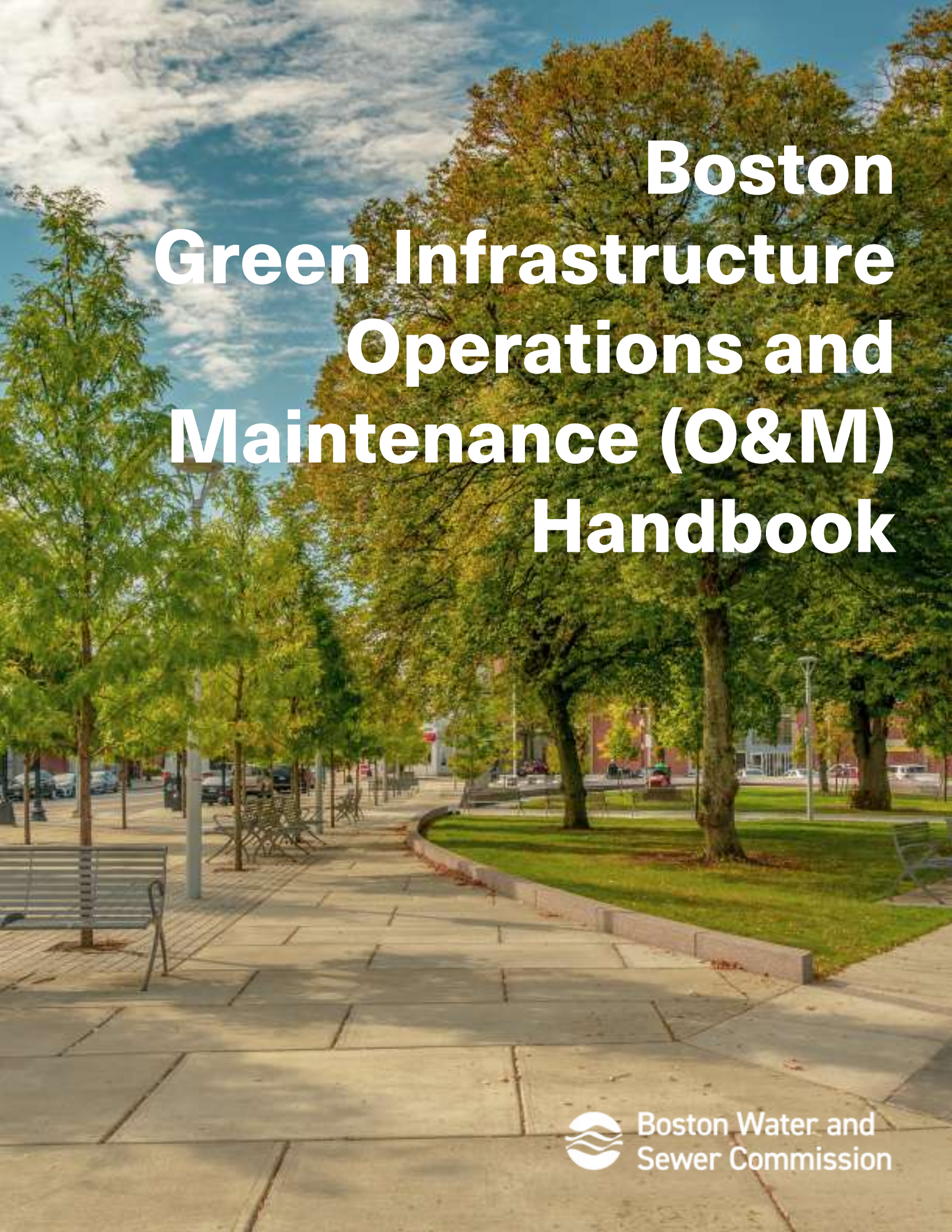


Boston Green Infrastructure Operations and Maintenance (O&M) Handbook

Boston Water and Sewer Commission



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Cover Image: Central Square, Boston, MA; Opposite: South Street and Bussey Street, Boston, MA



Table of Contents

Executive Summary
Terms and Definitions
Acronyms

Chapter 1: Introduction
1.1 Green Infrastructure Maintenance
1.2 Green Infrastructure Categories
1.3 Components of Green Infrastructure Solutions
1.4 Roles & Responsibilities for Operations & Maintenance

Chapter 2: Boston Context
2.1 Green Infrastructure Maintenance Considerations
2.2 Green Infrastructure Regulatory Considerations
2.3 Additional Considerations

Chapter 3: Inspection & Maintenance Actions
3.1 General Procedures
3.2 Pretreatment
3.3 Drainage Structures
3.4 Vegetation
3.5 Softscape Surfaces
3.6 Permeable Pavements
3.7 Rooftop Systems

Chapter 4: Inspection & Maintenance Checklists
4.1 Infiltration Practices
4.2 Bioretention Techniques
4.3 Permeable Pavements
4.4 Rooftop Systems

Opposite: Central Square, Boston, MA

Executive Summary

Urban development contributes to environmental changes affecting populations around the world, and the City of Boston is no exception. The addition of impervious surfaces creates excess stormwater runoff that creates several major issues including polluted water bodies, soil erosion, and flooding, all of which threaten quality of life if not dealt with in a responsible and sustainable manner. Green Infrastructure (GI) manages stormwater more sustainably, mimicking natural processes by employing a combination of plants, soils, filter media, and stone, in coordination with traditional stormwater solutions like drains, pipes, and outlet control structures. While the planning and design of GI stormwater solutions is an important part of their success, the operation and maintenance of these installations is just as imperative. Nothing can be considered a "set it and forget it" solution.

Regular inspection of Green Infrastructure is necessary to track the health of plants, the function of soils, and the performance of structural components such as underdrains and overflows. Inspections can also reveal symptoms of a larger issue or show signs of a problem that could get worse over time. Addressing these warning signs can prevent major interventions down the road, saving time and money. Maintenance of GI solutions can include regular cleaning, repair, and care of both structural and vegetated elements. Often a specific solution will require a specific combination of these maintenance actions, therefore being familiar with a site's specific needs is imperative to its success.

The Boston Water and Sewer Commission (BWSC) issued the Boston Green Infrastructure Planning and Design Handbook in 2021. This Boston Green Infrastructure Operations and Maintenance (O&M) Handbook (also referred to as O&M Handbook) accompanies the Planning and Design Handbook. This O&M Handbook describes GI maintenance considerations specific to Boston's urbanized landscape and serves as a guide for public and private property owners to manage sustainable stormwater solutions through the City of Boston.

Chapter 1: Introduction

Chapter 1 of this O&M Handbook provides an overview of common types of Green Infrastructure installations found in Boston and other urban areas. Many GI solutions have common components which are described in more detail. Chapter 1 also describes the roles and responsibilities of the many parties who can be involved in the successful implementation and maintenance of GI.

Chapter 2: Boston Context

Chapter 2 presents a brief overview of the common challenges and opportunities provided in the City of Boston when maintaining Green Infrastructure. In addition, the City of Boston is subject to specific regulatory requirements which may impact the frequency and actions of GI maintenance or inspections.

Chapter 3: Inspection & Maintenance Actions

Chapter 3 defines specific actions necessary to inspect and maintain Green Infrastructure solutions in Boston. Actions are grouped by category and provide an introduction to the tools, resources, and steps required. Some actions may need to be performed by a professional or licensed contractor, depending on the scope and scale of the infrastructure to be maintained.

Chapter 4: Inspection & Maintenance Checklists

Chapter 4 combines the actions described in Chapter 3 into checklists for each type of Green Infrastructure. These lists can be used as a guide by any Responsible Party to conduct an inspection and/or document maintenance items. (The Responsible Party is defined as the person or persons responsible for the operation and maintenance of a GI solution.) Consistent record keeping allows owners and designers to track the effectiveness of the system and prevent small issues from becoming larger, more expensive problems.

Opposite: Leonard P. Zakim Bunker Hill Memorial Bridge, Boston, MA



Terms and Definitions

This glossary provides a simplified overview of many critical terms and definitions related to stormwater management and Green Infrastructure (GI) implementation. Terms are adopted from the Environmental Protection Agency (EPA) website, EPA National Pollutant Discharge Elimination System (NPDES) Permit Writer Training Manual, and the Massachusetts Department of Environmental Protection (MassDEP), unless otherwise noted.

Clean Water Act (CWA)
An act passed by the U.S. Congress to control water pollution. It was formerly referred to as the Federal Water Pollution Control Act of 1972 or Federal Water Pollution Control Act Amendments of 1972.

Combined Sewer Overflow (CSO)
The discharge from combined sewers which collect both sanitary sewage and stormwater runoff for wastewater treatment under normal (dry) weather conditions. During rainstorms, the system becomes overloaded, and the excess is discharged directly into neighboring waterways from CSO outlets.

Green Infrastructure (GI)
The range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, subsurface systems, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters. (Section 502 of the Clean Water Act). Green Infrastructure (GI) is an effective, resilient approach to managing wet weather impacts that provides many community benefits. While single-purpose gray stormwater infrastructure is designed to move urban stormwater away from the built environment, GI reduces and treats stormwater at its source while delivering environmental, social, and economic benefits.

Gray Infrastructure
Used to characterize conventional stormwater management that relies on pipes, large above ground (ponds), or below ground storage (tunnels and tanks) for diverting runoff away from buildings and people and discharging at a single outfall location. Also used in reference to underground structures designed to expanding storage capacity of a combined sewer system to help reduce CSOs.

Impermeable / Impervious Surface
A surface or an area, which stormwater cannot penetrate through. Examples include traditional asphalt, concrete, brick or stone, and traditional roofs.

Low Impact Development (LID)
Refers to systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration or use of stormwater in order to protect water quality and associated aquatic habitat.

Municipal Separate Storm Sewer System (MS4)
A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains) owned by a State, city, town, or other public body, that is designed or used for collecting or conveying storm water, which is not a combined sewer, and which is not part of a publicly owned treatment works. Commonly referred to as an "MS4" [40 CFR §122.26(b)(8)].

National Pollutant Discharge Elimination System (NPDES)
The national program for issuing, modifying, revoking, and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 318, 402, and 405 of CWA.

Non-Structural Best Management Practices (BMPs)
Institutional, educational or pollution prevention practices designed to limit the amount of stormwater runoff or pollutants. The use of non-structural BMPs upstream can reduce the amount of runoff being generated, which in turn reduces the amount of stormwater that will need to be treated by structural BMPs downstream.

Pervious / Porous / Permeable Surface
Surfaces that allow water to percolate into the soil to filter out pollutants and recharge the water table. Examples include planting beds, mulched beds, gravel, permeable pavers, pervious asphalt, forested areas, and meadows. Turf and lawns are pervious, but generally much less so than the above-mentioned surfaces.

Stormwater Management
The practice of managing stormwater runoff using structural and non-structural best management practices, including Green Infrastructure.

Stormwater Runoff
Rain and snowmelt flowing over the land surface. Runoff picks up pollution such as excess fertilizers, bacteria and animal waste, road salt, and excess sediment and soil. This mixture often flows into storm drains, where it eventually flows into a nearby receiving water such as lakes or rivers.

Total Maximum Daily Load (TMDL)
The amount of pollutant, or property of a pollutant, from point, nonpoint, and natural background sources, that may be discharged to a water quality-limited receiving water. Any pollutant loading above the TMDL results in violation of applicable water quality standards.

Watershed
An area of land that drains to a specific point, such as a river, lake, ocean, storm drain inlet, or outfall. Catchments, subwatersheds, and basins all refer to different watershed scales.



Acronyms

ADA	Americans with Disabilities Act
BMP/BMPs	Best Management Practice(s)
BPDA	Boston Planning & Development Agency
BPRD	Boston Parks & Recreation Department
BPS	Boston Public Schools
BPWD	Boston Public Works Department
BTD	Boston Transportation Department
BWSC	Boston Water and Sewer Commission
CF	Cubic Feet
CSI	(Boston) Complete Streets Initiative
CSO/CSOs	Combined Sewer Overflow(s)
CWA	Clean Water Act
DCR	(Massachusetts) Department of Conservation & Recreation
EEA (or EOEEA)	(Massachusetts) Executive Office of Energy & Environmental Affairs
EEOS	(Boston) Environment, Energy & Open Space Cabinet
EPA	(U.S.) Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GCOD	Groundwater Conservation Overlay District
GI	Green Infrastructure
LEED	Leadership in Energy and Environmental Design
LID	Low Impact Development
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MBTA	Massachusetts Bay Transportation Authority
MS4	Municipal Separate Storm Sewer System
MVP	(Massachusetts) Municipal Vulnerability Preparedness Program
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
O&M	Operations and Maintenance
PROW	Public Right-of-Way
SDS	Safety Data Sheet
SF	Square Feet
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
USGBC	United States Green Building Council
USGS	United States Geological Survey
WQU	Water Quality Unit

Opposite: Metropolitan Waterworks Museum, Chestnut Hill, MA





CHAPTER 1

Introduction

The City of Boston and the Boston Water and Sewer Commission recognize the importance of implementing Green Infrastructure (GI) throughout the city to improve water quality and provide resilient stormwater management solutions. Like gray infrastructure, GI systems must be maintained on a regular basis. GI is not a "set it and forget it" solution. Each type of GI solution has specific requirements to ensure stormwater will be treated and managed effectively over time. It is imperative that requirements for the operations and maintenance (O&M) of any GI solution be considered during design and that owners and parties responsible for maintenance follow through with the designer's and manufacturer's recommendations.

Left: Copley Square, Boston, MA

1.1 Green Infrastructure Maintenance

Boston Green Infrastructure Planning and Design Handbook

In 2021, the Boston Water and Sewer Commission (BWSC) published the Boston Green Infrastructure Planning and Design Handbook as a guide for designers, engineers, landowners, and others to explain the benefits and design considerations for Green Infrastructure solutions in the City of Boston. This document explains six key drivers for implementation of Green Infrastructure (GI) solutions in Boston and why these solutions are imperative to creating a sustainable Boston. Chapter 3 of the Planning and Design Handbook contains a matrix of design requirements as well as a toolkit of GI solutions most likely to be installed in an urban or suburban area.

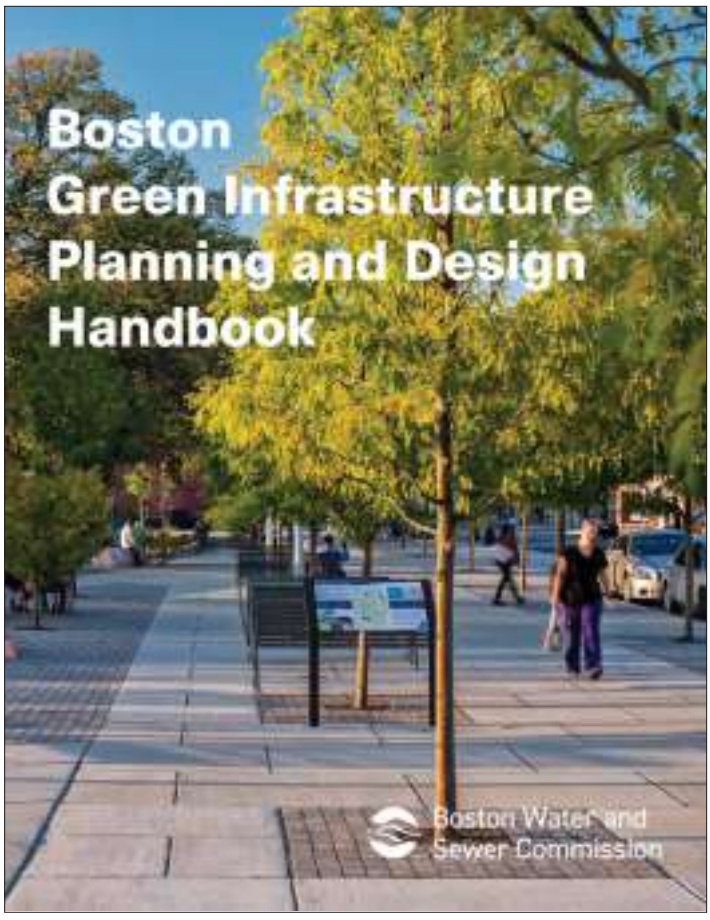
The Boston Green Infrastructure Planning and Design Handbook can be found on BWSC's website: https://www.bwsc.org/sites/default/files/2022-08/8.5x11-Green_Infrastructure_Handbook-02-07-2022.pdf



BWSC Green Infrastructure Suitability Matrix
(complete handbook available at BWSC.org)

Importance of Proactive Maintenance

GI solutions which are maintained on a regular basis often perform better and have a longer design life than those which are not properly maintained. In most cases, proactive maintenance, including having a regular schedule of inspection and maintenance actions, can be the most effective way to ensure the success of any GI solution. Property owners interested in implementing GI should be familiar with any specific maintenance actions required for their property and have a plan for regular upkeep. Actions such as debris removal or correcting issues related to minor erosion can prevent more serious clogging or damage to GI installations. Investing in regular maintenance often saves time and money compared to correcting major issues or a complete reconstruction of the stormwater solution. Being proactive, instead of reactive, has proven to be the best approach to GI operations and maintenance (O&M).



Boston Green Infrastructure Planning and Design Handbook
(complete handbook available at BWSC.org)

Goals of (O&M) Handbook

This O&M Handbook is intended to accompany the Boston Green Infrastructure Planning and Design Handbook, highlighting the requirements for each of the GI solutions previously presented. This O&M Handbook describes maintenance considerations specific to the urbanized Boston landscape including winter conditions and the changing climate. Chapter 4 of this O&M Handbook includes Inspection and Maintenance Checklists with specific action items for each GI solution which can be utilized by owners or responsible parties as documentation of routine inspections.

Below: Boston City Hall Plaza Tree Filter, Boston, MA;
Right: Bioswale installation





1.2 Green Infrastructure Categories

For the purpose of organizing this O&M Handbook, Green Infrastructure (GI) solutions are grouped into the following categories as established by the Boston Green Infrastructure Planning and Design Handbook:

Infiltration Practices



Infiltration practices are designed to allow stormwater to permeate surfaces and recharge groundwater. These practices are usually located in areas with soils that have a high infiltration rate, allowing water to move faster through soil media. Infiltration practices are also used where groundwater is low enough to provide capacity for runoff from typical storm events and prevent flooding of the system.

Bioretention



Bioretention systems are categorized by the use of plants and permeable soils to temporarily hold and filter stormwater. Some systems can be designed to infiltrate into the existing, underlying soils. Other systems may contain geotextile fabrics or liners to prevent or limit infiltration; in these cases, runoff filters through soils and may be directed to a traditional piped, gray infrastructure drainage system. These systems may not recharge groundwater, but slow and filter stormwater, still impacting water quality and quantity during typical rain events. Plants in these systems provide co-benefits by reducing urban heat island effects and improving air quality.





Permeable Pavements



Permeable pavement systems, also known as pervious pavements, are designed to allow stormwater runoff to infiltrate through the surface material instead of ponding on a traditionally impermeable surface. These systems often reduce or eliminate the need for drains, pipes, and other gray infrastructure. BWSC approved permeable pavement systems include a subsurface layer of crushed stone containing voids that can direct and slow runoff through the system. In Boston, these installations are designed to retain and infiltrate a volume of runoff equal to 1 inch of rainfall multiplied by the contributing drainage area, temporarily holding runoff to reduce peak flow rates.



Rooftop Storage



Rooftop storage solutions can take several forms including green roofs, blue roofs, and cisterns. In all cases, stormwater falling onto a roof, traditionally an impermeable surface, is captured or slowed using plants, pipes, or various containers. These systems improve water quality by capturing rainwater with few contaminants which can then be reused for irrigation or toilet flushing. Rooftop storage solutions can also provide benefits for water quantity by slowing and temporarily detaining runoff.



Opposite top: Stormtech subsurface storage installation;
Opposite bottom: University of Virginia rain garden, Charlottesville, VA;
Above right: Permeable pavers at Downtown Crossing, Boston, MA; Right: Green roof at Mad Oyster Studios, Somerville, MA (Source: Recover Green Roofs)

1.3 Components of Green Infrastructure Solutions

While Green Infrastructure (GI) installations differ from one another, many have similar components that serve important roles in their successful performance and must be properly maintained. The following are common components to look for when inspecting and maintaining GI:

Inlets

Most GI solutions need a way to receive stormwater, either via direct overland flow or a piped connection. Inlets can be designed to allow only a certain volume of runoff (sometimes referred to as the water quality volume) to be directed to the GI solution. This is often the case in small spaces or sites that present constraints. Some GI solutions may contain multiple inlets.

Pretreatment

GI solutions that utilize plants and soils should contain an area or device specifically for pretreatment which will remove trash and larger particles that may clog or compromise a treatment system. MassDEP requires many GI solutions to be paired with pretreatment devices such as deep sump catch basins or a sediment forebay to catch debris and settled solids prior to primary treatment in the GI feature. Some pretreatment devices are proprietary and require maintenance specified by the manufacturer.





Above right: Catch basins used as inlets for stormwater management; Right: Infiltration trench in Peabody Square, Boston, MA

Main Treatment

The main treatment area is often the largest component of a GI solution. This area performs the primary functions of treating stormwater through filtration and/or infiltration, improving water quality. Main treatment areas can also provide additional detention and retention capacity to reduce peak runoff rates, managing water quantity.

Outlet Structures & Emergency Overflow

Outlet structures allow accumulated stormwater runoff to exit the GI solution. Many GI solutions are designed to detain or treat a specific volume of runoff. Outlets are often carefully designed to allow treated excess runoff to continue downstream of the GI solution via overland flow or a pipe. Some GI solutions may have additional outlets that act as an emergency overflow to direct runoff from very large events to prevent flooding or damage to the system. Stormwater management solutions such as permanent retention basins may not have a designed outlet structure and only include an emergency overflow or spillway.

Below: Bioretention area at MIT North Corridor, Cambridge, MA (Source: Nitsch Engineering); Below right: Virginia Tech rain garden, Blacksburg, VA (Source: Nitsch Engineering)





1.4 Roles & Responsibilities for Operations & Maintenance

Each Green Infrastructure (GI) project will have an assigned division of responsibility of who owns and who maintains the GI. There may be an ownership agreement or a landscape maintenance plan as part of the permitting process. This O&M Handbook is intended to supplement any and all approved O&M documents and agreements including information on how to perform maintenance activities, what maintenance activities to perform, or where and when to seek professional assistance.

