



CITY OF **BOULDER**

Owner's Guide to Stormwater Control Measure (SCM) Maintenance

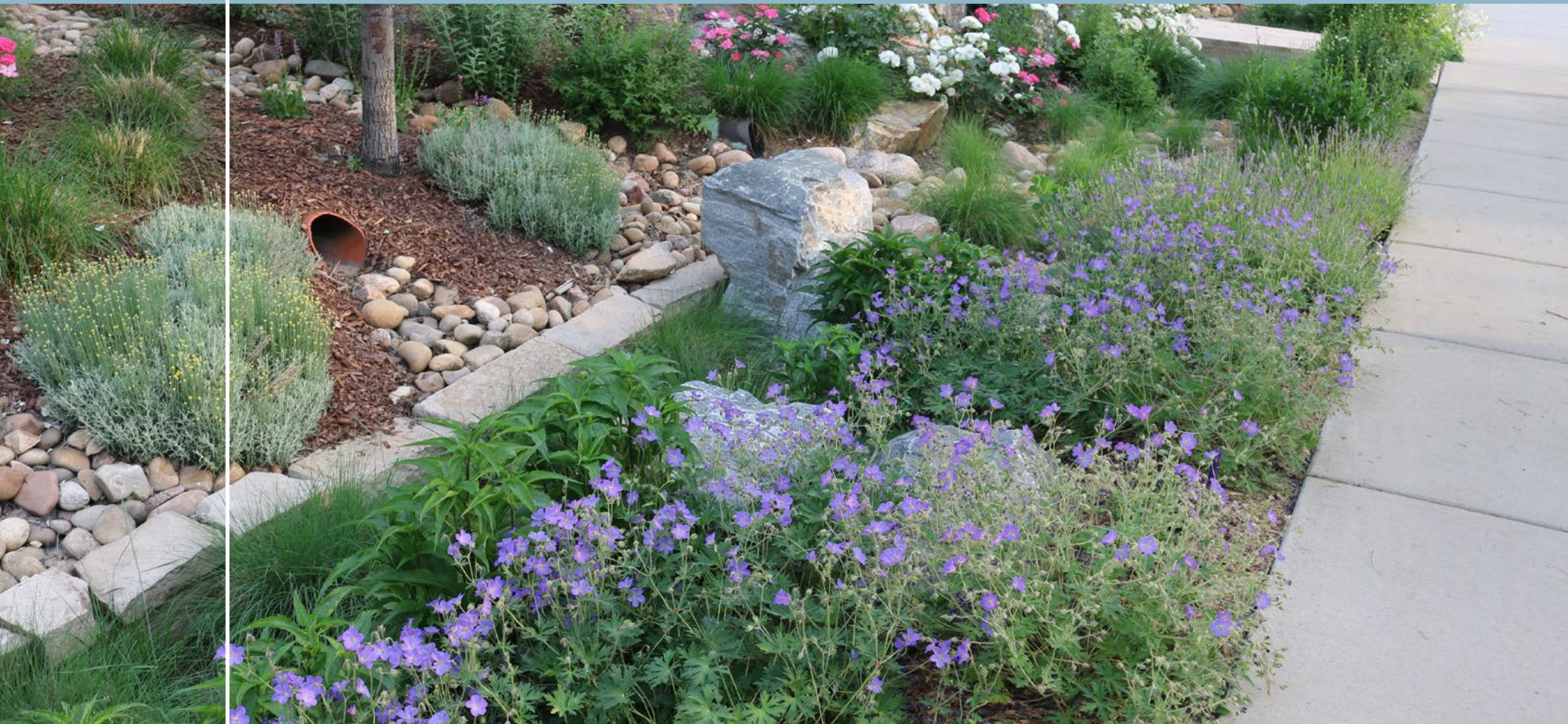




Table of Contents

Chapter 1 Introduction	5
Chapter 2 Extended Detention Basin (EDB)	17
Chapter 3 Bioretention / Raingarden	37
Chapter 4 Permeable Pavement	55
Chapter 5 Underground SCM	74
Chapter 6 Additional Resources	83



Chapter 1 Introduction

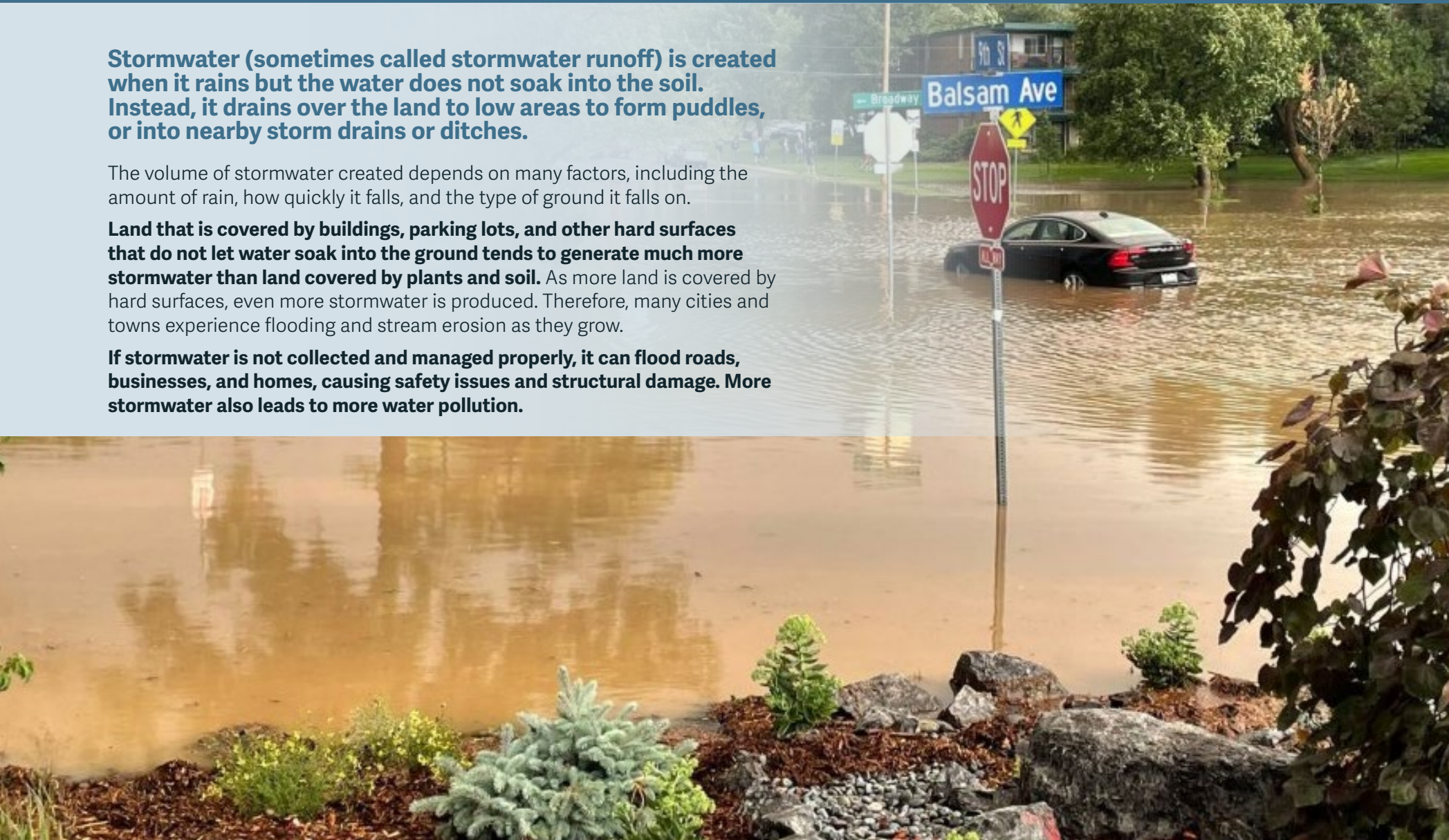
What is stormwater?

Stormwater (sometimes called stormwater runoff) is created when it rains but the water does not soak into the soil. Instead, it drains over the land to low areas to form puddles, or into nearby storm drains or ditches.

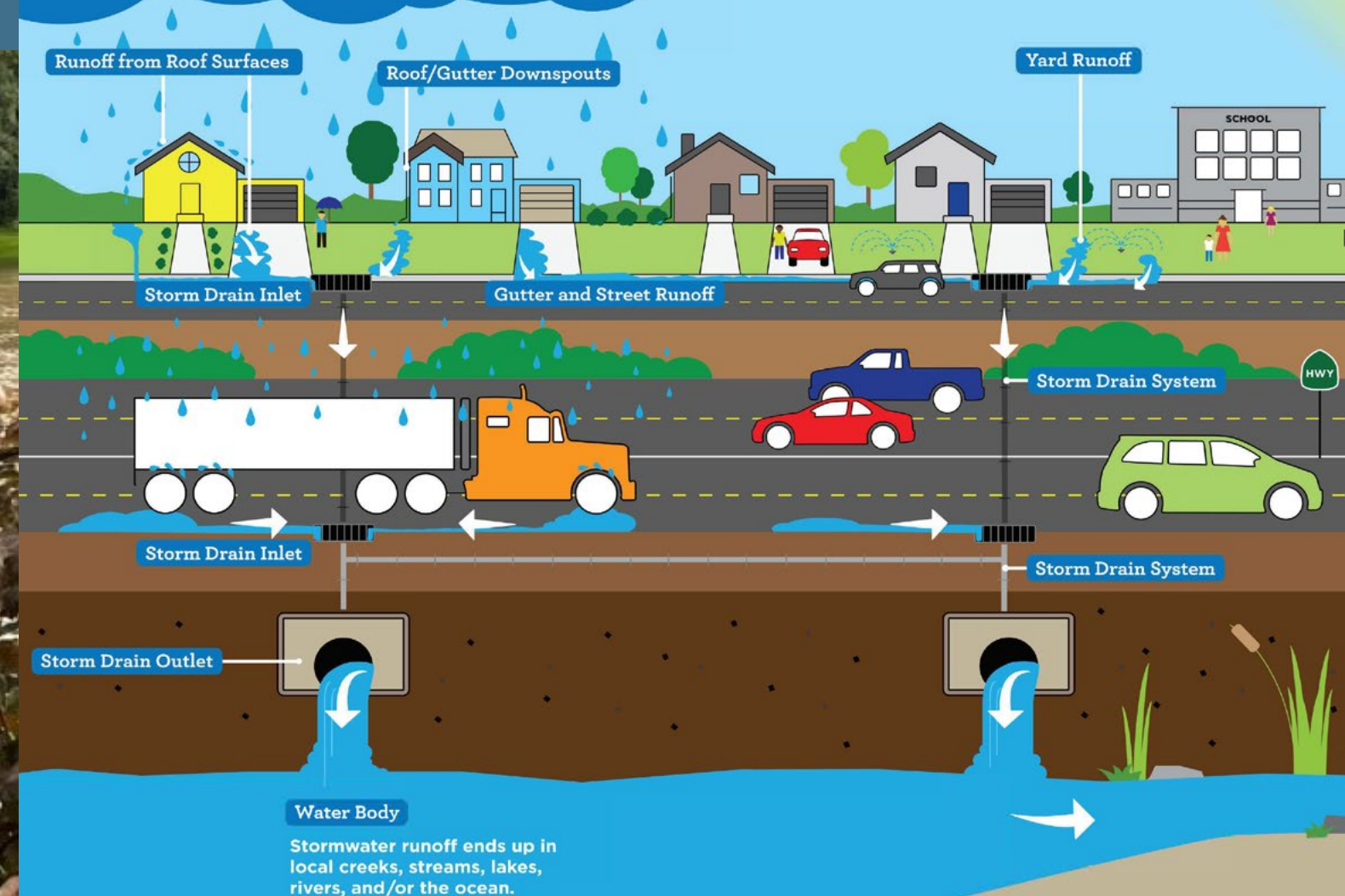
The volume of stormwater created depends on many factors, including the amount of rain, how quickly it falls, and the type of ground it falls on.

Land that is covered by buildings, parking lots, and other hard surfaces that do not let water soak into the ground tends to generate much more stormwater than land covered by plants and soil. As more land is covered by hard surfaces, even more stormwater is produced. Therefore, many cities and towns experience flooding and stream erosion as they grow.

If stormwater is not collected and managed properly, it can flood roads, businesses, and homes, causing safety issues and structural damage. More stormwater also leads to more water pollution.



Stormwater Runoff



More stormwater also leads to more water pollution. As stormwater runs off rooftops and travels over driveways, parking lots, yards, and roads, it washes away what is on the ground. This includes dirt (sediment), litter (trash), animal waste, pesticides, herbicides used on lawns and landscaping, oils and greases from cars and industries, dusts, and other substances. **Stormwater carries these pollutants wherever it flows.**

Unfortunately, stormwater does not flow to water treatment plants for cleaning. Instead, stormwater and the pollutants it carries flow along roadways and through ditches and pipes to our local streams, rivers, and lakes. **These natural waterways are critically important to the quality of life in our cities.** Not only do they receive our stormwater drainage, but they also supply our drinking water and support many recreational opportunities. **The City of Boulder continually combats stormwater issues, such as property flooding, stream erosion, and water pollution.**

We all have a part in helping keep our local waterways clean! The City of Boulder is committed to healthy streams through the Boulder Urban Stream Health (BUSH) Program. The goal of this program is to utilize funds and resources to enhance urban stream health and achieve optimal outcomes through studies, projects, education, and collaboration opportunities.

What are Stormwater Control Measures (SCMs)?

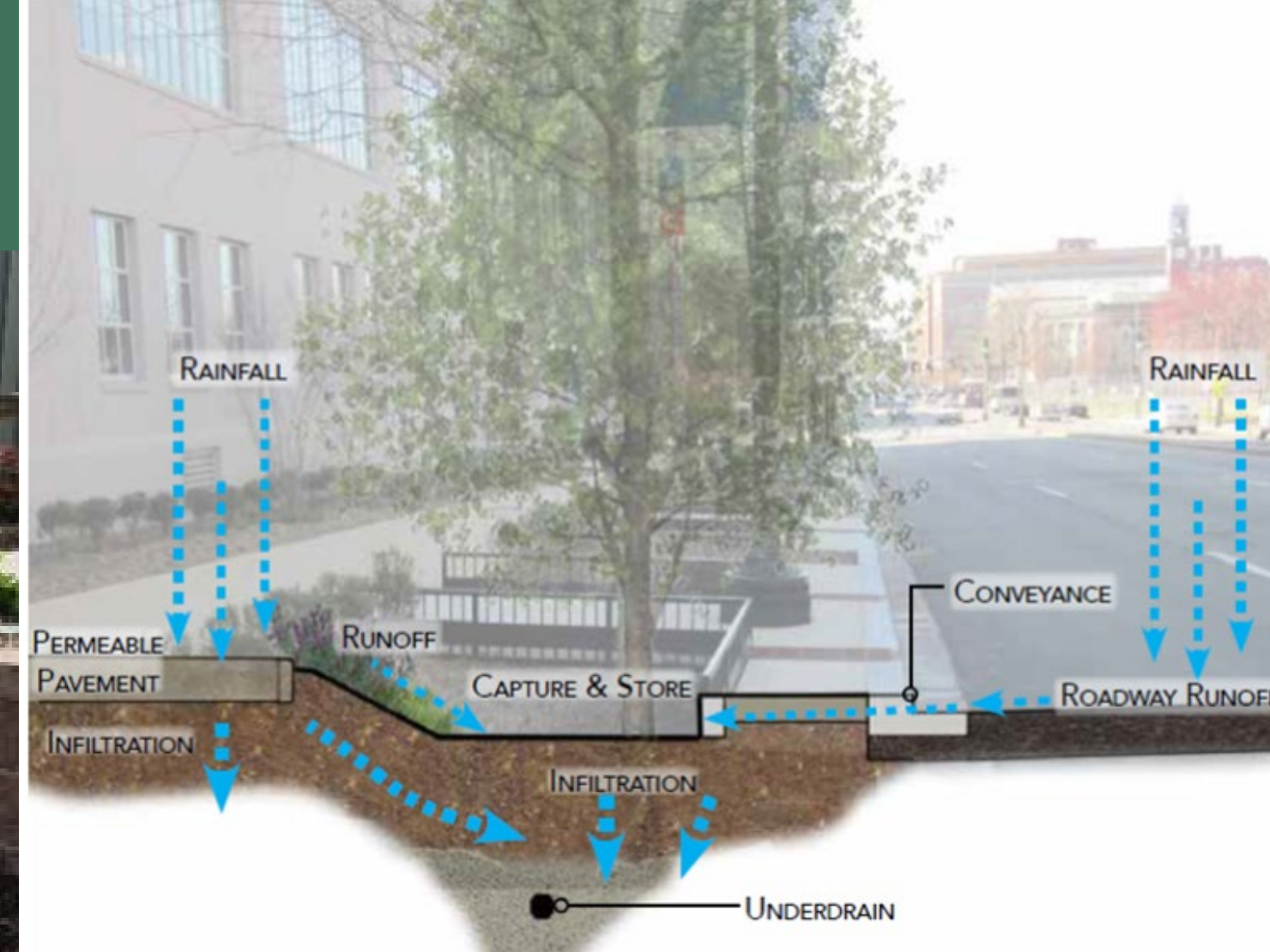
Stormwater Control Measures (usually just called SCMs) are devices that are designed and constructed for a developed property to manage its stormwater runoff. SCMs reduce flooding, erosion, and pollution problems caused when buildings and pavements replace natural landscapes.

