BMP MAINTENANCE MANUAL

A Guidance Manual for Maintenance of BMP Facilities

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ACRONYMS

BMP	Best Management Practice
CH	Virginia BMP Clearinghouse
DCR	Virginia Department of Conservation and Recreation
DEQ	Virginia Department of Environmental Quality
EPA	Environmental Protection Agency
GIS	Geographic Information System
IDDE	Illicit Discharge Detection and Elimination
LUP	Land Use Permit
MS4	Municipal Separate Storm Sewer System
MTD	Manufactured Treatment Device
NPDES	National Pollutant Discharge Elimination System
TMDL	Total Maximum Daily Load
VAC	Virginia Administrative Code
VPDES	Virginia Pollutant Discharge Elimination System
VSMP	Virginia Stormwater Management Program
VDOT	Virginia Department of Transportation
WLA	Waste Load Allocation

1 INTRODUCTION, BACKGROUND, AND PURPOSE

1.1 INTRODUCTION

The Virginia Stormwater Management Program (VSMP) General Permit for Discharges of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4s) requires VDOT to develop and implement a long-term documented operation and maintenance plan for stormwater management facilities. This includes development of an inspection manual and a maintenance manual to be prepared by EEE Consulting, Inc. describing operations and procedures to meet this requirement. The VDOT MS4 Program is designed to reduce to the discharge of pollutants from all regulated activities undertaken by the Department within its right-of-way and property boundaries located inside urbanized areas (as determined by the latest Decennial Census by the Bureau of the Census). The Program ensures the proper operation of stormwater facilities that reduces the discharge of pollutants, protects water quality, and reduces water quantity to satisfy requirements of the Clean Water Act and the State Water Control Law consistent with the VSMP Permit Regulations (9 VAC 25-870 et seq.) and VDOT's legal authority as authorized by the Commonwealth of Virginia. BMP inspections are required on an annual basis, once every 12 months, and within 48 hours after a storm event that exceeds the principal spillway, unless there are more stringent requirements in the VDOT ESC and SWM Annual Standards and Specifications.

Further information regarding the VSMP Laws and Regulations related to MS4 permitting and programs may be obtained from the Virginia Department of Environmental Quality and the Code of Virginia at:

- *http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/VSMPPermits/LocalVSMPProgramDevelopment.aspx*
- *http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/VSMPPermits/MS4Permits.aspx*
- *http://lis.virginia.gov/cgi-bin/legp604.exe?000+reg+9VAC25-890-40*

1.2 BACKGROUND

Land development disturbs stable vegetated landscapes and increases impervious area, which in turn increases the amount of stormwater runoff. Development increases pollutant concentrations in runoff, as pollution associated with development is deposited onto disturbed surfaces and carried by runoff into nearby water bodies. Such pollutants include sediment, suspended solids, nutrients, pesticides, herbicides, heavy metals, chlorides, hydrocarbons, other organics and bacteria. To remove pollutants from stormwater runoff, structures are installed to filter, slow, and treat drainage using various processes. These stormwater structures are called Best Management Practices, commonly referred to as BMPs. They are designed to reduce flooding, remove pollutants and decrease the amount of runoff from stormwater that ultimately flows to our creeks, streams, and rivers. There are many different types of BMPs, both on the ground surface and underground, that all serve to decrease the detrimental effects of stormwater runoff on our environment.

There are two types of maintenance that VDOT recognizes: Routine Maintenance and Corrective Maintenance. Routine Maintenance consists of items that are essential to the on-going care and upkeep of a BMP facility to ensure that it functions correctly as originally designed. Corrective Maintenance consists of items that are performed to rectify or correct an identified faulty component of a BMP facility.

1.3 PURPOSE

The intent of this manual is to provide guidance for the use of the online BMP Maintenance forms provided by VDOT. This manual provides guidance on the maintenance of these facilities and characterizes the different components of each type of BMP. This manual is primarily intended to be used in conjunction with the VDOT Inspection Manual to prioritize maintenance based on observations during inspections. As a part of this characterization, examples of component features and deterioration levels will be discussed and pictures provided. This manual follows the output items of the inspection form. Although there may be additional items that are in need of attention beyond the inspection checklist, an attempt should be made to follow the inspection form classifications. Maintenance corrections are listed below.