GI can be installed in both public and private lands in the City of Boston, therefore owners and responsible parties can vary. These parties play a role in the success of GI solutions:

Designer/Engineer

Federal, state, and local permitting authorities have specific regulatory oversight over construction and post-construction stormwater management, including water quality and runoff quantity mitigation. Because of these regulations, larger GI solutions will be designed by an engineer, landscape architect, or other qualified professional who will ensure the system can accommodate the required stormwater volume and function as a stormwater management solution. Many municipalities require the stormwater management design to be accompanied by an operations and maintenance (O&M) manual or procedures specific to the installation. Parties responsible for O&M should refer to these resources when planning and implementing maintenance actions. The methods in this O&M Handbook are not intended to supersede maintenance plans prepared by a design professional for a specific project or GI installation.

Responsible Party

Within this O&M Handbook, the Responsible Party is defined as the person or persons responsible for the operation and maintenance of a GI solution. This could be the Owner, a tenant, a landscaping company, or City department. Depending on the type of maintenance action required, a trained professional, such as a plumber or arborist, may be called upon to perform complex work or utilize specialized equipment.

Owner/Operator

In many cases, the property Owner is ultimately responsible for maintaining stormwater or GI installations. The Owner could delegate tasks to another party. Owners should clearly communicate expectations to other parties such as a tenant, landscaping crew, or other professional and keep documentation of any maintenance performed.

Inspector

Depending on regulatory requirements or a permitting process, some GI installations may be inspected on a regular basis. The Responsible Party may conduct regular voluntary inspections, while other municipalities may require inspections by a design professional, an employee, or delegate of the city or state permitting agencies. Owners or Responsible Parties should contact the City of Boston or BWSC for clarification on the inspection process for their specific GI installations at the time of permitting.

Maintenance Crew

A Maintenance Crew may be contracted to perform maintenance on GI installations. It is recommended that the Owner/Operator communicate any prepared maintenance recommendations or design specifics to the Maintenance Crew prior to negotiating work to be performed. Documentation of work performed is also recommended.

Opposite top: Triangle Park, Cambridge, MA (Source: Nitsch Engineering); Opposite bottom: Stormwater management at Rafael Hernández School, Boston, MA







CHAPTER 2

Boston Context

Due to its dense urban center and large areas of infill lands that were once tidal marshes, Boston's unique conditions require innovative approaches to infrastructure and stormwater. Boston's coastal geography also makes it highly vulnerable to climate change impacts including sea level rise and coastal and inland flooding. As Boston continues to expand its Green Infrastructure (GI) footprint to address these challenges, proper maintenance of GI will be necessary to ensure term long-term performance. Maintaining GI in Boston requires an understanding of its context, climate, and urban conditions.

Left: View of Boston from the Charles River

2.1 Green Infrastructure Maintenance Considerations

Urban Environment

Every year, Boston receives, on average, 44 to 46 inches of rain. Historically, most of this rainfall runs off impervious surfaces and directly into the Municipal Storm Sewer System where it is subsequently discharged to local water bodies. Unmanaged and untreated stormwater runoff can contribute to issues such as inland flooding, erosion, and water quality impairment. To address these issues, Green Infrastructure (GI) is a priority for the Boston Water and Sewer Commission (BWSC), the City of Boston, and numerous other local and regional stakeholders. In addition to its stormwater benefits, GI also provides numerous other co-benefits such as reducing the urban heat island effect, recharging groundwater, and providing habitat for urban wildlife.

As Boston continues to promote the expansion of GI across private and public lands, the operation and maintenance (O&M) of these GI installations must be prioritized to ensure the performative benefits will be achieved over the long term. Urban environments typically generate high contaminant loads and large volumes of trash and debris, which require frequent maintenance actions.

Integrating GI into Boston's narrow streets, alleyways, and one-way streets presents a challenge, and maintenance access to these spaces should be considered early in the planning and design process. Private landowners should ensure that GI can be accessed, inspected, and maintained as required.

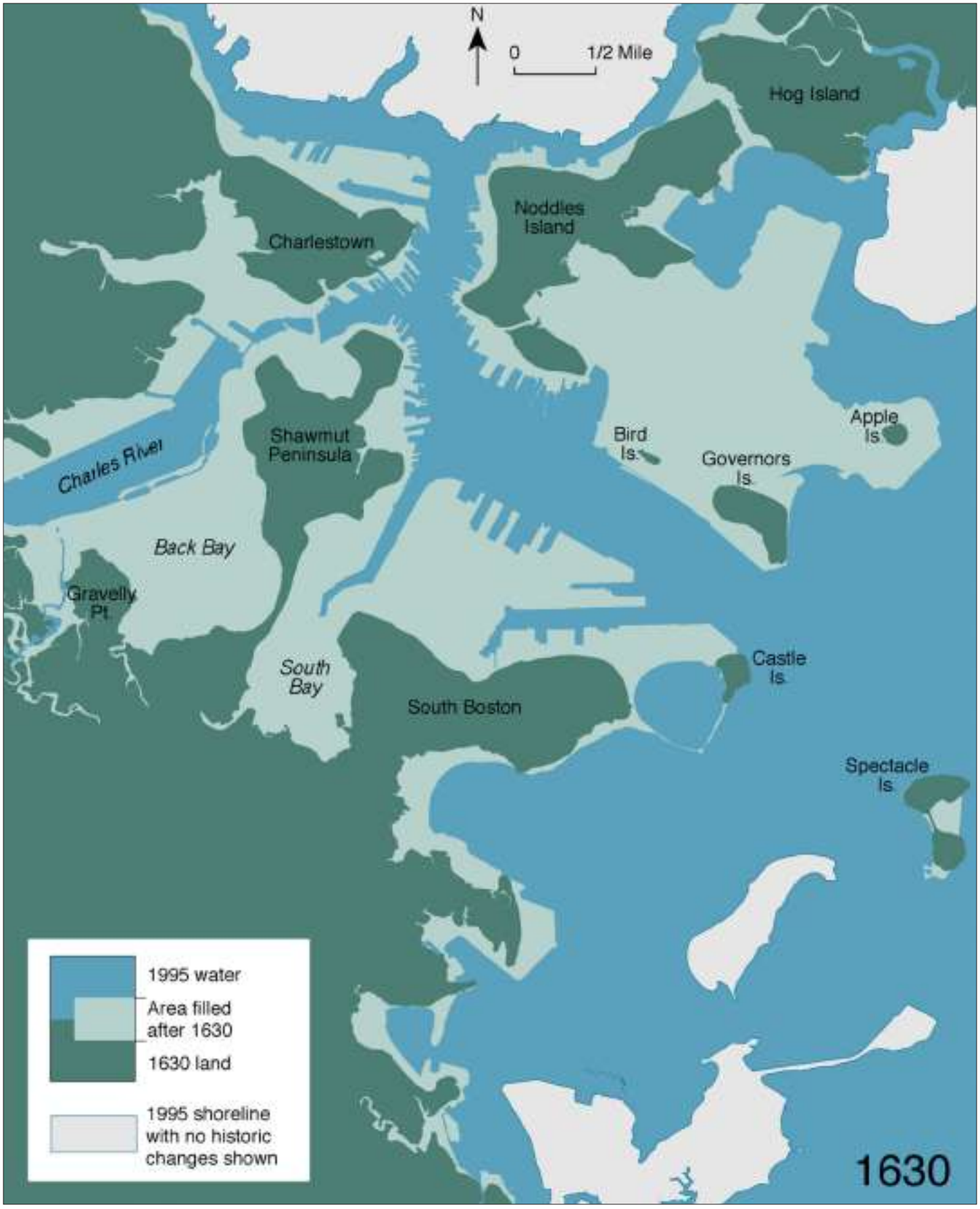
Winter Conditions

In addition to more intense rainfall events, snowstorms and Nor'easters are expected to become stronger and more intense. In the last decade, Boston has been inundated with large storms, including a record high of about 27 inches of snow. Snow can clog drainage inlets and reduce the capacity of systems by restricting flow. Areas for snow storage within Boston are scarce. In some cases, snow can be mistakenly piled onto areas with GI installations. This practice should be avoided, as storing snow in GI systems can damage plants, compact soil, concentrate pollutants, and reduce the system's capacity to manage stormwater.

It is important that maintenance considerations include coordination with snow removal crews to designate an area for snow storage as well as a spring cleanup plan to pick up any remaining debris and sediment from the snow piles. GI must also be designed to be durable in winter operations to prevent physical damage from plow blades and landscape impacts from sanding and salting operations.



Above: Public Garden, Boston, MA;
Opposite: Changes to land area in the City of Boston built on fill (Source: Map Works, Inc);


N
0
1/2 Mile
Hog Island
Noddles Island
Charlestown
Shawmut Peninsula
Charles River
Bird Is.
Governors Is.
Apple Is.
Back Bay
Gravelly Pt.
South Bay
South Boston
Castle Is.
Spectacle Is.
1995 water
Area filled after 1630
1630 land
1995 shoreline with no historic changes shown
1630

Climate Change Impacts

As precipitation events become more extreme and more frequent with climate change, Boston's GI systems need to be continually maintained to ensure proper function and design storage capacity. The 10 year 24-hour design storm in Boston is projected to increase from the current 5.2 inches to between 6.1 and 6.75 inches by the year 2100 depending on different emissions scenarios (see bottom figure on the following page). While GI is not typically sized to retain large storm events, it must be designed to detain and/or bypass large storm events. As larger and more extreme rainfall events are predicted, GI must be properly designed and frequently inspected and maintained to provide optimal resilience benefits.

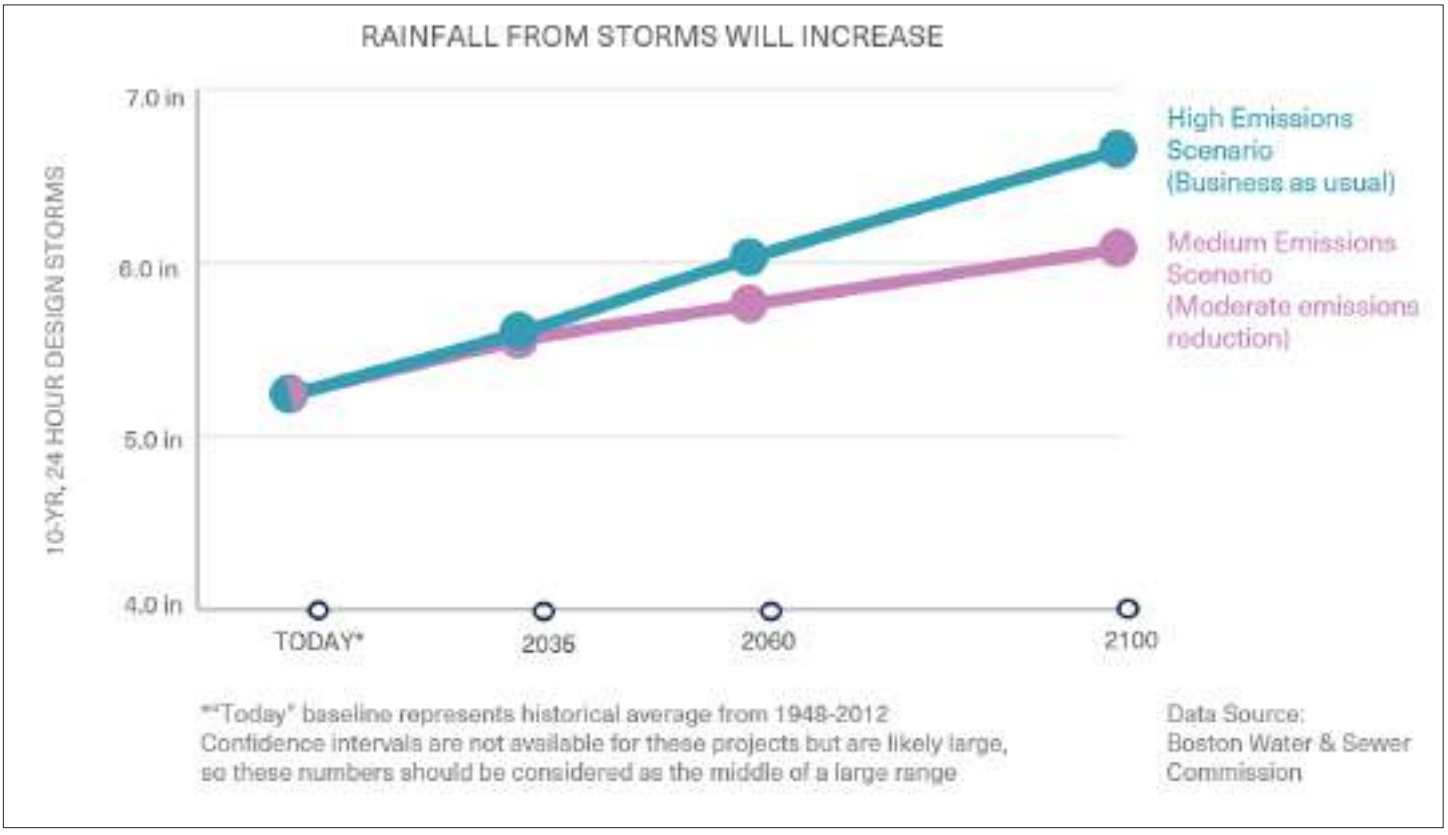
Boston is situated on the coast and built upon mostly fill materials. The placement of fill for building purposes reduces the carrying capacity of the floodplain making the area susceptible to coastal flooding. Climate change is also exacerbating coastal flooding, forcing cities to build more robust resilience measures to prepare and protect their infrastructure. Coastal GI installations should be designed using appropriate materials and plant selections to ensure their longevity. Frequent inspection and maintenance will also be necessary to ensure long-term success and benefits.

To view the BWSC flood model visit https://www.bwscstormviewer.com/flood-modeling.

Maintenance Implications

Green Infrastructure operations and maintenance (O&M) challenges in an urban environment include higher contaminant loads, trash, and debris. These challenges require more treatment and pretreatment systems to accommodate higher contaminant loads. Boston has narrow streets, one-way streets, and alleyways therefore integrating GI into small spaces makes maintenance access a challenge.

Below: Boston rainfall projections; Opposite top: Flooding in the North End neighborhood, Boston, MA (Source: Conservation Law Foundation); Opposite bottom: Revere Beach, MA (Source: Nitsch Engineering)







2.2 Green Infrastructure Regulatory Considerations

Local Green Infrastructure Policy and Initiatives

In both public and private spaces, Green Infrastructure (GI) installations in the City of Boston are being implemented more frequently as a result of local policy and resilience initiatives requiring stormwater management solutions.

In 2006, the City of Boston adopted a Groundwater Conservation Overlay District (GCOD). Zoning Article 32 requires projects within the district to include the design and installation of a groundwater recharge system capable of capturing 1 inch of precipitation over the impervious area of the lot. The practice of replenishing groundwater helps protect wood pile foundations on historic buildings, reduce water pollution, and maintain public safety. For more information on these policies and the Boston Groundwater Trust visit: http://www.bostongroundwater.org.

Another policy related to stormwater recharge is overseen by the Boston Water and Sewer Commission (BWSC) which requires projects involving its water, sewer, or storm drain systems to complete the site plan review process. BWSC's standard storm drain requirements state that projects in the City of Boston that are less than 100,000 square feet of floor area must infiltrate a volume of 1 inch of rainfall times the total impervious area on site prior to discharge to a storm drain or combined sewer system. For all projects that are at or above 100,000 square feet of floor area, the project must infiltrate a volume of runoff equal to 1.25 inches of rainfall times the total impervious area on-site. GI or Low Impact Development (LID) practices that utilize infiltration are necessary in order to meet the water quality requirements outlined in the Total Maximum Daily Load (TDML) for the Charles River and the BWSC Consent Decree. For more information about Site Plan Requirements visit: https://www.bwsc.org/builders-contractors/site-plan-requirements.

In 2024, BWSC launched a stormwater utility that will meet a growing need to modernize Boston's stormwater infrastructure and prepare for the impacts of climate change. The proposed stormwater utility will involve restructuring current billing and include a stormwater charge. In addition, credit and grant programs will give customers the opportunity to reduce stormwater charges by implementing approved stormwater management practices, including GI. Customers will be required to show documentation that these GI practices are being properly maintained in order to receive credits.

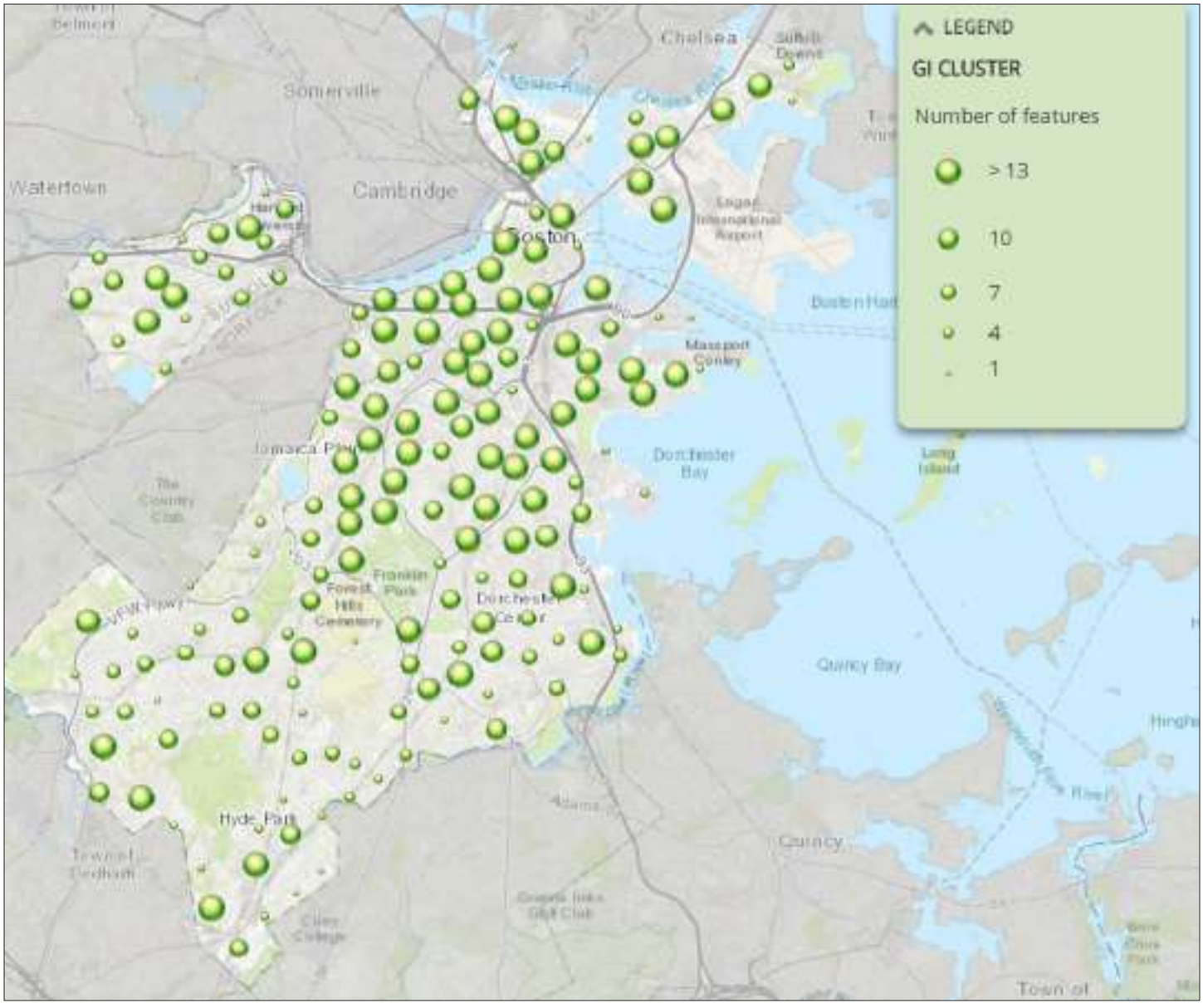
The City of Boston's Green Infrastructure Policy also sets internal standards and guidelines for City projects, including requirements for small scale GI in public street and sidewalk projects.

Climate Ready Boston, Resilient Boston Harbor Vision, and Boston's Climate Action Plan point to climate change as one of the most significant risks to the City. In order to help protect neighborhoods from sea level rise, heat island effect, and extreme precipitation, the Boston Planning & Development Agency (BPDA) adopted Zoning Article 37. This Resiliency Policy requires developers and property owners to implement sustainable and resilience building practices. This includes guidelines and policies that promote the use of GI as a strategy to address coastal and inland flooding and urban heat impacts. For more information on Article 37 visit: https://www.bostonplans.org/planning/planning-initiatives/article-37-green-building-guidelines.

To assist with the implementation of GI, BWSC released the Boston Green Infrastructure Planning and Design Handbook in 2021. Other GI guidelines and resources include the Green Stormwater Infrastructure Design and Implementation Guide prepared by Boston Parks and Recreation Department and the Complete Streets Guidelines, prepared by the City of Boston Transportation Department.

Opposite top: Permeable pavers, Peabody Square, Boston, MA; Opposite bottom: Boston GI map, July 2023




LEGEND
GI CLUSTER
Number of features
> 13
10
7
4
1
Somerville
Cambridge
Watertown
Chelsea
Boston
Jamaica Plain
Dorchester Bay
Quincy Bay
Hyde Park
Milton

Federal Stormwater Requirements

Consent Decree

In 2012, BWSC entered into a consent decree settlement with the Environmental Protection Agency (EPA), the Department of Justice, and the Conservation Law Foundation to enhance its ongoing efforts to comply with the Clean Water Act (CWA) and to clean and revitalize Boston Harbor and its tributaries, including the Charles, Neponset, and Mystic Rivers.

NPDES Permit

The National Pollutant Discharge Elimination System (NPDES) permit program was created in 1972 by the CWA. It address water pollution by regulating point sources that discharge pollutants to "waters of the United States". The CWA prohibits entities from discharging pollutants through a point source, such as a combined sewer or storm drain outfall, into a “water of the United States” unless they have a NPDES Permit for Massachusetts. Permits contain limits on what the Permittee can discharge, monitoring and reporting requirements, and other provisions to ensure that the discharge does not impair water quality.