There are many types of SCMs. For example, some SCMs are designed to **temporarily store (detain) stormwater** before it is released off the property. Most of the pollutants settle to the bottom of the SCM and are filtered out, allowing cleaner water to be released from the SCM.

Extended detention basin SCMs, can detain a large volume of stormwater. These SCMs protect nearby properties from flooding. After a storm, they release the stormwater slowly over several hours, rather than in a big rush.

Green infrastructure SCMs use loose soil and plants to mimic a natural landscape. They let stormwater soak into the ground rather than run off. This reduces the amount of stormwater and prevents pollutants from being washed into to local streams, rivers, and lakes.

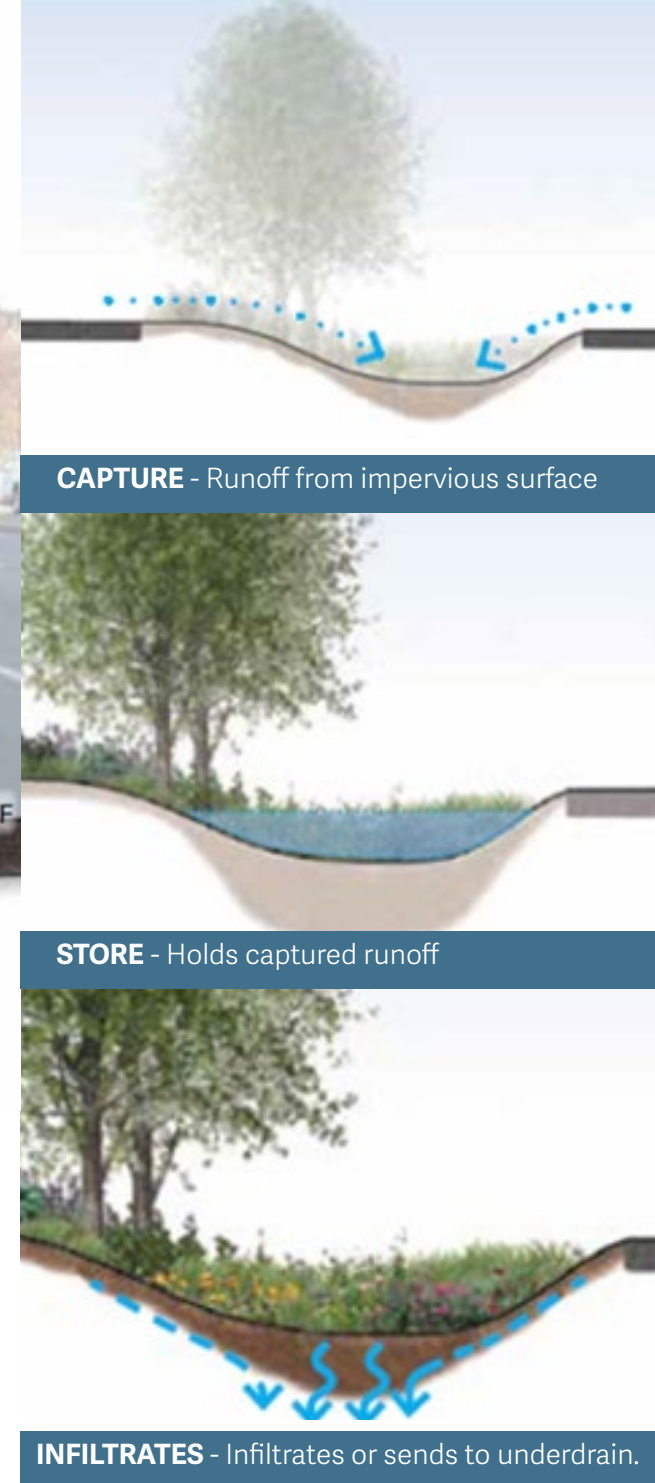
Many SCMs, like grass swales and buffers, look like typical lawns or garden areas.



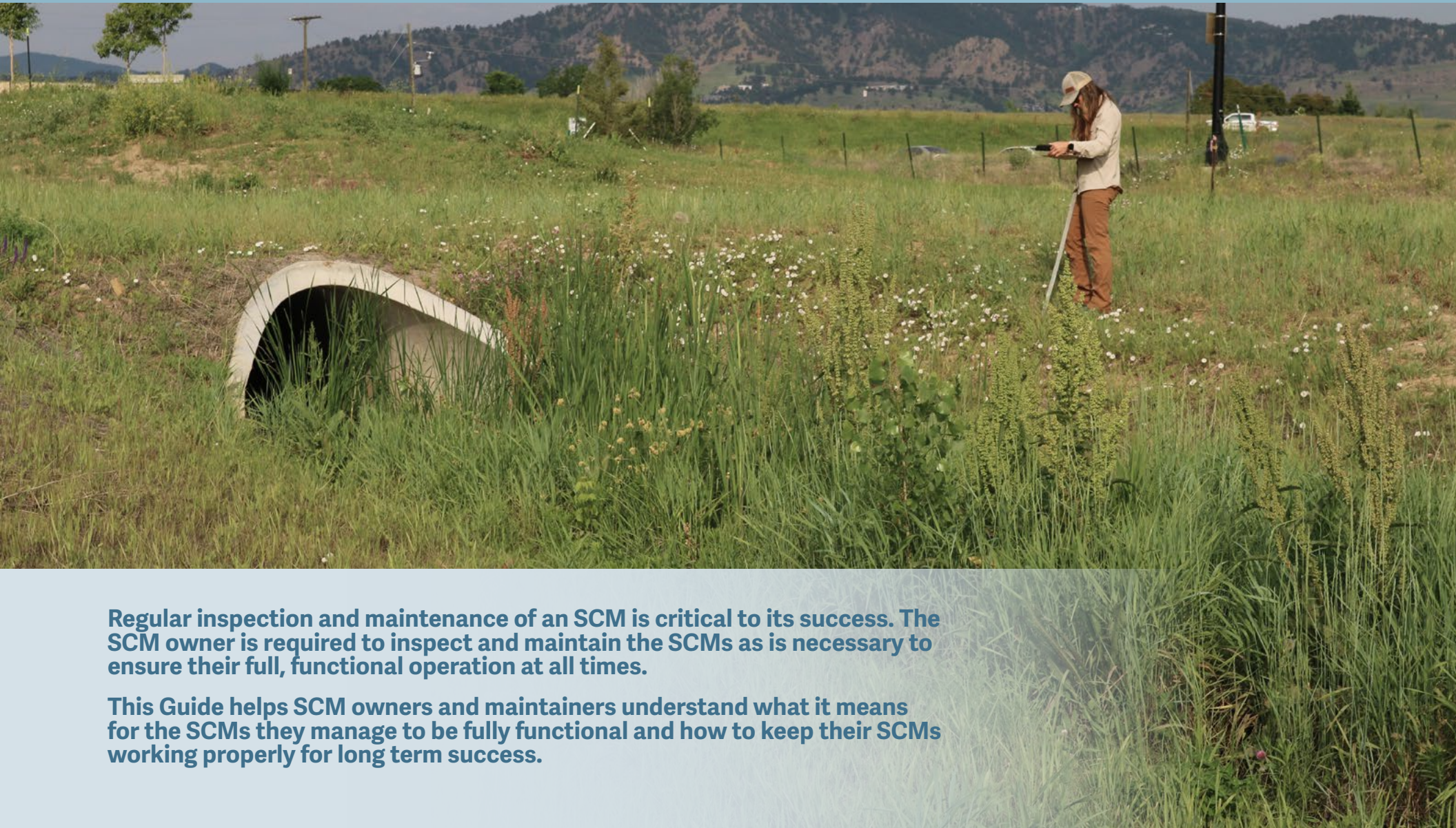
Like any piece of infrastructure, when SCMs are not maintained, they do not prevent stormwater problems when it rains.

In fact, an unmaintained SCM can make flooding, erosion, and pollution worse. There can be enormous costs to a community for the repair of properties, roadways, or waterways that are damaged or polluted because SCMs have been neglected. In addition, repairs to poorly maintained SCMs are costly.

Routine maintenance for SCMs is relatively inexpensive. In addition, properly maintained SCMs can function for many years needing only minor repairs.



What are an SCM Owner's responsibilities?



Regular inspection and maintenance of an SCM is critical to its success. The SCM owner is required to inspect and maintain the SCMs as is necessary to ensure their full, functional operation at all times.

This Guide helps SCM owners and maintainers understand what it means for the SCMs they manage to be fully functional and how to keep their SCMs working properly for long term success.

Although each SCM will have various inspection and maintenance activities, in general **all** SCMs require routine maintenance activities. Routine maintenance refers to the typical cleaning and light repair activities that are performed on a repetitive and frequent basis to sustain the ongoing proper operational performance of the SCM. It should be considered an ongoing activity that is done on a regular basis, ideally whenever general property and landscape maintenance occurs. The activities performed may vary depending on the type of SCM, the season (e.g., leaf removal from SCM inlets may be a frequent activity in the fall), and the land use and condition of the area draining to the SCM (e.g., a fast-food restaurant parking lot may require frequent trash removal).

Examples of **ROUTINE MAINTENANCE** include, but are not limited to:

1. Trash, debris, leaf litter, and minor sediment removal (sweeping, shoveling, vacuuming) within the SCM and in the area that drains to the SCM
2. Inlet and outlet cleaning
3. Mowing, pruning, or watering plants and replacing or refreshing mulch or rock/rip rap
4. Removal and replacement of dead or unhealthy plants
5. Irrigation audits to check for broken sprinkler heads and adjust watering throughout growing season to provide the proper irrigation rate and coverage
6. Erosion prevention and sediment control for bare soil or eroding surfaces in the SCM or in the area that drains to the SCM
7. Cleaning, repair, or replacement of SCM signs and other physical protection measures

- The SCM owner is responsible for routine maintenance and inspection of the SCM, and the City may request maintenance records at any time
- Detailed information pertaining to inspection and maintenance activities for each specific SCM can be found in the additional Chapters provided with this Guide.
- The SCM owner can use the SCM owner guidance information to help them fulfill maintenance responsibilities.



What happens if I don't maintain my SCM?

Utilities, Stormwater Quality staff inspect all SCMs in the city installed after March 10, 2008, at least once every 5-year permit term or when a complaint is received. The city aims to inspect each of these facilities on an annual basis. If deficiencies are found during these inspections, Stormwater Quality staff will contact you and provide the required maintenance activities. It is important to be responsive to the City staff during this time. If the SCM owner fails to inspect and maintain an SCM, the City may pursue enforcement action for the violation. Enforcement remedies include but are not limited to formal notices of violation, civil penalties, and criminal penalties as specified in BRC, Section 11.5.22.


Can I remove my SCM?

Generally, no, SCMs cannot be removed or relocated without prior approval from the City.


Remember, SCMs are critical to preventing flooding, erosion, and/or pollution not only on the properties where they are located, but on other properties, too. Changing the location of an SCM or removing it entirely may have negative impacts.

Can I change my SCM?

Property owners CAN modify the appearance of their SCM, provided it does not interfere with or change the function or operation of the SCM. Stated another way, the SCM must still function as it was designed to after a change is made.

 For example, the owner of a Bioretention SCM (which relies, in part, on plants to manage stormwater and prevent erosion) can remove and replace the plants in the SCM as long as the new planting scheme stays within the Bioretention SCM's Operating Standard provided in the Urban Storm Drainage Criteria Manual (USDCM). The USDCM requires the Bioretention SCM to be fully covered by plants, either dense grass or non-woody native plants. So, the owner cannot remove plants and replace them with other types of landscape materials such as mulch, wood chips, stone, etc. They must abide by the plant rules in the USDCM.

Outside of SCM appearance, property owners CANNOT make any changes to their SCM that will affect how it functions. Inadvertently changing the function of an SCM could result in flooding or erosion in or around the SCM, or on public or private properties located nearby.

 Please see the Design & Construction Standards on the City of Boulder's website.



- ✓ Property owners that remove, relocate, or improperly change an SCM without city approval will likely be required to rebuild the SCM at their own cost. This may require costly and detailed engineering analysis of the replaced or relocated SCM. They may also be responsible for correcting the damage to other properties that occurred because of SCM removal or relocation.
- ✓ Property owners are strongly encouraged to contact Stormwater Quality staff (StormwaterQuality@bouldercolorado.gov) if they have questions regarding changing, relocating, or removing an SCM before they take any such actions.



How do I find a contractor to maintain and repair my SCM?

It is important to find reliable contractors who can provide routine maintenance for your SCM to keep them functioning properly. Like all infrastructure, even well-maintained SCMs will age and require repairs and rehabilitative maintenance. You may refer to the Keep it Clean Partnership’s list of [Contractors for Stormwater Control Measure Inspection and Maintenance](#) for maintenance contractors in Boulder County.

Extended Detention Basins and Bioretention/Rain Gardens

For routine maintenance in extended detention basins and bioretention/rain gardens, landscapers will mow grasses, remove weeds, and maintain any trees or shrubs that are part of the SCM design. Search for a landscaper who has familiarity with SCMs and drainage features. You can reference this guide to understand what types of activities you will need a landscape maintenance company or staff member to perform. Even well-maintained extended detention basins and bioretention/rain gardens may have problems that require repairs or rehabilitative maintenance (see more on pages 35 and 53). Solicit the services of a licensed contractor, professional engineer, landscape architect, or soil scientist that has qualifications in the type of repair needed. If you don’t have maintenance access on your property and will need to work in the public right of way, please refer to pages 72-73 for a more detailed maintenance logistics checklist for completing this work.

Permeable Pavement and Underground SCMs

Due to their design, permeable pavement systems and underground SCMs require contractors with special equipment and expertise to provide even routine maintenance. For the convenience of property owners, the City of Boulder maintains lists of contractors who are understood to have experience in maintaining Permeable Pavement and Underground SCMs. Contact the City of Boulder Stormwater Quality staff at StormwaterQuality@bouldercolorado.gov to request more information. Property owners can also use the [Interlocking Concrete Pavement Institute \(ICPI\)](#) to search for contractors who have experience with permeable pavement. Depending on the location of your SCM and maintenance access, your maintenance contractor may need a variety of clearances and/or permits from the City of Boulder to perform the work. Refer to pages 72-73 for more information and a detailed maintenance logistics checklist for completing this work.