2 BMP INSPECTION DATABASE FORMAT

There are three parts to every stormwater facility inspection as outlined in the database. The first task is to enter the facility information on the Inventory Tab, including the general facility classification and specific facility type from the pull down menus. This step includes scanning in the approved plans and any long term regulatory permits. This item is particularly valuable to the employees performing maintenance so they have access to the proper configuration of the facility, which will guide them in their maintenance tasks. The second task is to perform the inspection utilizing the inspection tabs on the database form and checking the appropriate inspection items listed under their component headings, rating them based on guidance in the manual. The inspection item boxes under the component headings list facility items that require maintenance. This tab also requires an overall rating of the facility that prioritizes maintenance based on the conditions noted under the various component headings.

The third task is to fill out the maintenance tab of the database checking off the appropriate action items to repair the facility. The inspection and requested maintenance will then be reviewed and approved by an inspection supervisor; this is entered with a date in the maintenance tab.

2.1 BMP INVENTORY FORMS

The BMP Inventory tab provides details from the BMP plans that clarify what design features are present in the field. This input modifies the inspection tab by making BMP components that are not applicable to the facility un-selectable and grayed out in the inspection tab. This assists the inspector by listing the relevant parameters present under the inspection headings as well as showing which features are not relevant. This also prevents the inspector from checking off an absent BMP feature mistakenly or looking for a BMP feature that is not there.

The information input in this tab, as well as the nomenclature, should exactly match the as-built or construction record drawings submitted at permit termination. When selecting the BMP type, it is especially important to clarify whether the BMP was designed under the new regulations and the BMP Clearinghouse specifications or based on older stormwater standards. If the facility conforms to the BMP Clearinghouse standards, a “(CH)” is included in the facility name in the drop down menu. These different design criteria have different features, inspection criteria, and pollution reduction efficiencies established for the listed BMP types.

2.2 BMP INSPECTION FORMS

The six basic types of BMPs listed in the database are basins, filtration, infiltration, LID measures, manufactured structures and miscellaneous facilities. Each heading has multiple specific BMP types in a pull down menu that is provided in the inventory step. Once the type is selected and inventoried, the proper inspection heading components for the facility will show up on the Inspection Tab under various headings. Explanations of the various BMP types and components are included in the sections below.

Proper evaluation and classification of the BMP components play a key role in the facility rating and the maintenance plan of action that establishes the priority of needed maintenance and the specific maintenance requirements.

Each of the inspection component headings is rated on a scale of 1 to 5. The scoring defines the relative condition of each parameter. The objective is to provide a consistent framework for performing the scoring of individual parameters. These numbered ratings are then translated into an overall A-E rating of the facility as a whole. BMP components that do not affect the water levels in the BMP are weighted less than components that change the water level and functionality.

The following site is also available for additional information:

- http://vwrrc.vt.edu/swc/StandardsSpecs.html

2.2.1 Overall Facility Rating

There are two different rating fields for the Overall Facility Rating. One is the database generated rating titled “Database Rating”. This field provides the minimum facility rating based on the component heading ratings of 1-5 provided on the inspection form. The second field is the “Inspector Rating”, which is defined by the inspector and allows the overall rating to be upgraded based on the specific field conditions and professional judgment.

Please note the inspection rating establishes the time frame to take action on the maintenance plan consisting of the items listed in the inspection database. The time frames described in the Overall Facility Rating prioritize maintenance based on the severity of deterioration, failure potential and failure impacts. Each of the resulting five levels of overall facility ratings has a different set of specified maintenance repairs, and thus a specific VDOT procedure to follow. As used in this process, the term “implemented” describes any step in the process leading to repair completion. The first step in any maintenance plan consists of a supervisor review and approval of the inspection and requested maintenance items, including the time frame for enacting the plan. The goal of utilizing this concept is to show progress towards repair completion, accounting for the project specific issues while following appropriate and established VDOT procedures.