The EPA has issued two NPDES Permits to BWSC: a Combined Sewer Overflow (CSO) Permit and a Stormwater Permit. BWSC’s NPDES Stormwater Permit MAS010001 (Large MS4 Permit) became effective on October 29, 1999, authorizing stormwater and allowable non-stormwater discharges from its municipal separate storm sewer system (MS4).

BWSC’s current CSO NPDES Permit requires that they comply with the EPA’s Nine Minimum Controls and prohibits overflows from combined sewers in dry weather. Any overflows in dry weather, a rare occurrence, are reported to the EPA within 24 hours. The CSO NPDES Permit also requires BWSC to submit an annual report. These reports have been submitted to the US EPA and the MassDEP since 1990. Additional information regarding regulatory compliance can be found at https://bwsc.org/about/regulations-compliance.

Small MS4 Permitees

In 2003, EPA Region 1 issued its Final General Permit for Stormwater Discharges From Small Municipal Separate Storm Sewer Systems (2003 small MS4 permit) located in Massachusetts. Although this permit expired in 2008, it remains in effect for authorized operators until they are authorized under the 2016 MS4 general permit. The 2016 Massachusetts Small MS4 General Permit was signed in 2016 and became effective July 1, 2018. Other state-owned properties within the City of Boston may be covered as “non-traditional” Small MS4 Permittees. Traditional and non-traditional MS4 permittees must address six minimum control measures (MCMs):

MCM 1 - Public Education and Outreach
MCM 2 - Public Participation
MCM 3 - Illicit Discharge Detection and Elimination
MCM 4 - Management of Construction Site Runoff
MCM 5 - Management of Post-Construction Site Runoff
MCM 6 - Good Housekeeping in Operations

MCM 5 requires long-term operations and maintenance (O&M) plans of stormwater control measures. As public and private landowners implement GI to meet post-construction runoff requirements, these systems will need to be maintained in accordance with the MS4 Small Permit. For more information on the Massachusetts Small MS4 General Permit visit https://www.epa.gov/npdes-permits/massachusetts-small-ms4-general-permit



Above: Bioretention at Rafael Hernández School, Boston, MA; Opposite: Washington Irving Middle School, Boston, MA

State Stormwater Requirements

In 1996, MassDEP issued the Stormwater Policy that established Stormwater Management Standards. These standards encourage groundwater recharge and the prevention of stormwater discharges contributing to the pollution of the surface waters and groundwaters of the Commonwealth.

In 1997, MassDEP published the Massachusetts Stormwater Handbook as guidance on the Stormwater Policy. MassDEP has revised the Stormwater Management Standards and the Massachusetts Stormwater Handbook to promote increased stormwater recharge, the treatment of more runoff from polluting land uses, LID techniques, pollution prevention, the removal of illicit discharges to stormwater management systems, and improved O&M of stormwater best management practices (BMPs).

The Stormwater Management Standards address water quality (pollutants) and water quantity (flooding, low base flow, and recharge) by establishing standards that require the implementation of a wide variety of stormwater management strategies. These strategies include environmentally sensitive site design and LID techniques to minimize impervious surface and land disturbance, source control and pollution prevention, structural BMPs, construction period erosion and sedimentation control, and the long-term O&M of stormwater management systems.

For more information about the Massachusetts Stormwater Handbook, visit: https://www.mass.gov/guides/massachusetts-stormwater-handbook-and-stormwater-standards.

The Massachusetts Stormwater Management Standards require a long-term O&M plan be developed and implemented to ensure that stormwater management systems function as designed.

Stormwater management in Massachusetts is governed by sections of the Wetlands Regulations, 310 CMR 10.00, and the Water Quality Regulations, 314 CMR 9.00. The Boston Conservation Commission administers the Massachusetts Wetland Protection Act within the City of Boston.

In February 2020, in preparation for updating the Massachusetts Stormwater Handbook and the Massachusetts Wetland Protection Act (WPA) stormwater regulations (310 CMR 10.05(6)), MassDEP convened an advisory committee on aligning the Act's Stormwater Management Standards with the requirements of the federal Municipal Separate Storm Sewer System Permit. The committee will also look at precipitation projections for stormwater management. A revised Stormwater Handbook is expected in Spring 2024. For more information on the Stormwater Management Advisory Committee visit https://mass.gov/info-details/massachusetts-stormwater-management-updates-advisory-committee.



2.3 Additional Considerations

Project Specific Levels of Responsibility

This O&M Handbook has been developed for anyone who owns or maintains Green Infrastructure (GI) in the City of Boston. Each GI project may have a unique division of responsibility. The permitting process may dictate the need for an ownership agreement of landscape maintenance plan. The Boston Water and Sewer Commission (BWSC) encourages permittees, builders, and developers to review project-specific requirements, agreements, and O&M documents. These may dictate which maintenance activities are necessary and when to seek professional assistance.

As GI is installed in both public and private lands in the City of Boston, the owners and responsible parties for maintaining GI widely varies. In public spaces, GI may be maintained as agreed upon by Boston Public Works Department (BPWD), Boston Parks & Recreation Department (BPRD), BWSC, as well as neighborhood groups or other private entities. On private lands, it is the responsibility of the landowner or homeowner as required by landscape maintenance plans and long-term O&M plans established during the permitting and approvals process. In some cases, third-party contractors may need to be hired to perform specific types of maintenance involving specialty equipment or processes that typically cannot be performed by the average homeowner or landowner.

Regional Resources

The Boston metro area is home to companies with experience in GI maintenance. The City of Boston and BWSC have partnered with professionals and maintenance crews who are trained to operate specialized tools or vehicles. BPWD is supportive of GI installations and continues to oversee the maintenance of several projects throughout the City. In addition, several neighborhood groups have formed partnerships with entities like BPRD and Boston Public Schools (BPS) to encourage community ownership of GI installations and ensure maintenance will be a priority.

Resources for GI O&M Training

National Green Infrastructure Certification Program | NGICP

University of New Hampshire Stormwater Center | UNHSC



Above: Central Square, Boston, MA; Opposite: Tree trenches and permeable pavement at Central Square, Boston, MA







CHAPTER 3

Inspection & Maintenance Actions

Green Infrastructure (GI) solutions require specific actions for proper maintenance to ensure they provide water quality benefits as well as manage water quantity. This chapter describes typical procedures necessary to inspect and maintain GI installations, including descriptions of actions to be performed, suggested frequency, equipment needed, and recognizing when professional services may be required. In many cases, GI maintenance requires a diverse skill set, including the ability to maintain landscape and structural components. The end of this chapter includes a Maintenance Actions Matrix summarizing all applicable actions for each GI type.

Left: 401 Park Drive in Boston's Fenway neighborhood

3.1 General Procedures

Several inspection and maintenance action items must be conducted regardless of the type of Green Infrastructure (GI) installation. Below are several general procedures which should be considered during inspection and maintenance.

Research

The Owner or Responsible Party should obtain and review design plans, as-built plans, and/or maintenance manuals of GI installations to ensure all maintenance tasks are executed effectively and efficiently. Additional materials which may dictate maintenance actions include Safety Data Sheets (SDSs), permits, and access permissions. These materials can be cross-referenced with the Inspection and Maintenance Checklists in Chapter 4 of this Handbook to determine what specific actions are necessary for a particular GI installation.

The Inspection and Maintenance Checklists should be completed with each inspection and can be used to track any work order tickets, ongoing maintenance, and completed maintenance. Inspection and Maintenance Checklists ensure GI systems are operating as intended and provide documentation of maintenance activities for record keeping. Maintenance activities may require access to adjacent properties or coordination across jurisdictional boundaries. Personnel should seek necessary permissions or permits to access the site before beginning work.

Safety

Follow proper safety measures before and during any GI maintenance activities. Property owners or their contractors must contact Dig Safe prior to performing an excavation. Material Safety Data Sheets (SDSs) should be kept on file for any hazardous chemical that may be encountered in the field so that employees can easily identify and properly report these dangers. Massachusetts State Plan 454 CMR 25.00 requires public sector workers to follow Occupational Safety and Health Administration (OSHA) requirements. Many maintenance actions or procedures require specialized training and may require a professional.

The following OSHA topics may pertain to GI maintenance activities:

- Confined Space Entry
- Ergonomics
- Hazard Communication
- Hearing Conservation
- Heavy Equipment Safety
- Jobsite Safety Field Manuals
- Personal Protective Equipment

Safety Considerations



- **Wear proper eye and ear protection when operating motorized equipment. Always wear proper footwear. Refer to OSHA guidelines for PPE.**
- **Utilize signage, safety cones, and/or police detail when working near a road or street. Always wear a brightly-colored safety vest.**
- **Do not leave tools unattended. Be aware of nearby pedestrians, bicycles, and vehicles. Inspect the site for broken glass or other potential hazards.**
- **Contact the utility company prior to trimming trees near power lines.**
- **Use gloves or a grabber tool to handle broken glass, sharp objects, or biohazards and dispose property.**
- **Dress appropriately for any weather conditions.**

- Powered Hand Tools
- Powered Industrial Trucks & Forklift Safety
- Respiratory Protection
- Silica Awareness

Maintenance personnel must be informed of proper procedures and Personal Protective Equipment (PPE) required on any site. PPE items that may be necessary to perform maintenance work include:

- Ear Protection
- Gloves
- Hard Hat
- Proper Protective Footwear
- Respiratory Protection
- Safety Glasses
- Safety Vest

Inspection Scope & Documentation

Conduct an overall inspection of the GI system and its components. Inspect inlets, observation ports, and pretreatment devices to determine if there is accumulated sediment, structural damage, or standing water within the system. Inspect the surrounding area, including adjacent sidewalks, and report any damage or necessary repairs to the appropriate official. Follow all specific procedures on the Inspection and Maintenance Checklist and document findings.



Use of Personal Protective Equipment (PPE) during construction

Pollutant Remediation

Excess pollutants from parking areas or adjacent spaces can harm plant material and subsurface structures within the GI installation. Inspect the area for signs of odor, discoloration, or other abnormal substances. Attempt to determine the cause of the pollution and work with the Owner or Responsible Party to eliminate the source and provide remediation if necessary.

Site & Project Protection

GI installations could be negatively effected by excess foot traffic, encroachment from pets, and possibly vandalism. Check the GI installation for signs of damage, excess pet waste, or graffiti. Coordinate with the Owner or Responsible Party to provide additional protection such as fencing or install pest waste stations and signage. Graffiti should be removed to maintain a positive aesthetic appearance. Document and report any suspected vandalism to local authorities and either remove unwanted markings or repaint.



An unkempt Rain Garden with surface debris (Source: Nitsch Engineering)

3.2 Pretreatment

Pretreatment areas or devices within a Green Infrastructure (GI) installation will need to be inspected and cleaned on a regular basis. Refer to design drawings or specifications for the location and details of any pretreatment methods. Below are some general actions related to three types of pretreatment. Cleaning pretreatment devices ensures that the sediment and containments are continuously removed from stormwater. Otherwise, the device will become clogged over time and allow contaminants to bypass the structure continuing to flow into water resources. Any polluted water or sediments removed from pretreatment devices should be disposed of in accordance with state and federal laws including M.G.L.c. 21C and 310 CMR 30.00.

Cleaning Pretreatment Structures

Structures like manholes or deep sump catch basins can act as pretreatment devices for some types of GI. Clear all debris, down to the bottom of the structure, from catch basins, inlets, and other drain basins. Depending on the depth of the structure, this can be accomplished using manual tools like a shovel, or using more mechanical means, such as a clamshell bucket or vacuum truck. If compacted sediment is difficult to remove, use a shovel or pressure washer to loosen before collecting and disposing. Inspect each structure to ensure any traps are closed or screens are latched, if applicable.

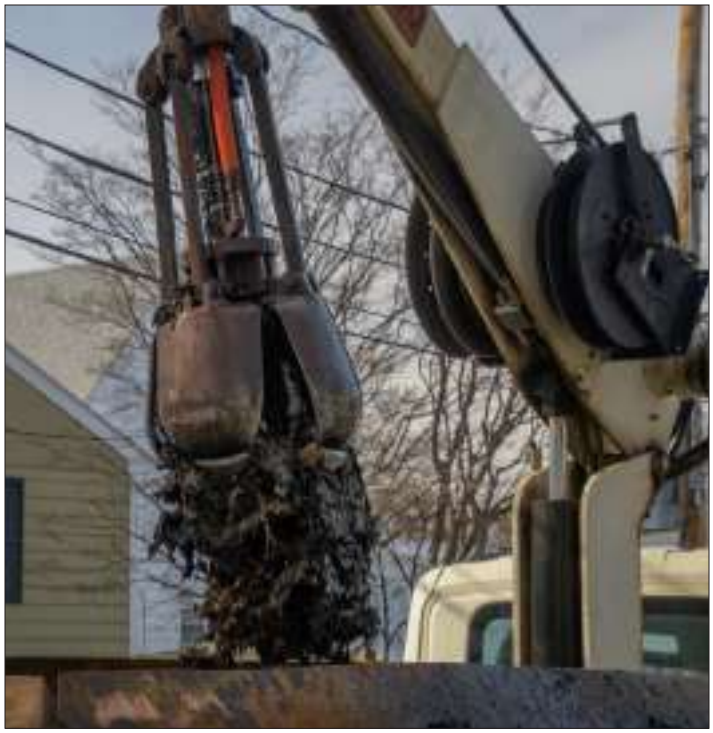
Cleaning Proprietary Pretreatment Devices

Pretreatment devices may include manufactured devices or oil/grit separators. Cleaning proprietary pretreatment devices may involve removing any sediment or material buildup in the filtration media or other areas of the device. Clamshell buckets or vacuum trucks could be used to clean sediment out of these units, depending on the manufacturer's recommendation. Maintain Water Quality Units (WQUs) according the recommendations set forth by the manufacturer.

See the MassDEP Stormwater Handbook for examples of pretreatment devices.



Sediment forebay requiring cleaning and weeding (Source: Nitsch Engineering)



Clamshell bucket cleaning a catch basin

Cleaning Vegetated Pretreatment Areas

Many bioretention basins include a sediment forebay of riprap, stone, or other rough, natural material to collect trash and larger sediment before runoff enters the vegetated area. Other installations may incorporate a vegetated pretreatment area or vegetated filter strip as pretreatment for an infiltration trench or basin. Frequent maintenance of vegetated pretreatment areas is essential to the success of the whole GI system therefore these areas are often easily accessible. Check for signs of rilling and gullying in the pretreatment areas as they are often the first point of access for incoming stormwater runoff.









Top left: Sediment forebay containing riprap; Top right: Infiltration trench with riprap forebay; Above left: Bioretention area with two pretreatment areas of riprap, South Street and Bussey Street, Boston, MA; Above right: Curb cuts and riprap forebays in bioretention area at Blackstone Heritage Corridor Visitors Center, Worcester, MA (Source: Nitsch Engineering)

3.3 Drainage Structures

Cleaning Drainage Structures

Removing sediment and debris from drainage structures, such as manholes or catch basins, prevents overflow and maintains the intended storage capacity of the system. Clear all debris, down to the bottom of the structure, from catch basins, inlets, and other drain basins. Depending on the depth of the structure, this can be accomplished using manual tools like a shovel, or using more mechanical means, such as a clamshell bucket or vacuum truck. If compacted sediment is difficult to remove, use a pressure washer or shovel to loosen before collecting and disposing. Remove debris from underdrains, pipes, observation ports, cleanouts, and outlet control structures. Ensure any traps are close and screens are latched, if applicable.

CCTV Inspection & Jetting

Closed-circuit television (CCTV) inspections can be used to investigate clogging within the pipe components of a Green Infrastructure (GI) installation. The type of CCTV camera required will depend on pipe size, length, and presence of bends in the pipe network. Hire a qualified professional to conduct the CCTV inspection.

If a CCTV inspection indicates that subsurface drainage pipes require maintenance, the professional that performed the inspection may be able to jet rod the obstruction from the pipes (jetting). Ensure that blockages are removed rather than pushed downstream. Obtain permissions from the appropriate officials to sanction work on subsurface pipes connecting to municipal infrastructure before performing any work.

Hardware Repair

Repairing hardware components of structures, such as grates, gates, or area drain covers, helps to maintain function and safety. Clean and lubricate any bolts. Extract and replace broken bolts. Replace missing or damaged accessories. Replace missing or damaged safety bars with concrete end walls and outfalls larger than 8 inches in diameter. Document any broken hardware and consult a professional if unsure how to repair.

Maintaining & Cleaning Riprap

Riprap is the rocky material used to protect soils from erosion in areas with high velocity flows. Riprap is often use in forebays, outfalls, and near level spreaders. Maintaining the design condition ensures proper functionality. Replace any missing rocks and repair damaged geotextile material. Remove weeds, brush growth, or excess organic material as these can fill in the spaces between the rocks and reduce the effectiveness of the riprap. In areas with an excess of sediment, remove the rocks and rake the area to remove the organic materials. Replace rocks to original design conditions.

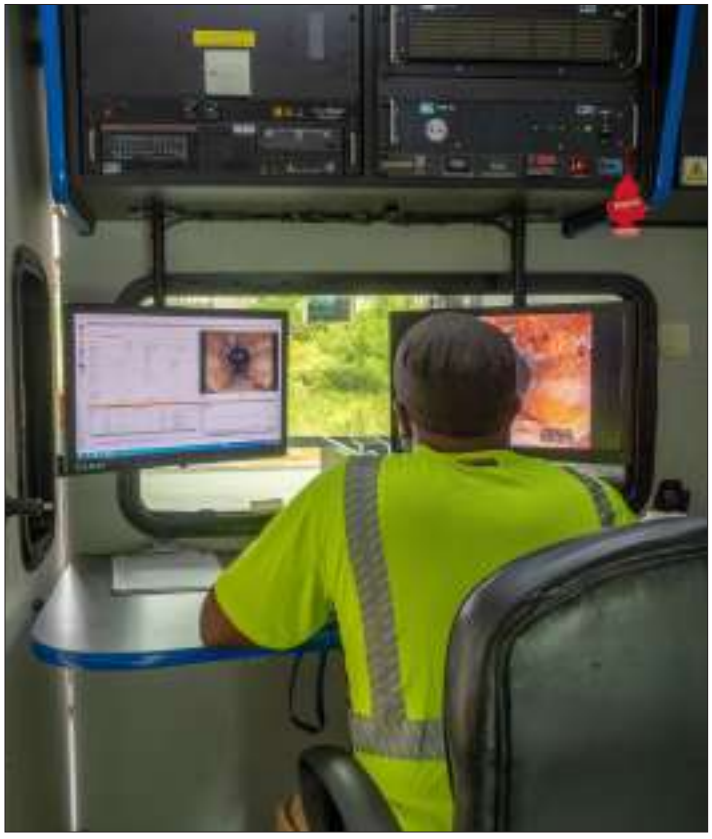
If the riprap is set in mortar or grout, vacuum or sweep the surface to remove debris. For repairs of cracks or rock replacement after extensive wear, place tarps over adjacent areas to protect surfaces, soil, and vegetation from spilled materials. Remove loose debris or material from the area. Apply mortar or adhesive according to the designed aesthetic and required structural strength according to manufacturer's specifications. Replace rock to match existing surfaces.

Signage

Signs or other interpretive devices help visitors understand the importance of GI and explain its function. Repair or replace any broken or missing signage around the GI installation. Consider replacing signage that has faded due to sun exposure.

Opposite top: CCTV Inspection in progress in Boston; Bottom left: An employee inspects pipes using CCTV equipment; Bottom right: Riprap protects from erosion (Source: Nitsch Engineering)







3.4 Vegetation



Vegetated filter strip at Washington Irving Middle School, Boston, MA

Weed Control

The process of removing weeds or preventing weed growth is necessary to ensure that plants in a Green Infrastructure (GI) installation have adequate space, nutrients, and sunlight to properly function. Consult the Landscape Plan or Planting Plan from the design documents for specific details on plants included in the bioretention area so that weeds can be properly identified and desired plants remain. Remove weeds by hand pulling or raking. Ensure that all plant parts, including the majority of the root mass, are removed and disposed of properly.

Green roofs may require special attention to weed control. Refer to a Planting Plan and/or design specifications related to the use of woody plant materials, large shrubs, or trees. Depending on the root capacity of the green roof, volunteer trees and other deep-rooted plants may need to be removed before they can damage the system.



Mowing in Central Square, Boston, MA

Mowing

Mowing is important to ensure that the overgrowth does not clog any outlet drains, support unwanted species growth, or occupy too much of the above ground storage volume. Grasses should be mowed to a height of 6-8 inches in the warm season and 3-4 inches in the cool season. Be sure to rake and remove excess clippings or use a mower with a bag attached. Do not mow within 1 foot of a tree or shrub; instead use hand tools to trim within this radius.



Maintenance of Bioretention vegetation at Rafael Hernández School, Boston, MA

















Weeds common in Massachusetts (Source: Massachusetts Department of Agricultural Resources Prohibited Plant List & Mass Audubon's Invasive Plant List)

String Trimming

In addition to mowing, string trimming creates a neat, managed aesthetic for landscaped areas. String trimmers are used in areas where slope or terrain makes mowing infeasible. Trim turf grasses to a height of 6-8 inches in the warm season (June-September) and 3-4 inches in the cool season. Trim by hand within 1 foot of any tree or shrub to avoid damaging the plant with a string trimmer. Taller grasses and weeds can be maintained using a string trimmer but may require a few passes to avoid tangling or damaging the equipment.

Fertilizing

Application of chemical fertilizers should be minimized to protect nearby wetland area and water resources. Only non-phosphate fertilizers should be used. The use of fertilizers may be restricted by permitting agencies. Proper plant selection can eliminate the need for fertilizers or pesticides. Use natural fertilizers when feasible and only pesticides approved by the Massachusetts Department of Agricultural Resources.

Pruning

Pruning vegetation promotes desired growth patterns and healthy stalks. Overgrown vegetation can be a detriment to the function of the GI system or impact public safety by blocking sidewalks or impeding a driver's line of sight. Pruning of small to medium-sized shrubs can be done by hand using sharp, sterilized pruning shears. This provides the cleanest cut and prevents the spreading of any disease from one plant to another. Inspect the plant and remove dead, diseased, or broken branches.

Seed the heads of cut blossoms or cut them adjacent to healthy flowering branches to promote growth. Dense vegetation next to walkways and street intersections should be trimmed when it exceeds 4 feet in height to maintain proper sight lines. Pruning and trimming of large trees will require larger equipment and use of a chain saw; ensure the operator has proper training and PPE for these tasks. Refer to the project's design documents to identify plants and research their specific pruning requirements. Online resources from the University of Massachusetts Amherst Center for Agriculture, Food, and the Environment provide guidance on pruning and other vegetation maintenance activities.

