

**A Citizen's Handbook for
Maintaining Stormwater Best
Management Practices**

Knox County, TN

Knox County Stormwater Management

**Prepared In Coordination With
Stormwater Solutions
August, 2013**



Table of Contents

<u>Section</u>	<u>Page</u>
Purpose.....	3
What is Stormwater Runoff?	3
Importance of Stormwater Treatment Systems	4
Requirements and Responsibilities.....	5
Maintenance Plans	7
Common BMPs	11
wet ponds, dry ponds, swales, vegetated buffers, bioretention, porous pavement, basic maintenance needs, indicators for maintenance, poorly maintained BMP examples	
Good Housekeeping Practices.....	15
Appendices	
A1 Inspection Checklists and Maintenance Guidelines.....	17
A2 Contacts and Links.....	26
A3 References and Credits.....	27



Purpose

This guide has been prepared to:

- help you identify stormwater systems in your neighborhood,
- describe stormwater inspection and maintenance requirements,
- provide inspection and maintenance guidelines for your stormwater systems, and
- identify resources available to provide assistance.

Effective stormwater management is a partnership between homeowners associations, individual homeowners, and Knox County Stormwater Management.

What is Stormwater Runoff?

Stormwater runoff is generated when precipitation from rain and snowmelt events flows over land or impervious surfaces and does not percolate into the ground.

The water picks up pollutants such as sediment, litter, oil, fertilizer, and animal waste as it flows into storm drains. This untreated water empties directly into our creeks, rivers, and lakes. The best method to control stormwater discharges is the use best management practices designed to retain and treat stormwater.



Stormwater runoff is the most common cause of water pollution. We all contribute to that pollution and have a responsibility to minimize it. Regular inspection of structural stormwater best management practices (BMPs) in our neighborhoods will protect our property and help keep our water clean.

BMPs – best management practices designed to reduce pollution from stormwater runoff. Wet and dry detention ponds are examples of structural BMPs.

Importance of Stormwater Treatment Systems

You may have stormwater treatment systems on or near your property and not realize it. Ponds, ditches or patches of pervious concrete may actually be engineered stormwater BMPs designed to reduce flooding and enhance water quality.



The most common BMPs found in Knox County neighborhoods are:

- Stormwater ponds
- Vegetated swales
- Vegetated buffers
- Bioretention areas, such as rain gardens, and
- Porous pavement

Each of these BMPs, described later in this guide, is designed to filter or separate pollutants from stormwater

runoff and/or control its flow. They are also designed to protect your property from flooding.

All stormwater controls require regular maintenance.

For example, ponds become repositories for sediment, litter and oil. Vegetated areas used to filter out pollutants can become overrun with invasive, non-native plants that prevent long-rooted native vegetation from flourishing. Eroded slopes and banks increase the amount of sediment in our waterways, adversely affecting fish and plant life.

Routine maintenance is vital to ensure stormwater BMPs remain effective and function as designed.

Regular inspection and maintenance of stormwater BMPs in your neighborhood reduces the potential for flooding and improves water quality.



Requirements and Responsibilities

What are the requirements for homeowners and HOA's?

Proper maintenance of stormwater facilities and best management practices is one of the most important factors in the long-term performance and effectiveness of a stormwater management plan. Knox County requires property owners or homeowners associations to properly maintain the stormwater system and BMPs located on private property.

Routine inspection and maintenance of stormwater BMPs protects you, the homeowner, from property damage caused by flooding. In addition, the costs associated with regular maintenance are far less than those required to replace a failed system.



Detention area used as play area

Homeowners and HOAs are bound by the requirements set forth by Section 5.1.3 of the *Knox County Stormwater Management Manual Vol. 1*.

The manual, based on Knox County's Stormwater Ordinance, states that property owners have the responsibility to ensure stormwater BMPs are maintained and function as designed. These requirements are also stipulated in Operations and Maintenance (O&M) Plans for property developed since 2008.

O&M Plans are recorded with the property deed, and contain *Covenants for Permanent Maintenance of Stormwater Facilities and Best Management Practices*. Also known as maintenance covenants or maintenance agreements, these documents assign responsibility for BMP maintenance to the property owner(s). If there is an O&M Plan for your neighborhood it will:

- locate and identify the types of stormwater BMPs,
- provide inspection and maintenance schedules and requirements, and
- locate drainage and access easements.

If you do not have an O&M Plan, you can call Knox County Stormwater Management at 865-215-5540 for assistance in determining your responsibilities.

All homeowners and HOAs should be familiar with requirements set forth in their neighborhood's maintenance agreements.

Homeowners should also maintain inspection and maintenance records. Checklists included with the property's O&M Plan, or those included in *Appendix A1* of this guide, can be used for documentation.

*State mandated standards require that BMPs be inspected by a professional engineer or landscape architect every 5 years. Property owners will still be required to conduct annual inspections and document all inspection and maintenance activities.

What is Knox County's role?

