

Section 5

BMP Inspection and Maintenance

5.1 Importance of BMP Maintenance

Stormwater BMPs are just one component in an agency's infrastructure. Like any other infrastructure installed, continual maintenance is required. Routine pothole repairs on a street are similar to the routine cleaning, weeding and replanting tasks required to maintain a BMP. However, the required skills of field crews are significantly different. A BMP is the water quality component of an agency's stormwater system, and to maintain and improve the quality of stormwater runoff, proper functioning of these BMPs is a necessity.

To aid an agency in inspection and maintenance of their BMP infrastructure, the following subsections have been included in this manual:

- 5.2 Fitting BMPs into the Development "Box"
- 5.3 Delegation of BMP Maintenance Tasks
- 5.4 BMP Maintenance Tasks (schedule, checklists)

5.2 Fitting BMPs into the Development "Box"

Stormwater BMPs are not a typical component of infrastructure. Unlike a street, storm, water, or sanitary installation, a BMP is not a hard-engineered element and thus BMPs do not fit within a defined development process. Typical inspection, acceptance practices, and timelines used by agencies to incorporate infrastructure into their system do not always complement BMP installation processes.

Though each agency will be different, there are two key milestones that are typical to the construction and acceptance process of infrastructure associated with development:

- Final Inspection and Acceptance of Infrastructure Construction (issuance of building and/or occupancy permits)
- Performance and Maintenance Bond Period (typically 2-years)

The definition of these processes may deviate to meet the unique needs of stormwater BMP installation and maintenance.

5.2.1 BMP Construction Timing and Acceptance

A BMP should be the last piece of infrastructure constructed on a site. This is difficult for many development situations because the completion of other infrastructure and/or building construction may not correspond to time periods for optimal

vegetation establishment. Vegetation is a critical component to BMP function, and thus an agency needs to take this into account when looking at a project's schedule. The project schedule should consider that the planting and establishment of vegetation will be most successful in early spring (optimally March-April), resulting in an appropriate vegetation density for withstanding stormwater runoff in the early summer.

Initially, a BMP will require continual inspection and maintenance, similar to what is required for good erosion and sediment control stabilization practices to be successful. Unlike traditional infrastructure acceptance, a BMP cannot be accepted as infrastructure immediately after construction and then left alone. The first three months of vegetation establishment is critical, and this vegetation maintenance on a minimum of a bi-annual basis is key to both short and long-term BMP success. Inspection and maintenance practices, both short and long-term, should be defined by each agency using ordinances and construction specifications. Acceptance requirements of a BMP into an agency's infrastructure system should consist of the completion of the design and construction requirements (Section 4), completion of the three month vegetation establishment period (Section 5.4), and an established schedule for future inspection and maintenance procedures (Section 5.4).

5.2.2 Performance and Maintenance Agreements

An agency also may choose to utilize the practice of requiring a contractor to issue a performance and maintenance bond specifically for BMP construction. This is a very common practice for other types of infrastructure construction. A bond is typically issued for the construction cost of the improvement or a percentage of the construction cost of the improvement. Typically, a contractor can obtain a bond but a developer cannot. An advantage to a bond is it is more in the form of insurance – a separate agency is insuring that the contractor is good for the amount of the bond. A disadvantage to the bonding process is it can be a difficult and lengthy process for an agency to actually get the money defined by the bond, if required. The dollar amount and length of time for a performance and maintenance bond should be determined by an individual agency.

Another option that could be considered to ensure performance and maintenance of a BMP is the establishment of an escrow account. An escrow account can be set up by either a contractor or a developer. An advantage to an escrow account is it provides immediate funding for an agency to draw on should a BMP fail during the defined maintenance period, and if the designated party(s) responsible does not satisfactorily address the issues. A disadvantage is the defined dollar amount of the escrow account must be provided to an agency upfront – this may be difficult financially for a developer or contractor.

Either a maintenance bond or escrow account provides a method for an agency to obtain funds for BMP maintenance should the developer and/or contractor not properly establish or maintain a BMP. What method used and whether an agency

chooses to use this practice are dependent on the ordinances, design criteria, and construction specifications of that particular agency.