Seeding

Spreading new seed in bare spots or reseeding areas is necessary to ensure the function of the GI solution and maintain the planting's aesthetic value. All areas to be seeded should be well graded and free of weeds, debris, stones, and other foreign materials. Loosen the top 2-3 inches of soil prior to seeding. Seeding can be performed with hand broadcast tools or hydroseeding equipment. Consult with the Owner for the best method to apply seed. Do not allow pedestrian or vehicular traffic on newly seeded areas for at least 4 weeks after seeding. Refer to details of seed mix for watering schedule; most applications will need to be watered frequently during the first few weeks until the grass reaches a height of 1 inch.

Vegetation Removal & Replacement

Removing and replacing vegetation is important for the aesthetic and function of the GI solution. Vegetation should be removed when it exhibits signs of pest infestation or deterioration without new growth. Remove herbaceous plants by hand using a small spade, digging around the perimeter of the root zone. Medium to large shrubs can also be removed by hand or using a small chainsaw to cut thicker roots and branches. Be sure to cut roots at the base of the stump and remove as much of the roots as feasible. Either replace the plant in the same location or backfill the area with topsoil. Volume 2, Chapter 2 of the MassDEP Stormwater Handbook includes an



Grasses in need of Vegetation Removal & Replacement

extensive list of recommended plant species suitable for use in bioretention applications.

Large tree removal (felling) should be done by a professional, especially when tree branches conflict with power lines. Contact a certified arborist or appropriate official for any large tree removal. A permit may be needed for full tree removal.

Watering

Watering is imperative to the success of newly planted GI solutions. Method of watering may vary depending on the size and scope of installation. Many designs will call for temporary irrigation systems and will not require permanent systems or connection to potable water.

Pest & Disease Management

Proper pest and disease management will help to maintain the health of vegetation and allow a GI system to function as intended. Pest management will also ensure that a GI system does not become a problem to public health and safety. Some signs of pest infestation or disease may include holes in the leaves, wilting, or discoloration. Other pest management activities may include the removal of animal carcasses, repair of animal burrows, or the removal of mosquito, wasp, or hornet infestations. Contact a professional to identify and apply the correct pesticides or remove pest infestations. Animal burrows may be hand packed with crushed stone and covered with mulch.

Winter Vegetation Management

Never store snow in bioretention areas. The Operation and Maintenance (O&M) plan must specify where on-site snow will be stored. All snow dumps must comply with MassDEP's guidance. When bioretention areas are located along roads, care must be taken during plowing operations to prevent snow from being plowed into the bioretention areas. Install traffic bollards for plowing to indicate and protect the extents of stormwater bump-outs. If snow is plowed into the bioretention area, runoff may bypass the plants and soils and drain into wetland area without first receiving the required water quality treatment. Minimize salt use and do not sand permeable surfaces in the winter. Flush or leach excess salt from the soil by irrigating with water. After flushing, the owner/operator may request a follow up soil analysis. Apply amendments. Typical amendments for correcting saline soil include gypsum, calcium chloride, sulfur, and iron sulfate. Attach rollers to the bottoms of snowplows to prevent them from catching on the edges of grass pavers and some paving stones.



Planting vegetation at Washington Irving Middle School, Boston, MA



Examples of pest & disease: aphids (left) and plant mold (right) (Source: Thespruce.com)

3.5 Softscape Surfaces

Infiltration Rate Monitoring

The infiltration rate is the speed at which water moves through soils. Monitoring this rate helps to determine if a Green Infrastructure (GI) system is functioning as designed. Monitoring can be done without equipment by noting the time when significant rainfall ended and comparing it to the time there is no longer standing water within the GI system. If the time is greater than 72 hours, thoroughly inspect the system for excess sediment or signs of clogging within the structural components. The Owner or Responsible Party should take immediate action to investigate and correct any issues found. (See CCTV Inspection and/or Soil Decompaction or Replacement.) A soil scientist may be consulted to determine if the soil media texture has become more silty or clayey, which would warrant potential replacement of the soil media.

Surface Debris Removal

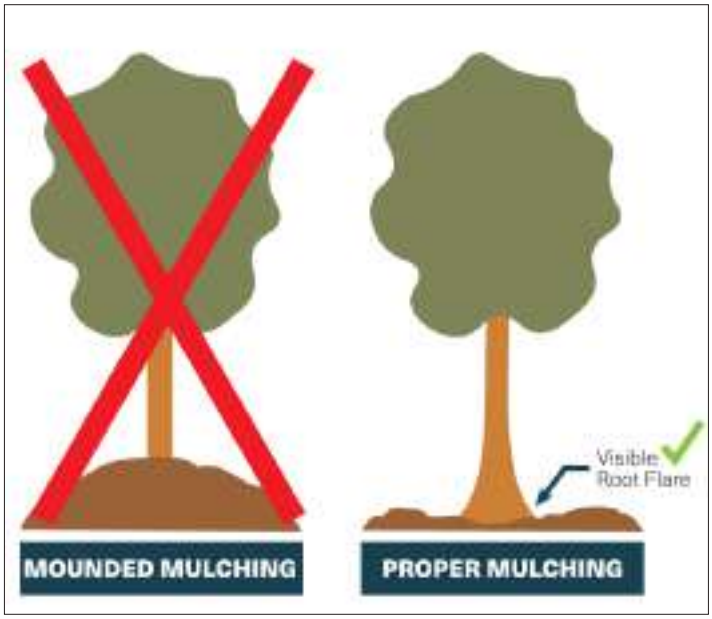
Accumulated surface trash and debris can clog drainage systems. Removing debris in and around the GI system can prevent blockages of inlets and outlets as well as improve the overall appearance of the site. Collect and dispose of any trash within the GI installation, near inflow structures, and on roadway areas within 5 feet of a drainage structure. Remove fallen tree limbs and branches. Rake organic debris from softscape surfaces, being cautious not to remove too much soil or damage the plant material.

Erosion Repair

Erosion is the transport of soil by water or wind. This can cause gullies or rills in the soil which can undermine GI systems and expose plant roots, making them vulnerable to pests and weather conditions. Repairing eroded areas retains the structural integrity of the system and health of the plants. Fill eroded areas with material matching that of the surrounding media profile. Consult design documents if available to determine what soil mix was installed. Reseed bare areas where applicable and stabilize with erosion control measures.

Mulching

Mulch is applied to the surface of soil to protect plant material, discourage weed growth, retain moisture, and enhance the aesthetic of a planted area. Hardwood mulch or other natural materials are most often used in GI installations, although many materials can be used as mulch. New mulch should be added where soil is exposed in planting areas or where mulch is less than 3 inches thick. Mulch will likely need to be added annually. New wood mulch can be placed over old mulch as long as the old does not show signs of mold or fungi disease. If old mulch layer is greater than 4 inches thick, remove before adding new mulch. Carefully rake old mulch into the topsoil before applying new mulch. Gather any removed mulch in compostable bags and dispose of properly. Add a new mulch layer at least 3 inches thick. Avoid mulching over inlets or grates. Do not mound mulch around the base of a tree; a flare at the base of the tree should be visible.



Proper tree mulching technique (Source: Nitsch Engineering)

Settling & Sinkhole Repair

Settling occurs when soil becomes unevenly compacted over time. Settling can undermine structures and create unintended low points in the system. Repair areas of settlement by first raking aside any mulch and then filling with clean topsoil and compacting. If these areas were grass, stabilize with erosion control matting, and then seed or sod, as necessary. If settling keeps occurring in the same area, it should be brought to the attention of the appropriate official and recorded in inspection documentation. If settling occurs beneath structures, the structure should be removed and a suitable subbase installed (i.e. 6 inches of compacted crushed stone). Notify BPW if the settling is occurring beneath a sidewalk, roadway, curb, or structure. A professional may be contracted out to assist with structural settling repair.

Soil Decompaction or Replacement

When soil becomes compacted from foot traffic, winter conditions, or weather events, it restricts the nutrient uptake of plants. In addition, the flow of stormwater through the system is restricted and the infiltration capacity and design of the system is impaired. Identify areas where soil has compacted and prevent further compaction by adding additional protection or modifying winter maintenance procedures. For bioretention areas or similar installations, remove existing plants by using a spade to cut out an area encompassing the plant's root ball and set plants aside or dispose of if they are to be replaced. Use a rototiller on the general area to loosen up the soil. Replant the vegetation and finish with a mulch layer. Use the proper hand tools or an air spade to break up soil compaction in tree pits. Do not use a conventional rototiller, which will damage roots near the surface. Top dress with 3 inches of compost over roots.

Green Roof systems may also require soil replacement. Check design specifications or manufacturer's recommendations if soils in the system are not infiltrating as designed.



Examples of softscape surfaces in need of maintenance: Top: Erosion and rilling in topsoil; Middle: Unmaintained new seeding; Bottom: Settling and compaction (Source: Nitsch Engineering)

3.6 Permeable Pavements

Sweeping (Manual)

Sweeping paved surfaces removes sediment and debris before it can enter a Green Infrastructure (GI) system. Hand sweeping with a push broom can be done in smaller areas to remove larger debris and trash from surfaces. Sweep the debris into a common area, collect and dispose properly. Mechanical broom sweepers and regenerative air sweepers can be used by professionals in large areas to collect finer particulates. Refer to design recommendations and coordinate type and frequency of sweeping with the Owner. Sweeping can reduce maintenance necessary for pretreatment devices and inlets.

Power Washing

Power washing is the spraying of highly pressurized water to dislodge particles and sediment without damaging the permeable pavements if the correct nozzle and technique is utilized. Removing excess sediment allows stormwater to infiltrate as designed. For porous asphalts and concretes, clean the surface using a power washer to dislodge trapped particles and then vacuum sweep the area. Power washing is not often recommend for permeable paver applications; consult manufacturers recommendations and/or design specifications.

Vacuuming & Power Sweeping

Vacuuming removes sediment from permeable pavements to allow stormwater to infiltrate. Use a power vacuum sweeper on permeable pavements or consult a professional on equipment use and frequency. Vacuuming can also be done on impermeable pavements surrounding a GI installation. For permeable pavers, add joint material after vacuuming to replace transported materials.

Permeability Rate Monitoring

Permeability rate is a measurement of water's ability to pass through a material and can be tested by applying water to a permeable pavement area for about thirty minutes. When the permeability of the pavement is less than the design rate after maintenance actions have been performed, the Owner should consider the following actions: for porous asphalt, mill existing pavement to the choker course and repave; for permeable pavers, remove and replace joint material between paving stones. Limit construction traffic on permeable surfaces and do not store any construction materials on the surfaces.

Permeable Pavement Repair

Permeable pavements can endure normal wear and tear, though repairs could be necessary to keep the system functioning as intended. Sections of damaged porous asphalt can be repaired by heating and rerolling the special-mix asphalt. Do not repave or reseal with impermeable materials. Permeable pavers that are cracked, broken or missing should be replaced. Pavers that have shifted, sunk, or otherwise become tripping hazards should be addressed.



Installation of porous asphalt

Winter Pavement Management

Special care should be taken for maintenance of permeable surfaces during winter months. Do not use sand on permeable pavement surfaces and reduce the use of salt. Attach rollers to the bottom of snowplow blades to prevent them from catching on the edge of pavers or porous pavements. Another option is to use a rubber plow blade, raised half an inch above the surface during plowing. Do not store snow on permeable pavements or pavers as it may cause clogging from the sediment accumulation in the snow.

Minimize the use of concentrated salts on paved surfaces that drain to bioretention basins or GI systems with vegetation. Concentrated salts could kill vegetation and may necessitate the removal and replacement of vegetation in the spring. See Vegetation section for more information.



BWSC crews removing snow from paved surfaces



Vacuuming porous pavers at Central Square, Boston, MA



Signage indicating porous pavement (Source: Nitsch Engineering)

3.7 Rooftop Systems

Green Roofs, Blue Roofs, and Cisterns require specific maintenance actions be performed to ensure they function as designed and to protect structures from damage. These systems can range in size and scope. For example, cisterns can range in size from residential-sized rain barrels to subsurface tanks that hold several thousands of gallons of rainwater. Larger systems are designed by professional engineers; consult the Owner and design specifications before conducting maintenance. In some cases, a licensed plumber will need to perform work beyond routine maintenance.

Rooftop Pest Management

Standing water on rooftops can be the ideal breeding ground for mosquitoes. Remove any standing water over 72 hours after a rain event. Seal off any potential mosquito entry points and ensure all lids are properly sealed. Consider applying larvicide to standing water in accordance with Massachusetts Department of Agriculture Resources Pesticide Bureau regulations to prevent mosquitoes from reaching adulthood.



Worcester Polytechnic Institute (WPI) Green Roof, Worcester, MA (Source: Nitsch Engineering)

Irrigation Systems

Some Green Roofs may incorporate an irrigation system to help establish plants after installation. Service any irrigation system according to the manufacturer's recommendation. Check for leaks or areas that appear to receive too much water. In the fall, turn off the irrigation system and drain the lines to prevent damage during winter months.

Waterproof Membrane Repair or Replacement

Waterproof membranes are often used in Green and Blue Roof installations to protect the building's structural system and prevent damage to the building itself. Check for cracking, leaking, or other signs of deterioration of the waterproof membrane. Look for water spots within the building interior, moisture on structural components under the green roof, or soils that are overly dry under normal rainfall conditions. Refer to design documents and the manufacturer's specifications for repair or replacement of waterproof membranes and green roof tray systems. Inspect the system regularly and contact a qualified roofing company to perform an assessment of larger, extensive roof systems.

Repair Drains, Scuppers, & Gutters

Inspect the roof drains, scuppers, and gutters to ensure they are properly directing rainwater. Repair any damaged components where leaks occur. Remove any obstructions within gutters or downspouts. Clean gutters of leaves and debris annually or consider hiring a professional to perform this work.

Winter Rooftop Management

Cisterns and rain barrels used only for seasonal irrigation will require specific maintenance. If left to freeze, these systems can break or become irreversibly damaged. Prior to the first freeze in late fall, drain all remaining water. Disinfect and rinse cisterns using a non-toxic disinfectant. Remove any remaining water and sediment using vacuum equipment. Finally, keep spigot valve open all winter to prevent water storage and allow for draining. After the last freeze, check for damage and close spigot to capture storage.

Plumbing, Pump & Mechanical Systems

Cisterns may contain more complex plumbing systems including pumps or connections to the building's internal plumbing. Consult with the Owner or designer to ensure these connections are made properly and in compliance with building codes. Contact a professional to service mechanical systems according to the manufacturer's recommendation. Inspect these systems for leaks or other signs of wear and tear to prevent damage.

Cleaning & Securing Cisterns

Rainwater harvesting tanks should be cleaned once per year or when inspections indicate it is needed. Remove floating litter and debris from the interior of the system. Drain down the tank, taking care not to damage or flood the surrounding area. Flush out debris and sediment with a hose and vacuum equipment. Use a power washer and/or non-metal bristle brush to clean the interior of the tank. Baking soda (sodium bicarbonate) can be used to assist in removing algae or stubborn sediment.



Right: Harvard Business School Green Roof, Boston, MA (Source: Recover Green Roofs); Below right: Green Roof, Boston University Center for Computing & Data Sciences, Boston, MA (Source: Nitsch Engineering; Copyright Dave Green Photography); Below: Cistern installation at Christian Science Plaza, Boston, MA (Source: Nitsch Engineering)





Maintenance Actions Matrix

This matrix summarizes all actions described in Chapter 3 and illustrates which actions apply to each type of GI solution described in Chapter 4.

			Subsurface Infiltration	Infiltration Trench	Surface Infiltration Basin	Tree Filter
3.1	**Pollutant Remediation**	If signs of pollution are present, attempt to determine the cause and eliminate it.	●	●	●	●
	Protection	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	●	●	●	●
3.2	**Cleaning Pretreatment Structures**	Remove debris from catch basins, area drains, other inlets	●	●	●	●
	Cleaning Proprietary Pretreatment Devices	Remove debris and clean filter of a device according to manufacturer instructions	●	●	●	●
	Cleaning Vegetated Pretreatment Areas	Remove debris from forebay (aka sediment forebay)		●	●	
3.3	**Cleaning Drainage Structures**	Remove debris from underdrains, pipes, observations ports, cleanouts, outlet control structures	●	●	●	●
	CCTV Inspection & Jetting	Use specialized camera(s) to investigate inside a pipe without having to dig; clear pipes using a process of flushing or jetting a high-powered stream of water through pipes	●		●	●
	Hardware Repair	Repair/replace grates, gates, covers, and/or bolts	●		●	●
	Maintaining & Cleaning Riprap	Remove organic material, vacuum or sweep surface; replace missing rock, repair damaged geotextile material		●	●	
	Signage	Repair or replace broken, missing, or faded signage	●	●	●	●
3.4	**Weed Control**	Identify weeds, remove, and dispose; includes volunteer trees; see design recommendations and owner requirements for herbicide application		●	●	●
	Mowing	Cut grasses to specific height, remove clippings		●	●	
	String Trimming	Trim grass to specific height in areas where mowing is infeasible		●	●	
	Fertilizing	Apply fertilizer specific to plant materials needs and manufacturer recommendations			●	●
	Pruning	Prune/cut plant material and remove clippings			●	●
	Seeding	Spread seed in bare spots		●	●	
	Vegetation Removal & Replacement	Remove dead or damaged plant material and replant new			●	●
	Watering	Water/irrigate newly planted vegetation, follow design recommendations, or specific plant needs/triggers			●	●
	Pest & Disease Management	Apply insecticide or pesticide as directed by owner or contact professional for pest removal	●		●	●
	Winter Vegetation Management	Minimize use of salts around vegetation; do not store snow in bioretention areas		●	●	●

Boxes marked with a circle ● indicate 80% of installs may require this action

Bioretention (infiltration)	Biofiltration	Bioretention Planters	Porous Asphalt	Permeable Pavers	Green Roofs	Blue Roofs	Cisterns
●	●	●			●	●	●
●	●	●			●	●	●
●	●	●					
●	●	●					
●	●	●					
●	●	●	●	●	●		
	●	●					
	●	●	●	●	●	●	●
●	●						
●	●	●	●	●	●	●	●
●	●	●			●		
●	●						
●	●						
●	●	●			●		
●	●	●					
●	●				●		
●	●	●			●		
●	●	●			●		
●	●	●			●		
●	●	●					

(continued on next page)

Maintenance Actions Matrix (continued)

			Subsurface Infiltration	Infiltration Trench	Surface Infiltration Basin	Tree Filter
3.5	**Infiltration Rate Monitoring**	Observe and record amount of time standing water occurs in soils/soft surfaces; compare to design rate		●	●	
	Surface Debris Removal	Remove trash and debris and properly dispose	●	●	●	●
	Erosion Repair	Fill eroded area with material according to design specifications or stabilize with erosion control measures		●	●	
	Mulching	Add mulch to bare or thin areas or completely remove old and replace with new annually			●	●
	Settling & Sinkhole Repair	Fill areas of settlement with clean topsoil; if settling occurs beneath structures, pack with a subbase			●	●
	Soil Decompaction or Replacement	Loosen/till existing soil or remove and replace with new soil		●	●	
3.6	**Sweeping**	Remove large debris from surface before vacuuming				
	Power Washing	Power wash to dislodge trapped particles before vacuuming				
	Vacuuming	Use power vacuum sweeper to clear pores of sediment				
	Permeability Rate Monitoring	Test infiltrative capacity and compare to design rate				
	Permeable Pavement Repair	Repair or replace areas with chipped or cracked asphalt; replace broken or missing pavers				
	Winter Pavement Management	Minimize use of salts, do not use sand; use rubber plow blade, do not store snow on permeable pavements				
3.7	**Rooftop Pest Management**	Ensure any lids are properly sealed; add larvicide to standing water to prevent mosquitoes from reaching adulthood				
	Irrigation Systems	Service irrigation systems according to manufacturer's recommendation				
	Waterproof Membrane Repair or Replacement	Refer to manufacturer's specifications for repair or replacement of waterproof membranes				
	Repair Drains, Scuppers, & Gutters	Check roof drains, overflow, scuppers, and gutters to ensure they are draining				
	Winter Rooftop Management	Break up ice formation around outlets and overflows; drain systems before first hard freeze				
	Pump & Mechanical Systems	Service mechanical systems according to manufacturer's recommendation; inspect for leaks				
	Cleaning & Securing Cistern	Level foundation, wipe outside, and remove debris and accumulated sediment inside cistern				
	Plumbing Systems	Ensure that spigot and other plumbing parts are functioning properly and inspect for leaks; repair or replace parts as necessary				
	Standing Water	Observe and record amount of time standing water occurs and compare to design rate; Inspect outlets and storage areas for leaf litter, debris, and sediment accumulation				

Boxes marked with a circle ● indicate 80% of installs may require this action

Bioretention (infiltration)	Biofiltration	Bioretention Planters	Porous Asphalt	Permeable Pavers	Green Roofs	Blue Roofs	Cisterns
●		●			●		
●	●	●	●	●	●	●	●
●	●				●		
●	●	●					
●	●	●	●	●			
●		●			●		
			●	●			
			●	●			
			●	●			
			●	●			
			●	●			
			●	●			
						●	●
					●		
					●		
					●	●	●
					●	●	●
							●
							●
					●	●	●
						●	


FedEx



CHAPTER 4

Inspection & Maintenance Checklists

This chapter contains guidance and checklists for inspecting and maintaining types of Green Infrastructure (GI) found in Boston. Regardless of GI type, establishing clear and easy to follow plans and procedures is essential to ensure the long-term success of a project. GI projects may fail to achieve intended design goals without a strategy to conduct maintenance on a regular basis. These checklists are intended to document and track the effectiveness of the system and can serve as a consistent form of record keeping.

Left: Old State House in downtown Boston





4.1 Infiltration Practices

Inspection & Maintenance Considerations

Infiltration practices include a variety of systems that provide temporary storage to filter and exfiltrate stormwater through gravel media and permeable soils. Proper maintenance of pretreatment measures and frequent cleaning of the subsurface system is essential to prevent clogging and failure.