Knox County is responsible for ensuring maintenance agreements are followed and for maintaining stormwater systems on public right-of-ways.

Knox County's enforcement responsibility includes periodic inspection of BMPs in your neighborhood. Notices of Violation (NOVs) may be issued if warranted.

If necessary, Knox County can perform corrective actions not addressed by property owners. The maintenance agreements require property owners to reimburse the county for expenses incurred.

Who's Responsible?

Homeowners must...

- Inspect BMPs in accordance with maintenance agreements
- Provide necessary maintenance
- Keep inspection and maintenance records
- After May 2015, ensure BMPs are inspected by a professional engineer or landscape architect every 5 years

Knox County must...

- Enforce provisions of maintenance agreements
- Periodically inspect BMPs located on private property
- Issue NOVs if necessary and ensure corrective actions are performed
- Maintain stormwater systems located in public right-of-ways

Drainage problems in your neighborhood can be prevented by regular BMP inspection and maintenance. If a problem arises, however, it may be necessary to contact a professional with expertise in drainage engineering.

Maintenance Plans

A maintenance plan should be developed to ensure responsibilities are assigned, inspection frequencies established, and efforts documented.



Components of a BMP Maintenance Plan

- ✓ ***Regulatory and legal requirements***
- ✓ ***BMP inventory***
- ✓ ***Assigned responsibilities for inspection and maintenance***
- ✓ ***Inspection frequencies***
- ✓ ***Inspection checklists***
- ✓ ***Maintenance activities for BMPs***
- ✓ ***Recordkeeping requirements***
- ✓ ***Resource allocation***
- ✓ ***Education***
- ✓ ***Annual program reviews***

Regulatory and Legal Requirements

BMPs on private property must be maintained by the property owner. Consult your O&M plan to determine

inspection and maintenance requirements. If you don't have an O&M plan, refer to the Knox County Stormwater Ordinance. You may also want to consult Knox County's Stormwater Management Manual for proper maintenance methods.

It is important to understand the legal implications of failing to maintain drainage systems on your property or in your neighborhood.

BMP Inventory

Use the plat to locate your BMPs and associated easements. Walk the site and note the condition of each. If the site contains older or complex BMPs, you may want to contact a professional with expertise in stormwater drainage for assistance.

Responsibilities

Designate a responsible person to ensure BMPs are inspected on a routine basis and maintenance is performed as required. Choose a person interested in the task who is detail-oriented, reliable, and willing to train others. Document inspector responsibilities as part of the maintenance plan. The services of a BMP inspection and maintenance

company, professional engineer or landscape architect may be required, depending on the condition and complexity of your stormwater systems.

Inspection Frequency

Your plan should specify an inspection frequency for each BMP. This will be determined by BMP complexity and the requirements set forth in the maintenance agreements. If a maintenance agreement doesn't exist for your neighborhood, follow the guidelines set forth in *Appendix A1*.

Inspection Checklists & Maintenance Activities

Inspection checklists, specific for each BMP, are important to ensure thoroughness and for documentation purposes. Inspection checklists are included in *Appendix A1* and may also be found in the O&M Plan for sites developed since 2008. Maintenance activities for each BMP are also found in *Appendix A1*.

Recordkeeping

The plan should specify how completed inspection checklists and BMP maintenance records will be retained. Also include your neighborhood site map, which identifies and locates all stormwater BMPs. (The map can be obtained from your O&M Plan or from Knox County Stormwater Management. See *Appendix A2*.) Your records should include identification numbers for each BMP, BMP type and location, data from previous inspections, special maintenance needs and photos of your BMPs.

Resource Allocation

Identify costs and funding mechanisms. How will funds be collected and distributed? Work with drainage professionals to estimate the costs of complex maintenance needs.

Education

Use HOA meetings or newsletters to ensure homeowners, particularly those living adjacent to a BMP, understand the function of their stormwater systems. For example, vegetated buffers shouldn't be mowed to make them more aesthetically pleasing, and ponds should be kept free of invasive vegetation. Review the simple

and effective steps provided in *Good Housekeeping Practices* (page 12) with all homeowners.

Annual Program Reviews

Review your inspection and maintenance program on an annual basis.

- Are inspection and maintenance activities being conducted at the appropriate frequency and documented as required?
- Are the checklists appropriate for your BMPs? Is modification required?
- Are you satisfied with the services of your landscaping or inspection and maintenance contractors?
- Are appropriate resources allocated to the program? Do you need to adjust HOA fees?

Engage Your Neighbors In Stormwater Management



Use HOA meetings to fine tune the maintenance plan. Assign responsibilities, discuss drainage issues, or organize neighborhood clean-up days.

A Word About Easements...

Easements are required for BMPs located on your property or in your neighborhood. These legally binding agreements, noted on the plat and in O&M plans, allow Knox County to access stormwater BMPs. Property owners are required to maintain access points.

Take Care of Your Easements

- ❖ Don't erect structures that prevent access or obstruct the flow of water, such as walls, buildings or sheds
- ❖ Avoid planting woody vegetation within the easement area
- ❖ Be aware that maintenance activities may require removal of temporary structures, such as fencing or paving, at homeowner's expense.