5.3 Delegating BMP Maintenance Tasks

Like any piece of public infrastructure, an agency should enact policy ensuring access to and maintenance of a BMP, if needed. An agency should record all inspection and maintenance activities for a BMP, regardless of who is performing it, either using a standard agency issued form, or utilizing a database or infrastructure inventory software package.

5.3.1 Developer/Contractor Responsibilities

It is critical that an agency work with a developer and contractor to ensure proper short-term maintenance of a BMP. Specific details of BMP installation, as well as a short-term maintenance should be defined as part of the construction plan submittal process for agency review. A vital component to short-term maintenance is the prevention and removal of sedimentation that is a result of any adjacent construction that has impacted the BMP prior to the site being fully established.

5.3.2 Non-Professional/Professional

Routine maintenance includes tasks such as weeding, pruning, litter removal, sediment removal, and mowing can be completed by nonprofessionals and may overlap with standard landscaping demands (MARC, 2008). BMP maintenance tasks can be a great way to involve and educate the community to their purpose and function. BMPs have the potential to create a highly interactive environment for community members and volunteers to get involved.

Although a nonprofessional can undertake many maintenance tasks of a BMP effectively, a professional should be consulted periodically to ensure that all needs of the BMP facility are met (NCDENR Stormwater BMP Manual, 2007). This includes inspection of structural components, including outlets and embankments, by a professional engineer and inspection of vegetated components by an appropriate plant professional. Any construction modifications to the BMP should be completed by a trained professional.

Emergency maintenance of a BMP may be required after floods or other extreme wet weather events. These maintenance issues will require coordination between an agency and design professionals to ensure that the BMP infrastructure continues to function as designed.

5.4 BMP Maintenance Tasks

BMP maintenance tasks vary depending on whether the BMP is vegetated. This section will present maintenance task checklists and maintenance and inspection scheduling information for both vegetated BMPs (Section 5.4.1) and non-vegetated BMPs (Section 5.4.2).

BMPs with natural components (vegetation and soils) require a maintenance schedule that evolves with time. Over a course of two to three years, natural components will become established and BMP maintenance tasks will become less frequent and more routine. BMPs without natural components, such as an infiltration trench, require a different maintenance schedule. BMP maintenance tasks are divided into two phases: (1) short-term maintenance and (2) long-term maintenance. Both phases are equally important for the long-term success and function of a BMP.

- **Short-Term Maintenance.** Short-term maintenance tasks are to be completed during construction of the area surrounding the BMP, during construction and establishment of the BMP itself, and approximately the first three months after the BMP is brought online. (Sections 5.4.1.1 and 5.4.2.1)
- **Long-Term Maintenance.** Long-term maintenance tasks should occur bi-annually for the lifetime of the BMP. (Sections 5.4.1.2 and 5.4.2.2)

An example of how BMP construction and initial inspection would be incorporated into a project construction and inspection schedule is shown in Table 5-1. This table also gives a visual representation of continuing bi-annual maintenance inspections that should be completed on each BMP and an approximate time frame in which inspection and maintenance work should occur.

It is important for an agency to document installation, inspection, and maintenance activities on each BMP in their stormwater system. A construction record is recommended (Figure 5-1 and Appendix D.4). This construction record can be formatted similar to Figure 5-1, but key components should include installation date, designer and installer contact information, key inspection and maintenance dates, and any performance and maintenance bond information. Similarly, maintenance inspections should also be documented.

An agency should record all maintenance activities for a BMP, regardless of who is performing it, either using a standard agency issued form, or utilizing a database or infrastructure inventory software package.

Table 5-1 Sample Construction and Long-Term Schedule for Project Construction, BMP Installation, and BMP Maintenance

	Example Construction Schedule												Long Term Schedule											
	Month of Year												Month of Year											
	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Project site/Building Construction																								
Project site Stabilization																								
Temporary Stormwater Control at BMP Site																								
BMP Installation & Veg. Establishment																								
Post Wet-Weather Checks																								
Annual Key Milestones-BMP																								
Fall Bi-annual Inspection/Maintenance																								
Spring Bi-annual Inspection/Maintenance																								

★ Indicates inspection and/or Maintenance Activity (See corresponding checklist)