How do I protect my SCM?

SCM Owners are encouraged to take steps to protect their SCMs from damage and not allow the SCM to be used for activities or uses that could cause damage to the SCM or introduce pollutants to the water it manages. Activities and uses that were not considered during the design of the SCM can damage an SCM and then require a costly repair. Some of these activities and uses include:

- 1. Storage of vehicles, equipment, materials, pesticides, herbicides, fertilizers, or wastes
- 2. Storage of vehicles or equipment under repair (e.g. auto repair shop) or in disrepair (e.g. a junk yard)
- 3. Dog parks, kennels, and livestock corrals (even on a limited/temporary basis)



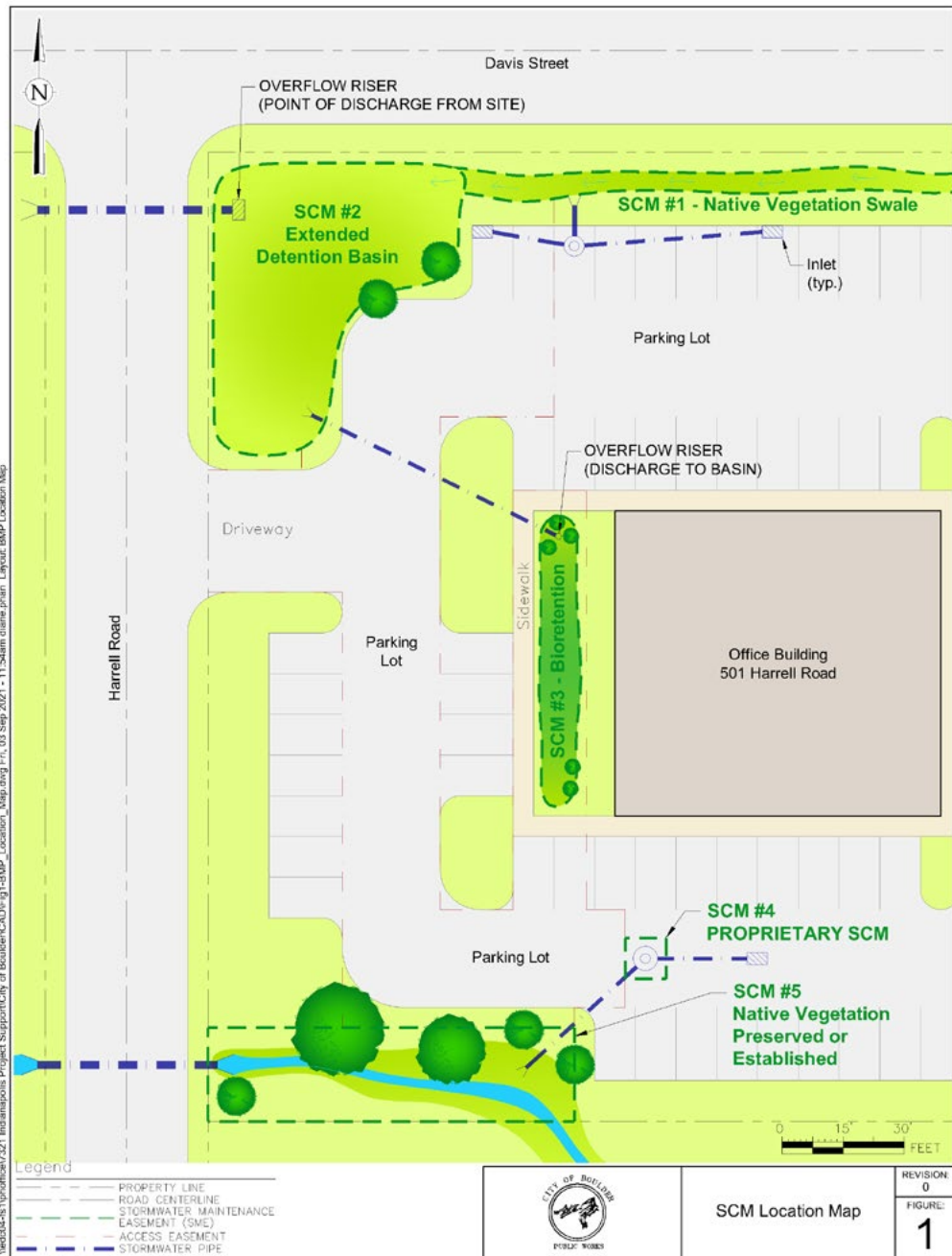
Example of signage being used as a protection measure

How do I locate my SCM?

Not every SCM is easily seen and identified, especially for people who don’t work in the land development field. In fact, many property owners are not aware they have an SCM. Or, they may be aware they have a “stormwater pond” but don’t really know what it does and that they are responsible for it. Many SCMs like grassed swales and buffers look like typical lawn and garden areas. Some first find out they have an SCM on their property at the time of property purchase (at closing) or when the City advises them of their responsibilities to the SCMs they own. Unless a property owner is present at the time a property is developed and the SCM is constructed, it’s possible they are not aware they have an SCM until the City advises them.

The City requires that every SCM designed after 2019 have an SCM Inspection and Maintenance Guide. The Inspection and Maintenance Guide provides the following key pieces of information to help you find and care for your SCM:

- 1. SCM Location Map
 - 2. Inspection Requirements
 - 3. Routine Maintenance Requirements
- ✓ When an Inspection and Maintenance Guide has not been created, SCM locations can be located by referring to the property’s drainage report/civil site plan.
 - ✓ For SCMs designed prior to 2019 contact the City of Boulder Stormwater Quality staff at StormwaterQuality@bouldercolorado.gov.
 - ✓ All SCMs should be located in a public easement.



Above is a SCM Location Map. The SCM Location Map provides clear boundary lines around the SCM (shown in green dashed above). A property can have more than one type of SCM on it, as demonstrated by the above SCM Location Map.



Chapter 2 Extended Detention Basin (EDB)

Extended Detention Basin SCMs

Extended detention basin Stormwater Control Measures (SCMs) are constructed to manage stormwater quality and quantity. They remove pollutants from stormwater by storing it in a basin for a short amount of time. The basin lets the sediment (dirt) settle out of the water before it is released. Plants in a detention basin SCM remove pollutants through their roots and leaves. This SCM is also good for flood control. During a storm, it will temporarily store water for water quantity and quality control. Extended detention basins will store water for up to 40 hours.

Benefits of Extended Detention Basin SCMs

- ✓ Cleans pollutants from stormwater
- ✓ Reduces erosion downstream
- ✓ Maintenance requirements are straightforward
- ✓ Creates an interesting landscape
- ✓ Can help reduce flooding

Prohibitive Uses for Extended Detention Basin SCMs

- ✗ Storage (even if temporary) or dumping of any equipment, vehicles, materials, stockpiles, or wastes
- ✗ Recreational areas, picnic areas, walking areas, swimming, fishing, or gathering spaces (unless the basin was designed and constructed for these uses)
- ✗ Vehicle or equipment storage, parking, or traffic
- ✗ Pet kennels, relief, or play areas, livestock grazing or raising, or any other animal uses
- ✗ Home or commercial gardening, including applying herbicides/pesticides/fertilizers not suitable for use in or around waterways.

How do I know if my extended detention basin SCM is functioning properly?



The first thing to understand is how your SCM is designed and how it is meant to properly function. Proper SCM function, which is the description of what the SCM is designed to do and how it works, can be monitored by maintaining the SCM Inspection Items and making sure the SCM is achieving the SCM Operation Standards. **The SCM Operation Standards for the SCM can be found on page 26.** In general, if the SCM doesn't drain in **40-hours**, it may be clogged and require maintenance.

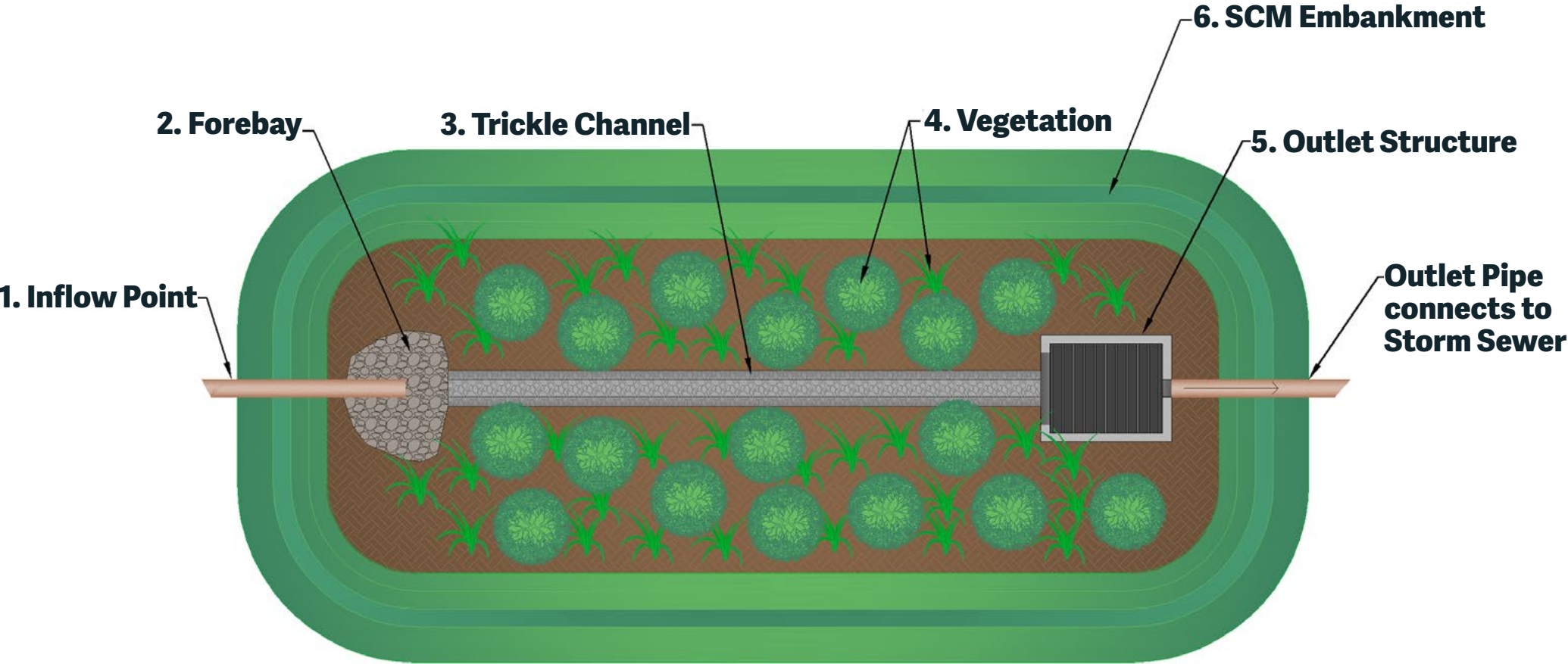


The SCM Inspection Items are the key parts of the SCM that support its proper function. The items must be checked, inspected, and maintained on a routine basis. The extended detention basin Inspection Items are shown in the graphic below.

SCM Inspection Items

EDB SCM Inspection Items

1. The **inflow point** lets the stormwater flow into the SCM. This typically enters from an inlet pipe.
2. The **forebay** area slows stormwater down before it enters the SCM (e.g., engineered soil), which helps to prevent channeling and erosion as stormwater rushes in. This is sometimes made of riprap rock and sometimes a concreted area.
3. The **trickle channel** conveys stormwater from the forebay and evenly distributes it throughout the basin. The trickle channel may be constructed of concrete, riprap, or have a soft natural look.
4. **Vegetation** is planted to help treat stormwater runoff through evapotranspiration, which is when water is absorbed into the leaves of the plants and sent back into the atmosphere. The roots of the plants can filter polluted stormwater and help hold the soils in the SCM in place.



EDB SCM Inspection Items

5. The **outlet structure** is connected to the outlet pipe and lets water exit the detention basin. Most outlets have an orifice plate and a trash rack/well screen on the front of the structure. The orifice plate contains small holes that allow the water to enter the outlet structure at a controlled rate to slow the flow of water through the outlet and allow for more water to soak into the SCM bottom. This will help control the rate at which water exits in the SCM. This allows for sediments, trash and other debris to settle out into the detention basin and helps keep them out of the streams.
6. An **SCM embankment** is a bank of earth that is intended to help prevent stormwater overflow in the detention basin to other parts of the property.

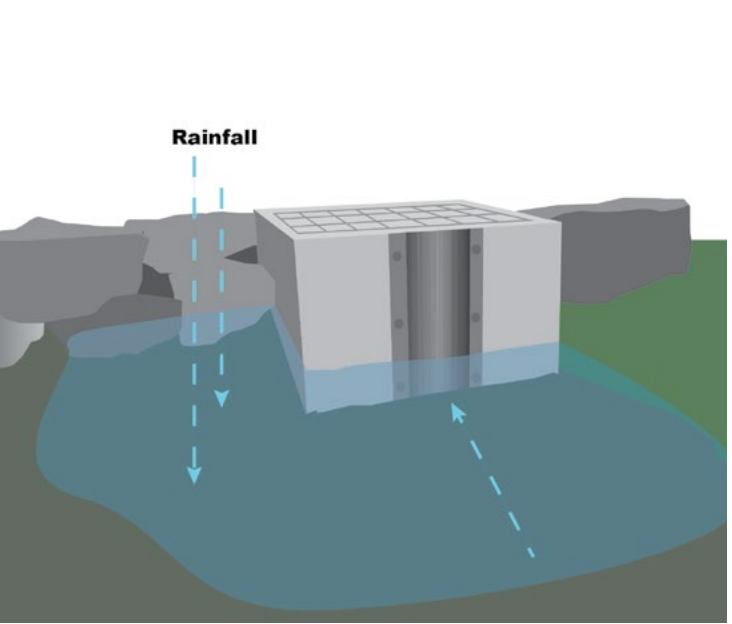
This is an example illustration of an extended detention basin SCM. Layout can vary between SCMs.

Keeping a close eye on the key parts of an extended detention basin is very important to make sure it is working properly. Frequent, informal inspections performed during landscaping activities and after strong storms and snows will help you catch and repair minor issues before they become major problems. Major problems can result in costly repairs, property damage, stream pollution, and legal issues with property owners affected by failure of your extended detention basin.

Outlet Control Structure Basics



Behind the Well Screen is the Water Quality Plate, which allows stormwater to be released at a specified rate. The above picture provides an example of what the Water Quality Plate looks like.



Routine Maintenance Activities



5. Embankment: check for structural damage and repair if necessary

4. Outlet Structure: check for erosion or bare soil and fix if necessary, remove any debris or trash.





3. Vegetation: ensure vegetation is thriving and area is mowed to appropriate height, remove woody and/or invasive plants, make sure area is draining within 48 hours.

2. Trickle Channel: remove any sediment, debris, or trash.

1. Inflow Point: remove any debris and trash, check area for damage, erosion, or bare soil

The SCM Operating Standards are the minimum benchmarks that describe a properly functioning extended detention basin SCM. They are written as non-technical descriptions, so specialized or technical knowledge of SCM design and construction is not needed to evaluate SCM function.