Who Should Perform Maintenance?

Consider cost, safety and effectiveness when determining who should perform BMP maintenance. Routine tasks, such as litter removal and landscaping, can be carried out by homeowners.

For more difficult work (mowing or working on sloped embankments, stabilizing eroded areas, removing sediment from ponds, or repairing/cleaning inlets and outlets) consider using the services of a professional landscaping or BMP inspection and maintenance company.

Extensive maintenance work may require the services of a professional engineer or landscape architect. Erosion; sink holes; a rusty, broken, or crushed pipe; odor; or algae blooms are all clear indications to call a consulting engineer.

Tips for Choosing a Contractor



How do you determine that a stormwater inspection and maintenance firm, landscaping service or contractor is

qualified to inspect and/or maintain your stormwater BMPs?

Choose a contractor who:

- ❖ understands the hydrology (the movement and distribution of water) in your area,
- ❖ is able to locate and identify the function of your stormwater BMPs,
- ❖ is familiar with the requirements of maintenance agreements,
- ❖ knows who to contact for technical assistance, and
- ❖ provides thorough documentation of all inspections and/or maintenance performed.

As of May, 2015, Knox County's stormwater ordinance will require that structural BMPs be inspected by a Professional Engineer or landscape architect at least once every 5 years. These professionals should have expertise in drainage engineering.

When working with lawn care companies for simple maintenance, be sure to

- *Communicate that BMP facilities are water quality devices.*
- *Communicate mowing practices: for instance, mowing at a higher level, not as frequently, or not at all, especially in buffer areas.*
- *Communicate the need to keep the BMP facility clear of grass clippings and leaf piles*
- *Verify the company uses minimal or no pesticides, and has a policy of not applying chemicals when there is a heavy rainfall in the forecast.*

Common BMPs

This section describes the most common structural BMPs found in Knox County neighborhoods, and summarizes basic maintenance requirements.

Homeowners are encouraged to use the inspection checklists and detailed maintenance guidelines provided in *Appendix A1*. These checklists, specific for each type of BMP, will help ensure the maintenance needs of each BMP are thoroughly addressed. They are also convenient for tracking and documenting your stormwater management efforts.

Wet Retention Ponds

Wet ponds may appear to be natural ponds, but they are specially *designed to* control stormwater runoff volume and quality.

Excess runoff is stored above a permanent pool of water and discharged at a controlled rate through an outlet.



Water quality is controlled through pollutant settling and absorption.

Dry Detention Ponds

Although dry ponds are sometimes



viewed as a waste of space, they are specifically designed to

collect and temporarily hold stormwater runoff. Knox County generally requires extended dry detention basins. In this case, settling rather than filtration is the pollutant removal mechanism.

Vegetated Swales



Swales are open, channel-like systems used to convey stormwater runoff. Although

swales may look like typical ditches, they are designed to slow water flow and absorb pollutants. They may be used to convey water to another BMP, such as a detention pond. Swales are often located along roadsides or parking lots.

Vegetated Buffers

Buffers are areas of vegetation established adjacent to waterways to slow stormwater runoff, provide an area where runoff can permeate the soil, and filter pollutants.



Bioretention



Bioretention areas, usually recessed and often referred to as rain gardens, are landscaping features that use engineered



soils and vegetation to capture, filter and store stormwater runoff.

Porous Pavement

An alternative to traditional asphalt or concrete, porous pavement is a



permeable pavement surface with a stone reservoir underneath. The



reservoir temporarily stores surface runoff before infiltrating it into the soil, thereby providing some water quality treatment.

Basic Maintenance

The basic maintenance guidelines that follow provide a glimpse of the efforts required to keep stormwater systems functioning properly. Homeowners are advised to use the checklists provided in *Appendix A1*, however, to ensure BMP-specific maintenance needs are addressed. Note that it may be necessary to consult with a professional who has expertise in drainage engineering for repeated or complex problems.

Basic BMP Maintenance

- ✓ Remove debris from inlet/outlet structures.
- ✓ Thick and healthy native vegetation is desirable, but keep stormwater ponds free of invasive vegetation. Proper vegetation may be addressed in the O&M Plan, or refer to Appendix A2.
- ✓ Repair eroded slopes.
- ✓ Don't fill ponds or swales with dirt. Remove sediment from ponds when it becomes noticeable.
- ✓ Keep trash, debris and grass clippings out of swales and ponds and away from storm drains.
- ✓ Inspect BMPs following any major rain event.

Indicators for Maintenance

Following are some common conditions that indicate a need for stormwater system maintenance.

Erosion

Finding the source of erosion and stabilizing it can improve the effectiveness of a wet basin or swale. Left unchecked, an erosion problem can necessitate dredging, replacement of an entire embankment or slope, or even an inlet structure. A prime cause of erosion is lack of deep-rooted vegetation that holds soil in place.

