

Module 7: Post-Construction Inspections of 15 Non-Proprietary BMPs

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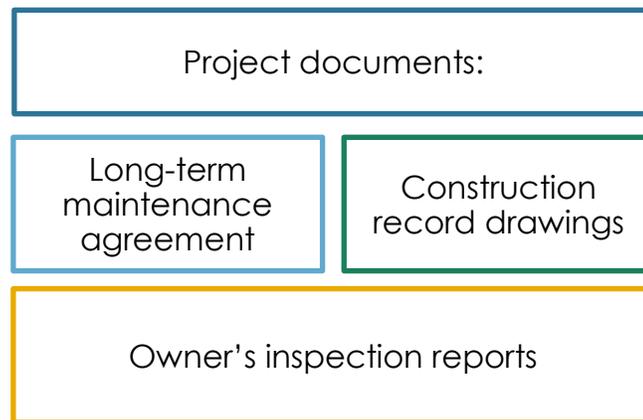
Objectives

- Identify common BMP maintenance issues
- Identify common signs of BMP failure
- Describe common post-construction inspections elements across the 15 non-proprietary BMPs
- Use long-term maintenance agreements and construction record drawings to locate relevant BMP post-construction details for use during inspection

7a. Overview

The success of a stormwater management facility is achieved through continuous maintenance by the owner. The VSMP inspector is responsible for conducting post-construction inspections to ensure stormwater management facilities are being maintained as designed.

This module will cover post-construction inspections of stormwater management facilities from utilizing project documents such as long-term maintenance agreements, construction record drawings, and the owner's inspection reports to the common BMP maintenance issues which should be a primary focus for an effective inspection program.



LONG-TERM MAINTENANCE AGREEMENT

The long-term maintenance agreement serves as an important inspection reference for both the owner and the VSMP inspector and may include the following information:

- Owner maintenance and inspection frequency (see Table 7.1)
- Components to be inspected
- Common problems to look for
- Remedies for any problems that may occur

Suggested Owner Inspection Frequency for BMPs

Table 7.1

Inspection Frequency	BMPs
Monthly and within 24 hours after every water quality storm (greater than 1-inch of rainfall); and at least twice after storm events that exceed 1.5 inch of rainfall during the first 6 months after installation	<ul style="list-style-type: none"> • Constructed Stormwater Wetlands • Wet Ponds • Wet Extended Detention Basins • Bioretention Cells
Quarterly and within 24 hours after every water quality storm (greater than 1-inch of rainfall)	<ul style="list-style-type: none"> • Level Spreaders • Infiltration Devices • Filter Practices • Dry Extended Detention Basins • Permeable Pavement • Rain Tanks and Cisterns • Vegetated Roofs • Filter Strips* • Wet and Dry Swales* • Grass Channels* • Restored Riparian Buffers*

*Usually more frequent mowing during growing season

Source: NCDENR, 2007 – Included in DEQ Draft Stormwater Management Handbook

CONSTRUCTION RECORD DRAWINGS

The construction record drawing, another important reference document for the VSMP authority, documents the condition of the stormwater management facility when it was installed. By comparing the condition at inspection with the condition when operation first began, it can be determined if the facility continues to operate as intended.

For example, a practice could require maintenance dredging or the replacement of components that have completed their useful design life. The construction record drawings are critical for determining the extent of dredging or the design of components that need to be replaced so the facility can continue to function as intended.

OWNER'S INSPECTION REPORTS

The owner's inspection reports are an important source of information for the VSMP inspector in determining the effectiveness of the owner's inspections and helping to establish if regular maintenance of BMPs is being conducted.

For example, contrary to common assumptions nonstructural BMPs, such as vegetated measures, require routine inspection and maintenance. In fact, proper maintenance of non-structural BMPs is essential for continued performance. Like structural BMPs, restored natural and riparian areas, disconnected impervious surfaces, grass channels, and similar practices can fail if inspections and monitoring are not routinely conducted. These requirements should be prescribed in the long-term maintenance agreement.