Extended Detention Basin SCM Operating Standards

<p>Operating Standard 1: Healthy Plants</p> 	<p>In general, SCM plants must be healthy and well-maintained. Vegetated areas* should not be overgrown or excessively weedy.</p> <p>*May include trees, shrubs, or grasses as indicated on the Stormwater Construction Plans and Drawings.</p>	<p>Operating Standard 2: Dry in 2 Days</p> 	<p>In general, most extended detention basins should fully drain 2 days after a storm. The SCM may have standing water for longer periods after frequent or long storms (no more than 2 days). Regardless, repeated instances of standing water after this two-day time limit can indicate a clog or other problem.</p>
<p>Operating Standard 3: Good Protection</p> 	<p>SCMs must be protected from damage. Pedestrians, vehicles, heavy equipment, and animals can damage SCMs not designed for such intrusions. See Section 1 for the prohibited uses and activities of SCMs.</p>	<p>Operating Standard 4: Keep It Clean</p> 	<p>The SCM itself and the area draining to the SCM needs to be kept clean. This reduces the chance of pollutants entering the SCM and impeding its function or being passed through to Boulder’s waterways. There should not be excessive sediment, litter, debris, or stored pollutants in the SCM or in the area draining to it.</p>





Below are examples of the different Operating Standards in good standing vs. poor standing, plus guidance on how to fix any issues.

Healthy Plants



Dry in Two Days

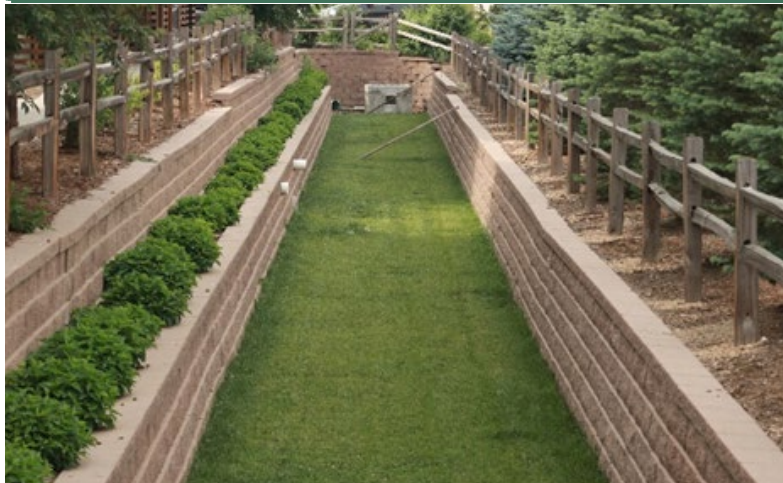


Good Standing	Poor Standing
	
<p><i>Vegetation is healthy, free of weeds, and not overgrown.</i></p>	<p><i>Plants are overgrown and could be blocking the outlet structure from draining properly.</i></p>
	
<p><i>The basin is draining properly after a storm, and there is no standing water.</i></p>	<p><i>The basin has standing water several days after a storm. This could indicate a clogged outlet or impacted inlet. Wetland plants and algae growth can also indicate there is a clogged outlet.</i></p>

Good Protection



Good Standing



This basin has fencing installed around the entire SCM. This will help reduce the chance for intrusion and damage to the SCM.

Poor Standing



This basin does not have any fencing or signage to could protect the SCM from intrusion or damage.

Keep It Clean



The inlet and forebay are clear to allow water to flow freely into the extended detention basin.



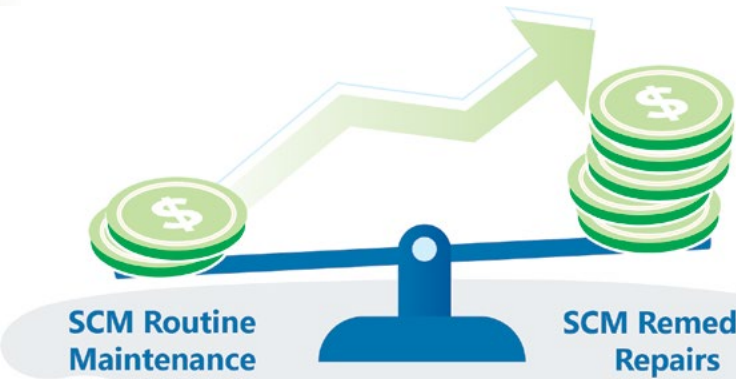
The outlet of this extended detention basin has debris that needs to be removed so that water can exit the SCM as needed.

How do I keep my extended detention basin functioning?

Routine maintenance refers to the typical cleaning and light repair activities that are performed on a repetitive and frequent basis to sustain the ongoing proper operational performance of the SCM. Routine maintenance should be considered an activity that is done on a regular basis, ideally whenever general property and landscape maintenance occurs. This can be done by the property owner, a tenant, a landscape company, or other person generally knowledgeable in landscape and property maintenance. Most maintenance needs are easy to see if the SCM is inspected and maintained regularly.





The following items will be described on the next pages:

1. Visual inspection
2. Debris and litter removal
3. Aeration
4. Mowing and plant care
5. Irrigation scheduling and maintenance
6. Sediment removal



Without routine maintenance, cost of remedial repairs could be much higher in the long run

1 Visual Inspection

Frequency: Twice annually, following precipitation		
What to do?		
Check the SCM Operation Standards:		
Healthy Plants		Plants should be healthy and thriving. Remove and replace dead or dying plants with appropriate vegetation.
Drain in 40 Hours		Water should drain over 40 hours. If there is standing water after 2 days (48 hours), check what is causing the clogging issue.
Good Protection		Check for foot or vehicle traffic and place signs or fences to prevent intrusion.
Keep It Clean		Remove any litter or debris in the basin, specifically checking the forebay and inlet and outlet structures. Check for erosion and repair as necessary.



2 Debris and Litter Removal

Frequency: As needed, checked monthly	
What to do?	
✓	Remove debris and litter as required to minimize clogging of the outlet. Some SCMs, like the one shown in the picture, may require more in-depth maintenance, like removing/replacing screws to clean the outlet plate



3 Aeration

Frequency: Annually, when the ground is not frozen	
What to do?	
✓	Aerate basins with manicured grass to improve infiltration and reduce soil compaction
✓	Aeration holes should be punched at least 2 inches deep and no more than 4 inches apart, focusing on heavy traffic areas
✓	Mark sprinkler heads and irrigation lines to prevent damage to the irrigation system
✓	Avoid aerating during extremely hot and dry conditions



4 Mowing and Plant Care

Frequency: As needed to maintain appropriate height and control weeds, seasonally dependent

What to do?

- ✓ When starting from seeds, only mow when required to deter weeds during the first three years
- ✓ Native and drought tolerant grasses should be mowed just enough to maintain a length of 6 inches or higher (taller grasses means deeper roots and greater drought tolerance)
- ✓ Monitor for invasive weed growth and complete weed mitigation as needed. This may include both manual and chemical treatments on weeds



5 Irrigation Scheduling and Maintenance

Frequency: As needed, checked monthly.

What to do?

- ✓ Adjust irrigation frequency according to season; native plants may need more water in peak summer months, but generally shouldn't need to be watered often, especially after they are established
- ✓ Due to climate variations, irrigation is important to keep plants thriving during drought conditions
- ✓ Check for broken sprinkler heads
- ✓ Drain irrigation system completely before the first winter freeze each year to avoid damage that could be caused by freezing water lines



6 Sediment Removal (Forebay, Trickle Channel, and Micropool)

Frequency:

Forebay/Trickle Channel - Annually; or after each storm event if undeveloped or near an area under construction

Micropool – Annually; or after each storm event if undeveloped or near an area under construction

What to do?

- ✓ Forebay/Trickle Channel
 - ✓ Remove any sediment
- ✓ Micropool
 - ✓ remove sediment when the depth of the pool has been reduced to about 18 inches
 - ✓ small micropools can be vacuumed
 - ✓ large micropools may need to be pumped to remove sediment from the bottom





Rehabilitative Maintenance

Problems with your extended detention basin SCM or the need for a repair more significant than routine maintenance can occur, even in well-maintained extended detention basin SCMs. In any case, problems must be corrected as soon as possible to prevent damage to the SCM, your property, and the properties around yours. Significant repairs may require the services of a licensed contractor, professional engineer, landscape architect, or soil scientist. Because it may be costly, creating a long-term fund for large maintenance items is highly recommended.

Erosion and Structural Repair

These repairs are usually necessary after a heavy storm or large snowmelt, or because of an unexpected disturbance.

- ✓ Repair all structural components required for the basin to operate as intended
- ✓ Revegetation may be required after removing sediment from the bottom of the basin
- ✓ Repair and vegetate eroded areas as needed

Sediment Removal from Basin Bottom

This type of maintenance is dependent on how old the SCM is, how often it is used, and whether construction is taking place in the area.

- ✓ Remove sediment when sediment accumulation results in observed flow blockages or areas of ponding between the SCM inlet and outlet
- ✓ Required frequency may be every 15-25 years, or more frequently where construction activities are occurring





Chapter 3 Bioretention / Raingarden

Bioretention (rain garden) SCMs

Bioretentions and rain gardens are Stormwater Control Measures (SCMs) that filter pollution from stormwater. Bioretention areas are built as shallow, sunken areas that catch stormwater from surrounding property. Deep-rooted plantings allow stormwater to sink into the soil, help filter out pollutants and create natural habitats for wildlife and beneficial insects.

A common bioretention area will easily handle rainfall from small storms and should drain completely in 12-24 hours after a storm. Bioretention is a great SCM to be used in median strips, parking lot islands, and landscaped swales.

Benefits of Bioretention SCMs

- ✓ Removes pollutants from stormwater
- ✓ Reduces erosion in nearby streams
- ✓ Decreases flooding
- ✓ Provides habitat for butterflies and birds
- ✓ Creates an interesting and functioning landscape
- ✓ Creates aesthetically pleasing landscape

Prohibitive Uses for Bioretention SCMs

- ✗ Storage (even if temporary) or dumping of any equipment, vehicles, materials, stockpiles, or wastes
- ✗ Recreational areas, picnic areas, walking areas, swimming, fishing, or gathering spaces (unless the bioretention area is designed and constructed for such use)
- ✗ Vehicle or equipment storage, parking, or traffic
- ✗ Pet kennels, relief, or play areas, livestock grazing or raising, or any other animal uses
- ✗ Home or commercial gardening, including applying herbicides/pesticides/fertilizers not suitable for use in or around waterways.

How do I know if my bioretention SCM is functioning properly?

The first thing to understand is how your SCM is designed and how it is meant to properly function. Proper SCM function, which is the description of what the SCM is designed to do and how it works, can be monitored by maintaining the SCM Inspection Items and making sure the SCM is achieving the SCM Operation Standards. **The SCM Operation Standards can be found on page 44.** In general, if the SCM doesn't drain in **24-hours**, it may be clogged and require maintenance.



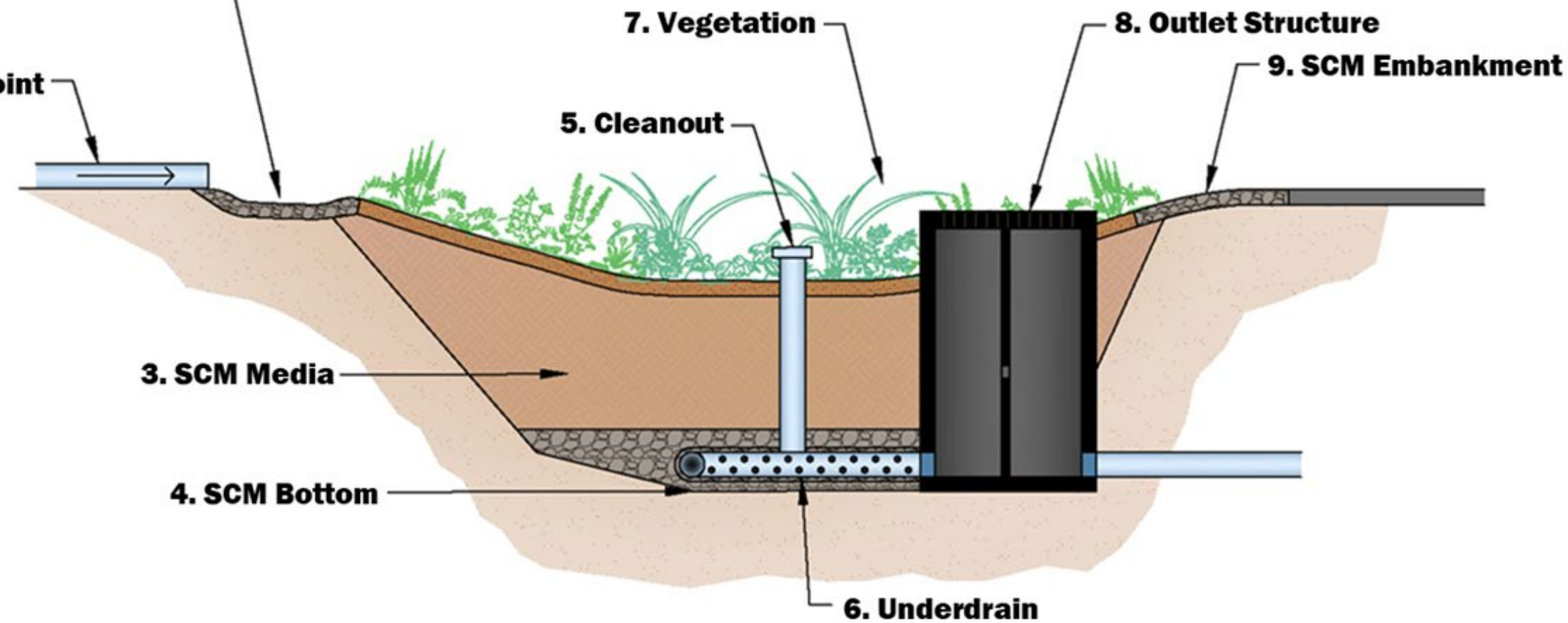
SCM Inspection Items

Bioretention SCM Inspection Items

1. The **inflow point** lets the stormwater flow into the bioretention area
2. The **forebay/energy dissipation** area slows stormwater down before it enters the bioretention SCM media, which helps to prevent scouring and erosion as stormwater rushes in.
3. **SCM media** is typically 18" thick and acts as the main treatment area where stormwater is collected and allowed to soak into the media (e.g., engineered soil).
4. **SCM bottom** is typically constructed 2 ft below ground surface and is where the stone/underdrain are placed.
5. The **cleanout** is used to access the underdrain, which may need to be periodically cleaned out if it becomes clogged with sediment or debris.
6. The **underdrain** discharges water that isn't absorbed by the bioretention SCM media into the stormwater system at a controlled rate.

2. Forebay/Energy Dissipation

1. Inflow Point



This is an example illustration of a bioretention SCM. Layout can vary between facilities.

Keeping a close eye on the key parts of any SCM is very important to make sure it is working properly. Frequent, informal inspections performed during landscaping activities and after strong storms and snows will help you catch and repair minor issues before they become major problems. Major problems can result in costly repairs, property damage, stream pollution, and legal issues with property owners affected by failure of your SCM.

Bioretention SCM Inspection Items

7. **Vegetation** is planted to help treat stormwater runoff through evapotranspiration, which is when water is absorbed into the leaves of the plants and sent back into the atmosphere. The roots of the plants also filter the polluted stormwater runoff before it makes its way to the underdrain. Vegetation also helps to keep the soil porous so it can continue to infiltrate.
8. The **outlet structure and pipe** lets water exit the bioretention SCM and is connected to the stormwater system.
9. An **SCM embankment** is a bank of earth or vertical wall that is intended to help prevent stormwater from overflowing in the bioretention area to other parts of the property.

Routine Maintenance Activities



Parking Area:

Check area for debris and trash.