Mosquitos

Mosquito's breeding grounds can be created in shallow ponds of standing water. It is likely the infiltration capacity of the BMP needs to be increased, or sediment needs to be removed. An insect control option for larger wet basins is to maintain a stock of fish to feed on mosquito larvae. In addition, natural vegetated buffers can provide shelter for mosquito predators.

Algae Growth

A healthy wet basin should require little maintenance. A good indicator of an unhealthy ecosystem is excessive algae growth. This could be caused by nutrients from fertilization practices by a landscape company or surrounding neighbors, upstream activities, or excess sediment.

*Without proper maintenance, any system will fail. Costs associated with BMP repair can far **exceed** the cost of preventive maintenance.*

Poorly Maintained BMPs

Following are examples of common BMP maintenance problems:



Poorly vegetated swales can lead to eroded swales. Land owners can lose valuable property and water becomes polluted with too much sediment.



Detention ponds with eroded banks cause ponds to lose volume and can cause localized flooding along with water pollution.



Blocked storm pipes and drainage ditches do not allow water to flow freely and can cause localized flooding.



A clogged storm drain creates flooding problems by not allowing runoff water to drain properly. If clogged with trash, leachate from the trash can pollute the water. pg. 14



Detention pond turned beach! Placing objects in a detention pond will cause damage to the objects as well as contribute to localized flooding.



Eroded swales are unsightly, contribute to sediment loading to streams and can eat away at usable property for a homeowner.



Poorly maintained and damaged inlets can cause flooding and property damage.

Good Housekeeping Practices

What else can homeowners do to reduce stormwater pollution?

Small changes to your daily activities can make a big difference.

- Keep soil or mulch piles covered to prevent wash off into storm drains.
- Use natural alternatives to pesticides where possible, and fertilize sparingly. Don't apply these chemicals when the forecast calls for heavy rain.
- Rake up leaves and lawn clippings for use as mulch or compost.
- Plant native vegetation and grasses. *See Appendix A2*
- De-chlorinate swimming pools before draining. Allow pool water to sit in the pool without adding chlorine. Chlorine levels will drop naturally over several days.

- Pick up dog waste. Scoop the poop, bag it and put it in the trash or flush it down the toilet. Dog waste contains harmful bacteria that may not be filtered by ponds or swales.



- Use Knox County's hazardous waste collection program to dispose of household hazardous waste.



See Appendix A2.

- Wash your car at a commercial car wash, or on the lawn to minimize runoff. Use detergent sparingly.



- Wash paint brushes and rollers in a sink that drains to the sanitary sewer system.



Clean water begins at home...

Appendix A1

Inspection Checklists and Maintenance Guidance

<i>Inspection and Maintenance Frequencies for Ponds.....</i>	<i>pg 18</i>
<i>Inspection Checklist for Ponds.....</i>	<i>pg 19</i>
<i>Inspection Checklist for Dry Ponds.....</i>	<i>pg 20</i>
<i>Inspection and Maintenance Frequencies for Grass Channels.....</i>	<i>pg 21</i>
<i>Inspection Checklist for Grass Channels.....</i>	<i>pg 21</i>
<i>Inspection and Maintenance Frequencies for Bioretention.....</i>	<i>pg 22</i>
<i>Inspection Checklist for Bioretention.....</i>	<i>pg 23</i>
<i>Inspection and Maintenance Frequencies for Porous Pavement.....</i>	<i>pg 24</i>
<i>Inspection Checklist for Porous Pavement.....</i>	<i>pg 25</i>

Stormwater Ponds



4.3.1.7 Maintenance Requirements and Inspection Checklist

Note: Section 4.3.1.7 must be included in the Operations and Maintenance Plan that is recorded with the deed.

Regular inspection and maintenance is critical to the effective operation of stormwater ponds as designed. It is the responsibility of the property owner to maintain all stormwater facilities in accordance with the minimum design standards and other guidance provided in this manual. The Director has the authority to impose additional maintenance requirements where deemed necessary.

This page provides guidance on maintenance activities that are typically required for stormwater ponds, along with a suggested frequency for each activity. Individual stormwater ponds may have more, or less, frequent maintenance needs, depending upon a variety of factors including the occurrence of large storm events, overly wet or dry (i.e., drought) regional hydrologic conditions, and any changes or redevelopment in the upstream land use. Each property owner shall perform the activities identified below at the frequency needed to maintain the pond in proper operating condition at all times.