Figure 5-1 Sample BMP Construction Record

BMP Construction Record	
BMP Number	_____
BMP Type	_____
Designed By	_____
Installation Date	_____
Scheduled 3 Month Inspection Date:	_____ Actual 3 Month Inspection Date: _____
Installed By	_____
Phone	_____
Email	_____
Maintenance Bond or Escrow Account?	_____ Number: _____
Date of Expiration:	_____
Final Inspection	_____
Added to Agency Maintenance Schedule?	_____
Inspection for First Two Growing Seasons:	
1st Fall Inspection Scheduled	_____ Actual 1st Fall Inspection Date: _____
1st Fall Maintenance Completed	_____
1st Spring Inspection Scheduled	_____ Actual 1st Spring Inspection Date: _____
1st Spring Maintenance Completed	_____
2nd Fall Inspection Scheduled	_____ Actual 2nd Fall Inspection Date: _____
2nd Fall Maintenance Completed	_____
2nd Spring Inspection Scheduled	_____ Actual 2nd Spring Inspection Date: _____
2nd Spring Maintenance Completed	_____

5.4.1 Vegetated BMPs

Bioretention facilities, native grass swales, filter strips, and extended wet and dry detention facilities rely on vegetation to improve their hydraulic function. These practices are considered “vegetated BMPs” and have different maintenance requirements than BMPs without vegetation.

5.4.1.1 Short-term

These tasks are to be completed during construction of the area surrounding the BMP, during construction and establishment of the BMP itself, and approximately the first three months after the BMP is brought online. Short-term maintenance tasks are listed on Table 5-2.

Prior to and During Installation and Establishment of BMP

During construction of the areas surrounding the BMP site, take preventative action to limit disturbances such as compacting, land exposure, or pollution. This may be achieved through phased construction to limit the amount of bare soil exposed to erosion and decrease need for erosion control devices. Prior to BMP construction, development of the surrounding areas must be complete. This is to reduce potential for sediment influx to BMP and consequent clogging. For infiltration BMPs such as

bioretention facilities it is critical that excess sediment be removed and measures be taken to prevent excess sediment from entering BMP.

Install BMP vegetation in the early spring (March-April) or according to the guidelines provided by a vegetation expert. Several methods can be utilized to augment grass establishment such as mulching and cover crops to reduce competition for resources and prevent weed growth. Prevent other disturbances, such as human/animal foot traffic, through signage and fencing. Signage can also be used to raise public interest and provide education (see Section 2). Stormwater runoff should be routed away from the BMP for the minimum establishment period of 45 days in order to prevent damage. This will prevent nascent (young) grasses and expensive BMP components from being overwhelmed and/or damaged in wet weather events. Irrigate vegetation as necessary during period that stormwater is routed away from BMP to aid in establishment.

During Three Months Post-Installation

This period is to monitor BMP function during the initial three months after the BMP begins to receive stormwater. Within 24 hours of every stormwater event which results in precipitation of 0.5 inches or greater, inspect BMP to ensure that vegetation and other erosion control mechanisms are intact. Check structures for stability and remove trash and debris. This three month time frame is an opportunity to begin community involvement – they will see the evolution of the BMP. Help establish “green teams” or other community groups to help maintain BMP with weeding and trash removal. During this time it is critical that vegetation be monitored and that dead plants are replaced. Try to maintain at least a 70-percent vegetation density to ensure stability. Continue irrigation to supplement rainfall during dry summer months.