The first action step for all facilities is the review and approval of the reported inspection which is recorded in the fields listed in the database. This step allows a higher level employee to supervise the process, clarify any questions, and evaluate and prioritize the recommended maintenance items. Once the inspection is approved, the time frame for the response begins as described in the “Overall Facility Rating” section of this manual and in the database for each of the six BMP categories. The response time frame for action varies based on the type of facility, severity of repairs required, and potential impacts resulting from further deterioration. The rating requirements are as follows:

Rating A: The stormwater facility is functioning as designed with no problem conditions identified. No signs of impending deterioration. Routine preventive maintenance will be performed twice a year or in accordance with the BMP Clearinghouse specifications, whichever is more stringent.

Rating B: Minor problems observed; however, the stormwater facility is functioning as designed and no critical parameters have problem conditions. Needed repairs can be achieved through routine maintenance. A maintenance work plan will be developed and enacted in 12-26 weeks.

Rating C: Moderate problems are observed, and the stormwater facility has small changes in functionality that do not change the water level or impact its structural integrity. Routine maintenance may address some of the required repairs, but not all of them. A maintenance work plan will be developed and enacted within 6-12 weeks. Rating D: Major problems are observed and the stormwater facility is not functioning as designed with at least one critical parameter requiring repairs. Conditions associated with the facility have compromised its performance and/or raised the water level, potentially impacting the structural integrity. The facility shows signs of impending deterioration with potential for failure. Deficiencies require repair and restoration. A maintenance work plan will be developed and enacted within 2-6 weeks. Part of the work plan may include immediate mitigation measures to temporarily preserve the basin and prevent further deterioration.

Rating E: Severe problems are observed and the stormwater facility is not functioning as designed with several critical parameters requiring immediate repairs. Conditions associated with the basin have compromised facility performance and further deterioration and/or failure is imminent. Deficiencies require repair and restoration. A secondary supervisor level inspection is necessary to clarify the extent of the maintenance work and what specific parties should be involved. A maintenance work plan will be developed and enacted within 2 weeks. Part of the work plan will include immediate mitigation measures to temporarily preserve the basin and prevent further deterioration.

There are many different variables that affect the inspection and maintenance processes along with repair completion. Therefore, once action is initiated upon the inspection approval, detailed records of anticipated schedules and completed process steps should be kept. Routine to minor maintenance can be approved and scheduled by the inspection reviewer. Moderate maintenance items may need to be field-verified and, if outflow structures are involved, an additional level of review may be warranted.
This comes into play particularly when a contractor must be involved to accomplish the repairs and potentially bids must be obtained and approved prior to commencing work. Detailed date records of key events in the process, as well as anticipated dates for meeting project milestones, should continue to demonstrate progress towards repair completion. Major and failure level ratings shall be elevated to the inspection reviewer's supervisor for evaluation. Maintenance involving structural repairs or replacement shall be evaluated by a qualified professional.

2.3 BMP MAINTENANCE FORMS

The maintenance form provided in the database has a list of maintenance / repair actions associated with the inspection criteria. The items are categorized into two headings, Routine and Corrective. Under this tab there is also a heading for "Weather related inspections" that are less intensive than the annual inspection, but check for damage and potential maintenance needs after storm events.

3 FILTRATION BMP MAINTENANCE

3.1 TYPES OF FILTRATION FACILITIES

3.1.1 Filtering Practice I & II (CH)

Filtering practices are very similar in structure and design to a bioretention facility, without the plantings. Stormwater filters capture, temporarily store, and treat stormwater runoff by passing it through sand or an engineered filter media in the ground, collecting the filtered water in an underdrain, and then returning it back to the storm drainage system. To preserve the performance and function of Filter type BMPs, they must be maintained.

3.1.2 Sheet Flow to Vegetation Filter or Conserved Open Space I or II (CH)

Filter strips are vegetated areas that treat sheet flow delivered from adjacent impervious and managed turf areas. The two design variants of filter strips are (1) *Conserved Open Space* and (2) designed *Vegetated Filter Strips*. The design, installation, and management of these design variants are quite different, as outlined in the BMP Clearinghouse specification. To preserve the performance and integrity of sheet flow to vegetation filter or conserved open space BMPs, they must be maintained

3.1.3 Constructed Wetland, Constructed Wetland I & II (CH)

Constructed wetlands, sometimes referred to as stormwater wetlands, are shallow depressions that treat inflow for water quality. To preserve the performance and function of the constructed wetlands, they must be maintained.

