 percent of their contributing drainage area

Arcata Marsh in Arcata, California (Photo taken by Brooke Ray Smith)

Performance

Pollutant Removal

●

Target Pollutants

- Sediment ● ⊛
- Nutrients ◒
- Organics ●
- Trash ○ ⊛
- Metal ●
- Bacteria ●
- Oil/Grease ●

Volume Reduction

◒

Peak Flow Reduction

●

- ○ Low
- ◒ Moderate
- ● High
- ⊛ Requires Pre-treatment

Benefits:

- Effective at removing stormwater pollutants (sediment, nutrients, organic compounds, pathogens, heavy metals)
- Reduces stormwater peak flows, can reduce overall volume if runoff is stored and used
- Attractive landscape feature and potential community park amenity
- Provides valuable wetland habitat
- Good in areas unsuitable for infiltration or with high groundwater table
- Easily customizable to various sizes and dimensions, based on site, budget, and design intent
- Can be designed to treat and store water for local non-potable use (e.g. for irrigation, toilet flushing, or fire protection), depending on site conditions and stormwater characteristics

Limitations:

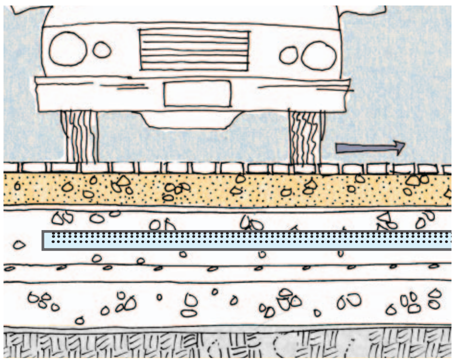
- Requires relatively large land area
- Variation in water quality improvement as plants senesce seasonally

Constructed wetland in Tanner Springs Park in Portland, Oregon

Stormwater conveyance at the constructed wetland in Tanner Springs Park in Portland, Oregon

Permeable Paving (Underdrained)

Slow It (Detention)


Schematic Diagram

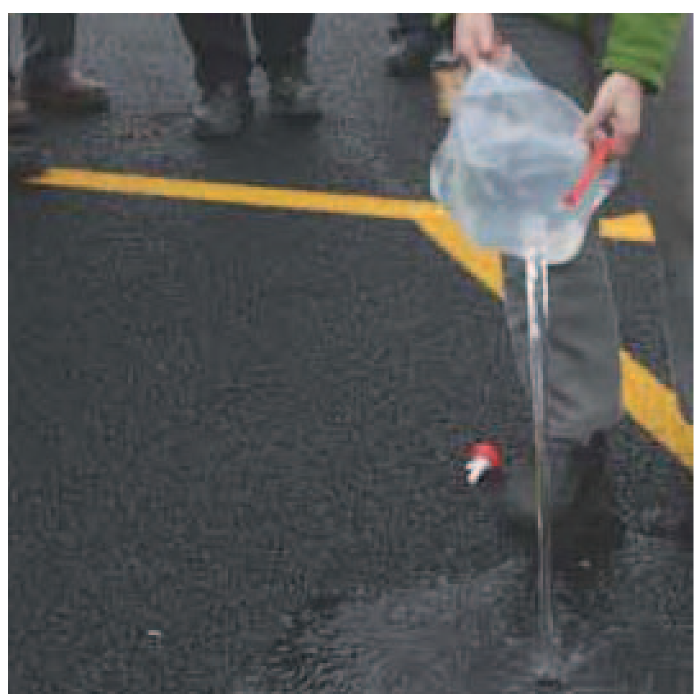
Description

Permeable paving is any porous load-bearing surface that temporarily stores rainwater in an underlying aggregate layer until it is routed to a collection system via an underground pipe. Similar to permeable paving without under drains, this version of permeable paving attenuates peak flows, and improves water quality by removing oil and grease, metals, and suspended solids. It does not typically remove nutrients.

Siting

- Areas with low-speed travel and light to medium-duty loads, such as: parking lots, low-traffic streets, parking lanes, driveways, bike paths, patios, plazas, sidewalks.
- Areas where soils have poor drainage rates.
- Common materials for the paving surface include porous asphalt, pervious concrete, interlocking block pavers, and plastic grid systems.
- The mimimum recommended setback of permeable pavement from building foundations is 10 feet if receiving run-on from adjacent surfaces and no setback if there is no run-on.