Maintenance Frequency

Maintenance of Infiltration Practices should occur monthly or after large storms, where 2.5 or more inches of precipitation occur in 24 hours. MassDEP recommends inspections occur twice per year during the first year. However, quarterly inspections may be warranted during the first year if stormwater runoff includes a heavy sediment load. After the first year, annual maintenance is suggested as well as maintenance after rain events greater than the 2-year, 24-hour storm, depending on the geographic location.

Opposite: Rainstore chambers at Massachusetts Institute of Technology Stata Center, Cambridge, MA (Source: Nitsch Engineering)

Subsurface Infiltration

Description

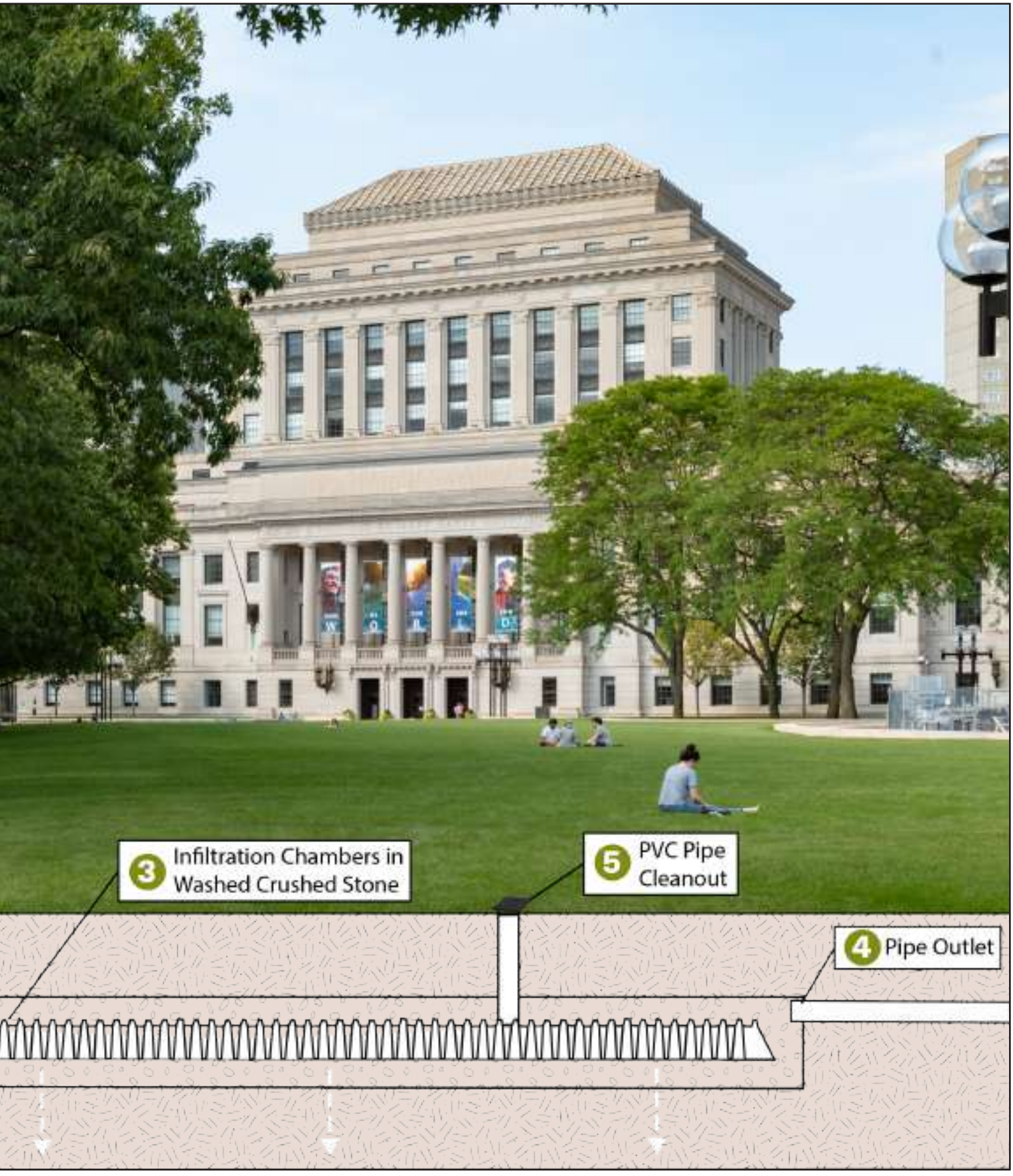
Subsurface Infiltration typically consists of storage voids within a bed of gravel/aggregate (washed crushed stone) or within storage devices (perforated pipes, plastic arch chambers, etc.) embedded within a bed of gravel used to temporarily store stormwater and exfiltrate to underlying soils.

Green Infrastructure Components to Maintain

#	Component	Reference Section
1	Inlet Structure	3.1; 3.2; 3.3
2	Pretreatment	3.2; 3.3
3	Main Treatment	3.3
4	Outlet/Emergency Overflow	3.3
5	PVC Pipe Cleanout	3.3



Right: Stormtech Chambers at Christian Science Center Plaza, Boston, MA (Source: Nitsch Engineering)


3 Infiltration Chambers in Washed Crushed Stone
5 PVC Pipe Cleanout
4 Pipe Outlet

Subsurface Infiltration - Inspection Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: twice per year and after storm events greater than a 2-year storm; see manufacturer's recommendations for frequency when using plastic arch chambers or similar storage devices

Reference	Item	Inspection Question	Observation
3.1 - General Procedures	1	Is there visual evidence of pollutants in the infiltration basin (e.g. oil sheen, odd discoloration, stains, odors, etc.)?	Y | N | N/A
	2	Are there signs of disturbance by humans or pets, such as compacted soils, displaced rocks, graffiti, tire tracks, or pet waste?	Y | N | N/A
3.2 - Pretreatment	3	Are adjacent area drains, inlets, or outlet control structures clogged or functioning poorly?	Y | N | N/A
	4	Is the proprietary pretreatment unit clogged or full of debris?	Y | N | N/A
3.3 - Drainage Structures	5	Do inlets, underdrains, observation ports, outlets, or other structures contain blockages or accumulated sediment?	Y | N | N/A
	6	Is the underdrain or other piping blocked or clogged despite routine maintenance? Is water not exiting system without other explanation? (Use observation ports or observation wells to check for standing water.)	Y | N | N/A
	7	Are the inlet/outlet structure, other grates, or gates damaged, cracked, or deteriorating?	Y | N | N/A
	8	Does GI installation include signage? Is it damaged, missing, or faded?	Y | N | N/A
3.4 - Vegetation	9	Is there evidence of animal borrows or rodents present?	Y | N | N/A
3.5 - Softscape Surfaces	10	Are litter, debris, and accumulated sediment present?	Y | N | N/A

Comments

Subsurface Infiltration - Maintenance Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: twice per year and after storm events greater than a 2-year storm; see manufacturer's recommendations for frequency when using plastic arch chambers or similar storage devices

Reference	Item	Maintenance Action	Maintenance Completed ex. Y | N | N/A
3.1 - General Procedures	1	If signs of pollution are present, attempt to determine the cause and eliminate it. If a persistent or frequent pollution issue occurs, contact the Owner. This could be a sign that pollutants are routinely being introduced into the basin.	
	2	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	
3.2 - Pretreatment	3	Remove debris from catch basins, area drains, other inlets	
	4	Remove debris and clean filter of the device according to manufacturer instructions	
3.3 - Drainage Structures	5	Remove debris from underdrains, pipes, observations ports, cleanouts, and/or outlet control structures	
	6	Use specialized camera(s) to investigate inside a pipe without having to dig; clear pipes using a process of flushing or jetting a high-powered stream of water through pipes	
	7	Repair/replace grates, gates, covers, and/or bolts	
	8	Repair or replace broken, missing, or faded signage	
3.4 - Vegetation	9	Apply insecticide or pesticide as directed by owner or contact professional for pest removal	
3.5 - Softscape Surfaces	10	Remove trash and debris and properly dispose	

Comments/Follow Up

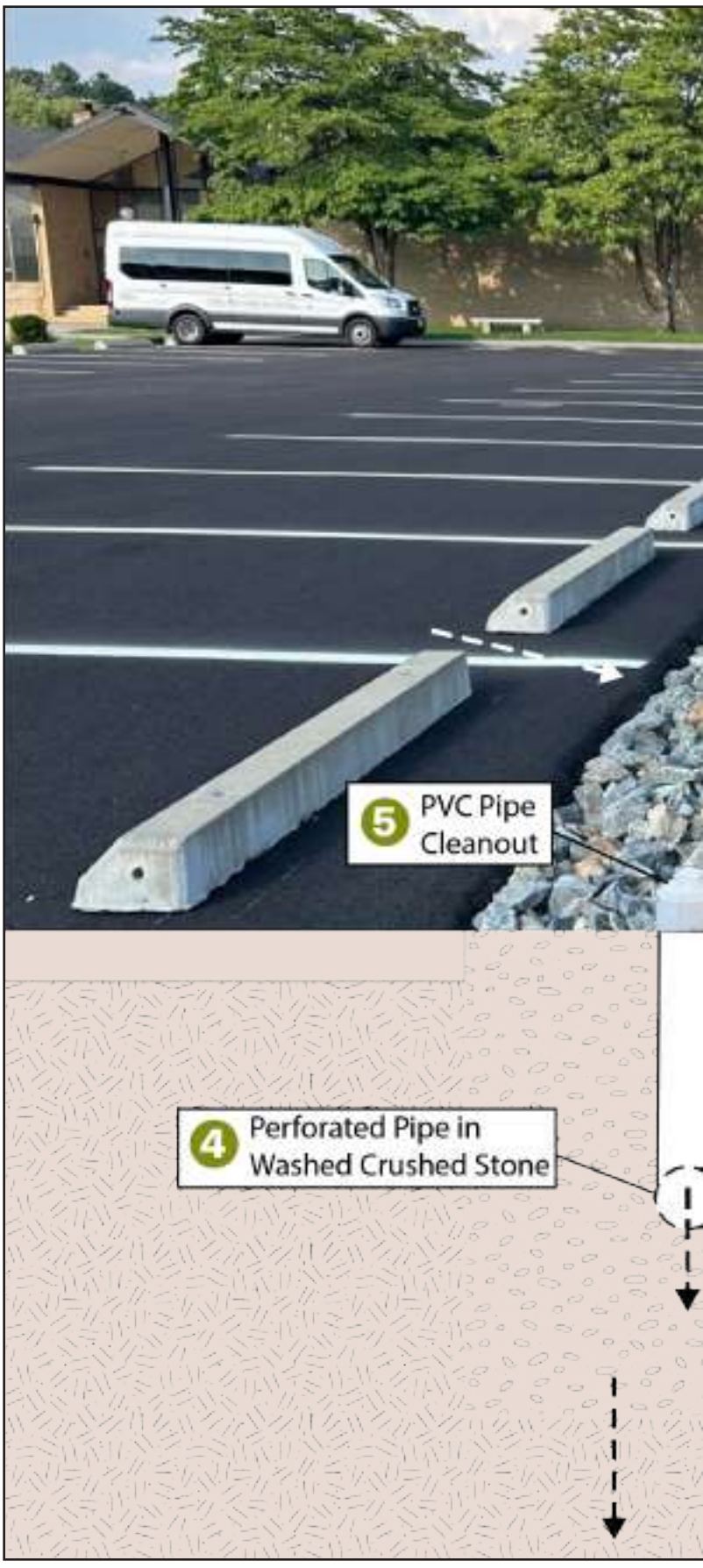
Infiltration Trenches

Description

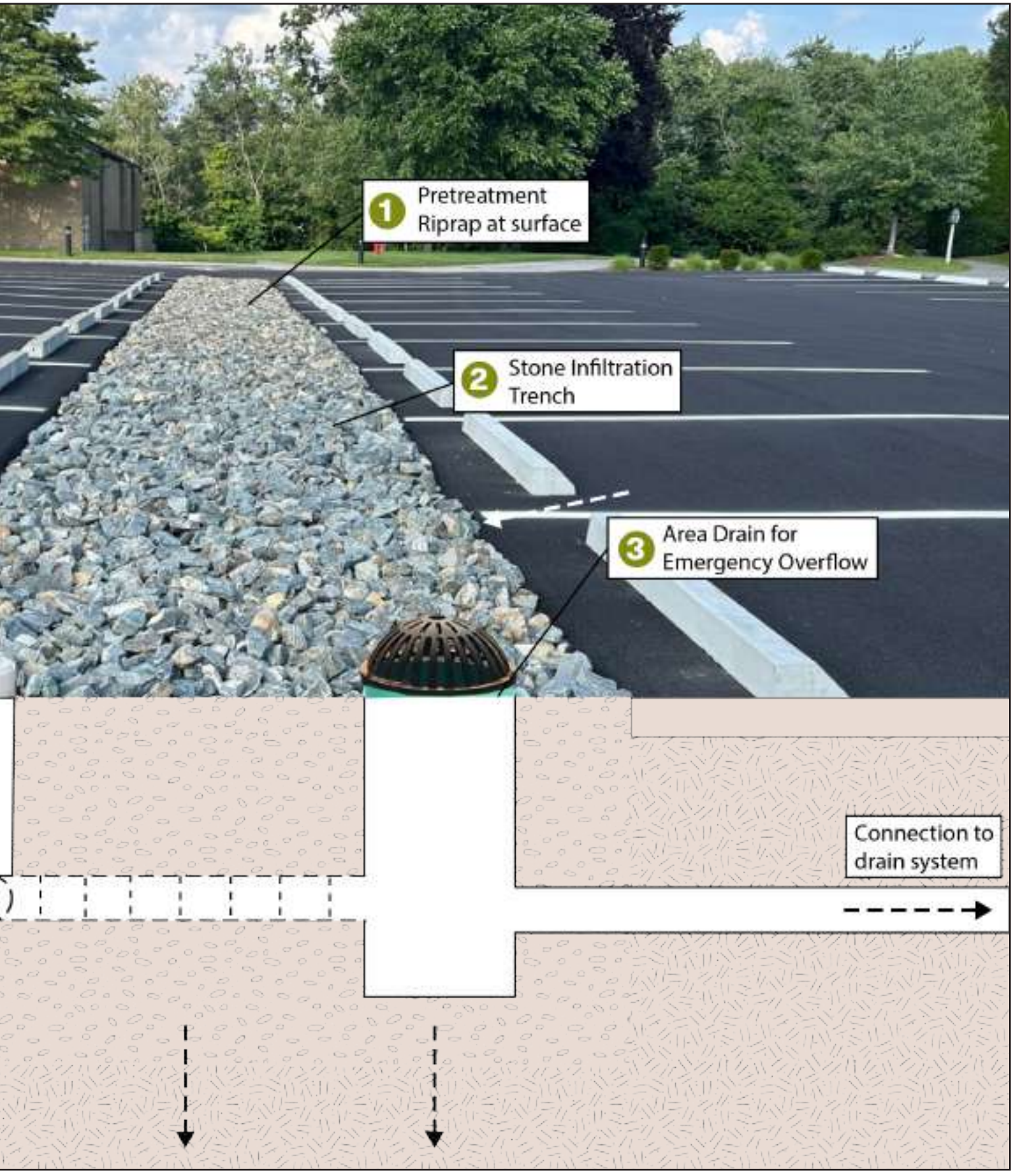
Infiltration Trenches are shallow excavations filled with washed crushed stone. Voids in the stone temporarily store stormwater for exfiltration into underlying soils. Optional infiltration risers can be used to optimize movement of stormwater into a stone reservoir and are typically designed to overflow at the surface.

Green Infrastructure Components to Maintain

#	Component	Reference Section
1	Pretreatment	3.1; 3.2
2	Main Treatment	3.1; 3.3; 3.4; 3.5
3	Outlet/Emergency Overflow	3.3
4	Underdrain	3.3
5	PVC Pipe Cleanout	3.3



Right: Infiltration Trench at The Rivers School, Weston, MA (Source: Nitsch Engineering)


1 Pretreatment
Riprap at surface
2 Stone Infiltration
Trench
3 Area Drain for
Emergency Overflow
Connection to
drain system

Infiltration Trenches - Inspection Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection twice per year after first year; after rain events greater than 3 inches in 24 hours

Reference	Item	Inspection Question	Observation
3.1 - General Procedures	1	Is there visual evidence of pollutants in the infiltration basin (e.g. oil sheen, odd discoloration, stains, odors, etc.)?	Y | N | N/A
	2	Are there signs of disturbance by humans or pets, such as compacted soils, displaced rocks, graffiti, tire tracks, or pet waste?	Y | N | N/A
3.2 - Pretreatment	3	Are adjacent area drains, inlets, or outlet control structures clogged or functioning poorly?	Y | N | N/A
	4	Is the proprietary pretreatment unit clogged or full of debris?	Y | N | N/A
	5	Is there excessive sediment, silt, or trash accumulation on the sediment forebay?	Y | N | N/A
3.3 - Drainage Structures	6	Do inlets, underdrains, observation ports, outlets, or other structures contain blockages or accumulated sediment?	Y | N | N/A
	7	Does riprap contain organic material or sediment?	Y | N | N/A
	8	Are riprap areas missing rock or in need of repair?	Y | N | N/A
	9	Does GI installation include signage? Is it damaged, missing, or faded?	Y | N | N/A
3.4 - Vegetation	10	Are tree seedlings, weeds, or other invasive plants present?	Y | N | N/A
	11	Does the height of grass in or near GI exceed 4 inches?	Y | N | N/A
	12	Where mowing is infeasible, does the height of the grass in or near GI exceed 4 inches?	Y | N | N/A
	13	Does grass or groundcover contain bare spots or thin areas of grass growth?	Y | N | N/A
	14	Does plant material show negative effects of salts from adjacent paved surfaces? (Refer to any established Winter Vegetation Management procedures)	Y | N | N/A
3.5 - Softscape Surfaces	15	Is standing water present more than 48 hours after a rain event?	Y | N | N/A
	16	Are litter, debris, grass clippings, leaves, or accumulated sediment present?	Y | N | N/A
	17	Are there signs of soil erosion or formation of rills and gullies?	Y | N | N/A
	18	Is stormwater not infiltrating within 72 hours despite routine maintenance?	Y | N | N/A

Comments

Infiltration Trenches - Maintenance Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection twice per year after first year; after rain events greater than 3 inches in 24 hours

Reference	Item	Maintenance Action	Maintenance Completed ex. Y | N | N/A
3.1 - General Procedures	1	If signs of pollution are present, attempt to determine the cause and eliminate it. If a persistent or frequent pollution issue occurs, contact the Owner. This could be a sign that pollutants are routinely being introduced into the basin.	
	2	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	
3.2 - Pretreatment	3	Remove debris from catch basins, area drains, other inlets	
	4	Remove debris and clean filter of the device according to manufacturer instructions	
	5	Remove debris from forebay (aka sediment forebay)	
3.3 - Drainage Structures	6	Remove debris from underdrains, pipes, observations ports, cleanouts, and/or outlet control structures	
	7	Remove organic material, vacuum or sweep surface	
	8	Replace missing rock, repair damaged geotextile material	
	9	Repair or replace broken, missing, or faded signage	
3.4 - Vegetation	10	Identify weeds, remove, and dispose; includes volunteer trees; see design recommendations and owner requirements for herbicide application	
	11	Cut grasses to specific height, remove clippings	
	12	Trim grass to specific height in areas where mowing is infeasible	
	13	Spread seed in bare spots	
	14	Minimize use of salts around vegetation; do not store snow in bioretention areas	
3.5 - Softscape Surfaces	15	Observe and record amount of time standing water occurs in soils/soft surfaces; compare to design rate	
	16	Remove trash and debris and properly dispose	
	17	Fill eroded area with material according to design specifications or stabilize with erosion control measures	
	18	Loosen/till existing soil or remove and replace with new soil	

Comments/Follow Up

Surface Infiltration Basins

Description

Surface Infiltration Basins are depressions or impoundments constructed over permeable soils and provide temporary surface storage for pretreated stormwater to exfiltrate into underlying soils.