Typical Routine Maintenance for Filtration Facilities:

- Mow any applicable areas such as grass filter strips or turf cover
- Remove any trash or debris including clippings from maintenance activities
- Remove blockages from outflow structures
- Remove blockages from inflow structures and/or forebays
- Mulch raking/mulch supplementation to maintain a 3 inch layer
- Prune trees and shrubs
- Spot weeding and invasive plant removal using recommended control methods
- Opening the underdrain observation well or cleanout for evaluation

Typical Corrective Maintenance:

- Broad leaf application
- Seeding
- Herbicide
- Restore access
- Remove sediment
- Replace filter media

- Repair outlet protection/erosion
- Remove woody vegetation
- Repair animal burrows
- Repair fence
- Repair erosion
- Repair structural deficiencies
- Repair plantings and vegetation

3.2 FACILITY ROUTINE MAINTENANCE HEADINGS

"Mowing"

All applicable areas shall be mowed to a recommended cutting height based on the Adopted VDOT Annual Standards and Specifications approved by DEQ.

All applicable areas shall be mowed to a recommended cutting height based on the Adopted VDOT Annual Standards and Specifications approved by DEQ. Care shall be taken to minimize the disturbance to any man-made or natural channels or native sites. Grass clippings shall be removed to prevent clogging of the media. Note, for constructed wetlands, consult the planting plan because the plantings are an integral part of the facility design and function, which may include certain grasses.

"Remove any trash or debris"

Any trash or debris, either "natural" or "man-made" (i.e. bottles, tires, brush, etc.), shall be removed from the site. Trash shall be disposed of in accordance with the waste classification and hazard level. Be aware of potential sources of illicit discharges within the debris. If there is potential for an illicit discharge or evidence of one occurring, please refer to the VDOT IDDE Manual for proper reporting procedures.

If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads, etc. This would allow VDOT to examine anything requiring more resources and cost. Trash and debris can clog the filter and increase the water level in the facility beyond design levels, thus their impacts are more significant than just aesthetics.

"Remove blockages from outflow structures"

Any trash or debris that is blocking or impeding operation of an outflow structure shall be removed so that the outflow is fully functional again.

Any trash or debris that is blocking or impeding operation of an outflow structure shall be removed so that the outflow is fully functional again. This trash or debris, either "natural or "man-made", shall be disposed of in accordance with the waste classification and hazard level. Blockages have the potential to increase the water level in the facility beyond design levels.

- If blockages extend into the outlet structure requiring physical entry inside the structure, please observe any Confined Space Requirements.
- If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads of materials. This would allow VDOT to examine anything requiring more resources and cost.

"Remove blockages from inflow structures and/or forebays"

Any trash or debris that is blocking or impeding operation of an inflow structure and/or forebay, "natural" or "man-made", shall be removed and disposed of in accordance with the waste classification and proper function restored.

- If blockages extend into the inflow structure requiring physical entry inside the structure, please observe any Confined Space Requirements.
- If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads of materials. This would allow VDOT to examine anything requiring more resources and cost.

Any trash or debris that is blocking or impeding operation of an inflow structure and/or forebay "natural" or "man-made", shall be disposed of in accordance with the waste classification and shall be removed to restore proper function.

"Mulch raking/mulch supplementation to maintain a 3 inch layer"

Mulch typically applies only to some filtration facilities as a 2"-3" pretreatment surface layer.

Mulch typically applies only to some filtration facilities as a 2"-3" pretreatment surface layer. Checking the mulch for debris, clogging, and weed growth all enhance the survival rate of the plantings. Raking is recommended to evaluate clogging and the depth of it, which could require replacing the mulch layer. Aged hardwood bark mulch is recommended because it leaches little or no nutrients and tends not to float away. The mulch will require replacement every few years to preserve its functionality and prevent impacts to the filtration media below.

"Prune trees and shrubs"

Maintaining the optimal size and shape of the plantings, as specified in the plans, ensures the long term function of the facility. The design of a filtration facility selects plants from an approved list to maximize the amount of pollutants removed. Having one species overpower other carefully selected plantings can change this efficiency and thus the function of the facility. This is particularly important to constructed wetlands, where some species can overpower others, which may require removal to preserve the approved planting plan. In addition, the trimmings shall be properly disposed of to prevent clogging from the vegetative debris.