Porous paving



Performance

Pollutant Removal

◒

Target Pollutants

Sediment	● ⊛
Nutrients	○
Organics	◒
Trash	○ ⊛
Metal	●
Bacteria	●
Oil/Grease	●

Volume Reduction

●

Peak Flow Reduction

◒

○ Low
◒ Moderate
● High
⊛ Requires Pre-treatment

Benefits:

- Attenuates peak flows
- Improves water quality by reducing fine-grained sediment, organic matter, and trace metals
- Reduces the heat island effect
- Provides noise reduction
- May increase driving safety by reducing ponding
- May increase safety for persons with disabilities by providing textured, non-slip surfaces and reducing ponding
- Can be used as a design element to provide aesthetic benefits

Limitations:

- Limited to paved areas with slow traffic and low traffic volumes
- Limited to sites with slopes that do not exceed 5%

Porous paving underdrained

Detention Tank

Slow It (Detention)

Detention tank

Description

Detention tanks are underground structures designed to temporarily hold a combination of wastewater (sewage) and stormwater during peak flows, and then slowly release those flows to downstream treatment. The tanks can be used to alleviate localized flooding, while also lessening the demand on treatment facilities during storm events and decreasing the likelihood of downstream flooding and/or combined sewer discharges. The tanks are usually constructed out of concrete; the area above the tanks can be landscaped and used for other purposes, such as playgrounds or parking lots.

Siting

- Requires open land, such as a parking lot, the street right of way, or basement of new building
- Must consider ease of access for maintenance
- Creates opportunities for dual use of area above the tank

Large pre-cast concrete detention tanks being installed

Performance

Pollutant Removal

○

Target Pollutants

Sediment	○
Nutrients	○
Organics	○
Trash	○
Metal	○
Bacteria	○
Oil/Grease	○

Volume Reduction

○

Peak Flow Reduction

●

○ Low
◒ Moderate
● High
⊛ Requires Pre-treatment

Benefits:

- Attenuates peak flows
- Provides protection against flooding
- Provides high volume storage
- Good for sites where infiltration is not an option

Limitations:

- Limited pollutant removal potential
- Requires subsurface stability for building underground structure
- High cost for underground systems

Concrete detention tank

Storage Pipe

Slow It (Detention)

Storage pipe

Description

A storage pipe is an underground structure designed to temporarily hold a combination of wastewater (sewage) and stormwater runoff during peak flows and then slowly release those flows to downstream treatment. Storage pipes can be used to alleviate localized flooding, while also lessening the demand on treatment facilities during storm events and decreasing the likelihood of downstream flooding and/or combined sewer discharges.

Siting

- Located underneath the street right-of-way
- Requires easement to cross parcels
- Must consider ease of access for maintenance

Cesar Chevez pipe construction, San Francisco, California

Performance

Pollutant Removal

Low

Target Pollutants

Sediment	Low
Nutrients	Low
Organics	Low
Trash	Low
Metal	Low
Bacteria	Low
Oil/Grease	Low

Volume Reduction

Low

Peak Flow Reduction

High

Low
Moderate
High
Requires Pre-treatment

Benefits:

- Attenuates peak flows
- Provides protection against flooding
- Provides moderate volume storage
- Good for sites where infiltration is not an option

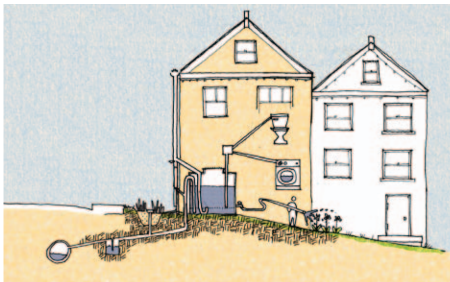
Limitations:

- Limited pollutant removal potential
- Outflow will likely require a pump system
- Requires subsurface stability for building underground structure
- High cost for underground systems
- For larger storage volumes, tunneling may be required for installation

Sunnydale tunnel construction, San Francisco, California

Rainwater Harvesting

Reuse It (Storage and Reuse)