7b. Common BMP Maintenance Issues

Many of the stormwater BMPs share common components (e.g. vegetation, pre-treatment areas, inlets, outfalls) and/or principle mechanisms of operation (e.g., filtration, settling, infiltration). Consequently, there are several common maintenance activities and issues associated with BMPs. For example, sediment build-up and debris at BMP inflow points may prevent sheet flow from reaching pervious areas or buffers, or vegetation used to restore natural areas may not have adequate survival rates. Additionally, landowner practices and behaviors, such as dumping yard waste and re-routing roof drains, may compromise the functionality of nonstructural BMPs. The following section discusses some of the more common maintenance issues associated with stormwater BMPs.

DEVIATION FROM CONSTRUCTION RECORD DRAWING

Overtime, maintenance or lack of maintenance may cause a BMP to deviate from the construction record drawing. This can result in:

- Encroachments in the BMP
- Incorrect vegetation
- Incorrect sizing
- Grading problems



Photo credit:
Center for Watershed Protection

DEBRIS AND LITTER

Debris and litter can lead to the following:

- Increased clogging risk for outlet structures, trash racks, and other facility components
- Increased risk of damage to vegetated areas
- Increased likelihood of stagnant pool formation
- Greater mosquito breeding habitats
- Optimal conditions for excessive surface algae
- Decreased facility aesthetics



Photo credit:
Stormwater Maintenance LLC

EROSION

Erosion is quite common in or around the inlets and outlets of BMP facilities. Erosion can lead to the following:

- Clogging of the facility with sediment and threatening its integrity
- Roots of woody vegetation (e.g., young trees and shrubs) can cause embankments to be unstable.
- Animal burrows diminish the structural integrity of an embankment.
- Sinkholes on embankments or basin and channel bottoms

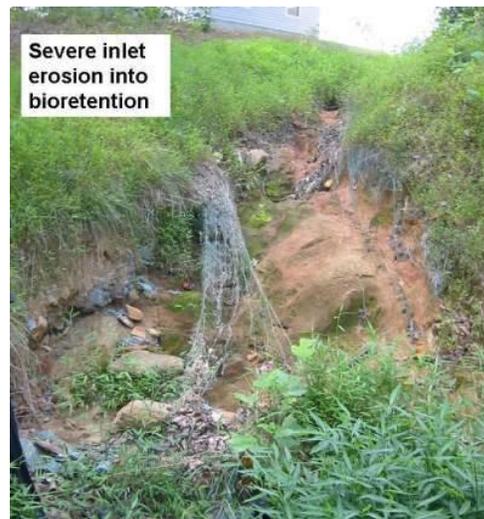


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Center for Watershed Protection

SEDIMENT BUILDUP

Sediment buildup can lead to the following:

- Reduced effectiveness of pretreatment practice
- Blockage at inlet
- Reduced infiltration rates



Sediment buildup in pretreatment area
Photo credit:
Center for Watershed Protection

VEGETATION

Sparse, dying vegetation, bare spots, and rills indicates that a BMP is not functioning properly, which can lead to the following:

- Erosion
- Excessive sediment accumulation
- Reduced pollutant removal



Sparse vegetation
Photo credit:
Center for Watershed Protection

Common Maintenance Issues

Table 7.2

Type of Practice	Issues
Stormwater Ponds	<ul style="list-style-type: none"> • Sediment build-up • Woody vegetation on dam • Slumping, animal burrows, and seepage associated with dam • Clogging of orifices • Unauthorized access to deep water areas, risers, pipes, and • Overgrown vegetation and trash • Standing water and mosquito habitat (mostly associated with dry extended detention ponds)
Stormwater Wetlands	<ul style="list-style-type: none"> • See above for ponds • Invasive species
Filtering Practices	<ul style="list-style-type: none"> • Clogged filter surface • Clogged filter media • Sediment build-up in sedimentation chamber (e.g., sand filters)
Infiltration Practices	<ul style="list-style-type: none"> • Clogging • Standing water
Bioretention	<ul style="list-style-type: none"> • Sparse vegetative cover • Clogging at inflow points (e.g., curb cuts) • Clogged underdrains • Impact from road salt and snow plows in cold climates
Open Channels	<ul style="list-style-type: none"> • Sediment build-up • Sparse vegetation • Erosion • Debris • Standing water
Grass Channels	<ul style="list-style-type: none"> • Sediment build-up • Erosion • Sparse vegetation • Standing water
Impervious Area Disconnection	<ul style="list-style-type: none"> • Runoff bypasses practice • Sediment and debris build-up at points where runoff enters pervious area • Adjacent uses pipe runoff through or around pervious areas • Sparse vegetation
Sheetflow to Buffer or Open Space	<ul style="list-style-type: none"> • Concentrated runoff (erosion rills and gullies) • Adjacent uses pipe runoff through open space or buffer
Natural Area Conservation and Restoration	<ul style="list-style-type: none"> • Encroachments (yard waste, cutting of trees, clearing, sheds, decks, etc.) • Invasive species

Source: CWP, 2008 - Included in DEQ Draft Stormwater Management Handbook

7c. Post-Construction Inspections of 15 Non-Proprietary BMPs

SPEC. 1 ROOFTOP (IMPERVIOUS SURFACE) DISCONNECTION

Look for the following potential problems:

- Practice is not accessible
- Practice does not match the construction record drawing
- Encroachments (e.g., new buildings, sidewalks, driveways, etc.) that impact the disconnection pathway or receiving pervious area
- Sediment/debris accumulation
- Mosquitoes
- Runoff is not entering the receiving pervious area
- Downspouts are not disconnected
- Downstream treatment is not being maintained
- Ponding at point of disconnection
- Erosion at downstream practice (e.g., bioretention/rain garden, filter path)



Downspouts and impervious areas does not flow to disconnection pathway



Ponding at point of disconnection

Source: DEQ Draft Stormwater Management Handbook

**SPEC. 2 SHEET FLOW TO A VEGETATED FILTER STRIP OR
CONSERVED OPEN SPACE**

Look for the following potential problems:

- Practice is not accessible
- Practice does not match the construction record drawing
- Flows through filter strip short-circuiting overflow control section
- Debris and/or sediment build-up at the top of the filter strip
- Compromised gravel diaphragm (e.g, foot or vehicle traffic)
- Scour and erosion within the filter strip
- Sediment in level spreader forebays and flow splitters
- Vegetated cover of less than 90%

* Ideally, inspections should be conducted in the non-growing season when it easier to see the flow path.



Level spreader showing signs of standing water, short-circuiting and sediment/debris

Source: Design Spec. No. 2 pg. 18

SPEC. 3 GRASS CHANNELS

Look for the following potential problems:

- Practice is not accessible
- Practice does not match the construction record drawing
- Encroachments (e.g., new buildings, sidewalks, driveways, etc.)
- Less than 90% vegetative cover
- Sand or sediment deposits behind check dams
- Evidence of undercutting or erosion at check dams
- Trash or blockages at weepholes
- Erosion, braiding, excessive ponding or dead grass in channel bottom
- Clogging at inflow points
- Rill or gully erosion on side slopes and/or grass filter strip
- Bare soil or sediment sources in the contributing drainage area



Erosion, dead grass in channel bottom



Erosion of grass filter strip

Source: Design Spec. No. 3 pg. 20

SPEC. 4 SOIL COMPOST AMENDMENT

Look for the following potential problems:

- Practice is not accessible
 - Practice does not match the construction record drawing
 - Encroachments (e.g., new buildings, sidewalks, driveways, etc.)
 - Trash and debris
 - Bare or eroding areas in contributing drainage area or around soil restoration area
 - Evidence of excessive use of fertilizer or lawn chemicals
 - Runoff is ponding, creating rills and/or causing erosion
 - Erosion and/or bare or exposed soil
-