Table 5-2 Short-Term Maintenance Tasks for Vegetated BMP

Short Term Vegetated BMP Maintenance	
Prior to and During Installation and Establishment of BMP	
Task	Explanation
Encourage phased construction of development surrounding BMP	Utilize staged construction to limit erosion potential of land exposed
Provide temporary stormwater control	Stormwater runoff shall be routed around facility until vegetation is established (generally 2-3 months)
Provide site stabilization	Utilize erosion control during construction and until facility is established
Protection from foot traffic and BMP education through signage	Use fencing and signage to prevent damage from animal and human foot traffic and to initiate public interest and education
Planting of native vegetation	Optimum planting window depends on location in KS; For seeding rates and other assistance contact local NRCS
Mulching	Use mulch made from native hay or native plants to reduce potential competition for resources
Fertilization	Typically with native vegetation fertilization is not required, however consult local NRCS for fertilizing suggestions after soils test
Irrigation/Watering	Watering schedule must be established for upkeep of vegetation
During 3 Months Post-Installation	
Post wet-weather event (Precipitation > 0.5")	Ensure that vegetation and other erosion stabilizing mechanisms are intact and check inlet/outlet structures and surrounding area for signs of erosion or instability
Protection from foot traffic and BMP education through signage	Use fencing and signage to prevent damage from animal and human foot traffic and to encourage BMP education and interest
Check areas surrounding BMPs	Check for signs of erosion or instability and make sure that aesthetics are maintained throughout the BMP footprint
Irrigation/Watering	Watering schedule must be established for upkeep of vegetation
Weeding	Particularly important during initial growth to reduce competition for moisture, nutrients, and sunlight
Replacement of dead plants	All dead plants should be removed, the cause of their death investigated, and If the cause is the BMP environment, attempt growth of new plant type
Establish "Green Teams" or other community groups	Encourage community involvement and establish maintenance crews to perform routine clean out of trash and debris and to maintain appearance of BMP

5.4.1.2 Long-term

These tasks are to be completed bi-annually according to the vegetation growing season. Tasks to be carried out during these bi-annual inspections will be routine for each year of the BMP's life. Native grasses typically become fully established in two to three growing seasons. The main purpose of these inspections is to assess the BMP condition, and remedy functional and vegetation issues identified. Long-term maintenance tasks are listed on Table 5-3.

Fall Inspection - End of Growing Season (August-September)

The timing of this inspection should correspond to the tapering of vegetation growth in early fall. At this time, the vegetation should be harvested to retain the maximum nutrient value. Clip or mow vegetation to a minimum of 4-6 inches. Retain 4-6 inches of stalk to ensure winter survival and maintenance of the root systems. General clean up of the plant bed should also occur at this time to remove dead plants and invasive species. Other landscaping may be required to maintain the aesthetic condition of the BMP over the winter.

Spring Inspection-Beginning of Growing Season (March-April)

The Spring Inspection should occur at the beginning of the spring season before vegetation growth. Landscaping duties include replacing and augmenting existing vegetation. Winter weather will warrant a general clean up of the BMP to maintain aesthetics. Clean out trash and debris and clean up educational signs. This would be an optimum time for "Green teams" and active community members to help tidy the BMP site.

Common Inspection Items for Both Fall and Spring

A professional inspection should occur once a year at either the Fall or Spring inspection to assess the functional condition of the BMP. BMP structures such as dams, embankments, inlets, and outlets should be assessed for stability and function. Ways to assess BMP function include checking for standing water, sediment accumulation, and signs of erosion. Sediment should be removed from the BMP when the ground surface is completely dry. Removing sediment when the BMP is wet may cause compaction.

Check areas surrounding the BMP for signs of erosion or instability. Also make sure that aesthetics are maintained throughout the BMP footprint. Trees and other large vegetation should be removed to prevent lateral damage to the BMP via root growth. Shade-producing vegetation is not desirable in a BMP with grasses.

Table 5-3 Long-Term Maintenance Tasks for Vegetated BMP

Long Term Vegetated BMP Maintenance	
End of Growing Season (August - September)	
Task	Explanation
General Inspection	Check for standing water, slope stability, sediment accumulation, trash and debris, presence of burrows and erosion, and integrity of inlet/outlet, dam, and other engineered structures
Clean out sediments and debris	Clean out sediments and debris from inlet, outlet, the BMP and for detention basins, remove sediment when accumulation reduces the permanent pool by 10-percent or the forebay by 50-percent and dispose of appropriately
Check areas surrounding BMPs	Check for signs of erosion or instability and make sure that aesthetics are maintained throughout the BMP footprint
Mowing/Harvest	Native grasses should be trimmed to 4-6" to provide adequate biomass for regrowth the following year
Maintain BMP Signage	Repairs should be made to signage, walkways, picnic tables, or any other public recreation equipment as necessary
Winter stabilization	May be necessary to establish erosion prevention practices to maintain BMP over the winter when plants are dormant
Continue to support and educate "Green Teams" or other community groups	It is important to maintain community involvement and provide education and opportunities for service
Beginning of Growing Season (March-April)	
General Inspection	Check for standing water, slope stability, sediment accumulation, trash and debris, presence of burrows and erosion, and integrity of inlet/outlet, dam, and other engineered structures
Clean out sediments and debris	Clean out sediments and debris from inlet, outlet, the BMP and for detention basins, remove sediment when accumulation reduces the permanent pool by 10-percent or the forebay by 50-percent and dispose of appropriately
Provide site stabilization	Ensure that vegetation and other erosion stabilizing mechanisms are intact
Check areas surrounding BMPs	Check for signs of erosion or instability and make sure that aesthetics are maintained throughout the BMP footprint
Weeding/Pruning	Remove invasive and excess biomass and dispose of appropriately.
Replace/augment vegetation	Augment existing plants by same planting procedure as during construction if necessary and dead plants should be removed and replaced
Continue to support and educate "Green Teams" or other community groups	It is important to maintain community involvement and provide education and opportunities for service