Inlet:

remove sediment, trash, debris, and leaf litter

Outlet:

remove sediment, trash, debris, and leaf litter

Energy Dissipation:

Check for sediment and debris

Inflow Point:





Check area for sediment, debris and trash

Planting Bed:

Pruning and water plants, remove and replace dead/dying plants, remove invasive weeds, smooth media, and refresh mulch

The **Bioretention SCM Operating Standards** are the minimum benchmarks that describe a properly functioning bioretention SCM. **Operating Standards** will vary by SCM type. They are written as non-technical descriptions, so specialized or technical knowledge of **bioretention design and construction** is not needed to evaluate the SCM's function.

Bioretention SCM Operating Standards

<p>Operating Standard 1: Healthy Plants</p> 	<p>This standard describes the required plant coverage and types of plants for the bioretention SCM. In general, plants* must be healthy and well-maintained. Vegetated areas should not be overgrown or excessively weedy.</p> <p>*May include trees, shrubs, or grasses as indicated in the Stormwater Construction Plans and Drawings.</p>	<p>Operating Standard 2: Dry in 12-24 Hours</p> 	<p>In general, most bioretention SCMs should fully drain in 12 to 24 hours after a storm. The SCM may have standing water for longer periods after frequent or long storms. Regardless, repeated instances of standing water after this one-day time limit can indicate a clog or other problem.</p>
<p>Operating Standard 3: Good Protection</p> 	<p>Bioretention SCMs must be protected from damage. Pedestrians, vehicles, heavy equipment, and animals can damage SCMs not designed for such intrusions. See Chapter 1 for the prohibited uses and activities of SCMs.</p>	<p>Operating Standard 4: Keep It Clean</p> 	<p>The bioretention SCM itself and the area draining to the SCM needs to be kept clean. This reduces the chance of pollutants entering the SCM and impeding its function or being passed through to Boulder's waterways. There should not be excessive sediment, litter, debris, or stored pollutants in the SCM or in the area draining to it.</p>

Below are examples of the different **Operating Standards** in good standing vs. poor standing, plus guidance on how to **fix any issues**.

Healthy Plants



Dry in One Day



Good Standing



Plants are healthy and thriving. Planted area is free of weeds and overgrowth.



Bioretention area fully drains one day after the most recent rainfall event.

Poor Standing



Plants are overgrown and there is potential for invasive species in this area. Overgrowth, invasives, and weeds need to be removed.



The SCM media isn't draining properly. Check the outlet structure for blockage.

Good Protection



Keep It Clean



Good Standing



Bioretention area is protected by stone barriers to help indicate that the area should not be trafficked.



The inlet of this bioretention area is clean and free of debris, allowing runoff to enter the main treatment area.

Poor Standing



While there are no signs of vehicle or pedestrian traffic, adding informational signs about the bioretention area could help protect the SCM from intrusion and damage.



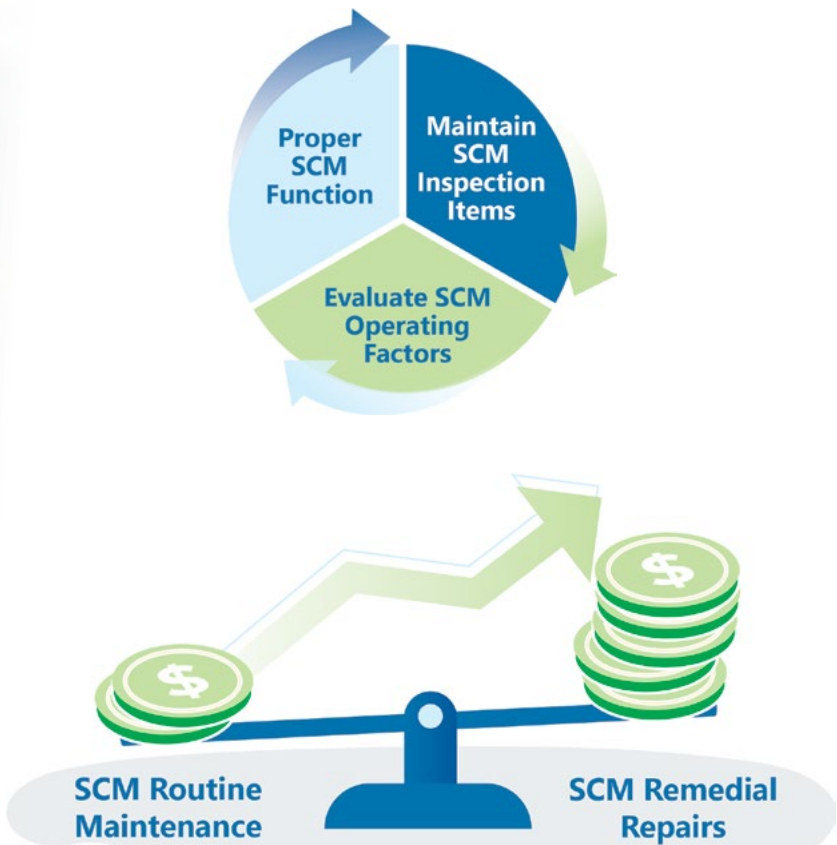
The inlet has sediment buildup, which could prevent the SCM from draining properly. The sediment should be removed with a shovel and disposed of.

How do I keep my bioretention functioning?

Routine maintenance refers to the typical cleaning and light repair activities that are performed on a repetitive and frequent basis to sustain the ongoing proper operational performance of the SCM. Routine maintenance should be considered an activity that is done on a regular basis, ideally whenever general property and landscape maintenance occurs. This can be done by the property owner, a tenant, a landscape company, or other person generally knowledgeable in landscape and property maintenance. Most maintenance needs are easy to see if the SCM is inspected and maintained regularly.

The following items will be described on the next pages:

- 1. Visual inspection
- 2. Debris and litter removal
- 3. Irrigation scheduling and maintenance
- 4. Replacement of wood mulch
- 5. Plant care and mowing







Without routine maintenance, cost of remedial repairs could be much higher in the long run

1 Visual Inspection

Frequency: Twice annually, following precipitation

What to do?

Check the SCM Operation Standards:

Healthy Plants		Plants should be healthy and thriving. Remove and replace dead or dying plants with appropriate vegetation.
Drain in 12-24 Hours		Water should drain in 12 hours. If there is standing water after 24 hours, check what is causing the clogging issue.
Good Protection		Check for foot or vehicle traffic and place signs or fences to prevent intrusion.
Keep It Clean		Remove any litter or debris in the bioretention area, specifically checking the SCM media and inlet and outlet structures. Check for erosion and repair as necessary.



2 Debris and Litter Removal

Frequency: As needed, checked monthly

What to do?

- ✓ Remove any debris or litter to prevent media from clogging
- ✓ Remove any debris or litter from the overflow structure
- ✓ Inspect area surrounding Bioretention and remove any debris or litter



3 Irrigation Scheduling and Maintenance

Frequency: As needed, checked monthly

What to do?

- ✓ Adjust irrigation frequency according to season; native plants may need more water in peak summer months, but generally shouldn't need to be watered often, especially after they are established
- ✓ Due to climate variations, irrigation is important to keep plants thriving during drought conditions
- ✓ Check for broken sprinkler heads
- ✓ Drain irrigation system completely before the first winter freeze each year to avoid damage that could be caused by freezing water lines



4 Replacement of Wood Mulch

Frequency: As needed, checked annually

What to do?

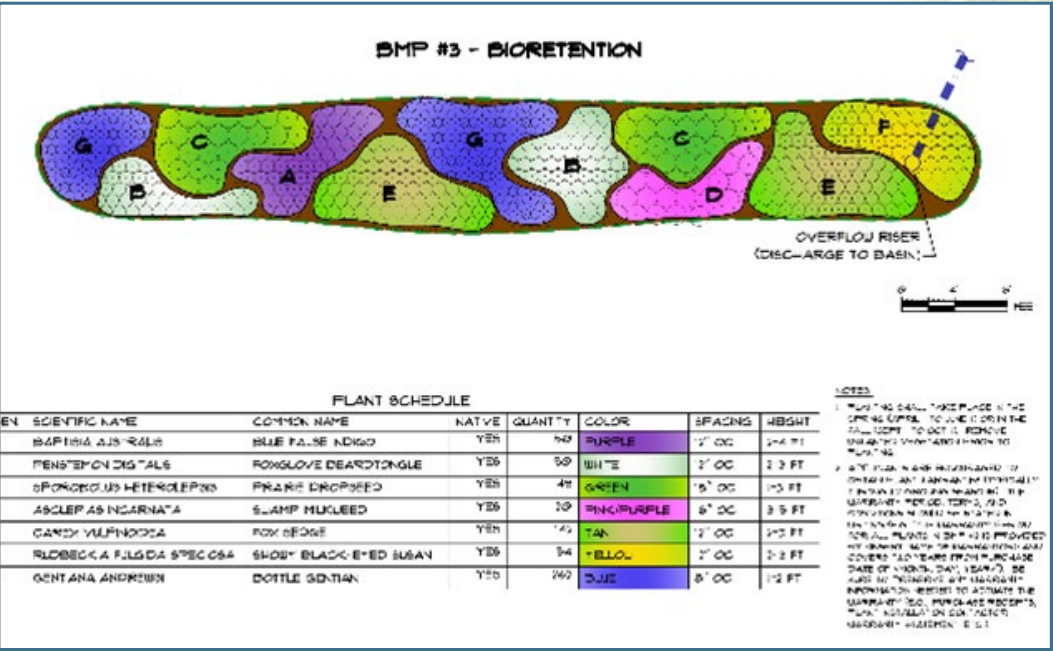
- ✓ Maintain a wood or rock mulch depth of about 3 inches; too much mulch will reduce the volume for stormwater runoff storage
- ✓ Check for erosion or scour of the wood or rock mulch at the inflow point; mulch can move around with heavy rainfall
- ✓ Smooth out, add, or replace mulch if necessary
- ✓ Check the wood or rock mulched area after heavy rains; if mulch is causing repeated clogs to the outlet structure, consider replacing mulch w/ additional plants



5 Plant Care and Mowing

- Frequency:** Every two weeks, seasonally dependent
- What to do?**
- ✓ Remove any weeds, especially before they flower, if possible
 - ✓ Identify invasive species early and eliminate as soon as possible.
 - Common invasive species examples are provided to the right
 - ✓ Mow native grasses to a length no less than 6 inches
 - If starting grass from seed, allow time for establishment before mowing weeds (use string trimmer if necessary)
 - ✓ Keep desired vegetation dense to prevent weeds from growing. Desired vegetation can be found on the 'Planting Plan'
 - ✓ Common Native plant species include (examples provided on the next page):

- a. Buffalo Grass
- b. Blue Gama
- c. Gayfeather
- d. Golden Currant
- e. Rabbit Brush
- f. Prairie Cone Flower
- g. Black-eyed Susan
- h. Butterfly Weed



Example Planting Plan can be used to determine the desired vegetation in your bioretention SCM.



Rehabilitative Maintenance

Problems with your Bioretention SCM or the need for a repair more significant than routine maintenance can occur, even in well-maintained Bioretention SCMs. These issues usually occur after a heavy storm or large snowmelt, or as the result of an unexpected disturbance. Problems can also occur from slight grading issues that have gotten worse over time. This can be monitored by ensuring the original grade is still present with a positive drainage away from the inflow point. In any case, problems must be corrected as soon as possible to prevent damage to the SCM, your property, and the properties around yours. Significant repairs may require the services of a licensed contractor, professional engineer, landscape architect, or soil scientist. Because it may be costly, creating a long-term fund for large maintenance items is highly recommended.

Examples of rehabilitative maintenance tasks include:

- ✓ Repairs to or replacement of structural components (e.g., curbing, outlets, underdrain, observation wells, riprap forebay, cleanout pipes, etc.)
- ✓ Removing large amounts of sediment, debris, and/or mature trees
- ✓ Repairing soil compaction in the main treatment area of SCMs that require loose soil for stormwater management
- ✓ Large-scale removal and replacement of dead, damaged, or unhealthy vegetation
- ✓ Repairing the grade of the engineered soil. A common problem occurs when scouring in one area leads to mounding in another. This can cause an impacted drainage area, and parts of the SCM will receive too much, or not enough, water.
- ✓ Replacing media due to clogged conditions (or improperly installed media)
- ✓ Removal of sediment and debris from energy dissipation/rip rap is an important and common step in maintenance





Chapter 4

Permeable Pavement

Permeable Pavements

Permeable pavements are Stormwater Control Measures (SCMs) that include several types of paved surfaces that allow stormwater to infiltrate through an engineered surface layer below the pavement surface. The water then enters a rock storage layer and either soaks into the soil underneath or exits through an underdrain. Permeable pavement surfaces either consist of porous concrete or asphalt surfaces where water seeps through the material pore spaces or permeable interlocking concrete pavers (PICP) where water enters through the joint spaces between the paver blocks. Permeable pavement systems capture runoff during and immediately after rain events. The permeable surface should be dry about 12 hours after a storm.

Benefits of Permeable Pavement

- ✓ Reduce runoff and increase infiltration
- ✓ Can be used in smaller street sections to decrease unnecessary imperviousness (e.g. hard surfaces)
- ✓ Recharges groundwater
- ✓ Improves tree health by providing additional air and water to nearby roots
- ✓ Can be used in cold climates, even below freezing, which can reduce black ice
- ✓ Lasts longer than traditional pavement by reducing effects of freeze-thaw cycles
- ✓ Can provide traffic calming benefits
- ✓ Reduces spray from moving vehicles and roadway noise
- ✓ Adds aesthetic and architectural interest
 - ✓ Includes various shapes, colors, and sizes that can be arranged in creative patterns and color schemes

Prohibitive Uses for Permeable Pavement

- ✗ Storage (even if temporary) or dumping of any materials on the surface, stockpiles (including mulch and soil), or wastes
- ✗ Using sand as a deicer or to fill the joints
- ✗ Using sealants (this will prevent the flow/infiltration of runoff)
- ✗ Stockpiling snow in any area of the pavement, this will cause clogging

How do I know if my permeable pavement SCM is functioning properly?

The first thing to understand is how your SCM is designed and how it is meant to properly function. Proper SCM function, which is the description of what the SCM is designed to do and how it works, can be monitored by maintaining the SCM Inspection Items and making sure the SCM is achieving the SCM Operation Standards. **The SCM Operation Standards can be found on page 64.** In general, if the SCM doesn't drain in **12-hours**, it may be clogged and require maintenance.



Example educational signage of prohibitive uses for Permeable Pavement



Example of permeable pavement adding visual interest and sense of place to a downtown area.

The SCM Inspection Items are the key parts of the SCM that support its proper function. The items must be checked, inspected, and maintained on a routine basis. The permeable pavement Inspection Items are shown in the graphic below.

SCM Inspection Items

1.

The **permeable pavement surface** is where water flows into the SCM

2.

Joints are the spaces that allow runoff on the surface to migrate down into the subgrade and is filled with an aggregate stone that provides filtration

3.

The **underdrain cleanout** is used to access the underdrain in case of clogging issues

4.

Bedding layer is the material on which the paving units are set, facilitating the free passage of water through the underlying sub-base layers

5.