Inspection Activities	Suggested Schedule
<ul style="list-style-type: none"> After several storm events or an extreme storm event, inspect for: bank stability; signs of erosion; and damage to, or clogging of, the inlet/outlet structures and pilot channels. 	As needed
<ul style="list-style-type: none"> Inspect for: trash and debris; clogging of the inlet/outlet structures and any pilot channels; excessive erosion; sediment accumulation in the basin, forebay and inlet/outlet structures; tree growth on dam or embankment; the presence of burrowing animals; standing water where there should be none; vigor and density of the grass turf on the basin side slopes and floor; differential settlement; cracking; leakage; and slope stability. 	Semi-annually
<ul style="list-style-type: none"> Inspect that the inlet/outlet structures, pipes, sediment forebays, and upstream, downstream, and pilot channels are free of debris and are operational. Check for signs of unhealthy or overpopulation of plants and/or fish (if utilized). Note signs of algal growth or pollution, such as oil sheens, discolored water, or unpleasant odors. Check sediment marker(s) for sediment accumulation in the facility and forebay. Check for proper operation of control gates, valves or other mechanical devices. Note changes to the wet pond or contributing drainage area as such changes may affect pond performance. 	Annually
Maintenance Activities	Suggested Schedule
<ul style="list-style-type: none"> Clean and remove debris from inlet and outlet structures. 	Monthly
<ul style="list-style-type: none"> Mow side slopes (embankment) and maintenance access. Periodic mowing is only required along maintenance rights-of-way and the embankment. The remaining pond buffer can be managed as a meadow (mowing every other year) or forest. 	Monthly
<ul style="list-style-type: none"> If wetland vegetation is included, remove invasive vegetation. 	Semi-annually
<ul style="list-style-type: none"> Repair damage to pond, outlet structures, embankments, control gates, valves, or other mechanical devices; repair undercut or eroded areas. Remove pollutants or algal overgrowth as appropriate. 	As Needed
<ul style="list-style-type: none"> Perform wetland plant management and harvesting. 	Annually (if needed)
<ul style="list-style-type: none"> Remove sediment from the forebay. Sediments excavated from stormwater ponds that do not receive runoff from land uses that require a Special Pollution Abatement Permit (SPAP) are not considered toxic or hazardous material and can be safely disposed of by either land application or landfilling. Sediment testing may be required prior to sediment disposal when the pond receives discharge from a land use that requires a SPAP. 	5 to 7 years or after 50% of the total forebay capacity has been lost
<ul style="list-style-type: none"> Monitor sediment accumulations, and remove sediment when the pond volume has become reduced significantly or the pond is not providing a healthy habitat for vegetation and fish (if used). Discharges of pond water may be considered an illegal discharge, as per the Knox County Stormwater Management Ordinance. Care should be exercised during pond drawdowns to prevent downstream discharge of sediments, anoxic water, or high flows with erosive velocities. Knox County should be notified before draining a stormwater pond. 	10 to 20 years or after 25% of the permanent pool volume has been lost

Knox County encourages the use of the inspection checklist that is presented on the next page to guide the property owner in the inspection and maintenance of stormwater ponds. The Director can require the use of this checklist or other form(s) of maintenance documentation when and where deemed necessary in order to ensure the long-term proper operation of the stormwater pond. Questions regarding stormwater facility inspection and maintenance should be referred to the Knox County Department of Engineering and Public Works, Stormwater Management Division.



**INSPECTION CHECKLIST AND MAINTENANCE GUIDANCE (continued)
STORMWATER POND INSPECTION CHECKLIST**

Location: _____ Owner Change since last inspection? Y N

Owner Name, Address, Phone: _____

Date: _____ Time: _____ Site conditions: _____

Inspection Items	Satisfactory (S) or Unsatisfactory (U)	Comments/Corrective Action
Embankment and Emergency Spillway		
Healthy vegetation?		
Erosion on embankment?		
Animal burrows in embankment?		
Cracking, sliding, bulging of dam?		
Blocked or malfunctioning drains?		
Leaks or seeps on embankment?		
Obstructions of spillway(s)?		
Erosion in/around emergency spillway?		
Other (describe)?		
Inlet/Outlet Structures and Channels		
Clear of debris and functional?		
Trash rack clear of debris and functional?		
Sediment accumulation?		
Condition of concrete/masonry?		
Metal pipes in good condition?		
Control valve operation?		
Pond drain valve operation?		
Outfall channels function, not eroding?		
Other (describe)?		
Sediment Forebays		
Evidence of sediment accumulation?		
Permanent Pool Areas (if applicable)		
Undesirable vegetation growth?		
Visible pollution?		
Shoreline erosion?		
Erosion at outfalls into pond?		
Headwalls and endwalls in good condition?		
Encroachment by other activities?		
Evidence of sediment accumulation?		
Dry Pond Areas (if applicable)		
Vegetation adequate?		
Undesirable vegetation growth?		
Excessive sedimentation?		
Hazards		
Have there been complaints from residents?		
Public hazards noted?		