Green Infrastructure Components to Maintain

#	Component	Reference Section
1	Inlet Structure	3.1; 3.2; 3.3
2	Pretreatment	3.2; 3.3; 3.4; 3.5
3	Main Treatment	3.1; 3.2; 3.4; 3.5
4	Outlet/Emergency Overflow	3.3



Right: Infiltration Basin at Gallery Automotive, Hingham & Rockland, MA (Source: Nitsch Engineering)


3 Plants & Soils for Infliltration
2 Sediment Forebay Pretreatment
1 PVC Pipe Inlet

Surface Infiltration Basins - Inspection Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection after major storm events during first 3 months of operation and twice per year and when discharges are through outlet control structure thereafter

Reference	Item	Inspection Question	Observation
3.1 - General Procedures	1	Is there visual evidence of pollutants in the infiltration basin (e.g. oil sheen, odd discoloration, stains, odors, etc.)?	Y | N | N/A
	2	Are there signs of disturbance by humans or pets, such as compacted soils, displaced rocks, graffiti, tire tracks, or pet waste?	Y | N | N/A
3.2 - Pretreatment	3	Are adjacent area drains, inlets, or outlet control structures clogged or functioning poorly	Y | N | N/A
	4	Is the proprietary pretreatment unit clogged or full of debris?	Y | N | N/A
	5	Is there excessive sediment, silt, or trash accumulation on the sediment forebay?	Y | N | N/A
3.3 - Drainage Structures	6	Do inlets, underdrains, observation ports, outlets, or other structures contain blockages or accumulated sediment?	Y | N | N/A
	7	Is the underdrain or other piping blocked or clogged despite routine maintenance? Is water not exiting system without other explanation? (Use observation ports or observation wells to check for standing water.)	Y | N | N/A
	8	Are the inlet/outlet structure, other grates, or gates damaged, cracked, or deteriorating?	Y | N | N/A
	9	Does riprap contain organic material or sediment?	Y | N | N/A
	10	Are riprap areas missing rock or in need of repair?	Y | N | N/A
	11	Does GI installation include signage? Is it damaged, missing, or faded?	Y | N | N/A
3.4 - Vegetation	12	Are tree seedlings, weeds, or other invasive plants present?	Y | N | N/A
	13	Does the height of grass in or near GI exceed 4 inches?	Y | N | N/A
	14	Where mowing is infeasible, does the height of the grass in or near GI exceed 4 inches?	Y | N | N/A
	15	Does any plant material require fertilization according to design recommendations?	Y | N | N/A
	16	Is any woody vegetation in need of shaping, thinning, or removal of dead branches?	Y | N | N/A
	17	Does grass or groundcover contain bare spots or thin areas of grass growth?	Y | N | N/A
	18	Do any plants show signs of damage, decay or dead vegetation?	Y | N | N/A
	19	Do any plants show signs of wilting or distress or does DI contain newly installed plant material that requires watering?	Y | N | N/A
	20	Do any plants show signs of pests or disease, such as animal borrows?	Y | N | N/A
	21	Does plant material show negative effects of salts from adjacent paved surfaces? (Refer to any established Winter Vegetation Management procedures)	Y | N | N/A
3.5 - Softscape Surfaces	22	Is standing water present more than 48 hours after a rain event?	Y | N | N/A
	23	Are any of the following present: litter, debris, grass clippings, leaves, or accumulated sediment?	Y | N | N/A
	24	Are there signs of soil erosion or formation of rills and gullies?	Y | N | N/A
	25	Are there areas of exposed soil or bare earth?	Y | N | N/A
	26	Is there evidence of sinkholes or subsidence?	Y | N | N/A
	27	Is stormwater not infiltrating within 72 hours despite routine maintenance?	Y | N | N/A

Comments

Surface Infiltration Basins - Maintenance Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection after major storm events during first 3 months of operation and twice per year and when discharges are through outlet control structure thereafter

Reference	Item	Maintenance Action	Maintenance Completed ex. Y | N | N/A
3.1 - General Procedures	1	If signs of pollution are present, attempt to determine the cause and eliminate it. If a persistent or frequent pollution issue occurs, contact the Owner. This could be a sign that pollutants are routinely being introduced into the basin.	
	2	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	
3.2 - Pretreatment	3	Remove debris from catch basins, area drains, other inlets	
	4	Remove debris and clean filter of the device according to manufacturer instructions	
	5	Remove debris from forebay (aka sediment forebay)	
3.3 - Drainage Structures	6	Remove debris from underdrains, pipes, observations ports, cleanouts, and/or outlet control structures	
	7	Use specialized camera(s) to investigate inside a pipe without having to dig; clear pipes using a process of flushing or jetting a high-powered stream of water through pipes	
	8	Repair/replace grates, gates, covers, and/or bolts	
	9	Remove organic material, vacuum or sweep surface	
	10	Replace missing rock, repair damaged geotextile material	
	11	Repair or replace broken, missing, or faded signage	
3.4 - Vegetation	12	Identify weeds, remove, and dispose; includes volunteer trees; see design recommendations and owner requirements for herbicide application	
	13	Cut grasses to specific height, remove clippings	
	14	Trim grass to specific height in areas where mowing is infeasible	
	15	Apply fertilizer specific to plant material needs and manufacturer recommendations	
	16	Prune/cut plant material and remove clippings	
	17	Spread seed in bare spots	
	18	Remove dead or damaged plant material and replant new	
	19	Water/irrigate newly planted vegetation, follow design recommendations, or specific plant needs/triggers	
	20	Apply insecticide or pesticide as directed by owner or contact professional for pest removal	
	21	Minimize use of salts around vegetation; do not store snow in bioretention areas	
3.5 - Softscape Surfaces	22	Observe and record amount of time standing water occurs in soils/soft surfaces; compare to design rate	
	23	Remove trash and debris and properly dispose	
	24	Fill eroded area with material according to design specifications or stabilize with erosion control measures	
	25	Add mulch to bare or thin areas or completely remove old and replace with new annually	
	26	Fill areas of settlement with clean topsoil; if settling occurs beneath structures, pack with a subbase	
	27	Loosen/till existing soil or remove and replace with new soil	

Comments/Follow Up

Tree Filters

Description

Tree Filters (a.k.a. tree pits or tree trenches) are systems with a tree planted in porous soil and an underlying trench of washed crushed stone and perforated pipe. They often accept sheet flow from paved surfaces. Diverted stormwater from roadway catch basins can also be diverted through a perforated pipe in the crushed stone trench.

Green Infrastructure Components to Maintain

#	Component	Reference Section
1	Main Treatment	3.1; 3.2; 3.4; 3.5
2	Inspection Port/ Cleanout	3.3
3	Perforated Pipe Underdrain	3.3



Right: Tree Filter at Central Square, Boston, MA (Source: Klopfer Martin Design Group; Rendering by Nitsch Engineering)


1 Infiltrative soils and planting
2 Inspection Port/ Cleanout
3 Perforated Pipe Underdrain in Washed Crushed Stone Connecting All Tree Filters

Tree Filters - Inspection Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection twice per year during first year; then annually and after rain events greater than 3 inches in 24 hrs.

Reference	Item	Inspection Question	Observation
3.1 - General Procedures	1	Is there visual evidence of pollutants in the infiltration basin (e.g. oil sheen, odd discoloration, stains, odors, etc.)?	Y | N | N/A
	2	Are there signs of disturbance by humans or pets, such as compacted soils, displaced rocks, graffiti, tire tracks, or pet waste?	Y | N | N/A
3.2 - Pretreatment	3	Are adjacent area drains, inlets, or outlet control structures clogged or functioning poorly?	Y | N | N/A
	4	Is the proprietary pretreatment unit clogged or full of debris?	Y | N | N/A
3.3 - Drainage Structures	5	Do inlets, underdrains, observation ports, outlets, or other structures contain blockages or accumulated sediment?	Y | N | N/A
	6	Is the underdrain or other piping blocked or clogged despite routine maintenance? Is water not exiting system without other explanation? (Use observation ports or observation wells to check for standing water.)	Y | N | N/A
	7	Are the inlet/outlet structure, other grates, or gates damaged, cracked, or deteriorating?	Y | N | N/A
	8	Does GI installation include signage? Is it damaged, missing, or faded?	Y | N | N/A
3.4 - Vegetation	9	Are tree seedlings, weeds, or other invasive plants present?	Y | N | N/A
	10	Does any plant material require fertilization according to design recommendations?	Y | N | N/A
	11	Is any woody vegetation in need of shaping, thinning, or removal of dead branches?	Y | N | N/A
	12	Do any plants show signs of damage, decay or dead vegetation?	Y | N | N/A
	13	Do any plants show signs of wilting or distress, or does GI contain newly installed plant material that requires watering?	Y | N | N/A
	14	Do any plants show signs of pests or disease, such as animal borrows?	Y | N | N/A
	15	Does plant material show negative effects of salts from adjacent paved surfaces? (Refer to any established Winter Vegetation Management procedures)	Y | N | N/A
3.5 - Softscape Structures	16	Are any of the following present: litter, debris, grass clippings, leaves, or accumulated sediment?	Y | N | N/A
	17	Are there areas of exposed soil or bare earth?	Y | N | N/A
	18	Is there evidence of sinkholes or subsidence?	Y | N | N/A

Comments

Tree Filters - Maintenance Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection twice per year during first year; then annually and after rain events greater than 3 inches in 24 hrs.

Reference	Item	Maintenance Action	Maintenance Completed ex. Y | N | N/A
3.1 - General Procedures	1	If signs of pollution are present, attempt to determine the cause and eliminate it. If a persistent or frequent pollution issue occurs, contact the Owner. This could be a sign that pollutants are routinely being introduced into the basin.	Y | N | N/A
	2	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	Y | N | N/A
3.2 - Pretreatment	3	Remove debris from catch basins, area drains, other inlets	Y | N | N/A
	4	Remove debris and clean filter of the device according to manufacturer instructions	Y | N | N/A
3.3 - Drainage Structures	5	Remove debris from underdrains, pipes, observations ports, cleanouts, and/or outlet control structures	Y | N | N/A
	6	Use specialized camera(s) to investigate inside a pipe without having to dig; clear pipes using a process of flushing or jetting a high-powered stream of water through pipes	Y | N | N/A
	7	Repair/replace grates, gates, covers, and/or bolts	Y | N | N/A
	8	Repair or replace broken, missing, or faded signage	Y | N | N/A
3.4 - Vegetation	9	Identify weeds, remove, and dispose; includes volunteer trees; see design recommendations and owner requirements for herbicide application	Y | N | N/A
	10	Apply fertilizer specific to plant material needs and manufacturer recommendations	Y | N | N/A
	11	Prune/cut plant material and remove clippings	Y | N | N/A
	12	Remove dead or damaged plant material and replant new	Y | N | N/A
	13	Water/irrigate newly planted vegetation, follow design recommendations, or specific plant needs/triggers	Y | N | N/A
	14	Apply insecticide or pesticide as directed by owner or contact professional for pest removal	Y | N | N/A
	15	Minimize use of salts around vegetation; do not store snow in bioretention areas	Y | N | N/A
3.5 - Softscape Structures	16	Remove trash and debris and properly dispose	Y | N | N/A
	17	Add mulch to bare or thin areas or completely remove old and replace with new annually	Y | N | N/A
	18	Fill areas of settlement with clean topsoil; if settling occurs beneath structures, pack with a subbase	Y | N | N/A

Comments/Follow Up

Infiltration Practices



Maintenance Triggers

Common maintenance triggers for Infiltration Practices include an excess of surface debris, compacted soils, and unhealthy vegetation.



A newly seeded slope that requires reseeding to replace the seeds displaced by stormwater and erosion control blankets to prevent further erosion until plantings have developed. (Source: Nitsch Engineering)



Riprap inlet overgrown with weeds and inundated with soil. Reset the stones after clearing out the vegetation and soil. Stones should be set above grade sloping down to the infiltration practice. (Source: Nitsch Engineering)



Mow or string trim infiltration trench to ensure design storage and flow volumes. (Source: Nitsch Engineering)



Prune dead plants and replace as needed.



Inlet should be cleared of all debris and vegetation. Clear and grub vegetation within inlet. (Source: Nitsch Engineering)



Jet rodding is required to clear the cleanout/inspection port structure.



Settling has compacted soils below the outlet control structure and prohibited growth from over-saturated soils. Decompact to meet grade with outlet structure and replant or reseed as necessary. (Source: Nitsch Engineering)



Clean out conveyance to GI to ensure proper flow and prevent clogging.



4.2 Bioretention Techniques

Inspection & Maintenance Considerations

Bioretention maintenance includes trash and sediment removal from the pretreatment measures and landscape maintenance. Design considerations, such as plant selection, and proper support during the establishment of vegetation can impact the necessary maintenance frequency. To prevent clogging, frequent cleaning and maintenance of the bioretention techniques is critical.

Maintenance Frequency

Maintenance for bioretention techniques should take place monthly or after large storms that record 2.5 inches or more in 24 hours. MassDEP recommends that maintenance occur more frequently while plants are being established. Once vegetation is established, seasonal landscaping maintenance is recommended.

Left: Bioretention at Massachusetts Institute of Technology Stata Center (Source: Nitsch Engineering)

Bioretention (infiltration)

Description

Bioretention (infiltration) systems are shallow depressions filled with sandy soil and planted with dense, usually native vegetation. Stormwater runoff is temporarily stored in the surface depression, percolates through soil and a stone reservoir, and finally infiltrates into the ground. Often placed in open spaces adjacent to impervious surfaces.

Green Infrastructure Components to Maintain

#	Component	Reference Section
1	Pretreatment	3.1; 3.2; 3.3
2	Main Treatment	3.1; 3.3; 3.4; 3.5
3	Outlet/Emergency Overflow	3.3
4	Perforated Pipe Underdrain	3.3
5	Cleanout	3.3



Right: Bioretention at Scissortail Park, Oklahoma City, OK (Source: Nitsch Engineering)


2 Bioretention Plants and Soils
5 Cleanout
Mulch
Sand
Pea Gravel
4 Perforated Pipe Underdrain in Washed Crushed Stone

Bioretention (infiltration) - Inspection Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection after major storm events during first 3 months of operation, then twice per year and when discharges are through outlet control structure thereafter

Reference	Item	Inspection Question	Observation
3.1 - General Procedures	1	Is there visual evidence of pollutants in the infiltration basin (e.g. oil sheen, odd discoloration, stains, odors, etc.)?	Y | N | N/A
	2	Are there signs of disturbance by humans or pets, such as compacted soils, displaced rocks, graffiti, tire tracks, or pet waste?	Y | N | N/A
3.2 - Pretreatment	3	Are adjacent area drains, other inlets, or outlet control structures clogged or functioning poorly?	Y | N | N/A
	4	Is the proprietary pretreatment unit clogged or full of debris?	Y | N | N/A
	5	Is there excessive sediment, silt, or trash accumulation on the sediment forebay?	Y | N | N/A
3.3 - Drainage Structures	6	Do inlets, underdrains, observation ports, outlets, or other structures contain blockages or accumulated sediment?	Y | N | N/A
	7	Are riprap areas missing rock, in need of repair, or contain excess sediment?	Y | N | N/A
	8	Does GI installation include signage? Is it damaged, missing, or faded?	Y | N | N/A
3.4 - Vegetation	9	Are tree seedlings, weeds, or other invasive plants present?	Y | N | N/A
	10	Does the height of grass in or near GI exceed 4 inches?	Y | N | N/A
	11	Where mowing is infeasible, does the height of the grass in or near GI exceed 4 inches?	Y | N | N/A
	12	Does any plant material require fertilization according to design recommendations?	Y | N | N/A
	13	Is any woody vegetation in need of shaping, thinning, or removal of dead branches?	Y | N | N/A
	14	Does grass or ground cover contain bare spots or thin areas of grass growth?	Y | N | N/A
	15	Do any plants show signs of damage, decay or dead vegetation?	Y | N | N/A
	16	Do any plants show signs of wilting or distress? (refer to design recommendations for watering, especially newly installed plant material)	Y | N | N/A
	17	Is there evidence of animal borrows or rodents present? Do any plants show signs of pests or disease?	Y | N | N/A
	18	Does plant material show negative effects of salts from adjacent paved surfaces? (Refer to any established Winter Vegetation Management procedures)	Y | N | N/A
3.5 - Softscape Surfaces	19	Is standing water present more than 48 hours after a rain event?	Y | N | N/A
	20	Are any of the following present: litter, debris, grass clippings, leaves, or accumulated sediment?	Y | N | N/A
	21	Are there signs of soil erosion or formation of rills and gullies?	Y | N | N/A
	22	Are there areas of exposed soil or bare earth?	Y | N | N/A
	23	Is there evidence of sinkholes or subsidence?	Y | N | N/A
	24	Is stormwater not infiltrating within 72 hours despite routine maintenance?	Y | N | N/A

Comments

Bioretention (infiltration) - Maintenance Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection after major storm events during first 3 months of operation, then twice per year and when discharges are through outlet control structure thereafter

Reference	Item	Maintenance Action	Maintenance Completed ex. Y | N | N/A
3.1 - General Procedures	1	If signs of pollution are present, attempt to determine the cause and eliminate it. If a persistent or frequent pollution issue occurs, contact the Owner. This could be a sign that pollutants are routinely being introduced into the basin.	
	2	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	
3.2 - Pretreatment	3	Remove debris from catch basins, area drains, other inlets	
	4	Remove debris and clean filter of the device according to manufacturer instructions	
	5	Remove debris from forebay (aka sediment forebay)	
3.3 - Drainage Structures	6	Remove debris from underdrains, pipes, observations ports, cleanouts, and/or outlet control structures	
	7	Remove organic material, vacuum or sweep surface; replace missing rock, repair damaged geotextile material	
	8	Repair or replace broken, missing, or faded signage	
3.4 - Vegetation	9	Identify weeds, remove, and dispose; includes volunteer trees; see design recommendations and owner requirements for herbicide application	
	10	Cut grasses to specific height, remove clippings	
	11	Trim grass to specific height in areas where mowing is infeasible	
	12	Apply fertilizer specific to plant material needs and manufacturer recommendations	
	13	Prune/cut plant material and remove clippings	
	14	Spread seed in bare spots	
	15	Remove dead or damaged plant material and replant new	
	16	Water/irrigate newly planted vegetation, follow design recommendations, or specific plant needs/triggers	
	17	Apply insecticide or pesticide as directed by owner or contact professional for pest removal	
	18	Minimize use of salts around vegetation; do not store snow in bioretention areas	
3.5 - Softscape Surfaces	19	Observe and record amount of time standing water occurs in soils/soft surfaces; compare to design rate	
	20	Remove trash and debris and properly dispose	
	21	Fill eroded area with material according to design specifications or stabilize with erosion control measures	
	22	Add mulch to bare or thin areas or completely remove old and replace with new annually	
	23	Fill areas of settlement with clean topsoil; if settling occurs beneath structures, pack with a subbase	
	24	Loosen/till existing soil or remove and replace with new soil	

Comments/Follow Up

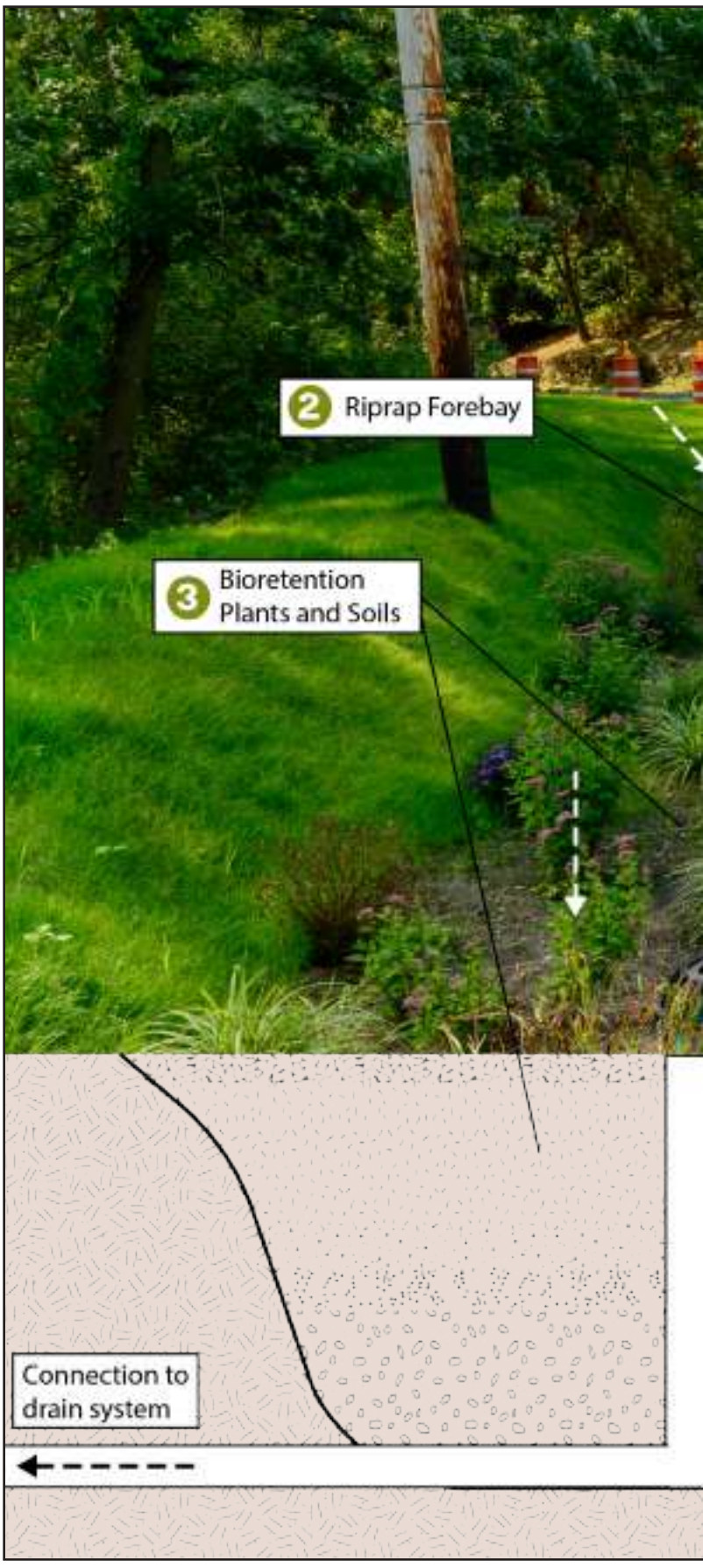
Biofiltration

Description

Biofiltration can be used where poor underlying soil conditions will not allow for infiltration. Biofiltration is similar to Bioretention in that it includes a surface depression filled with sandy soil and plantings. Stormwater percolates through the soil and stone reservoir where it is drained away by underdrains.