Subgrade aggregate is where runoff is treated through filtration

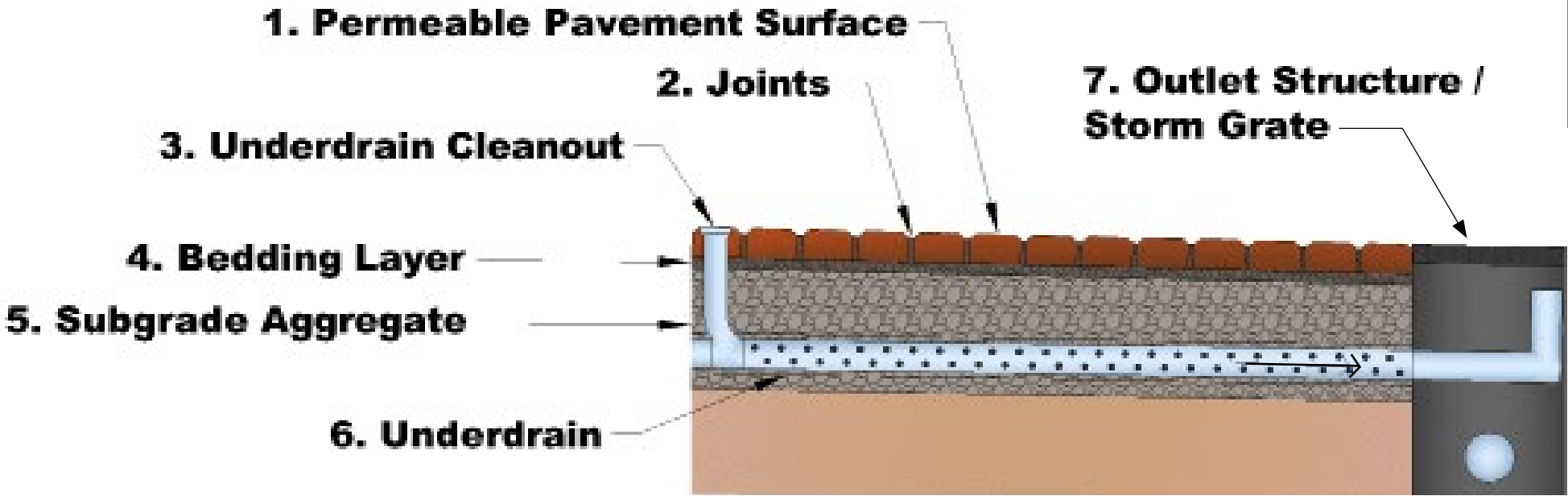
6.

The **underdrain** moves water toward the outlet to be released from the SCM

7.

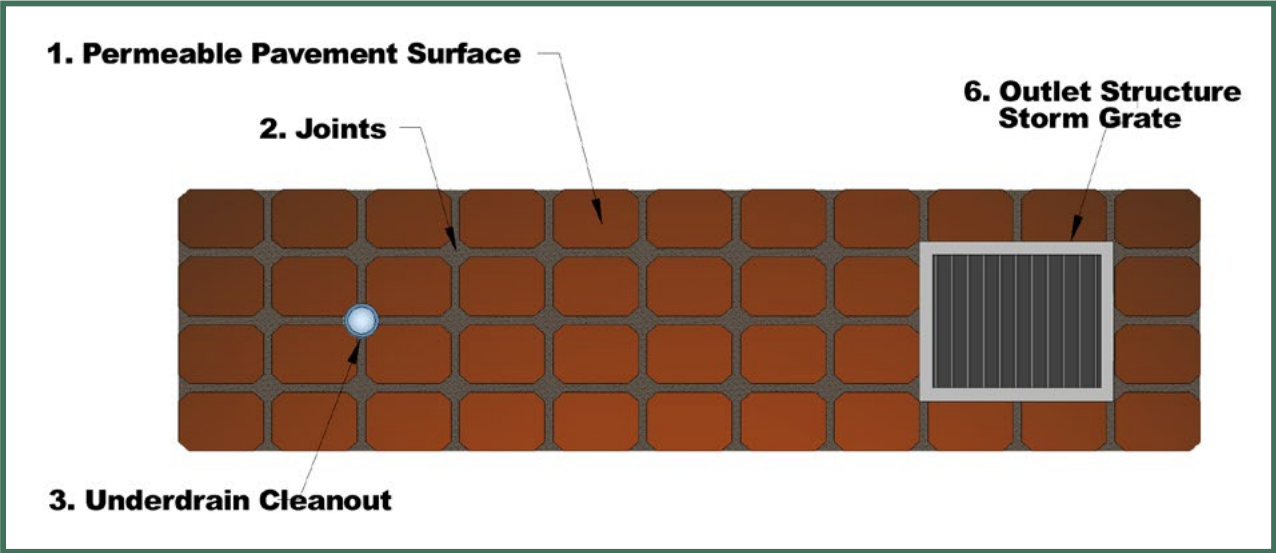
The **outlet structure or storm grate** allows cleaner water to exit the SCM

SCM Inspection Items



This is an example illustration of a permeable pavement SCM. Layout can vary between SCMs

Keeping a close eye on the key parts of a permeable pavement SCM is very important to make sure it is working properly. Frequent, informal inspections performed during landscaping activities and after strong storms and snows will help you catch and repair minor issues before they become major problems. Major problems can result in costly repairs, property damage, stream pollution, and legal issues with other property owners affected by failure of your permeable pavement.



Routine Maintenance Activities

Area Surrounding Permeable Pavement:

Check that vegetation is healthy and that there is no bare soil in an area that drains to the pavement, as this could cause clogging. Replace dead or dying plants with healthy, thriving ones.

Permeable Pavement Surface:

Remove any trash or debris from the surface. If sediment is present, sweep or vacuum the pavement. If weeding is required, do so carefully. It is important that the media is not removed during the weeding process. If there is rutting, cracking, slumping, or the structure is damaged, consult a professional.

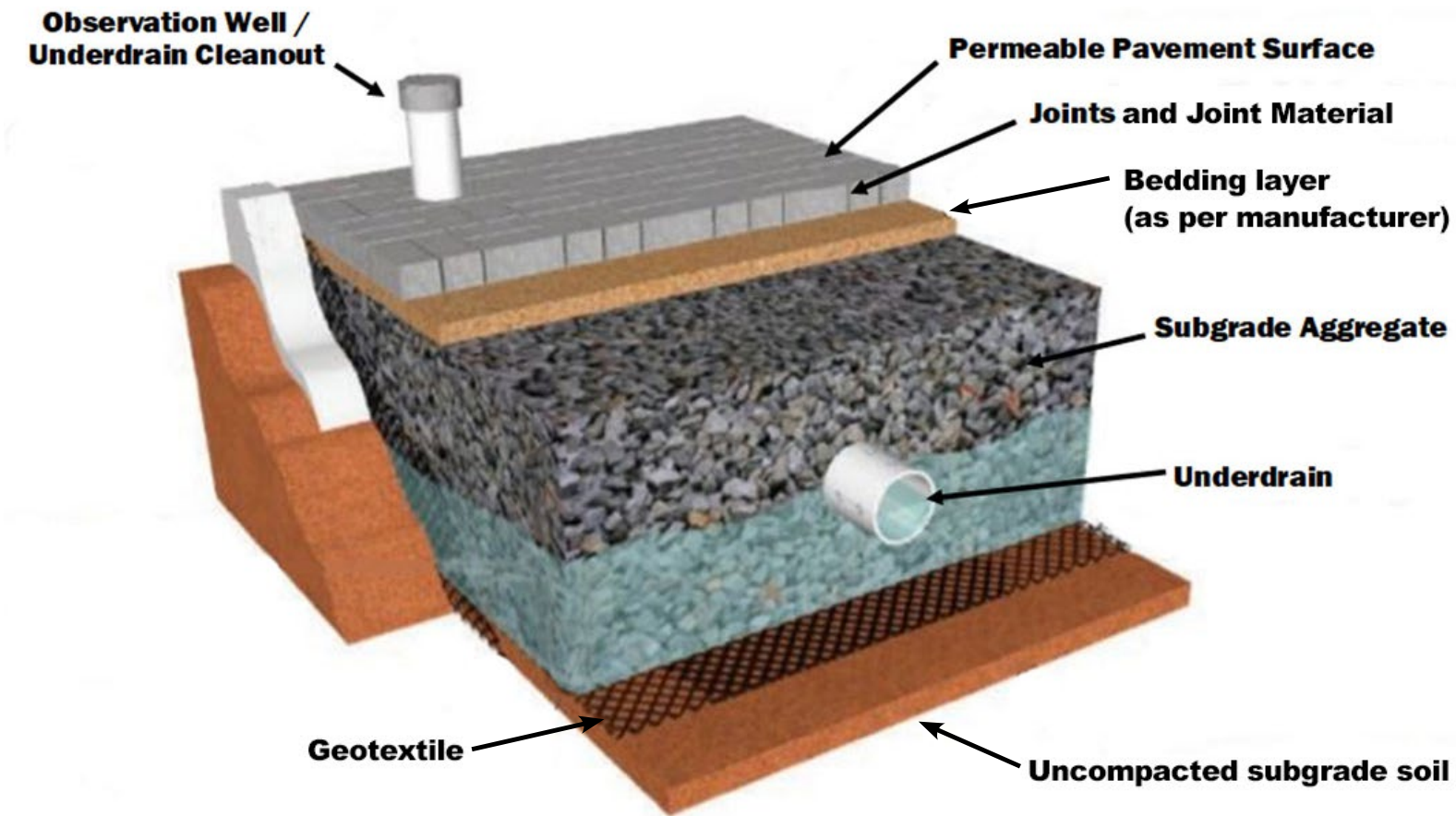


Joints: The spaces between the pavers should be kept clean and free of trash or debris. Periodically, the permeable pavement surface should be vacuumed to remove any debris that is lodged in the aggregate. Aggregate material (small rocks) **should be present and visible between the joints** as they are designed to be there and help keep larger debris from clogging the joints. It may be necessary to add more aggregate at the joints.

Outlet Structure: Remove any trash or debris from the outlet structure or storm grate. During or right after a rain event, it may be helpful to check that the outlet structure is draining the cleaner, filtered water to ensure proper function.

Underdrain Cleanout: Check the cleanout regularly (and especially after large rain events) and remove any trash or debris that could cause clogging.

Routine Maintenance Activities: Below the Surface



Subgrade Aggregate: If there is standing water after a rain event, there could be a clog in the aggregate below the surface. Investigate the problem and call a professional, if necessary.

Underdrain: Check the observation well to see if water is present more than five days after a storm. If there is water, clean out the underdrain with a pressurized water jet at the upstream cleanout and collect water using a vacuum truck at the outlet structure or nearest downstream location.

To avoid issues with permeable pavement surfaces, do NOT:

- ✗ Store soil, mulch, or other landscaping materials on permeable pavement or in an area draining to the SCM as it could clog the aggregate between the joints
- ✗ Use salt or sand for deicing or snow removal, or pile snow that has salt or sand on the pavement. These materials can clog the joints and subgrade aggregate, which will cause ponding on the pavement
- ✗ Neglect maintenance needs, like sweeping or litter pickup, as this can negatively affect the function of the SCM
- ✗ Put sealants on the pavement or repave the SCM with materials that don't let water drain through
- ✗ Don't use area for storage of materials or equipment that could block the drainage capacity of the paver



DO NOT store mulch on permeable pavement




DO NOT neglect maintenance efforts and let sediment build up



DO NOT use sand for deicing or snow removal

The **SCM Operating Standards** are the minimum benchmarks that describe a properly functioning SCM. Operating Standards will vary by SCM type. They are written as non-technical descriptions, so specialized or technical knowledge of SCM design and construction is not needed to evaluate SCM function.

Permeable Pavement SCM Operating Standards

<p>Operating Standard 1: Healthy Plants Adjacent to SCM</p> 	<p>Plants are generally not included in the design of permeable pavement systems, but there might be vegetation nearby. If this is the case, make sure the plants are healthy and there is no bare soil or landscaping material that could erode and create clogs in the permeable pavement system.</p>	<p>Operating Standard 2: Dry in 12 Hours</p> 	<p>In general, most permeable pavement SCMs should fully drain 12 hours after a storm. The SCM may have standing water for longer periods after frequent or long storms. Regardless, repeated instances of standing water after this 12-hour time limit indicates the need to sweep and vacuum the pavement surface to restore infiltration capacity.</p>
<p>Operating Standard 3: Good Protection</p> 	<p>Permeable pavement SCMs must be protected from damage. Heavy equipment and sand used as a deicer could potentially damage permeable pavement systems. See above section for the prohibited uses and activities of SCMs.</p>	<p>Operating Standard 4: Keep It Clean</p> 	<p>The SCM itself and the area draining to the SCM needs to be kept clean. This reduces the chance of pollutants entering the SCM and impeding its function or being passed through to Boulder’s waterways. There should not be excessive sediment, litter, debris, or stored pollutants on the SCM or in the area draining to it. For more information on how to keep permeable pavement clean, see pages 68- 70.</p>

Below are examples of the different **Operating Standards** in good standing vs. poor standing, plus guidance on how to **fix any issues**.

Healthy Plants



Good Standing



The vegetation near these pavers are well-maintained. Keeping plants and grass healthy prevents the potential for bare soil or sediment to clog the permeable paver system. There are no weeds growing through the pavers.

Poor Standing



This system should not have vegetation growing between the pavers. This could clog the SCM. Vegetation must be carefully removed so as not to remove the small rocks (aggregate) between the joints. If aggregate cannot be seen in joints, it will need to be replaced.

Dry in One Day



The SCM is draining immediately even when large amounts of water are flowing over the permeable pavers. This indicates that the SCM is draining properly.



Standing water in a permeable pavement system generally means there is a clogging or settling issue in the SCM. This needs to be investigated and repaired.

Good Protection



Good Standing



The curbs and walls installed between the permeable pavement SCMs are a good way to protect the SCM from sediment and debris (e.g., grass clippings) that could clog the SCM.

Poor Standing



Salt or sand could cause clogging issues for the permeable pavement SCM. The parking lane is not protected from adjacent landscaping.

Keep It Clean



Regularly removing leaf debris and sediment from the permeable pavement SCM helps reduce future clogging issues. Adequate aggregate material (small rocks) should be visible between the pavers.



This permeable paver parking lot has both sediment and debris that will cause the SCM to drain improperly. Sediment and debris needs to be removed.

How do I keep my permeable pavement system functioning?

Routine maintenance refers to the typical cleaning and light repair activities that are performed on a repetitive and frequent basis to sustain the ongoing proper operational performance of the SCM. Routine maintenance should be considered an activity that is done on a regular basis, ideally whenever general property and landscape maintenance occurs. This can be done by the property owner, a tenant, a landscape company, or other person generally knowledgeable in landscape and property maintenance. Most maintenance needs are easy to see if the SCM is inspected and maintained regularly.

The following items will be described on the next pages:

- 1. Visual inspection
- 2. Infiltration test
- 3. Sweeping and vacuuming
- 4. Snow removal







Without routine maintenance, cost of remedial repairs could be much higher in the long run

1 Visual Inspection

Frequency: Annually
What to do?

Check the SCM Operation Standards:

Healthy Plants		Make sure the plants are healthy and there is no bare soil or landscaping material that could create clogs in the permeable pavement system.
Drain in 12 Hours		Observe infiltration performance either during a rain event or by using a garden hose. Take pictures and notes to assist in measuring infiltration rates.
Good Protection		Ensure the permeable pavement SCM is protected from excessive heavy equipment traffic, de-icing solutions like salt and sand, and debris like grass clippings and landscaping materials.
Keep It Clean		Regularly sweep or vacuum the surface to ensure proper drain time.



2 Infiltration Test

Frequency: Twice a year when routine maintenance is performed
What to do?

The below test outlines an infiltration test following the method specified in the **Permanent Water Quality BMP Inspection and Maintenance Field Guide**. It does not provide detailed infiltration rates, however it does not require any special equipment.

1. Pour 1 gallon of water onto the permeable pavement over about 30 seconds
2. The water will infiltrate through the surface, creating a “wetted area”
3. Observe the movement of the water and the distance it covers. If water spreads quickly and covers a long distance without infiltrating, maintenance is likely required. If streams of water follow the spaces between bricks without infiltrating, joint material likely needs replaced.