If any of the above inspection items are **UNSATISFACTORY**, list corrective actions and the corresponding completion dates below:

Corrective Action Needed	Due Date

Inspector Signature: _____ Inspector Name (printed) _____



**INSPECTION CHECKLIST AND MAINTENANCE GUIDANCE (continued)
CONVENTIONAL DRY DETENTION POND INSPECTION CHECKLIST**

Location: _____ Owner Change since last inspection? Y N

Owner Name, Address, Phone: _____

Date: _____ Time: _____ Site conditions: _____

Inspection Items	Satisfactory (S) or Unsatisfactory (U)	Comments/Corrective Action
Embankment and Emergency Spillway		
Vegetation coverage adequate?		
Erosion on embankment?		
Animal burrows in embankment?		
Cracking, sliding, bulging of dam?		
Blocked or malfunctioning drains?		
Leaks or seeps on embankment?		
Obstructions of spillway(s)?		
Erosion in/around emergency spillway?		
Other (describe)?		
Inlet/Outlet Structures and Channels		
Clear of debris and functional?		
Trash rack clear of debris and functional?		
Sediment accumulation?		
Condition of concrete/masonry?		
Metal pipes in good condition?		
Control valve operational?		
Pond drain valve operational?		
Outfall channels function, not eroding?		
Other (describe)?		
Pond Bottom		
Vegetation adequate?		
Undesirable vegetation growth?		
Excessive sedimentation?		
Hazards		
Have there been complaints from residents?		
Public hazards noted?		

If any of the above inspection items are **UNSATISFACTORY**, list corrective actions and the corresponding completion dates below:

Corrective Action Needed	Due Date

Inspector Signature: _____ Inspector Name (printed) _____

Grass Channels



4.3.10.7 Maintenance Requirements and Inspection Checklist

Note: Section 4.3.10.7 must be included in the Operations and Maintenance Plan that is recorded with the deed.

Regular inspection and maintenance is critical to the effective use of grass channels as stormwater best management practices. It is the responsibility of the property owner to maintain all stormwater facilities in accordance with the minimum design standards and other guidance provided in this manual. The Director has the authority to impose additional maintenance requirements where deemed necessary.

This page provides guidance on maintenance activities that are typically required for grass channels, along with a suggested frequency for each activity. Individual grass channels may have more, or less, frequent maintenance needs, depending upon a variety of factors including the occurrence of large storm events, overly wet or dry (i.e., drought) regional hydrologic conditions, and any changes or redevelopment in the upstream land use. Each property owner shall perform the activities identified below at the frequency needed to maintain grass channels properly at all times.

Inspection Activities	Suggested Schedule
<ul style="list-style-type: none"> Inspect check dams (if used) for clogging (i.e., standing water or sediment build-up). Inspect vegetation for signs of erosion or un-vegetated areas. Inspect to ensure that grass is healthy and well-established. 	<p>Annually (Semi-annually first year)</p>
Maintenance Activities	Suggested Schedule
<ul style="list-style-type: none"> Maintain a dense, healthy stand of grass and other vegetation by frequent mowing. Grass heights of 3 to 5 inches should be maintained, with a maximum grass height of 8 inches. 	<p>Regularly (frequently)</p>
<ul style="list-style-type: none"> Remove trash, debris and sediment accumulated in the channel or behind check dams (if present). Repair areas of erosion and re-vegetate. Re-vegetate as need to maintain healthy vegetation. 	<p>As-needed</p>

Knox County encourages the use of the inspection checklist presented below for guidance in the inspection and maintenance of the grass channel. The Director can require the use of this checklist or other form(s) of maintenance documentation when and where deemed necessary in order to ensure the long-term proper operation of the channel. Questions regarding inspection and maintenance should be referred to the Knox County Department of Engineering and Public Works, Stormwater Management Division.

INSPECTION CHECKLIST FOR GRASS CHANNELS

Location: _____ Owner Change since last inspection? Y N

Owner Name, Address, Phone: _____

Date: _____ Time: _____ Site conditions: _____

Inspection Items	Satisfactory (S) or Unsatisfactory (U)	Comments/Corrective Action
Healthy vegetation?		
Signs of erosion?		
Clogged check dams?		
Sediment build-up on channel bottom?		
Standing water for extended periods?		
Soggy channel bottom for extended periods?		
Other (describe)?		
Hazards		
Have there been complaints from residents?		
Public hazards noted?		

If any of the above inspection items are **UNSATISFACTORY**, list corrective actions and the corresponding completion dates below:

Corrective Action Needed	Due Date

Inspector Signature: _____ Inspector Name (printed) _____

Bioretention Areas



4.3.5.7 Maintenance Requirements and Inspection Checklist

Note: Section 4.3.5.7 must be included in the Operations and Maintenance Plan that is recorded with the deed.

Regular inspection and maintenance is critical to the effective operation of bioretention areas as designed. It is the responsibility of the property owner to maintain all stormwater BMPs in accordance with the minimum design standards and other guidance provided in this manual. The Director has the authority to impose additional maintenance requirements where deemed necessary.

This section provides guidance on maintenance activities that are typically required for bioretention areas, along with a suggested frequency for each activity. Individual bioretention areas may have more, or less, frequent maintenance needs, depending upon a variety of factors including the occurrence of large storm events, overly wet or dry (i.e., drought) regional hydrologic conditions, and any changes or redevelopment in the upstream land use. Each property owner shall perform the activities identified below at the frequency needed to maintain the pond in proper operating condition at all times.