5.4.2 Non-Vegetated BMPs

Infiltration trenches and other non-vegetated BMPs have no living components. These BMPs are similar to traditional stormwater systems, and thus don't require as much maintenance as vegetated BMPs. However, their stormwater capacity will be the best on the first day, whereas vegetated BMPs have the potential to become more efficient systems with time. The use of pretreatment BMPs will significantly reduce maintenance requirements of non-vegetated BMPs (Barr Engineering, 2001). Non-vegetated BMPs can be put into service right after construction (assuming tributary drainage area is stabilized) because no time is needed to establish BMP vegetation.

For practical purposes, non-vegetated maintenance tasks are broken down into two main phases similar to vegetated BMPs: (1) short-term maintenance and (2) long-term maintenance. Both phases are equally important for the long-term success and function of a BMP.

5.4.2.1 Short-term

These tasks are to be completed during construction of the area surrounding the BMP, during construction of the BMP itself, and approximately the first three months after the BMP is brought online. Short-term maintenance tasks are listed on Table 5-4.

Prior to and During Installation of BMP

During construction of the areas surrounding the BMP site, take preventative action to limit disturbances such as compacting, land exposure, or pollution. This may be achieved through phased construction, which limits the amount of bare soil exposed to erosion. Prior to BMP construction, all tributary area must be stabilized. This is to reduce potential for sediment influx to BMP and consequent clogging. For infiltration BMPs such as infiltration trenches, it is critical that the excess sediment load be eliminated.

During Three Months Post-Installation

Once the BMP has gone online, inspections should occur within 24 of every storm event which results in precipitation of 0.5 inches or greater to ensure proper stabilization and function. Water levels in observation wells should be checked at these times to ensure infiltration through the BMP matrix profile. Ponding within the trench or high levels of water in the observation well may indicate clogging in the trench bottom. Failure in infiltration trenches is most often caused by clogging in the BMP surface and is indicated by visible ponded water. When ponding occurs at the surface or in the trench, corrective maintenance is required immediately. Structures should be checked for stability and any trash and debris removed.

This three month time frame is an opportunity to begin community involvement – they will see the evolution of the BMP. Help establish “green teams” or other community groups to help maintain BMP with weeding and trash removal.

Table 5-4 Short-Term Maintenance Tasks for Non-Vegetated BMP

Short Term Non-Vegetated BMP Maintenance	
Prior to and During Installation of BMP	
Task	Explanation
Encourage phased construction of development surrounding BMP	Utilize staged construction to limit erosion potential of land exposed
Provide site stabilization	Utilize erosion control during construction and until facility is established
Encourage infiltration through BMP bottom into surrounding soil	Roto-till the bottom soil to increase potential for deep percolation
Protection from foot traffic and BMP education through signage	Use fencing and signage to prevent damage from animal and human foot traffic and to initiate public interest and education
During 3 Months Post-Installation	
Post wet-weather event (Precipitation > 0.5")	Ensure erosion stabilizing mechanisms are intact and check inlet/outlet structures and surrounding area for signs of erosion or instability
Prevent surface clogging	Remove surface debris (grass clippings, sediment, etc.) and monitor ponding
Monitor internal clogging	Check levels of well to ensure proper infiltration from BMP to surrounding soil
Check areas surrounding BMPs	Check for signs of erosion or instability and make sure that aesthetics are maintained throughout the BMP footprint
Protection from foot traffic and BMP education through signage	Use fencing and signage to prevent damage from animal and human foot traffic and to encourage BMP education and interest
Establish "Green Teams" or other community groups	Encourage community involvement and establish maintenance crews to perform routine clean out of trash and debris and to maintain appearance of BMP