Quantitative methods for infiltration testing that determine infiltration rates are recommended following installation or restorative maintenance actions. City staff and/or contractors may use these methods for determining if permeable pavement is functioning as designed. Quantitative infiltration test methods include the Simple Infiltration Test (SIT) 2x4 box test or the ASTM C1781 – Standard Test Method for Surface Infiltration Rate of Permeable Pavement System cylindrical ring test.



3 Sweeping and Vacuuming

Frequency: Twice a year is recommended for routine maintenance, unless there are more frequent requirements in specific operation and maintenance plan. As needed for restorative maintenance and removal and installation.

What to do?

There are three levels of maintenance intervention for permeable pavement systems: routine, restorative, and removal and reinstallation. Routine maintenance can delay the need for the more costly rehabilitative interventions. Refer to “Three Levels of Maintenance” on pages 70-71 for information.

Debris should be removed, routinely, as a source control measure. This is frequently performed with a broom sweeper. Although this type of sweeper can be effective at removing solids and debris from the surface, it will not remove solids from the void space of a permeable pavement. A regenerative air sweeper and regenerative air street sweeper and/or muti-surface lawn vacuum. vacuum should be used to lift and remove the dirt and debris from the joint and pore spaces to help maintain or restore infiltration. Pressure washing alone is not sufficient.



4 Snow Removal

In general, permeable pavements do not form ice to the same extent as conventional pavements. Additionally, conventional liquid deicers (e.g., magnesium chloride, salt brine, etc.) are ineffective because they do not stay at the surface. Sand should not be applied to a permeable pavement as it can reduce infiltration. Plowing is the recommended snow removal process. Conventional plowing operations should not cause damage to the pavements. Protective rubber edges on the snowplow equipment should be used to avoid damaging the permeable pavement surface.

PICP and Concrete Grid: Deicers may be used on PICP and grid pavers; however, it may not be effective for the reason stated above. Sand should not be used. If sand is accidentally used, use a vacuum sweeper to remove the sand. Mechanical snow and ice removal should be used.

Pervious Concrete: Do not use liquid or solid deicers or sand on pervious concrete. Deicers can damage pervious concrete.

Porous Asphalt: Use liquid or solid deicers sparingly; mechanical snow and ice removal is preferred. Do not apply sand to porous asphalt.



Three Levels of Maintenance

Routine

Recommendation: Sweep and vacuum twice a year, adjust based on on-site use. Sweep and vacuum using a regenerative air street sweeper and/or multi-surface lawn vacuum twice a year.

The joint and pore spaces of a permeable pavement system will fill with debris over time reducing the rate at which water can drain into the storage area below. The rate at which permeable pavement systems will clog is dependent on the dirtiness of the contributing drainage area. Pavers in the roadway will collect more dirt and debris than walkway pavers and will clog at a faster rate, requiring more frequent maintenance. It is recommended that routine maintenance be conducted twice a year and adjusted based on site observations. Routine maintenance will involve using a regenerative air street sweeper and/or multi-surface lawn vacuum.. The goal of sweeping and vacuuming is to lift and remove the dirt and debris from the joint and pore spaces. Sweeping dislodges the dirt and vacuuming lifts the dirt out of the joint spaces.



Restorative

Recommendation: As needed, remove debris buildup from joints by pressure washing and using a high-pressure vacuum, then replace joint aggregate.

Left unmaintained, debris will migrate down into the joint spaces of a permeable pavement system below the depth that vacuum equipment can remove. Restorative maintenance is required when routine maintenance methods do not restore the infiltration capacity of the SCM. An infiltration test or continued ponding of water can indicate when restorative maintenance is needed. Restorative maintenance will involve using a high-pressure vacuum to remove the joint aggregate and the debris within it. Pressure washing in tandem with vacuuming can be effective at dislodging material in the joint spaces, however, pressure washing alone is not recommended for permeable pavement maintenance.

After vacuuming the surface, the joints will be empty and need to be refilled with joint aggregate. Joint aggregate needs to be properly sized to fit into the pore spaces. Consult with design documentation for your system to obtain properly sized aggregate (angular #89 stone is typical).



Clogged Joints, Empty Joints and Finished Joints (left to right)



Using a pressure washer with a Ditch Witch FX20 Vacuum to dislodge material from the joint spaces.

Removal and Reinstallation

Recommendation: As needed, remove existing pavers, clean underlying debris buildup, reinstall 2" of clean bedding layer, and replace pavers and joint aggregate.

Permeable pavement systems in dirty, high-traffic areas that have not received consistent routine maintenance may need more intensive maintenance involving the removal and reinstallation of the pavers.

Below the brick pavers is a bedding layer of aggregate. The pavers are completely removed to clean underlying debris buildup and replace the top 2" portion of the bedding layer. The pavers are replaced, and the joints refilled with clean, properly sized joint aggregate.

In cases of structural damage, repairs to the drainpipes, aggregate layers, or pavers may be needed. Most repairs and maintenance require the services of a licensed contractor or professional engineer. Because it may be costly, creating a long-term fund for large maintenance items is highly recommended.



Right-of-Way Maintenance Checklist

Conducting even routine maintenance on permeable pavement systems requires planning and permitting since they are often located in the public right-of-way. Depending on the location of your SCM and maintenance access, your maintenance contractor may need a variety of clearances and/or permits from the City of Boulder to perform the work. Allow plenty of time to complete, submit, and receive approval for permits.

☑ Identifying Vendors

For the convenience of property owners, the City of Boulder maintains lists of contractors who are understood to have experience in maintaining stormwater management facilities. Contact the City of Boulder Stormwater Quality staff at StormwaterQuality@bouldercolorado.gov to request more information.

☑ Right of Way (ROW) Permits

To ensure that rights-of-way areas (streets, alleys, sidewalks) continue to serve their intended purposes, the city regulates work in these areas through contractor licensing and construction permitting. The maintenance vendor must be a [Licensed Right-of-Way Contractor](#) in the City of Boulder to apply for the ROW Permit. The maintenance vendor will need to apply for a “Right-of-Way, Wet Utilities, and In-Property Permit”, available on the [Planning and Development Applications and Forms webpage](#). The permit will then require additional documents, including a Traffic Control Plan.

☑ Traffic Control Plans

Work done within the Public ROW requires a Traffic Control Plan developed by a certified Traffic Control Supervisor. This includes plans for sidewalk, traffic lane, and parking impacts. The maintenance contractor will need to work with a traffic control company who can develop the Traffic Control Plan and is certified to install temporary traffic control devices.



Maintenance on this permeable pavement system involved blocking of multiple paid parking spots and closing a small side street.

Parking Services will need to provide signage for any parking spots that will be blocked during the maintenance.



☑ Parking Services Clearances

If the maintenance work will require the contractor to occupy or use any paid, 2-hour, or 3-hour parking spaces that are managed by City of Boulder Parking Services, the ROW Permit along with a “Special Activity Construction Media Application”, available on the [Parking webpage](#), will need to first be sent to Parking Services at ParkingServices@bouldercolorado.gov for their signature in the “Other Departmental Approval” section of the ROW Permit. If the permit is issued, the contractor will receive detailed instructions from Parking Services about what signs will be required and where to pick them up. There will be a daily cost for reserving parking spaces and a small fee for each sign. The maintenance contractor may also need to work with Parking Services if cars need to be cleared from the work area.

☑ Permit Submittal

When all required documentation is ready to submit, send the permit application, traffic plan(s), Special Activity Construction Media Application, reference map/plan showing areas of proposed work, and any other materials specified by the permit to ROW@bouldercolorado.gov.



Chapter 5

Underground/Proprietary SCM

Underground Proprietary SCMs

Underground Proprietary SCMs provide stormwater quality treatment by removing sediment, debris, and trash through screening or hydrodynamic separation in an underground vault accessed from a manhole. A variety of systems and configurations are possible, but most systems include both floatables and sediment capture components that require routine cleanings.

Benefits of Underground Proprietary SCMs

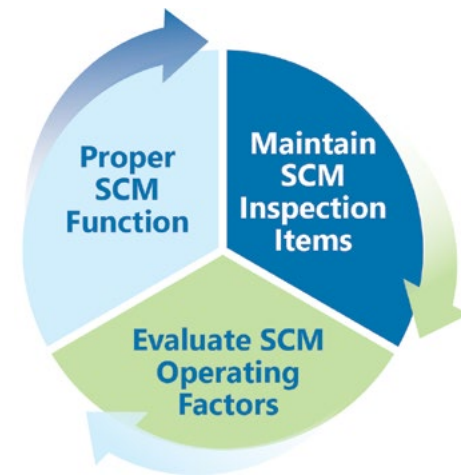
- ✓ Useful for properties where surface SCMs are unfeasible
- ✓ Can be placed in highly urban areas to meet water quality requirements
- ✓ May be designed to provide pretreatment in space-constrained situations
- ✓ There are many options for configuring the design of these SCMs
- ✓ Can be used to address TMDL requirements

Prohibitive Uses for Underground Proprietary SCMs

- ✗ Don't wash cars or change automotive fluids in an area that drains to the SCM
- ✗ Don't enter the SCM unless you have confined entry certifications

How do I know if my underground/proprietary SCM is functioning properly?

The first thing to understand is how your SCM is designed and how it is meant to properly function. **Proper SCM function**, which is the description of what the SCM is designed to do and how it works, can be monitored by maintaining the **SCM Inspection Items** and making sure the underground proprietary SCM is cleaned out on a routine basis.



How do I maintain my underground proprietary SCM?

The underground SCM access manhole may be in an area where maintenance work will impede the right-of-way - sidewalk, parking lot, or road. Depending on the location of your SCM and maintenance access, your maintenance contractor may need a variety of clearances and/or permits from the City of Boulder to perform the work. Allow plenty of time to complete, submit, and receive approval for permits. Refer to pages 72-73 for more information and a detailed maintenance logistics checklist for completing work in the public right-of-way.

The following will factor into the cost of maintaining underground proprietary SCMs:

- Number, size and depth of the underground vaults, which will determine the amount of waste that needs to be handled.
- Personnel trained to enter confined spaces.
- Waste analysis and disposal. Companies will need to classify the waste (which could involve sending it to a lab) to identify an approved disposal facility.

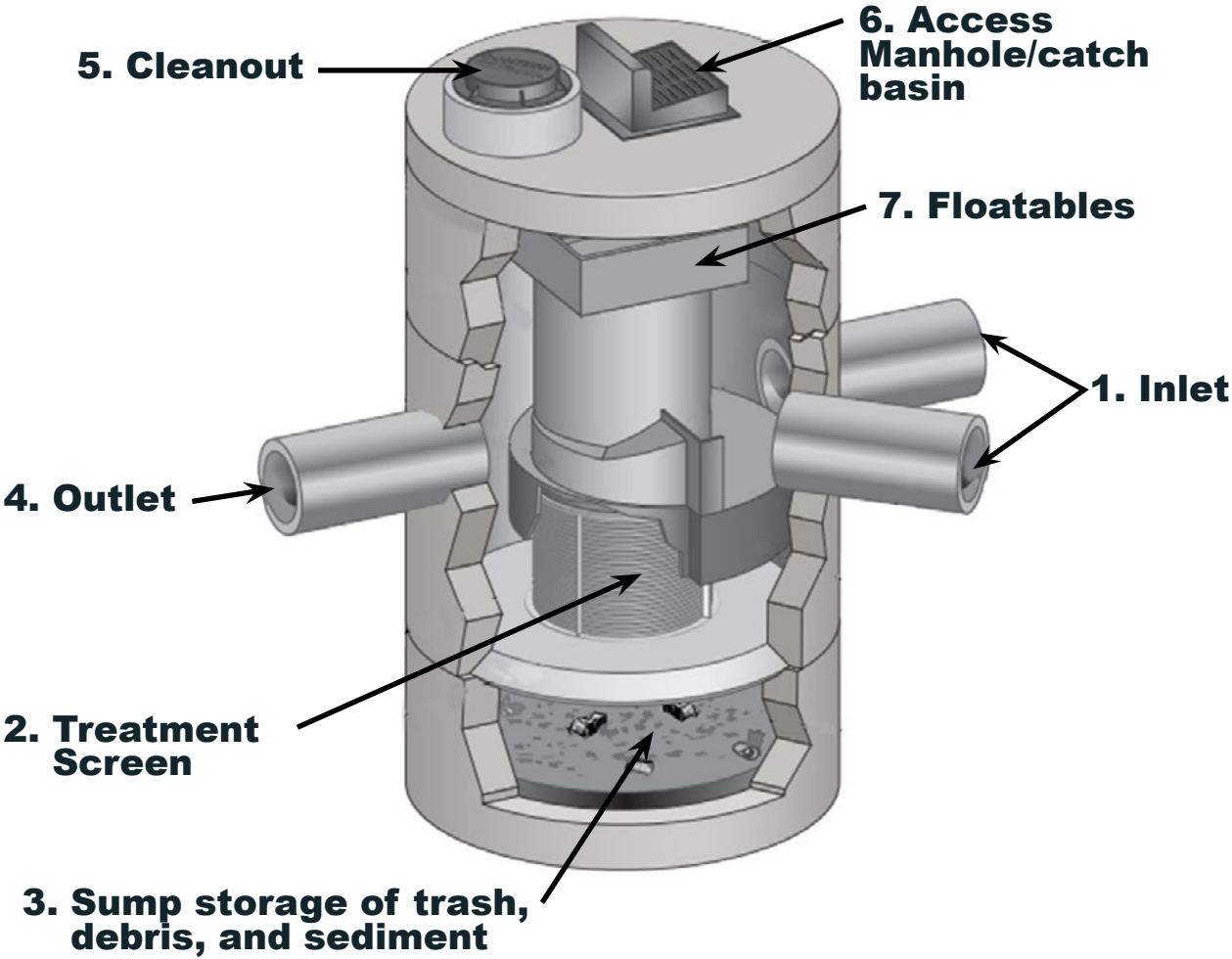


The SCM Inspection Items are the key parts of the SCM that support its proper function. The items must be checked, inspected, and maintained on a routine basis. The items and locations listed here are typical but all underground proprietary SCMs have slightly different configurations and referring to manufacturer guidelines is recommended. The underground proprietary SCM Inspection Items are shown in the graphic to the right.

SCM Inspection Items

1. The **inlet structure** is where water flows into the underground SCM; there can be multiple inlets
2. The **treatment screen** removes smaller particles and fines from the stormwater
3. The **sump storage** collects trash, debris, and sediment that would otherwise flow out of the SCM
4. The **outlet structure** is where the cleaner water exits the SCM and enters the stormwater system
5. The **cleanout** is accessed to remove buildup of sediment and debris on a routine basis to ensure proper function of the SCM
6. The **access manhole/catchbasin** allows for surface water to enter the system and for personnel access into the SCM.
7. **Floatables** (light weight trash and debris) are pushed to the top of most proprietary SCMs and easily removed during cleanout of the system

SCM Inspection Items



This is an example illustration of a underground proprietary SCM. Layout can vary between SCMs

The **Operating Standards** are the minimum benchmarks that describe a properly functioning SCM.

Underground Proprietary SCM Operating Standards

Protection



Protect the area draining to SCM by picking up litter/debris that could enter the SCM and cause clogging or the need for premature vacuuming of the vault



Keep it Clean



Cleaning an underground SCM typically involves two components:

1. Floatables: Oils and trash need to be removed from the top of the storage chamber with a vacuum truck.
2. Sediment: Collected debris in the sump storage needs to be removed with a vacuum truck.

Refer to manufacturer recommendations for access and maintenance recommendations for these two components.