Green Infrastructure Components to Maintain

#	Component	Reference Section
1	Inlet Structure	3.1; 3.2; 3.3
2	Pretreatment	3.1; 3.2; 3.3
3	Main Treatment	3.1; 3.3; 3.4; 3.5
4	Outlet/Emergency Overflow	3.3
5	Perforated Pipe Underdrain	3.3
6	Cleanout	3.3
7	Impermeable Liner	3.5



Right: Biofiltration at South Street and Bussey Street, Boston, MA (Rendering by Nitsch Engineering)


1 PVC Pipe Inlet
1 PVC Pipe Inlet
6 Cleanout
Mulch
Sand
Pea Gravel
5 Perforated Pipe Underdrain in Washed Crushed Stone
7 Impermeable Liner

Biofiltration - Inspection Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection after major storm events during first 3 months of operation, then twice per year and when discharges are through outlet control structure thereafter

Reference	Item	Inspection Question	Observation
3.1 - General Procedures	1	Is there visual evidence of pollutants in the infiltration basin (e.g. oil sheen, odd discoloration, stains, odors, etc.)?	Y | N | N/A
	2	Are there signs of disturbance by humans or pets, such as compacted soils, displaced rocks, graffiti, tire tracks, or pet waste?	Y | N | N/A
3.2 - Pretreatment	3	Are adjacent area drains, inlets or outlet control structures clogged or functioning poorly?	Y | N | N/A
	5	Is the proprietary pretreatment unit clogged or full of debris?	Y | N | N/A
	6	Is there excessive sediment, silt, or trash accumulation on the sediment forebay?	Y | N | N/A
3.3 - Drainage Structures	7	Do inlets, underdrains, observation ports, outlets, or other structures contain blockages or accumulated sediment?	Y | N | N/A
	8	Is the underdrain or other piping blocked or clogged despite routine maintenance? Is water not exiting system without other explanation? (Use observation ports or observation wells to check for standing water.)	Y | N | N/A
	9	Is the inlet or outlet structure or other grates or gates damaged, cracked, or deteriorating?	Y | N | N/A
	10	Does riprap contain organic material or sediment?	Y | N | N/A
	11	Are riprap areas missing rock or in need of repair?	Y | N | N/A
	12	Does GI installation include signage? Is it damaged, missing, or faded?	Y | N | N/A
3.4 Vegetation	13	Are tree seedlings, weeds, or other invasive plants present?	Y | N | N/A
	14	Does the height of grass in or near GI exceed 4 inches?	Y | N | N/A
	15	Where mowing is infeasible, does the height of the grass in or near GI exceed 4 inches?	Y | N | N/A
	16	Does any plant material require fertilization according to design recommendations?	Y | N | N/A
	17	Is any woody vegetation in need of shaping, thinning, or removal of dead branches?	Y | N | N/A
	18	Does grass or groundcover contain bare spots or thin areas of grass growth?	Y | N | N/A
	19	Do any plants show signs of damage, decay or dead vegetation?	Y | N | N/A
	20	Do any plants show signs of wilting or distress, or does GI contain newly installed plant material that requires watering?	Y | N | N/A
	21	Do any plants show signs of pests or disease, such as animal borrows?	Y | N | N/A
	22	Does plant material show negative effects of salts from adjacent paved surfaces? (Refer to any established Winter Vegetation Management procedures)	Y | N | N/A
3.5 - Softscape Structures	23	Are litter, debris, grass clippings, leaves, or accumulated sediment present?	Y | N | N/A
	24	Are there signs of soil erosion or formation of rills and gullies?	Y | N | N/A
	25	Are there areas of exposed soil or bare earth?	Y | N | N/A
	26	Is there evidence of sinkholes or subsidence?	Y | N | N/A

Comments

Biofiltration - Maintenance Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection after major storm events during first 3 months of operation, then twice per year and when discharges are through outlet control structure thereafter

Reference	Item	Maintenance Action	Maintenance Completed ex. Y | N | N/A
3.1 - General Procedures	1	If signs of pollution are present, attempt to determine the cause and eliminate it. If a persistent or frequent pollution issue occurs, contact the Owner. This could be a sign that pollutants are routinely being introduced into the basin.	
	2	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	
3.2 - Pretreatment	3	Remove debris from catch basins, area drains, other inlets	
	4	Remove debris and clean filter of the device according to manufacturer instructions	
	5	Remove debris from forebay (aka sediment forebay)	
3.3 - Drainage Structures	7	Remove debris from underdrains, pipes, observations ports, cleanouts, and/or outlet control structures	
	8	Use specialized camera(s) to investigate inside a pipe without having to dig; clear pipes using a process of flushing or jetting a high-powered stream of water through pipes	
	9	Repair/replace grates, gates, covers, and/or bolts	
	10	Remove organic material, vacuum or sweep surface	
	11	Replace missing rock, repair damaged geotextile material	
	12	Repair or replace broken, missing, or faded signage	
3.4 Vegetation	13	Identify weeds, remove, and dispose; includes volunteer trees; see design recommendations and owner requirements for herbicide application	
	14	Cut grasses to specific height, remove clippings	
	15	Trim grass to specific height in areas where mowing is infeasible	
	16	Apply fertilizer specific to plant material needs and manufacturer recommendations	
	17	Prune/cut plant material and remove clippings	
	18	Spread seed in bare spots	
	19	Remove dead or damaged plant material and replant new	
	20	Water/irrigate newly planted vegetation, follow design recommendations, or specific plant needs/triggers	
	21	Apply insecticide or pesticide as directed by owner or contact professional for pest removal	
	22	Minimize use of salts around vegetation; do not store snow in bioretention areas	
3.5 - Softscape Structures	23	Remove trash and debris and properly dispose	
	24	Fill eroded area with material according to design specifications or stabilize with erosion control measures	
	25	Add mulch to bare or thin areas or completely remove old and replace with new annually	
	26	Fill areas of settlement with clean topsoil; if settling occurs beneath structures, pack with a subbase	

Comments/Follow Up

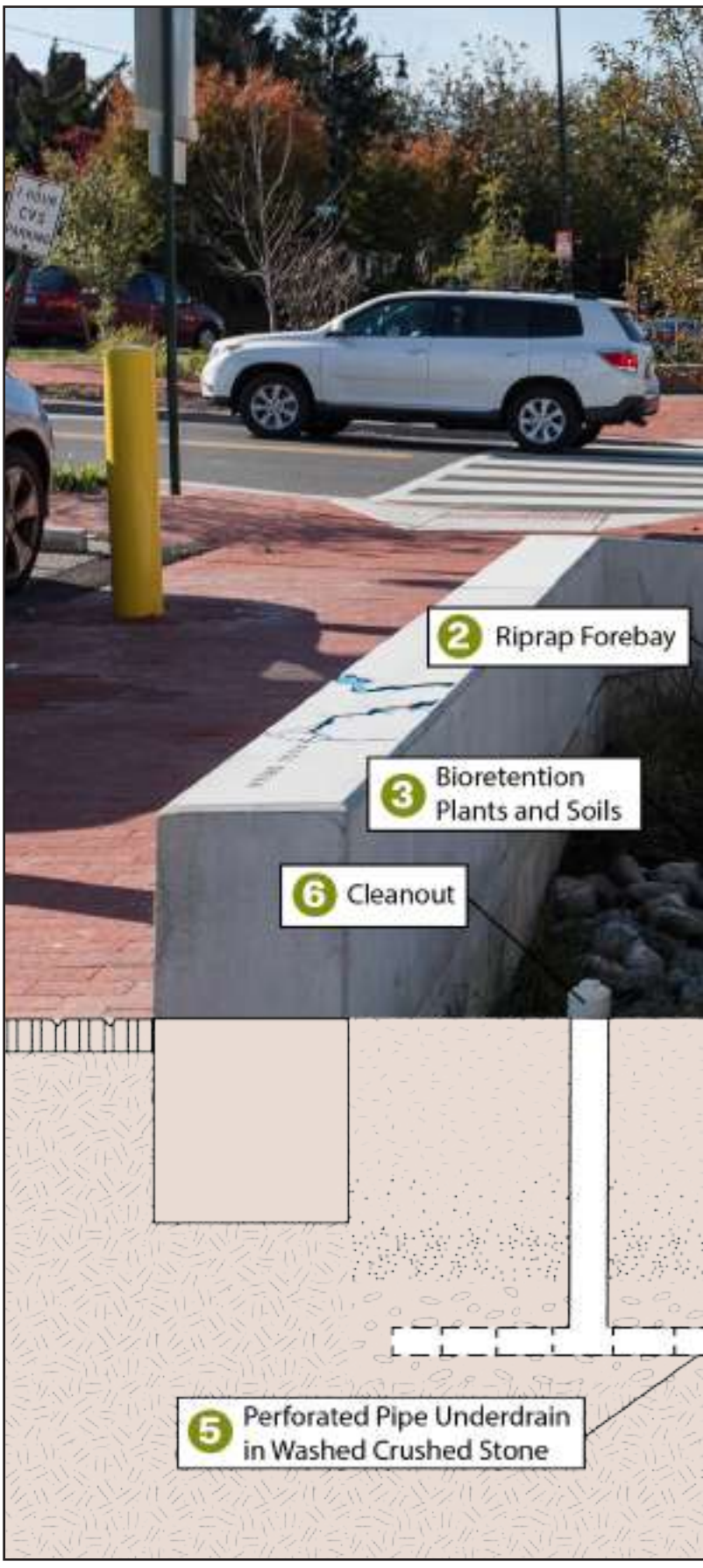
Bioretention Planters

Description

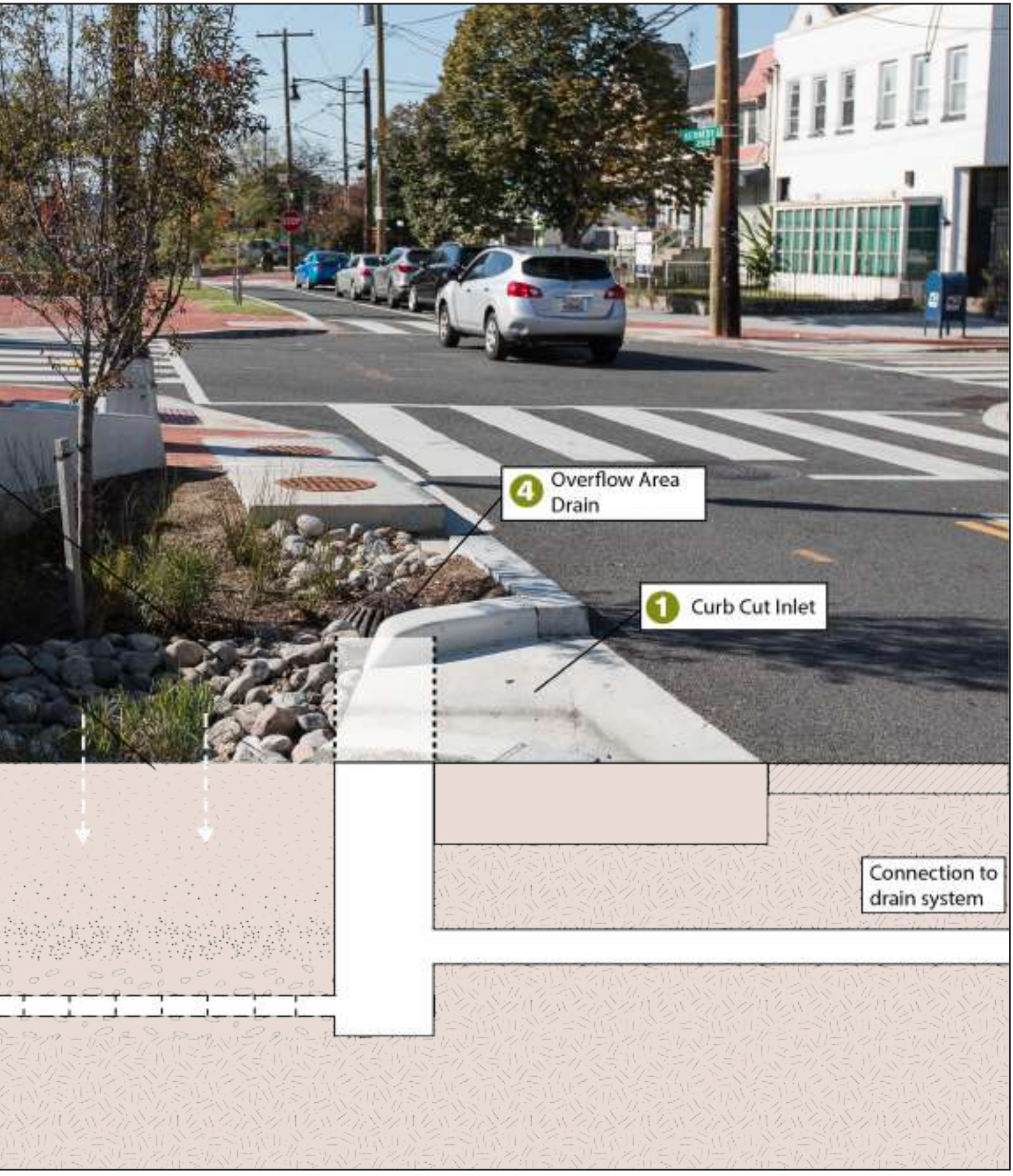
Bioretention planters are recessed bioretention or biofiltration systems typically contained within a planter or curbing within paved areas such as sidewalks or plazas. Stormwater runoff that drains across paved surfaces often enters through curb cuts.

Green Infrastructure Components to Maintain

#	Component	Reference Section
1	Inlet Structure	3.1; 3.2; 3.3
2	Pretreatment	3.1; 3.2; 3.3
3	Main Treatment	3.1; 3.3; 3.4; 3.5
4	Outlet/Emergency Overflow	3.3
5	Perforated Pipe Underdrain	3.3
6	Cleanout	3.3



Right: Bioretention on Kennedy Street, Washington, DC (Source: Nitsch Engineering)


4 Overflow Area Drain
1 Curb Cut Inlet
Connection to drain system

Bioretention Planters - Inspection Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection after major storm events during first 3 months of operation, then twice per year and when discharges are through outlet control structure thereafter

Reference	Item	Inspection Question	Observation
3.1 - General Procedures	1	Is there visual evidence of pollutants in the infiltration basin (e.g. oil sheen, odd discoloration, stains, odors, etc.)?	Y | N | N/A
	2	Are there signs of disturbance by humans or pets, such as compacted soils, displaced rocks, graffiti, tire tracks, or pet waste?	Y | N | N/A
3.2 - Pretreatment	3	Are adjacent area drains, other inlets, or control outlet structures clogged or functioning poorly?	Y | N | N/A
	4	Is the proprietary pretreatment unit clogged or full of debris?	Y | N | N/A
	5	Is there excessive sediment, silt, or trash accumulation on the sediment forebay?	Y | N | N/A
3.3 - Drainage Structures	6	Do inlets, underdrains, observation ports, outlets, or other structures contain blockages or accumulated sediment?	Y | N | N/A
	7	Is the underdrain or other piping blocked or clogged despite routine maintenance? Is water not exiting system without other explanation? (Use observation ports or observation wells to check for standing water.)	Y | N | N/A
	8	Are the inlet/outlet structure, other grates, or gates damaged, cracked, or deteriorating?	Y | N | N/A
	9	Does GI installation include signage? Is it damaged, missing, or faded?	Y | N | N/A
3.4 - Vegetation	10	Are tree seedlings, weeds, or other invasive plants present?	Y | N | N/A
	11	Does any plant material require fertilization according to design recommendations?	Y | N | N/A
	12	Is any woody vegetation in need of shaping, thinning, or removal of dead branches?	Y | N | N/A
	13	Do any plants show signs of damage, decay or dead vegetation?	Y | N | N/A
	14	Do any plants show signs of wilting or distress? (refer to design recommendations for watering, especially newly installed plant material)	Y | N | N/A
	15	Is there evidence of animal borrows or rodents present? Do any plants show signs of pests or disease?	Y | N | N/A
	16	Does plant material show negative effects of salts from adjacent paved surfaces? (Refer to any established Winter Vegetation Management procedures)	Y | N | N/A
3.5 - Softscape Surfaces	17	Is standing water present more than 48 hours after a rain event?	Y | N | N/A
	18	Are any of the following present: litter, debris, grass clippings, leaves, and accumulated sediment?	Y | N | N/A
	19	Are there signs of soil erosion or formation of rills and gullies?	Y | N | N/A
	20	Are there areas of exposed soil or bare earth?	Y | N | N/A
	21	Is there evidence of sinkholes or subsidence?	Y | N | N/A
	22	Is stormwater not infiltrating within 72 hours despite routine maintenance?	Y | N | N/A

Comments

Bioretention Planters - Maintenance Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection after major storm events during first 3 months of operation, then twice per year and when discharges are through outlet control structure thereafter

Reference	Item	Maintenance Action	Maintenance Completed ex. Y | N | N/A
3.1 - General Procedures	1	If signs of pollution are present, attempt to determine the cause and eliminate it. If a persistent or frequent pollution issue occurs, contact the Owner. This could be a sign that pollutants are routinely being introduced into the basin.	
	2	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	
3.2 - Pretreatment	3	Remove debris from catch basins, area drains, other inlets	
	4	Remove debris and clean filter of the device according to manufacturer instructions	
	5	Remove debris from forebay (aka sediment forebay)	
3.3 - Drainage Structures	6	Remove debris from underdrains, pipes, observations ports, cleanouts, and/or outlet control structures	
	7	Use specialized camera(s) to investigate inside a pipe without having to dig; clear pipes using a process of flushing or jetting a high-powered stream of water through pipes	
	8	Repair/replace grates, gates, covers, and/or bolts	
	9	Repair or replace broken, missing, or faded signage	
3.4 - Vegetation	10	Identify weeds, remove, and dispose; includes volunteer trees; see design recommendations and owner requirements for herbicide application	
	11	Apply fertilizer specific to plant material needs and manufacturer recommendations	
	12	Prune/cut plant material and remove clippings	
	13	Remove dead or damaged plant material and replant new	
	14	Water/irrigate newly planted vegetation, follow design recommendations, or specific plant needs/triggers	
	15	Apply insecticide or pesticide as directed by owner or contact professional for pest removal	
	16	Minimize use of salts around vegetation; do not store snow in bioretention areas	
3.5 - Softscape Surfaces	17	Observe and record amount of time standing water occurs in soils/soft surfaces; compare to design rate	
	18	Remove trash and debris and properly dispose	
	19	Fill eroded area with material according to design specifications or stabilize with erosion control measures	
	20	Add mulch to bare or thin areas or completely remove old and replace with new annually	
	21	Fill areas of settlement with clean topsoil; if settling occurs beneath structures, pack with a subbase	
	22	Loosen/till existing soil or remove and replace with new soil	

Comments/Follow Up

Bioretention Techniques

Maintenance Triggers

Common maintenance triggers for Bioretention Techniques include excess surface debris, unhealthy vegetation, compacted soils, and erosion.



Clear inlet of sediment and reset riprap stones in a down gradient sloping towards the bioretention technique. (Source: Nitsch Engineering)



Clear trash and debris. Replant and mulch if required. (Source: Nitsch Engineering)



Reseed to replace the seeds carried away by stormwater and place erosion control blankets to prevent further erosion until plantings have developed. (Source: Nitsch Engineering)



Water to maintain moisture with newly seeded areas. (Source: Nitsch Engineering)



Dig soils away from outlet/inlet pipe. Remove soils from GI to match design documents.
(Source: Nitsch Engineering)



Treat or remove diseased tree.



Vacuum out area drain to remove sediments and allow water to flow. (Source: Nitsch Engineering)



Replant, mulch, and decompact soils as needed.
(Source: Nitsch Engineering)


ONLY



4.3 Permeable Pavements

Inspection & Maintenance Considerations

Maintenance considerations for Permeable Pavements should include coordination with snow removal crews to plan an area for snow storage and provide a spring cleanup plan to pick up any accumulated debris and sediment from the snow piles. No winter sanding shall be conducted on porous pavement. Additionally, frequent cleaning and maintenance is critical to prevent clogging, and frequent vacuum sweeping along with jet washing is required to keep the surface clean.

Maintenance Frequency

Permeable pavements should typically be maintained monthly during the first 3 months of operation and every 3 to 6 months thereafter, though maintenance frequency will depend on the type of permeable pavement utilized. Regardless of permeable pavement type, it is recommended that additional maintenance occur following large storms and after the winter season.

Left: Permeable pavement at Peabody Square, Boston, MA
(Source: Nitsch Engineering)

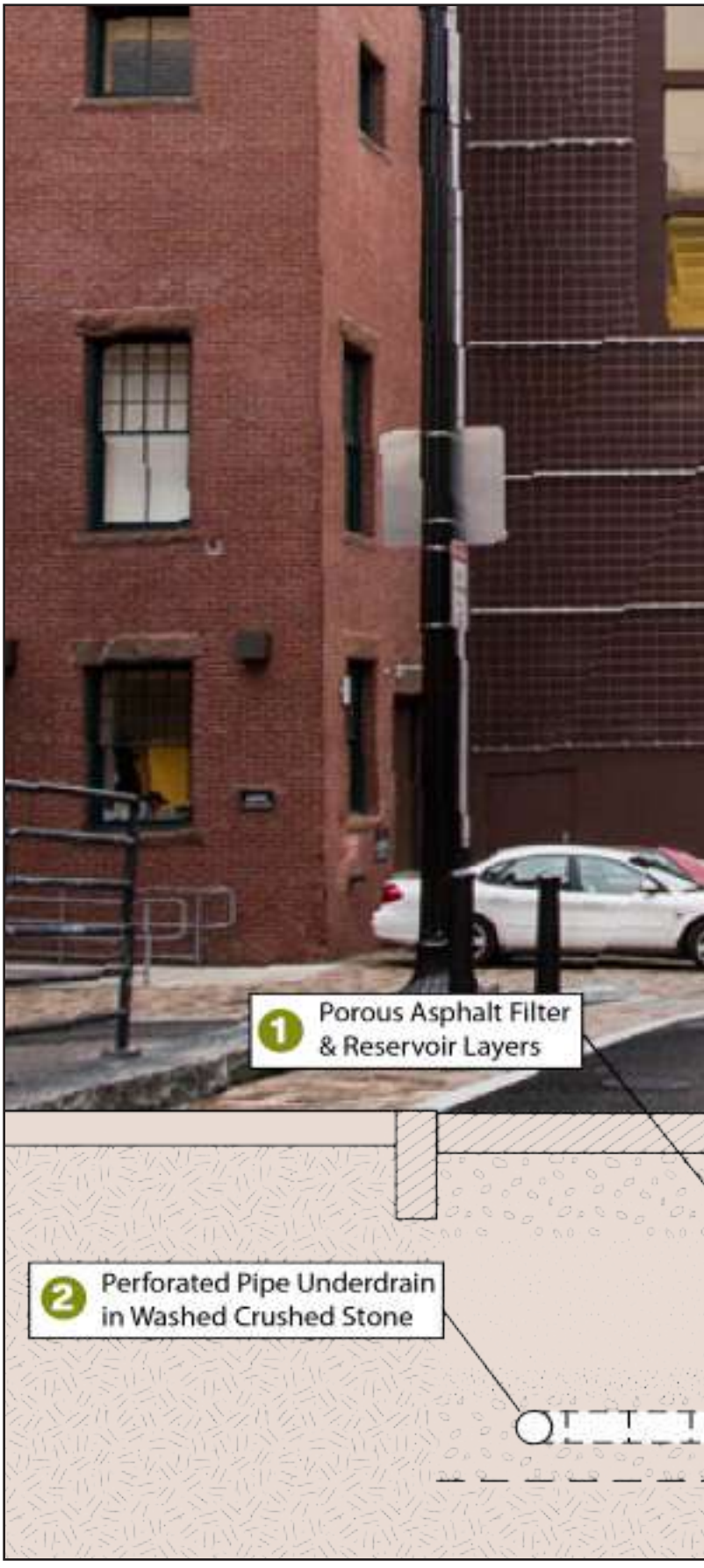
Porous Asphalt

Description

Porous Asphalt looks like traditional asphalt but is comprised of larger aggregate and fewer fine particles, creating voids in the pavement, allowing water to infiltrate. It includes several layers of material with specific sizes to absorb, filter, and infiltrate stormwater.