"Spot weeding and invasive plant removal using recommended control methods"

Invasive plants and weeds shall be removed to restore the area to its original design conditions.

Invasive plants and weeds shall be removed to restore the area to its original design conditions. Weeds and invasive plant roots shall be removed to ensure that the plant does not re-establish and to prevent clogging of the media. Some invasives, such as cattails, may have such a thick root mat that they can affect the design water levels in the facility.

"Opening the underdrain observation well or cleanout for evaluation"

Underdrains are typically not a part of Constructed Wetlands (CH), but can be a part of other filtration systems based on the soil conditions.

Underdrains are typically not a part of Constructed Wetlands (CH), but can be a part of other filtration systems based on the soil conditions. Consult the scanned plans for further clarification. If poured water remains in the observation well, it indicates clogging or damage somewhere in the system. The purpose of this check is to inspect for standing water all the way down through the soil. If there is standing water on top, but not in the underdrain, then there is a clogged soil layer. If the underdrain and stand pipe indicates standing water, then the underdrain must be clogged or damaged and may need to be snaked, repaired or replaced.

3.3 FACILITY CORRECTIVE MAINTENANCE HEADINGS

"Broad leaf application"

All broad leaf applications shall be applied by a qualified VDOT employee or representative with the appropriate VDACS certifications and endorsements. All chemicals shall be applied only when necessary, appropriate and in accordance with the label, in addition to any state or federal laws that govern use.

"Seeding"

Any seeding that takes place shall be in accordance with Section 603 of VDOT's adopted Nutrient Management Plan, which governs seeding. Seeding shall be done to stabilize areas and prevent erosion. A 90% vegetative cover shall be maintained.

"Herbicide"

All herbicide applications shall be applied by a qualified VDOT employee or representative with the appropriate VDACS certifications and endorsements. All chemicals shall be applied only when necessary, appropriate and in accordance with the label, in addition to VDOT's adopted Nutrient Management Plan and any state or federal laws that govern use.

"Remove Sediment"

All facility forebays, micropools, and stormwater storage areas shall be cleaned of sediment to return the area to original design grades and ensure functionality.

- To prevent future sedimentation the source must be identified and remedied.
- While stabilization is occurring, E&S measures may be appropriate to prevent further impacts to the downstream areas.

All facility forebays, micropools, and stormwater storage areas shall be cleaned of sediment to return the area to original design grades and ensure functionality. Sediment shall be disposed of in accordance with local, state and federal requirements. Care shall be taken to minimize the extent of any land disturbance and to leave the site in non-erosive pre- maintenance condition. This will likely involve some type of stabilization and seeding operation. Operations shall follow any state ESC standard and VDOT"s adopted Nutrient Management Plan. Removing sediment in a constructed wetland may be more problematic due to the plantings. For more detailed information on seeding requirements please refer to the topic above labeled "Seeding".

http://medent.usyd.edu.au/arbovirus/mosquit/plumpton.jpg on May 27,2014

"Restore Access"

Access to the facility, including construction equipment access, must be provided to ensure maintenance can be achieved for proper function. Establishing and maintaining access to the BMP and its outlet is imperative for proper upkeep of the facility. This may include removing brush or trees, grading, seeding, or installing a stone road base. If the disturbed area exceeds 2500 sq. ft. in a Chesapeake Bay Preservation Area or 10,000 sq. ft. outside of a Chesapeake Bay Preservation Area, consult the appropriate VDOT department to determine if an E&S Plan is required.

"Replace filtration media"

Filter media is typically used in filtration facilities and on occasion, sheet flow to a vegetative filter strip. By comparison, it not typically used in a constructed wetland. When replacement of the media is warranted, the plantings (if any), the mulch layer and amended soil shall be removed and disposed of properly. The amended soil shall be replaced to meet all of the plan specifications and the plantings shall be re-installed. Care shall be taken in the operation not to damage the underdrain (if present) in the facility, because it is vital for proper operation.

The contractor shall provide verification that the proposed media meets the approved specifications, including filtration rates, as specified in the original approved design plans. Note that lab testing may be required to verify the infield conditions meet the specified infiltration rates.