Before



After

1 Visual Inspection

Frequency:

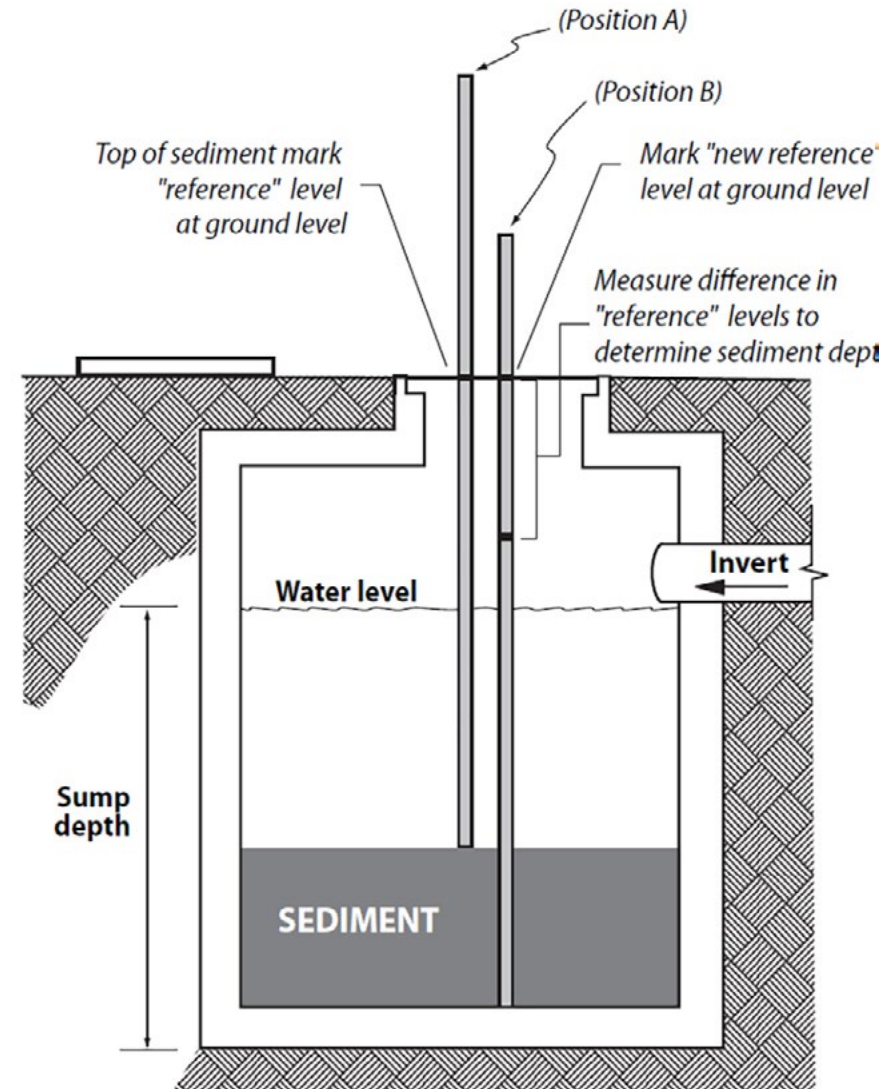
- Every 3 months for the first two years of operation (or following storm event), then twice a year for the life of the SCM (e.g., spring and fall)
- Frequency may be greater depending on site activities (e.g., heavy winter sanding/salting, excessive litter/trash accumulation in an urban area)

What to do?

1. Locate the underground SCM access manhole and safely remove the lid.
2. Check the SCM components and flow paths for clogging or structural damage.
3. Determine if floatables (trash and oils) have accumulated in the system. Record presence and vac out if accumulation of floatables is present.
4. Determine the depth of sediment accumulation in the sump storage. Record depth and vac out if greater than manufacturer recommended depth. Debris accumulation should not exceed 75% of the capacity as listed in the manufacturer recommendations and system as-built.
5. Refer to manufacturer recommendations and inspect system specific components such as filter cartridges.



How do I keep my underground/proprietary SCM functioning?



2 Debris Removal/Vacuuming

Frequency:

It is recommended that underground SCMs be cleaned with a vacuum truck at a minimum of once per year (or more frequently if indicated by visual inspections) on a reoccurring schedule with a contractor. Refer to manufacturer recommendations when establishing the maintenance frequency and any specialized needs for the device.

What to do?

1. Find and refer to system location map, design drawings, and manufacturer maintenance recommendations.
2. Contact a vacuum truck company that provides vault clean out services.
3. Establish a maintenance frequency for clean out and proper disposal of sediment and floatables.
4. Maintain records of vault clean out events and the amount of material removed. Maintenance frequency can be adjusted over time if good records are kept on debris accumulation rate.





Chapter 6

Additional Resources

Who do I call when I need help?

Whether you are an individual residential property owner, a homeowners’ association representative, a non-residential property owner, a property manager, or part of a landscape or property maintenance staff, this Guide is intended to provide guidance for the protection, inspection, maintenance, and planning needed to keep your SCM functioning properly. Sometimes, SCMs will require maintenance that requires more technical or specialized expertise. This Chapter is designed to guide you to additional resources.

Colorado Stormwater Center is housed in the Department of Civil and Environmental Engineering at Colorado State University (CSU) and provides education, training, and assistance on SCMs. Specifically, CSC provides participants who complete the training and pass the qualifying exam receive a certificate from Colorado State University Extension and are published on the below website.



<http://stormwatercenter.colostate.edu>

The Mile High Flood District (MHFD) has established the design criteria, procedures, and details for SCMs providing treatment of post-construction urban runoff. Search for SCMs at MHFD.org



<http://MHFD.org>

Engineers and landscape architects are specially trained to conduct the calculations required to meet these requirements and design SCMs accordingly. If you are experiencing problems with your SCM despite regular maintenance and upkeep, or if it is damaged and its components need repairs, then it may be time to obtain the services of a technical specialist. Vegetated areas may require the use of a professional landscape firm to maintain healthy vegetation, manage weeds, replant problem areas, and maintain optimal soil and drainage conditions. Before hiring a landscape company or having one work on your property, make sure they know they will be working with an SCM designed to manage stormwater runoff, and provide them with the SCM plan for your property. They need to be aware that maintenance of your SCM is required by city’s stormwater management code and that special care will be needed to protect the SCM components.



COLORADO

**Department of
Regulatory Agencies**

Division of Professions and Occupations

CO Professional Engineers website:

<https://dpo.colorado.gov/AES>

CO Professional Landscape Architect website:

<https://dpo.colorado.gov/LandscapeArchitects>

City of Boulder Stormwater Quality staff are here to help!

Contact StormwaterQuality@bouldercolorado.gov:

- 4 To ask additional questions
- 4 To determine available resources
- 4 To determine the design engineer for your SCM

Master Gardeners are gardeners that have been specially trained, by Colorado State University (CSU) Boulder County Extension Office. Master Gardeners volunteer their expertise and services to the community, providing reliable, gardening information and education opportunities.



MASTER GARDENER

**COLORADO STATE UNIVERSITY
EXTENSION**

CO Master Gardener website:

<https://cmg.extension.colostate.edu>

Native plant nurseries will have the inventory and the expertise you need to maintain your vegetation. Commercial nurseries may not have the specific plants you need. If you choose to contact a nursery, make sure they are familiar with your type of SCM by sharing pertinent information found in the SCM guide.

Colorado Department of Agriculture provides helpful information and program support in identifying noxious weeds and determining the best method for removal. The website provides a noxious weed photograph library and assistance programs.



COLORADO

Department of Agriculture

CO Department of Agriculture website:

<https://ag.colorado.gov/>



Photo and Graphic References

The photographs and graphics in this manual are credited to the sources in the table below. Photographs and graphics NOT listed below are credited to the City of Boulder or WSP.

Page #	Photograph or Graphic Location and Description	Source
7	Stormwater Runoff graphic	Caltrans Municipal Separate Storm Sewer (MS4) Program. March 2023. Website: Caltrans Municipal Separate Storm Sewer System (MS4) Program California State Water Resources Control Board
9	Street scape graphic on the left of the page Three small graphics on the right of the page	Green Streets Guidelines: A Guide to Green Street Implementation in the County of San Diego. January 2019. Website: San Diego Countywide Model 2 Cover
16	Extended detention basin across the page	Susdrain. March 2023. Website: Detention basins (susdrain.org)
29	Background Picture	“Aesthetically Enhanced Detention and Water Quality Ponds”. City of Denver. September 2010. Website: https://www.denvergov.org/files/assets/public/doti/documents/permits/wweng/detention_pond_guide_full.pdf
31	Machine aerating lawn at bottom right of the page.	“There is no debate, you really do need to aerate”. Denver Water. September 20, 2022. Website: https://www.denverwater.org/tap/there-no-debate-you-really-do-need-aerate
32-33	Extended detention basin at bottom right of the page	“Aesthetically Enhanced Detention and Water Quality Ponds”. City of Denver. September 2010. Website: https://www.denvergov.org/files/assets/public/doti/documents/permits/wweng/detention_pond_guide_full.pdf
	Sprinkler head maintenance at the bottom middle of the page	iStock by Getty Images. March 2023. Website: Sprinkler Head Adjustment For Home Lawn Irrigation System Stock Photo - Download Image Now - iStock (istockphoto.com)
35	Extended detention pond at right of page	Mile High Flood District Stormwater. Criteria Manual Volume 3. Best Management Practices (BMPs). Updated January 2010. Website: 06 T-05-Extended-Detention-Basin.pdf (mhfd.org)
36	Main picture of bioretention	“Stormwater Resources for Property Owners and Landscapers”. City of Boulder. March 2023. Website: https://bouldercolorado.gov/stormwater-resources-property-owners
39	Picture of bioretention at right of page	The Columbus Dispatch. November 5, 2018. Website: Rain-garden rollout in Clintonville far from perfect, official says (dispatch.com)

Page #	Photograph or Graphic Location and Description	Source
45	Picture of poorly draining bioretention at bottom right of page	Hunt, William. “A Retrospective Comparison of Water Quality Treatment in a Bioretention Cell 16 Years Following Initial Analysis. April 2019. Website: Bioretention cell during initial monitoring period (left) and return... Download Scientific Diagram (researchgate.net)
46	Picture showing lack of protection of bioretention at top right of page.	Greenrise Technologies. Camellia: Modern Bioswales and Detention to the Rescue. March 2023. Website: https://greenrisetech.com/projects/camellia/
49	Sprinkler head maintenance at the bottom left of the page	iStock by Getty Images. March 2023. Website: Sprinkler Head Adjustment For Home Lawn Irrigation System Stock Photo - Download Image Now - iStock (istockphoto.com)
50	Pictures of common invasive species at right of page.	Noxious Weed Species ID. Colorado Department of Agriculture. March 2023. Website: https://ag.colorado.gov/conservation/noxious-weeds/species-id#a
51	Pictures of common native species across top of page.	Pictures A-D and F-G: Colorado Native Plan Society. March 2023. Website: Search Plant Photos - Colorado Native Plant Society (conps.org) Picture E: Arbor Valley. March 2023. Website: Rabbitbrush - Plant Guide (arborvalleynursery.com) Picture H: Vanderlinden, Colleen. “How to Grow and Care for Butterfly Weed. The Spruce. March 24, 2022. Website: How to Grow and Care for Butterfly Weed (thespruce.com)
	Plant image at bottom right	“Low Water Native Plans for Colorado Gardens: Front Range and Foothills”. Colorado State University Extension. 2017. Website: https://extension.colostate.edu/docs/pubs/native/FrontRangeSm.pdf
56	Picture of permeable pavement sign at right of page	Flickr. Paul Sableman. September 24, 2011. Website: https://www.flickr.com/photos/pasa/6179174381/in/photostream/
57	Picture of permeable pavement across page	“Green Infrastructure in Denver”. City of Denver, CO. January 6. 2021. Website: https://storymaps.arcgis.com/stories/31e9a14ca0ae4932a1162b65fbe27cda
62	Schematic profile of permeable pavement	Tennessee Permanent Stormwater Management and Design Guidance Manual. Chapter 17. 5.4.8 Permeable Pavement. Updated January 14, 2015. Website: https://tnpermanentstormwater.org/manual.asp
63	Picture of wheelbarrow and mulch at top right of page	University of Maryland Extension. Mulching Trees and Shrubs. March 2023. Website: Mulching Trees and Shrubs University of Maryland Extension (umd.edu)
	Picture of unmaintained permeable pavement at bottom left of page	Sustainable Technologies. Inspection and Maintenance of Stormwater Best management Practices. Permeable Pavements. March 2023. Website: Permeable-Pavement-Fact-Sheet.pdf (sustainabletechnologies.ca)
	Picture of permeable pavement with snow at bottom right of page	CanStockPhoto. Garden Stone Path With Snow. Brick Sidewalk. March 2023. Website: Wintertime. garden stone path with snow. brick sidewalk. CanStock (canstockphoto.com)
65	Permeable pavement with fire truck at bottom left of page	“Over 2 Million SF of Permeable Pavers Installed in Tennessee”. Belgard. March 2023. Website: https://www.belgardcommercial.com/resources/news_and_articles/permeable_pavers_tennessee
	Permeable pavement with weeds at top right of page	Belgard. Paver Rehab Project. June 18, 2020. Website: Paver Rehab Project: Phase 1 - Rejointing Concrete Pavers - Belgard

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69	Sweeping permeable pavement at bottom left of page	Hunt, William F. PhD. "Urban Waterways: Maintaining Permeable Pavements." NC Cooperative Extension. March 2023. Website: https://multires.eos.ncsu.edu/stormwater-bae-ncsu-edu/wp-content/uploads/sites/11/2016/05/AG-588-23-w.pdf
	Snow storage on permeable pavement at bottom right of page	Hiser, Elizabeth. "Winter SCM Maintenance Do's and Don'ts". Cuyahoga Soil & Water Conservation District. March 2023. Website: https://www.cuyahogawcd.org/blog/2016/12/06/winter-scm-maintenance-dos-and-donts
70	Small mechanical street sweeper at top right of page	Hunt, William F. PhD. "Urban Waterways: Maintaining Permeable Pavements." NC Cooperative Extension. March 2023. Website: https://multires.eos.ncsu.edu/stormwater-bae-ncsu-edu/wp-content/uploads/sites/11/2016/05/AG-588-23-w.pdf
	Clogged, empty and finished joints at bottom left of page	Left picture: "Pervious Pavement Maintenance for Your Community. Triverus. March 2023. Website: https://triverus.com/services/pervious-pavement-maintenance/ Middle and right pictures: Conrad, Lauren. "Winter Maintenance for Permeable Pavements." March 2023. Website: https://www.cuyahogawcd.org/blog/2022/11/15/winter-maintenance-for-permeable-pavements
71	Picture of permeable pavers across page	Mississippi Watershed Organization. Children's Dental Services Project. March 2023. Website: Children's Dental Services - MWMO
72	Underground/Proprietary SCM graphic	Hydro International. First Defense. March 2023. Website: First Defense stormwater separator Hydro International (hydro-int.com)
76	Proprietary SCM graphic	Contech Engineered Solutions. CDS Hydrodynamic Separator. March 2023. Website: CDS - Stormwater Treatment from Contech (conteches.com)
77	Trash near SCM inlet at top right of page	New4Jax. "5 Points historic district tarnished by trash". February 24, 2020. Website: 5 Points historic district tarnished by trash (news4jax.com)
78-79	Graphic of underground/proprietary SCM in middle of page	King County Drainage Maintenance Standards. King County, WA. June 2008.
	Vacuum truck at bottom right of page	JG Environmental. Stormwater Management. March 2023. Website: Stormwater System Cleaning Jet Vac Trucks Lancaster, PA (jgenvironmental.net)
80	Bioretention main graphic	WEF Stormwater Report. "New York City Awards Dewberry Contract to Improve Green Infrastructure". October 4, 2016. Website: New York City awards Dewberry contract to improve green infrastructure - Stormwater Report (wef.org)



The City of Boulder Owner’s Guide to Stormwater Control Measures Maintenance was created by the City of Boulder Stormwater Quality Team working with WSP USA E&I