Compost amended area in first spring following fall planting
Bare spots around perimeter

Source: DEQ Draft Stormwater Management Handbook

SPEC. 5 VEGETATED ROOF

Look for the following potential problems:

- Practice is not accessible
- Practice does not match the construction record drawing
- Plant cover is less than 90%
- Wilting plants
- Leaves and woody debris
- Invasive and nuisance plants
- Drought conditions
- Pest infestation
- Trash and debris
- Waterproof membrane is leaking or cracked
- Root barrier is perforated
- Ponding water
- Mosquito habitat



Good vegetative cover
Courtesy Chesapeake Bay Program

Source: DEQ Draft Stormwater Management Handbook

SPEC. 6 RAINWATER HARVESTING

Look for the following potential problems:

- Practice is not accessible
 - Practice does not match the construction record drawing
 - Excessive overhanging vegetation/tress
 - Gutters are clogged and water is backed up
 - Mosquito habitat
 - Lids are damaged
 - Erosion at overflow discharge point, along filter path/secondary reduction practices
 - Overflow pipe in poor condition
-



Rainwater harvesting system
Courtesy Chesapeake Bay Program

Source: Design Spec. No. 6 pg. 31 and DEQ Draft Stormwater Management Handbook

SPEC. 7 PERMEABLE PAVEMENT

Look for the following potential problems:

- Practice is not accessible
- Practice does not match the construction record drawing
- Standing water in observation well 3 days after storm event in excess of ½ inch
- Evidence of sediment deposition, organic debris, staining, or ponding
- Signs of surface deterioration (e.g., slumping, cracking, spalling, broken pavers)
- Sediment buildup in pretreatment cells, inlets
- Observation well not capped
- Sources of sediment in contributing drainage area



Observation well

Photo credit: Stormwater Maintenance LLC



Organic debris on porous concrete



Surface deterioration

Photo credit: Stormwater Maintenance LLC



Erosion in contributing drainage area

Source: Design Spec. No. 7 pg. 22 and DEQ Draft Stormwater Management Handbook

SPEC. 8 INFILTRATION PRACTICES

Look for the following potential problems:

- Practice is not accessible
- Practice does not match the construction record drawing
- Standing water in observation well 3 days after storm event in excess of ½ inch
- Sediment buildup in pre-treatment cells, inlets
- Structural damage
- Observation well not capped
- Vegetative cover less than 90%
- Sources of sediment in contributing drainage area
- Sparse vegetative cover, erosion or slumping



Too much mulch and grass clippings, and overgrowth of grass which over time would lead to thick mat of weeds over gravel



Weeds and other vegetation indicate accumulation of fines and sediment



Sediment in grass filter strip

Source: Design Spec. No. 8 pg. 19 and DEQ Draft Stormwater Management Handbook

SPEC. 9 BIORETENTION AND 10 DRY SWALE

Look for the following potential problems:

- Practice is not accessible
- Practice does not match the construction record drawing
- Less than 75-90% cover (mulch plus vegetation)
- Sediment buildup at curb cuts, gravel diaphragms or pavement edges
- Winter or salt killed vegetation
- Sand, sediment, trash in pre-treatment cell or filter beds
- Sources of sediment in contributing drainage area
- Rill or gull erosion on side slopes and/or grass filter strip
- Clogging at inflow
- Mulch flotation in bed
- Excessive ponding, dead plants or concentrated flows
- Clogged or slow-draining soil media, incorrect soil media
- Standing water on surface 48 hours after a storm
- Clogged underdrains (check observation well)
- Erosion at outlet
- Mosquito habitat



Sediment and organic debris buildup at curb cut



Uneven ponding
Photo credit:
Stormwater Maintenance LLC



Slope erosion

Photo credit: Stormwater Maintenance LLC



Clogged underdrain

Source: Design Spec. No. 9 pg. 38, Design spec. No. 10 pg. 20, and DEQ Draft Stormwater Management Handbook