Green Infrastructure Components to Maintain

#	Component	Reference Section
1	Main Treatment	3.1; 3.3; 3.5; 3.6
2	Perforated Pipe Underdrain	3.3
3	Inspection Port/ Cleanout	3.3



Right: Boston Architectural College Green Alley, Boston, MA (Source: Nitsch Engineering)


3 Cleanout

Porous Asphalt - Inspection Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection after major storm events during first 3 months of operation, then twice per year and when discharges are through outlet control structure thereafter

Reference	Item	Inspection Question	Observation
3.1 - General Procedures	1	Is there visual evidence of pollutants in the infiltration basin (e.g. oil sheen, odd discoloration, stains, odors, etc.)?	Y | N | N/A
	2	Are there signs of disturbance by humans or pets, such as compacted soils, displaced rocks, graffiti, tire tracks, or pet waste?	Y | N | N/A
3.3 - Drainage Structures	3	Do inlets, underdrains, observation ports, outlets, or other structures contain blockages or accumulated sediment?	Y | N | N/A
	4	Are any grates, gates, covers or bolts on drainage structures in need of repair or replacement?	Y | N | N/A
	5	Does GI installation include signage? Is it damaged, missing, or faded?	Y | N | N/A
3.5 - Softscape Surfaces	6	Are any of the following present: litter, debris, grass clippings, leaves, and accumulated sediment?	Y | N | N/A
	7	Is there evidence of sinkholes or subsidence?	Y | N | N/A
3.6 - Permeable Pavements	8	Is large debris (trash, leaves) present on asphalt surface?	Y | N | N/A
	9	Is sand or excess sediment clogging pores of asphalt?	Y | N | N/A
	10	Is sand or excess sediment still present after power washing?	Y | N | N/A
	11	Is system not functioning properly despite routine maintenance?	Y | N | N/A
	12	Does surface show signs of deterioration, spalling, or other flaws?	Y | N | N/A
	13	Is there excess or accumulated salt from paved surfaces in spring? (Refer to any established Winter Vegetation Management procedures)	Y | N | N/A

Comments

Porous Asphalt - Maintenance Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly or after large storms (2.5 inches or more in 24 hours); MassDEP recommends inspection after major storm events during first 3 months of operation, then twice per year and when discharges are through outlet control structure thereafter

Reference	Item	Maintenance Action	Maintenance Completed ex. Y | N | N/A
3.1 - General Procedures	1	If signs of pollution are present, attempt to determine the cause and eliminate it. If a persistent or frequent pollution issue occurs, contact the Owner. This could be a sign that pollutants are routinely being introduced into the basin.	
	2	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	
3.3 - Drainage Structures	3	Remove debris from underdrains, pipes, observations ports, cleanouts, and outlet control structures	
	4	Repair/replace grates, gates, covers, bolts	
	5	Repair or replace broken, missing, or faded signage	
3.5 - Softscape Surfaces	6	Remove trash and debris and properly dispose	
	7	Fill areas of settlement with clean topsoil; if settling occurs beneath structures, pack with a subbase	
3.6 - Permeable Pavements	8	Remove large debris from surface before vacuuming	
	9	Power wash to dislodge trapped particles before vacuuming	
	10	Use power vacuum sweeper to clear pores	
	11	Test infiltrative capacity and compare to design rate	
	12	Repair or replace ares with chipped or cracked asphalt	
	13	Minimize use of salts, do not use sand, use rubber plow blade, do not store snow	

Comments/Follow Up

Permeable Pavers

Description

Permeable Pavers are made up of interlocking concrete modules or unit brick pavers. Space between the pavers creates open voids in the surface and allows water to drain into a base of crushed stone.

Green Infrastructure Components to Maintain

#	Component	Reference Section
1	Main Treatment	3.1; 3.3; 3.5; 3.6
2	Perforated Pipe Underdrain	3.3
3	Inspection Port/ Cleanout	3.3



Right: Permeable pavement at Peabody Square, Boston, MA (Source: Nitsch Engineering)


3 Cleanout

Permeable Pavers - Inspection Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: cleaned after the winter season and every three months thereafter

Reference	Item	Inspection Question	Observation
3.1 - General Procedures	1	Is there visual evidence of pollutants in the infiltration basin (e.g. oil sheen, odd discoloration, stains, odors, etc.)?	Y | N | N/A
	2	Are there signs of disturbance by humans or pets, such as compacted soils, displaced rocks, graffiti, tire tracks, or pet waste?	Y | N | N/A
3.3 - Drainage Structures	3	Do inlets, underdrains, observation ports, outlets, or other structures contain blockages or accumulated sediment?	Y | N | N/A
	4	Are any grates, gates, covers or bolts on drainage structures in need of repair or replacement?	Y | N | N/A
	5	Does GI installation include signage? Is it damaged, missing, or faded?	Y | N | N/A
3.5 - Softscape Surfaces	6	Are any of the following present: litter, debris, grass clippings, leaves, and accumulated sediment?	Y | N | N/A
	7	Is there evidence of sinkholes or subsidence?	Y | N | N/A
3.6 - Permeable Pavements	8	Is large debris (trash, leaves) present on asphalt surface?	Y | N | N/A
	9	Is sand or excess sediment clogging pores of asphalt?	Y | N | N/A
	10	Is sand or excess sediment still present after power washing?	Y | N | N/A
	11	Is system not functioning properly despite routine maintenance?	Y | N | N/A
	12	Does surface show signs of deterioration, spalling, or other flaws?	Y | N | N/A
	13	Is there excess or accumulated salt from paved surfaces in spring? (Refer to any established Winter Vegetation Management procedures)	Y | N | N/A

Comments

Permeable Pavers - Maintenance Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: cleaned after the winter season and every three months thereafter

Reference	Item	Maintenance Action	Maintenance Completed ex. Y | N | N/A
3.1 - General Procedures	1	If signs of pollution are present, attempt to determine the cause and eliminate it. If a persistent or frequent pollution issue occurs, contact the Owner. This could be a sign that pollutants are routinely being introduced into the basin.	
	2	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	
3.3 - Drainage Structures	3	Remove debris from underdrains, pipes, observations ports, cleanouts, outlet control structures	
	4	Repair/replace grates, gates, covers, bolts	
	5	Repair or replace broken, missing, or faded signage	
3.5 - Softscape Surfaces	6	Remove trash and debris and properly dispose	
	7	Fill areas of settlement with clean topsoil; if settling occurs beneath structures, pack with a subbase	
3.6 - Permeable Pavements	8	Remove large debris from surface before vacuuming	
	9	Power wash to dislodge trapped particles before vacuuming	
	10	Use power vacuum sweeper to clear pores; Replace joint material for permeable paver installations	
	11	Test infiltrative capacity and compare to design rate	
	12	Repair or replace areas with broken or missing pavers	
	13	Minimize use of salts, do not use sand, use rubber plow blade, do not store snow	

Comments/Follow Up

Permeable Pavements

Maintenance Triggers

Common maintenance triggers for Permeable Pavements include excess sand or sediment clogging pore spaces, broken or missing pavers, settling, and excess surface debris especially near trees or vegetation.



Debris, trash, and sediment blocking the voids of the porous concrete. Sweep large debris, then vacuum concrete.



Porous pavers are not properly infiltrating. Perform further investigations to determine the blockage.



Power wash and vacuum sediment from porous concrete.



Power wash and vacuum porous pavement to clear voids.



Remove and replace joint material between pavers.



Perform investigations to determine the cause of the sinking. Replace migrated soils, reset pavers, and joint material.



Report graffiti to the appropriate officials. Power wash from surface.



Remove weeds, vacuum joints, and replace joint material.



4.4 Rooftop Systems

Inspection & Maintenance Considerations

Rooftop storage solutions come in several different forms, including green roofs, blue roofs, and cisterns. In all cases, stormwater falling onto a roof, which would traditionally fall on an impermeable surface, is captured or slowed.

Maintenance Frequency

Maintenance frequency will vary depending on the form of rooftop storage system implemented. While green roofs require frequent active landscaping maintenance, blue roofs and cisterns require minimal maintenance. For all forms of rooftop storage systems, maintenance recommendations from manufacturers should always be followed.

Left: Green Roof at Harvard Business School, Boston, MA
(Source: Goody Clancy)

Green Roofs

Description

Green Roofs are planted rooftops that consist of plants and engineered soil media which intercept and store rainwater. Some rainwater is returned to the atmosphere by evapotranspiration while treated excess water is slowly released to a drainage system.

Green Infrastructure Components to Maintain

#	Component	Reference Section
1	Main Treatment	3.1; 3.3; 3.4; 3.5; 3.7
2	Outlet Structure	3.3
3	Impermeable Liner	3.7



Right: Worcester Polytechnic Institute (WPI) Green Roof, Worcester, MA (Source: Nitsch Engineering)


3 Impermeable Liner
2 Drain System to Convey Excess Rain

Green Roofs - Inspection Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly, follow maintenance recommendations from manufacturer for modular systems

Reference	Item	Inspection Question	Observation
3.1 - General Procedures	1	Is there visual evidence of pollutants in the infiltration basin (e.g. oil sheen, odd discoloration, stains, odors, etc.)?	Y | N | N/A
	2	Are there signs of disturbance by humans or pets, such as compacted soils, displaced rocks, graffiti, or pet waste?	Y | N | N/A
3.3 - Drainage Structures	3	Are the roof drains clogged?	Y | N | N/A
	4	Is the inlet or outlet structure or other grates or gates damaged, cracked, or deteriorating?	Y | N | N/A
	5	Does GI installation include signage? Is it damaged, missing, or faded?	Y | N | N/A
3.4 - Vegetation	6	Are tree seedlings, weeds, or other invasive plants present?	Y | N | N/A
	7	Does any plant material require fertilization according to design recommendations?	Y | N | N/A
	8	Does grass or groundcover contain bare spots or thin areas of grass growth?	Y | N | N/A
	9	Do any plants show signs of damage, decay or dead vegetation?	Y | N | N/A
	10	Do any plants show signs of wilting or distress? (refer to design recommendations for watering, especially newly installed plant material)	Y | N | N/A
	11	Is there evidence of animal borrows or rodents present? Do any plants show signs of pests or disease? Any signs of mosquitoes?	Y | N | N/A
3.5 - Softscape Surfaces	12	Is standing water present more than 48 hours after a rain event?	Y | N | N/A
	13	Are any of the following present: litter, debris, grass clippings, leaves, and accumulated sediment?	Y | N | N/A
	14	Are there signs of soil erosion?	Y | N | N/A
	15	Is stormwater not infiltrating within 72 hours despite routine maintenance?	Y | N | N/A
3.7 - Rooftop Storage	16	Are irrigation systems present?	Y | N | N/A
	17	Is there evidence of cracking, leaking, or other signs of deterioration of the waterproof membrane?	Y | N | N/A
	18	Is there evidence of emergency overflow failing or excess standing water outside green roof system?	Y | N | N/A
	19	Are established winter management procedures being followed?	Y | N | N/A
	20	Are systems draining too quickly during a rain event and exceeding the design drain down rate?	Y | N | N/A

Comments

Green Roofs - Maintenance Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: monthly, follow maintenance recommendations from manufacturer for modular systems

Reference	Item	Maintenance Action	Maintenance Completed ex. Y | N | N/A
3.1 - General Procedures	1	If signs of pollution are present, attempt to determine the cause and eliminate it. If a persistent or frequent pollution issue occurs, contact the Owner. This could be a sign that pollutants are routinely being introduced.	
	2	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	
3.3 - Drainage Structures	3	Remove debris or blockages from drain inlets and outlets	
	4	Repair/replace grates, gates, covers, and/or bolts	
	5	Repair or replace broken, missing, or faded signage	
3.4 - Vegetation	6	Identify weeds, remove, and dispose; may include volunteer trees; see design recommendations and owner requirements for herbicide application	
	7	Apply fertilizer specific to plant material needs and manufacturer recommendations.	
	8	Spread seed in bare spots based on designer recommendation and/or planting plan	
	9	Remove dead or damaged plant material and replant new	
	10	Water/irrigate newly planted vegetation, follow design recommendations, or specific plant needs/triggers	
	11	Apply insecticide or pesticide as directed by owner or contact professional for pest removal	
3.5 - Softscape Surfaces	12	Observe and record amount of time standing water occurs in soils/soft surfaces; compare to design rate	
	13	Remove trash and debris and properly dispose	
	14	Fill eroded area with material according to design specifications or stabilize with erosion control measures	
	15	Loosen/till existing soil or remove and replace with new soil	
3.7 - Rooftop Storage	16	Service irrigation systems according to manufacturer's recommendation	
	17	Refer to manufacturer's specifications for repair or replacement of waterproof membranes. Contact a qualified roofing company to perform an assessment of larger, extensive roof systems.	
	18	Check roof drains, overflow, scuppers, and gutters to ensure they are draining	
	19	Break up ice formation around outlets and overflows	
	20	Ensure that spigot and other plumbing parts are functioning properly and inspect for leaks; Repair or replace parts as necessary	

Comments/Follow Up

Blue Roofs - Inspection Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: Annual, follow maintenance recommendations from manufacturer for mechanical or treatment systems; blue roof should be designed to draw down within 48 hours in accordance with the International Building Codes and Massachusetts Building Codes

Reference	Item	Inspection Question	Observation
3.1 - General Procedures	1	Is there visual evidence of pollutants (e.g. oil sheen, odd discoloration, stains, odors, etc.)?	Y | N | N/A
	2	Are there signs of disturbance, such as graffiti, pet waste, or unwanted plant material?	Y | N | N/A
3.3 - Drainage Structures	3	Are the blue roof drains clogged?	Y | N | N/A
	4	Is the inlet or outlet structure or other grates or gates damaged, cracked, or deteriorating?	Y | N | N/A
	5	Does GI installation include signage? Is it damaged, missing, or faded?	Y | N | N/A
3.7 - Rooftop Storage	6	Is standing water present more than 48 hours after a rain event?	Y | N | N/A
	7	Is there litter, debris, and accumulated sediment within storage area, downspouts or gutter systems?	Y | N | N/A
	8	Are mosquitoes or evidence of mosquito larvae present?	Y | N | N/A
	9	Is there evidence of emergency overflow failing or excess standing water outside the blue roof system?	Y | N | N/A
	10	Are established winter management procedures being followed?	Y | N | N/A
	11	Are systems draining too quickly during a rain event and exceeding the design drain down rate?	Y | N | N/A

Comments

Blue Roofs - Maintenance Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: Annual, follow maintenance recommendations from manufacturer for mechanical or treatment systems; blue roof should be designed to draw down within 48 hours in accordance with the International Building Codes and Massachusetts Building Codes

Reference	Item	Maintenance Action	Maintenance Completed ex. Y | N | N/A
3.1 - General Procedures	1	If signs of pollution are present, attempt to determine the cause and eliminate it. If a persistent or frequent pollution issue occurs, contact the Owner. This could be a sign that pollutants are routinely being introduced.	
	2	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	
3.3 - Drainage Structures	3	Remove debris or blockages from drain inlets and outlets	
	4	Repair/replace grates, gates, covers, and/or bolts	
	5	Repair or replace broken, missing, or faded signage	
3.7 - Rooftop Storage	6	Observe and record amount of time standing water occurs and compare to design rate; Inspect outlets and storage areas for leaf litter, debris, and sediment accumulation	
	7	Remove debris and leaf litter and properly dispose	
	8	Ensure any lids are properly sealed; add larvicide to standing water to prevent mosquitoes from reaching adulthood	
	9	Check roof drains, overflow, scuppers, and gutters to ensure that they are draining	
	10	Break up ice formation around outlets and overflows	
	11	Ensure that spigot and other plumbing parts are functioning properly and inspect for leaks; Repair or replace parts as necessary	

Comments/Follow Up

Cisterns - Inspection Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: Seasonally, follow maintenance recommendations from manufacturer for mechanical or treatment systems

Reference	Item	Inspection Question	Observation
3.1 - General Procedures	1	Is there visual evidence of pollutants (e.g. oil sheen, odd discoloration, stains, odors, etc.)?	Y | N | N/A
	2	Are there signs of disturbance by humans or pets, such as graffiti or pet waste?	Y | N | N/A
3.3 - Drainage Structures	3	Is the downspout, roof connection, or outlet structure cracked or deteriorating?	Y | N | N/A
	4	Does GI installation include signage? Is it damaged, missing, or faded?	Y | N | N/A
3.7 - Rooftop Storage	5	Are mosquitoes or evidence of mosquito larvae present?	Y | N | N/A
	6	Is there evidence of an emergency overflow failing or excess standing water outside the system?	Y | N | N/A
	7	Are established winter management procedures being followed?	Y | N | N/A
	8	Are accessories, such as rain diverters, soaker hoses, linking kits, or gutters properly connected?	Y | N | N/A
	9	Are pumps and mechanical systems functioning properly?	Y | N | N/A
	10	Are spigot and other plumbing parts functioning properly?	Y | N | N/A
	11	Is cistern leaning or has the foundation shifted?	Y | N | N/A
	12	Is there dust, grime, or other residue on the outside of the cistern?	Y | N | N/A
	13	Is litter, debris, or accumulated sediment present within the cistern?	Y | N | N/A

Comments

Cisterns - Maintenance Checklist

Location: _____
Approx. Date of Installation: _____
Inspector: _____
Date/Time of Inspection: _____
Weather Conditions: _____
Days Since Last Rain Event: _____

Suggested Frequency: Seasonally, follow maintenance recommendations from manufacturer for mechanical or treatment systems

Reference	Item	Maintenance Action	Maintenance Completed ex. Y | N | N/A
3.1 - General Procedures	1	If signs of pollution are present, attempt to determine the cause and eliminate it. If a persistent or frequent pollution issue occurs, contact the Owner. This could be a sign that pollutants are routinely being introduced.	
	2	Coordinate with owner/operator; increase protection measures; add signage and/or pet waste stations	
3.3 - Drainage Structures	3	Repair or replace as necessary	
	4	Repair or replace broken, missing, or faded signage	
3.7 - Rooftop Storage	5	Ensure lid is properly sealed; add larvicide to standing water to prevent mosquitoes from reaching adulthood	
	6	Check roof drains, overflow, scuppers, and gutters to ensure that they are draining	
	7	In winter: Drain all remaining water prior to first freeze; disinfect and rinse using approved non-toxic disinfectant; remove remaining water and sediment using vacuum cleaning; keep overflow spigot valve open all winter to prevent water storage and allow for draining; In spring: Check for winter damage and close overflow spigot	
	8	Secure connections	
	9	Service mechanical systems according to manufacturer's recommendation	
	10	Repair or replace as necessary	
	11	Level and stabilize the foundation and cistern	
	12	Wipe outside of cistern	
	13	Remove litter, debris, and accumulated sediment by vacuum; flush out any debris in bottom of cistern with a hose	

Comments/Follow Up

Rooftop Systems

Maintenance Triggers

Common maintenance triggers for rooftop storage include vegetation management on green roofs, leaks or damage to piping or water collection systems, and improper seasonal care in preparation for freezing temperatures. Presence of mosquitoes and other pests should trigger proper maintenance and elimination of standing water for more than 72 hours.



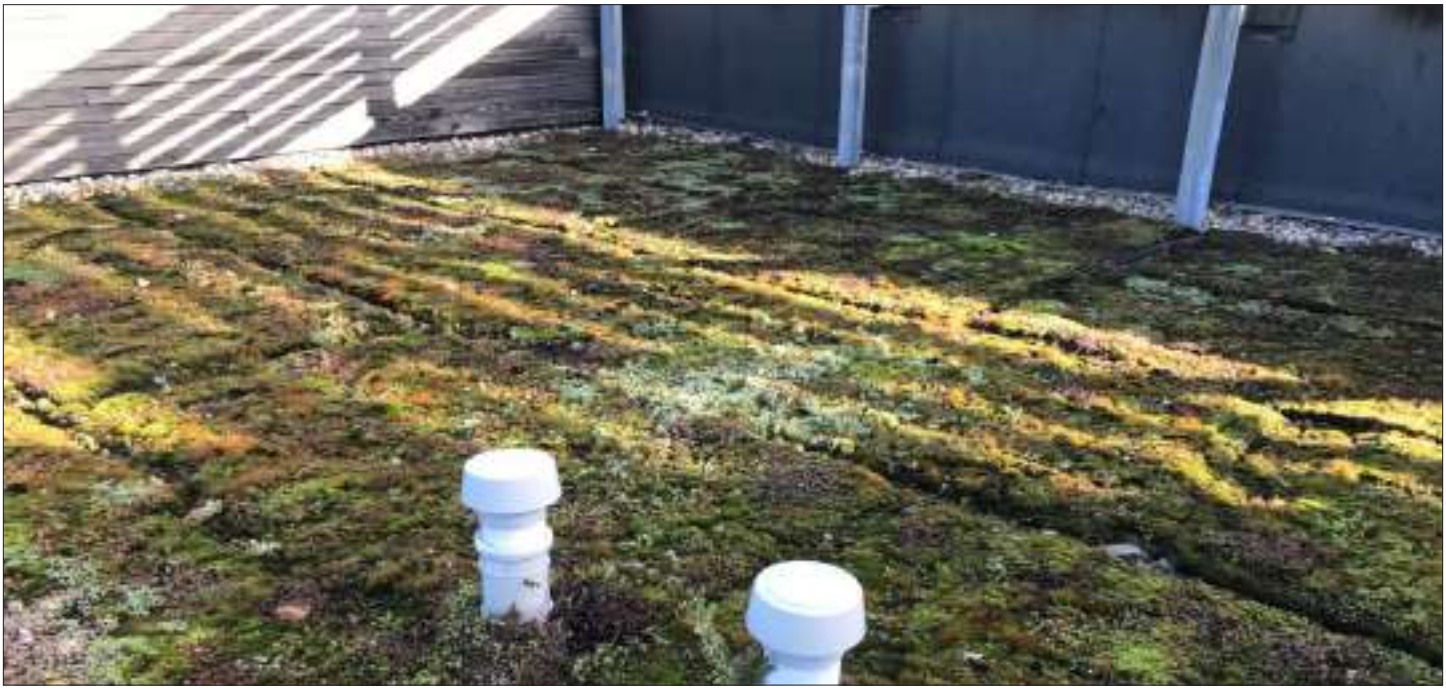
Break up ice around inlet
(Source: Nitsch Engineering)



Investigate possible water damage from green roof
(Source: True Services)



Drain and vacuum cistern to remove algae (Source: Colorado Stormwater Center)



Remove moss from green roof by hand weeding (Source: The Urban Greening Company)