- Filtration media clogged by sediment and debris will typically need to be replaced. Identifying the source of the impacts and taking measures to remedy the upstream issues is critical to the success and function of the facility and its filter media.
- While stabilization of the facility is occurring, ESC measures may be appropriate to prevent additional impacts to the downstream area.
- Care shall be taken to work from the sides of the facility so the soils in the footprint are not compacted which affects their ability to infiltrate run off. Inspection of the observation well is a good indicator of proper function of the replacement or in situ media and any clogging or related issues.

"Remove woody vegetation"

All woody vegetation not included in design specifications shall be removed, including the roots when possible, and disposed of appropriately.

All woody vegetation not included in design specifications shall be removed, including the roots when possible, and disposed of appropriately. All areas shall be returned to the original design specifications, which will include plantings for a constructed wetland. It is imperative that you consult the approved design plans, or a qualified professional for substitutions to the designed plantings. Removing the root system is critical to maintaining system functionality because it will halt further growth and limit clogging of the media which slows or prevents filtration.

"Repair animal burrows"

All animal burrows shall be filled and compacted with material that meets the original design specifications.

All animal burrows shall be filled and compacted with material that meets the original design specifications. Attention shall be given to ensure that the burrow has not affected the structural integrity of the filtration facility. If the structural integrity is comprised, an appropriate qualified VDOT representative shall be contacted for further investigation and to determine appropriate structural repair measures.

"Repair fence"

All compromised fence areas shall be repaired in accordance with the original design plans to ensure public safety. This includes locks and gates.

"Repair erosion"

This includes upland drainage areas that may be controllable sources of sediment or erosion.

This includes upland drainage areas that may be controllable sources of sediment or erosion. Erosion can contribute to sedimentation in the facility and also weaken the structure, depending on its severity and location. Erosion shall be corrected by seeding, grading, and/or installation of soil stabilization matting to correct the deficiency. If the erosion is on a structural part of the facility, a competent VDOT representative shall be consulted to determine the proper repair and methodology, such as soil type and compaction requirements to ensure structural stability of the facility. For additional sediment impacts, please see the section above titled "Remove Sediment".

"Repair structural deficiencies"

Repairs to all structural deficiencies shall be designed and reviewed by a competent VDOT representative. Repairs to an underdrain system would fall into this category. Maintenance repairs shall follow any repair designs precisely, and in some cases, construction monitoring may be appropriate. Consult the appropriate VDOT representative to determine if an ESC Plan is required during repairs (e.g., a dewatering plan).

"Repair plants and vegetation"

Required plantings shall be installed per the approved project specifications to maintain the desired vegetation density and meet pollutant removal requirements.

Required plantings shall be installed per the approved project specifications to maintain the desired vegetation density and meet pollutant removal requirements. If the plans are not available, good judgment shall be used to determine if and where any plant mortality has occurred, warranting replacement. If plans are not available or alternative species may be warranted, it may be appropriate to consult a competent VDOT representative to specify plantings. There is typically a planting palette list of approved plantings and potential substitutions on the plans, or retained by the appropriate VDOT personnel. A 90% vegetative cover shall be maintained.

“Repair outlet”

Outlet protection shall be installed per the original approved plans including riprap footprint dimensions, size of stone and placement specifications.

Outlet protection shall be installed per the original approved plans including riprap footprint dimensions, size of stone and placement specifications. If the original design plans are not available or if the original design is clearly inadequate, the outlet protection shall be designed by a qualified professional in accordance with the applicable specifications and design requirements. If the riprap replacement characteristics differ from the approved plans, or are not available, this information should be specified in the maintenance request, typically input by the inspector.

4 INFILTRATION BMP MAINTENANCE

4.1 TYPES OF INFILTRATION FACILITIES

4.1.1 Bioretention I, II, and Urban Bioretention (CH)

Bioretention facilities are shallow, landscaped depressions that incorporate many of the pollutant removal mechanisms that occur in our natural environment. To preserve the performance of the bioretention facilities, all aspects of the facility must be maintained. Plants are a main component of bioretention, and ensuring that the landscape features are in prime condition is a key part of maintenance.