SPEC NO. 12 FILTERING PRACTICES

Look for the following potential problems:

- Practice is not accessible
- Practice does not match the construction record drawing
- Debris at inlet and/or flow splitters
- Standing water or ponding more than 48 hours after a storm
- Sources of sediment in contributing drainage area
- Turf on filter bed and buffer is more than 12 inches high
- Damage to observation well and/or cleanout pipes
- Evidence of spalling, joint failure, leakage, corrosion at concrete structures and outlets

*Underground filter practices can only be inspected by individuals with confined space entry training



Sediment on filter bed



Underground filter cartridges

Source: Design Spec. No. 12 pg. 15 and DEQ Draft Stormwater Management Handbook

SPEC. 13 CONSTRUCTED WETLANDS AND NO. 11 WET SWALES

Look for the following potential problems:

- Practice is not accessible
 - Practice does not match the construction record drawing
 - Sediment accumulation in forebays and micropools
 - Material damage, erosion or undercutting at inlets
 - Sloughing, animal burrows, boggy areas, woody growth or gully erosion on banks
 - Erosion, undercutting, rip-rap displacement, woody growth at outfall
 - Spalling, joint failure, leakage, corrosion of principal spillway or riser
 - Clogging, leakage, debris accumulation at trash racks, reverse-sloped pipes, flashboard risers
-



Woody vegetation needs to be controlled

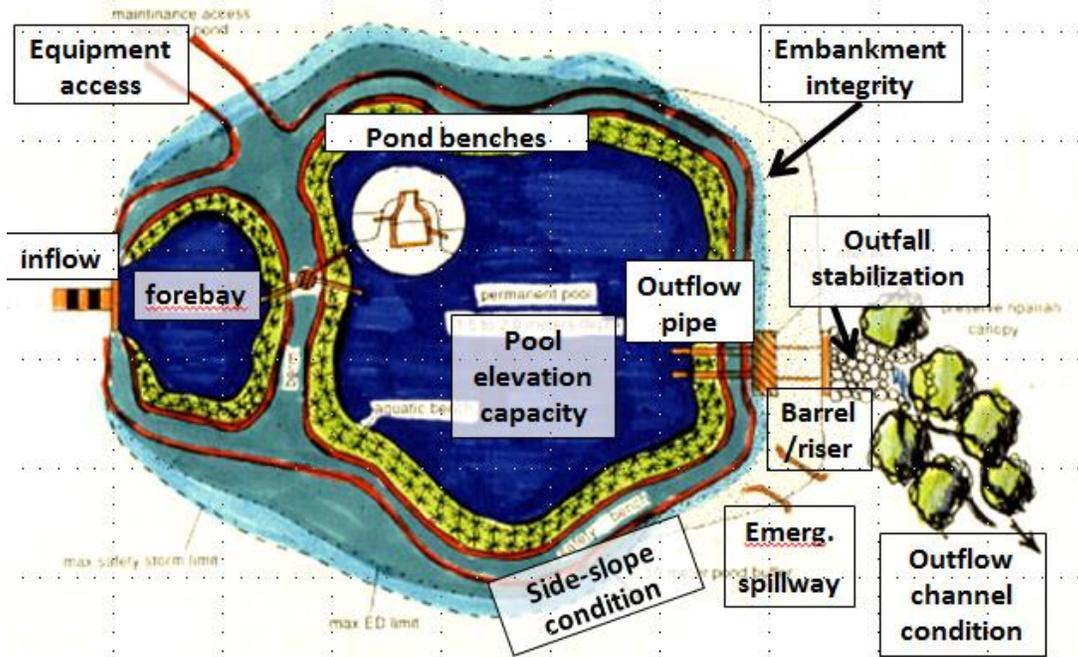


Structural elements are vulnerable to erosion, clogging, sediment accumulation, etc.