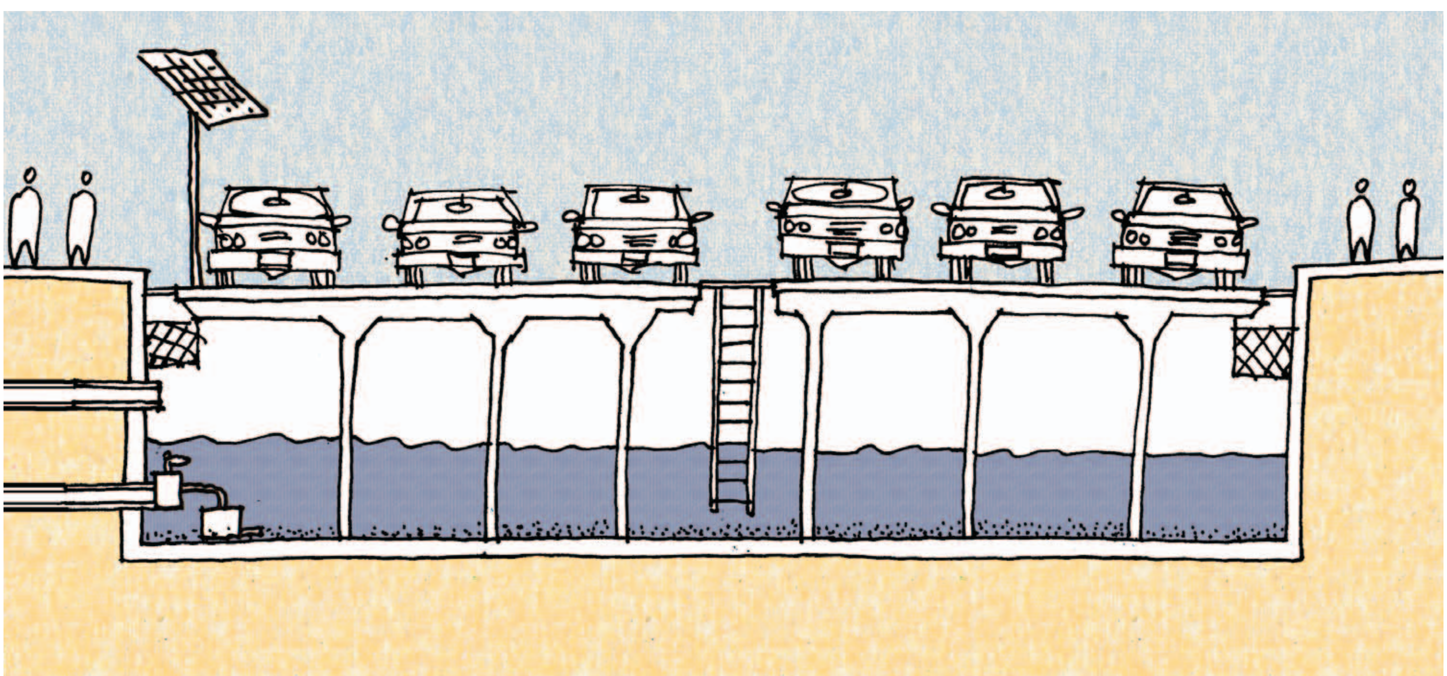
Schematic Diagram

Description

Rainwater harvesting is the practice of collecting and using rainwater from impervious surfaces, such as roofs and patios, for non-potable use, such as irrigation and toilet flushing. It is now legal to divert stormwater from San Francisco's combined sewer system. In 2005, city staff amended the plumbing code via Ordinance 137-05, making it possible to direct rainwater to alternative locations such as rain gardens, rain barrels, and cisterns. Proper design and sizing of the rainwater harvesting system are critical to ensure full runoff reduction benefits.