Inspection Activities	Suggested Schedule
<ul style="list-style-type: none"> After several storm events or an extreme storm event, inspect for signs of erosion, signs of mulch movement out of the treatment area, signs of damage to plants or dead or diseased vegetation. 	As needed
<ul style="list-style-type: none"> Inspect: inflow points for clogging (off-line systems), strip/grass channel for erosion or gulying, Inspect trees, shrubs and other vegetation to evaluate their health and replace any dead or diseased vegetation. Inspect surrounding drainage area for erosion or signs of sediment delivery to the bioretention area. 	Semi-annually
<ul style="list-style-type: none"> Check for signs of vegetation overgrowth. Inspect treatment area during a rain event and visually verify that stormwater recedes within 24-48 hours from the treatment area. 	Annually
Maintenance Activities	Suggested Schedule
<ul style="list-style-type: none"> Replace mulch and repair areas of erosion, when identified. Replace dead or diseased plants. 	As needed
<ul style="list-style-type: none"> Remove clogs from the stormwater system inflow and overflow components. Remove sediments from pretreatment areas and restabilize with stone or vegetation as appropriate. 	Semi-annually
<ul style="list-style-type: none"> Harvest overgrown vegetation and remove from the bioretention area. 	As Needed
<ul style="list-style-type: none"> The planting soils should be tested for pH to establish acidic levels. If the pH is below 5.2, limestone should be applied. If the pH is above 7.0 to 8.0, then iron sulfate plus sulfur can be added to reduce the pH. Check that planting soils still have infiltration rate. 	Annually
<ul style="list-style-type: none"> Replace mulch over the entire area. Replace pea gravel diaphragm if warranted. Note that the surface of the ponding area may become clogged with fine sediment over time. Core aeration or cultivating of un-vegetated areas may be required to ensure adequate filtration. 	2 to 3 years

Knox County encourages the use of the inspection checklist that is presented on the next page to guide the property owner in the inspection and maintenance of bioretention areas. The Director can require the use of this checklist or other form(s) of maintenance documentation when and where deemed necessary in order to ensure the long-term proper operation of the bioretention area. Questions regarding stormwater facility inspection and maintenance should be referred to the Knox County Department of Engineering and Public Works, Stormwater Management Division.



**INSPECTION CHECKLIST AND MAINTENANCE GUIDANCE (continued)
BIORETENTION AREA INSPECTION CHECKLIST**

Location: _____ Owner Change since last inspection? Y N

Owner Name, Address, Phone: _____

Date: _____ Time: _____ Site conditions: _____

Inspection Items	Satisfactory (S) or Unsatisfactory (U)	Comments/Corrective Action
Inflow and Overflow Points		
Clear of debris and functional?		
Sediment accumulation?		
Vegetation in good condition?		
Signs of erosion?		
Other (describe)?		
Sediment Pretreatment		
Evidence of sediment accumulation?		
Treatment Area and Vegetation		
Signs of erosion or movement of mulch?		
Vegetation healthy or damaged?		
Signs of sediment?		
Signs of thinning mulch layer?		
Vegetation overgrown and in need of harvesting?		
Standing water for more than 24-48 hours after rain events?		
Other (describe)?		
Hazards		
Have there been complaints from residents?		
Public hazards noted?		

If any of the above inspection items are **UNSATISFACTORY**, list corrective actions and the corresponding completion dates below:

Corrective Action Needed	Due Date

Inspector Signature: _____ Inspector Name (printed) _____

Porous Pavement



4.3.12.6 Maintenance Requirements and Inspection Checklist

Note: Section 4.3.12.6 must be included in the Operations and Maintenance Plan that is recorded with the deed.

Regular inspection and maintenance is critical to the effective use of porous pavement as a stormwater best management practice. It is the responsibility of the property owner to maintain all stormwater facilities in accordance with the minimum design standards and other guidance provided in this manual. The Director of Engineering and Public Works has the authority to impose additional maintenance requirements where deemed necessary.

This page provides guidance on maintenance activities that are typically required for porous pavement, along with a suggested frequency for each activity. Individual porous pavement applications may have more, or less, frequent maintenance needs, depending upon a variety of factors including traffic loads, the occurrence of large storm events, overly wet or dry (i.e., drought) regional hydrologic conditions, and any changes or redevelopment in the upstream land use. Each property owner shall perform the activities identified below at the frequency needed to maintain porous pavement properly at all times.