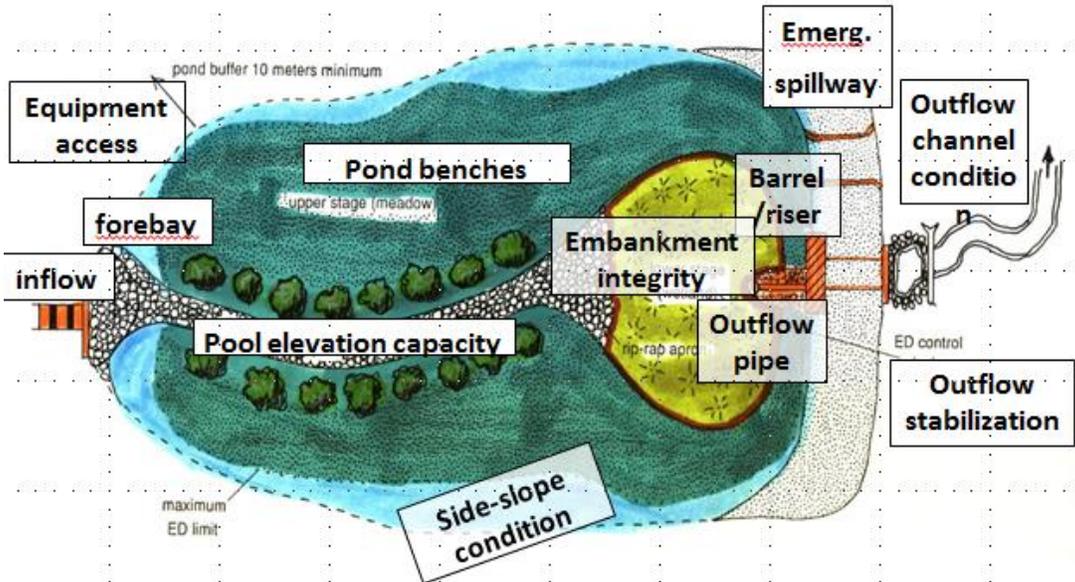
Source: Design Spec. No. 13 pg. 27-28 and DEQ Draft Stormwater Management Handbook

SPEC. 14 WET PONDS AND
15 EXTENDED DETENTION

Key Inspection Zones: Wet Pond



Key Inspection Zones: ED Pond





1. Inflow Pipe(s) - Look for:

- Scour
- Metal Pipe Corrosion
- Blockage



2. Equipment access – Look for:

- Easement width
- Vegetation growth in easement
- Slope
- Fences
- Locks



3. Forebay – Look for:

- Presence/absence
- Need for cleanout
- Trash/debris
- Conveyance to main pond



4. Pond benches – Look for:

- Presence or absence
- Vegetative condition
- Trash/floatables
- Erosion



5. Pool elevation – Look for:

- High pool indicates:
 - Incorrect design, or
 - Clogged outfall
- Low pool indicates:
 - Potential seepage at outfall or thru embankment
 - sediment accumulation
- Variable pool indicates:
 - Bad ED design



6. Side-slope condition – Look for:

- Ability to mow
- Vegetative cover
- Rill erosion
- Slumping



7. Embankment integrity – Look for:

- Trees on the embankment
- Sloughing
- Burrows
- Seepage through embankment
- Moist areas on toe
- Voids/moisture around barrel



8. Pool Outflow pipe/drain- Look for:

- “Plumbing” can be accessed and is in operable condition



9. Barrel and riser – Look for

- Barrel Corrosion or joint deflection
- Seepage around barrel



10. Emergency spillway – Look for:

- Erosion or sloughing
- Tree growth
- Blockages
- Capacity



11. Outfall stabilization – Look for:

- Erosion
- Rip-rap displacement
- Blockage



12. Outfall channel condition – Look for:

- Check for pipe under-cutting
- Pond slime
- Downstream Channel stability

Other Common Problems:

- Graffiti/ Vandalism
- Lock or fence problems
- Illegal dumping
- Geese
- Mosquitoes

Source: Design Spec. No. 14 pg. 18-20, Design Spec. No. 15 pg. 14-15

References

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