5.4.2.2 Long-Term

For non-vegetated BMPs the long-term maintenance schedule should follow the same schedule as for vegetated BMPs. Tasks to be carried out during these bi-annual inspections will be routine for each year of the BMPs life. The main purpose of these inspections is to assess the BMP condition and remedy functional issues. Functional issues are typically caused by clogging. Long-term maintenance tasks are listed on Table 5-5.

Fall Inspection - End of Growing Season (August-September)

A professional inspection should occur to assess the condition of the BMP. The inspector should check for standing water, slope stability, sediment accumulation, trash and debris, and signs of erosion. Sediment should be removed from the surface of the BMP when the surrounding ground surface is completely dry. Removing sediment when the BMP is wet may cause compaction.

At this time, check for signs of clogging. Internal clogging can be observed via an observation well. Ponding of surface water 24 hours after a rain event could indicate surface clogging. If the clogging appears to be only at the surface, it may be necessary to remove surface material and replace filter material. Clogging inside the trench (water in observation well for longer than 24 hours) may require complete excavation and replacement of bed material. Remove sediment accumulated at the bottom of BMP, repair base as necessary, and then replace filter material.

Check areas surrounding the BMP for signs of erosion or instability. Also make sure that aesthetics are maintained throughout the BMP footprint. Trees and other large vegetation should be removed to prevent lateral damages caused by roots. At this time it may be necessary to establish erosion prevention practices to maintain the BMP when soils become frozen and surface materials may freeze

Spring Inspection-Beginning of Growing Season (March-April)

A professional inspection should be completed during the spring maintenance period if the annual professional inspection was not fulfilled during the fall maintenance period. Winter weather will warrant a general clean up of the BMP and surrounding areas to maintain aesthetics. Clean out trash and debris and clean up educational signs. This would be an optimum time for “Green Teams” and active community members to help tidy the BMP site.

Check areas surrounding the BMP for signs of erosion or instability. Also make sure that aesthetics are maintained throughout the BMP footprint. Trees and other large vegetation should be removed to prevent lateral damages.

Table 5-5 Long-Term Maintenance Tasks for Non-Vegetated BMP

Long Term Non-Vegetated BMP Maintenance	
End of Growing Season (August - September)	
Task	Explanation
General Inspection	Check for standing water, slope stability, sediment accumulation, trash and debris, presence of burrows and erosion, and integrity of inlet/outlet, dam, and other engineered structures
Clean out sediments and debris	Clean out sediments and debris from surface and check for signs of ponding or clogging
Check areas surrounding BMPs	Check for signs of erosion or instability and make sure that aesthetics are maintained throughout the BMP footprint
Maintain BMP Signage	Repairs should be made to signage, walkways, picnic tables, or any other public recreation equipment as necessary
Winter stabilization	May be necessary to establish erosion prevention practices to maintain BMP when soils become frozen and surface materials may freeze
Continue to support and educate "Green Teams" or other community groups	It is important to maintain community involvement and provide education and opportunities for service
Beginning of Growing Season (March-April)	
General Inspection	Check for standing water, slope stability, sediment accumulation, trash and debris, presence of burrows and erosion, and integrity of inlet/outlet, dam, and other engineered structures
Prevent surface clogging	Remove surface debris (grass clippings, sediment, etc.) and monitor ponding
Monitor internal clogging	Check levels of well to ensure proper infiltration from BMP to surrounding soil
Clean out sediments and debris	Clean out sediments and debris from surface and check for signs of ponding or clogging
Provide site stabilization	Ensure that BMP media and other erosion stabilizing mechanisms are intact
Maintain aesthetics	General clean up of the BMP and surrounding areas to maintain aesthetics
Check areas surrounding BMPs	Check for signs of erosion or instability and make sure that aesthetics are maintained throughout the BMP footprint,
Continue to support and educate "Green Teams" or other community groups	It is important to maintain community involvement and provide education and opportunities for service