Siting

- Both rain barrels and above-ground cisterns must be sited in a stable, flat area
- Rain barrels and cisterns may not block the path of travel for fire safety access
- Overflow locations, which can include rain gardens, additional rain barrels or cisterns, or a discharge point to the collection system, must be designed to both direct outflow away from building foundations and prevent nuisance flows to adjacent properties
- Tanks should be placed in a cool or shaded area to avoid algal growth



In urban areas, underground cisterns can store stormwater runoff from paved surfaces

Performance

Pollutant Removal

Target Pollutants

- Sediment
- Nutrients
- Organics
- Trash
- Metal
- Bacteria
- Oil/Grease

Volume Reduction

Peak Flow Reduction

Low
Moderate
High
Requires Pre-treatment

Benefits:

- Offsets the volume of potable water used for non-potable applications, such as irrigation and toilet flushing
- Keeps relatively clean water out of the combined sewer system, thereby enhancing the performance and lengthening the life of the City's combined sewer infrastructure
- Reduces the volume and peak flows of stormwater entering the sewer
- Reduces the energy and chemicals needed to treat stormwater in the City's sewage treatment plants
- Reduces the energy expended transporting potable water from distant sources
- Low maintenance requirements (for above ground cisterns)
- Good for sites where infiltration is not an option

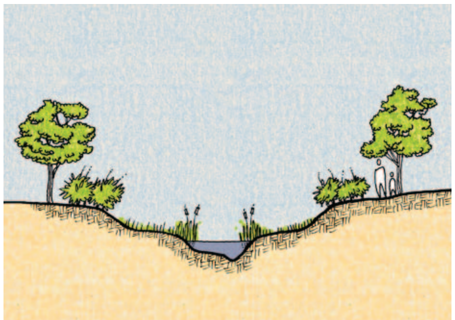
Limitations:

- Requires infrastructure (pumps or valves) to use stored water
- Roof surfaces serving as catchments for watering shall not include copper or materials treated with fungicides or herbicides

Rainwater Harvesting at Layfayette Elementary School, located in the Sunset Basin in San Francisco, California

Creek Daylighting

Move It (Conveyance)



Schematic Diagram

Description

Creek daylighting refers to projects that uncover and restore creeks, streams, and rivers that were previously buried in underground pipes and culverts, covered by decks, or otherwise removed from view. The City of San Francisco has several historical creeks. Water from these creeks currently runs via the combined sewer system to treatment plants and then to the Bay and Ocean. Daylighting these historical creeks can decrease demand on the treatment facilities and enhance local neighborhoods.

Siting

- Creek daylighting is well suited for historic creek paths that traverse existing open space or the public right-of-way

Daylit creek in Zurich, Switzerland

Performance

Pollutant Removal

●

Target Pollutants

Sediment	●
Nutrients	●
Organics	●
Trash	○ ⊛
Metal	●
Bacteria	●
Oil/Grease	●

Volume Reduction

●

Peak Flow Reduction

●

○ Low
◒ Moderate
● High
⊛ Requires Pre-treatment

Benefits:

- Reduces runoff volume and attenuates peak flows
- Improves water quality
- Improves urban hydrology and facilitates groundwater recharge
- Replaces deteriorating culverts with an open drainage system that can be more easily monitored and repaired
- Creates habitat and increases biodiversity in the city
- Provides recreational amenities
- Provides educational opportunities

Limitations:

- High installation costs
- May have high maintenance costs
- May require land acquisition
- Some benefits are lost if only fragmented segments are daylit

Daylit creek in Zurich, Switzerland

Conveyance Pipe

Move It (Conveyance)

Draining to pipes below

Description

Conveyance pipes carry a combination of wastewater (sewage) and stormwater runoff to downstream treatment. Conveyance pipes can be used to alleviate localized flooding by directing stormwater from constrained challenge areas to downstream areas that have adequate capacity to handle increased flows. Much of the sewer pipe network works with the natural topography and carries flows by gravity to downstream storage and treatment areas.

Siting

- Located underneath the street right-of-way
- Requires easement to cross parcels

Pipes

Performance

Pollutant Removal

○

Target Pollutants

Sediment	○
Nutrients	○
Organics	○
Trash	○
Metal	○
Bacteria	○
Oil/Grease	○

Volume Reduction

○

Peak Flow Reduction

◒

○ Low
◒ Moderate
● High
⊛ Requires Pre-treatment

Benefits:

- Conveys flows to areas with room for storage or treatment
- Provides protection against flooding when combined with downstream storage

Limitations:

- Requires available alignment to route the pipe underground
- Requires that the downstream system has adequate capacity to handle increased flows

Drain

Pipes convey water quickly and efficiently

San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission

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