Inspection Activities	Suggested Schedule
<ul style="list-style-type: none"> Ensure that the porous pavement surface is free of sediment and debris (e.g., mulch, leaves, trash, etc.). Ensure that the contributing area upstream of the porous pavement surface is free of sediment and debris. 	As needed
<ul style="list-style-type: none"> Check to make sure that the porous pavement dewateres between storms. 	Monthly
<ul style="list-style-type: none"> Inspect the surface for structural integrity. Inspect for evidence of deterioration or spalling. 	Annually
Maintenance Activities	Suggested Schedule
<ul style="list-style-type: none"> Ensure that contributing area and porous pavement surface are clear of debris (e.g., mulch, leaves, trash, etc.). Ensure that the contributing and adjacent area is stabilized and mowed, with clippings removed. 	As needed, based on inspection
<ul style="list-style-type: none"> Vacuum sweep porous pavement surface to keep free of sediment. 	Typically three to four times a year
<ul style="list-style-type: none"> Replace the porous pavement, including the top and base course, as needed. 	Upon failure

Knox County encourages the use of the inspection checklist presented below for guidance in the inspection and maintenance of porous pavement. The Director can require the use of this checklist or other form(s) of maintenance documentation when and where deemed necessary in order to ensure the long-term proper operation of the unit. Questions regarding inspection and maintenance should be referred to the Knox County Department of Engineering and Public Works, Stormwater Management Division.



INSPECTION CHECKLIST – POROUS PAVEMENT

Location: _____ Owner Change since last inspection? Y N
 Owner Name, Address, Phone: _____
 Date: _____ Time: _____ Site conditions: _____

Inspection Items	Satisfactory (S) or Unsatisfactory (U)	Comments/Corrective Action
Signs of clogging (e.g., standing water)?		
Debris (mulch, trash) accumulation?		
Sediment accumulation?		
Standing water?		
Erosion from underdrain (if present)?		
Exposed soil in areas discharging or adjacent to the porous pavement area?		
Runoff discharge from pavement area 24 to 48 hours after the end of a storm event?		
Other (describe)?		
Other (describe)?		
Hazards		
Have there been complaints from residents?		
Public hazards noted?		

If any of the above inspection items are **UNSATISFACTORY**, list corrective actions and the corresponding completion dates below:

Corrective Action Needed	Due Date

Inspector Signature: _____ Inspector Name (printed) _____

Appendix A2

Contacts and Links

- Knox County Stormwater Management
<http://www.knoxcounty.org/stormwater>
205 West Baxter Avenue
Knoxville, TN 37917
865-215-5540
stormwater@knoxcounty.org
- Tennessee Department of Environment & Conservation
<http://www.tn.gov/environment/wpc>
Knoxville Environmental Field Office
3711 Middlebrook Pike
Knoxville, TN 37921
865-594-6035
- Knox County Soil Conservation District
<http://www.knoxcounty.org/epw/soilconservation>
4730 New Harvest Lane, Suite 200
Knoxville, TN 37918
865-523-3338 x 3
- Household Hazardous Waste Collection
<http://www.cityofknoxville.org/solidwaste/hazwaste>
1033 Elm Street
Knoxville, TN 37917
865-215-6700
- Native plant information:
Landscaping with Native Plants <http://www.se-eppc.org/pubs/east.pdf>
Tennessee Native Plant Society <http://www.tnps.org/Links.html>
TVA Native Plant Selector:
www.tva.gov/river/landandshore/stabilization/plantsearch.htm

Appendix A3

References

Technical Guidance:

Knox County Stormwater Management Manual, 2008,

http://www.knoxcounty.org/stormwater/pdfs/KCSWM_2008_VOL_2.pdf

A Citizen's Guide to Maintaining Stormwater Best Management Practices, Lake County Stormwater Management Commission, 2004,

<http://bcn.boulder.co.us/basin/kicp/construction/KICPPermBMPGuidanceforHOAs.pdf>

Neighborhood Guide to Stormwater Systems, St. Johns River Water Management District, 2012

http://floridaswater.com/publications/pdfs/bk_stormwatersystems.pdf

A Homeowner's Guide to a Healthy Stormwater Drainage System, York County Stormwater Advisory Committee

<http://www.yorkcounty.gov/LinkClick.aspx?fileticket=2I08kz%2fi2qE%3d&tabid=7472&mid=12138>

BMP Effectiveness Requires Regular Inspection and Maintenance, Stormwater, May-June 2012

http://www.stormh2o.com/SW/Articles/BMP_Effectiveness_Requires_Regular_Inspection_and_3197.aspx

Photo Credits:

Kari Baksa, Knoxville, TN

Dave Fowler, Milwaukee Metropolitan Sewage District and Eddee Daniel, Friends of Milwaukee's Rivers

Maintaining Privately Owned Stormwater Management Facilities

www.rivanna-stormwater.org/bmp01.htm

LakeSuperiorStreams.org : www.lakesuperiorstreams.org/stormwater/toolkit/swales.html

Coastal Waccamaw Stormwater Education Consortium <http://cwsec-sc.org/277/maintain-vegetation-plant-trees-buffers/>

Environmental Protection Agency: www.epa.gov/oaintrnt/stormwater/best_practices.htm

cnycentral.com <http://share.cnycentral.com/media/view/2379905>

Knox County Stormwater Management: www.knoxcounty.org/stormwater

National Ready Mix Concrete Association: www.nrmca.org/

Jason Scott, Town of Farragut, TN: www.townoffarragut.org/