4.1.2 Infiltration I and II CH, Infiltration Trenches and Infiltration Basins

Infiltration practices are most effective for reducing the volume of runoff and pollutant removal through natural processes. Stormwater passes through designed pretreatment cells upstream of the facility removing sediment and organic matter, then into a temporary surface or underground stone storage structure, where it infiltrates into underlying soil. Only permeable soils are appropriate for infiltration facilities because the runoff must soak through the media into the undisturbed ground, which is called permeability. For example, sand has a higher permeability than clay soil because water infiltrates through the material faster. To preserve the function and stability of infiltration systems proper maintenance is essential.

4.1.3 Rooftop Disconnection CH

This practice disconnects impervious surfaces within a site by routing rooftop runoff onto the pervious areas or to other BMP systems for treatment. This practice functions by intercepting, reusing, infiltrating, filtering, or connecting with other methods of stormwater treatment to decrease the runoff generated by impervious areas within the watershed, rooftops in particular. To preserve the performance and integrity of any disconnection system, it must be maintained.

4.1.4 Dry Swales I and II CH

These vegetated channels are designed to decrease flow rates; increase pollutant removal through filtration and infiltration; and enhance runoff storage. They can be used as pre-treatment practices, carrying runoff to other treatment facilities. They are designed to receive relatively clean stormwater runoff and are not suitable for direct sedimentation from disturbed areas.

The swales should be situated adjacent and parallel to the drainage area, and should be at least as long as the drainage area. Channel side slopes should be 2:1 or less. The channel longitudinal slope should be 4% or less, ideally 1-2%.

4.1.5 Permeable Pavers and Pavement

Permeable pavement systems have integrated voids for runoff to filter through the surface

into an underground stone reservoir. This reservoir stores the runoff and infiltrates it into the underlying soils. Various types of permeable pavement systems are available such as pervious concrete, porous pavement, and permeable interlocking pavers.

Typical Routine Maintenance for Infiltration Facilities:

- Mow any applicable areas such as grass filter strips or turf cover and remove the clippings to prevent clogging
- Remove any trash or debris
- Remove blockages from outflow structures
- Remove blockages from inflow structures and/or forebays

Typical Corrective Maintenance for Infiltration Facilities:

- Broad leaf application
- Seeding
- Herbicide
- Restore access
- Remove sediment
- Replace filter media
- Repair outlet protection/erosion
- Remove woody vegetation
- Repair animal burrows
- Repair fence
- Repair erosion
- Repair structural deficiencies
- Repair plantings and vegetation

4.2 FACILITY ROUTINE MAINTENANCE HEADINGS

"Mowing"

All applicable areas shall be mowed to a recommended cutting height based on the adopted VDOT Annual Standards and Specifications approved by DEQ.

All applicable areas shall be mowed to a recommended cutting height based on the adopted VDOT Annual Standards and Specifications approved by DEQ. Care shall be taken to minimize the disturbance to any man-made or natural channels or native sites. Grass clippings shall be removed to prevent clogging of the media.

"Remove any trash or debris"

Any trash or debris, either "natural" or "man-made" (i.e. bottles, tires, brush, etc.), shall be removed from the site. Trash and debris can clog the infiltration media and increase the water level in the facility beyond design levels, thus their impacts are more significant than just aesthetics. Trash shall be disposed of in accordance with the waste classification and hazard level. Be aware of potential sources of illicit discharges within the debris. If there is potential for an illicit discharge or evidence of one occurring, please refer to the VDOT IDDE Manual for proper reporting procedures.

If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads, etc. This would allow VDOT to examine anything requiring more resources and cost.

"Remove blockages from outflow structures"

Any trash or debris, either "natural or "man-made," that is blocking or impeding operation of an outflow structure shall be removed so that the outflow is fully functional again. Blockages have the ability to raise the design water level in the facility. For infiltration facilities, outflow structures could be underdrains, high- flow bypass systems or channels, or any pipe connection. However, the normal function of infiltration type facilities is to direct the runoff back into the ground, so they typically would not have an outflow (bypass or overflow) except for high flow events. Be aware of potential sources of illicit discharges within the debris. If there is potential for an illicit discharge or evidence of one occurring, please refer to the VDOT IDDE Manual for proper reporting procedures.

The trash or debris shall be disposed of in accordance with the waste classification and hazard level. If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads, etc.

This would allow VDOT to examine anything requiring more resources and cost.

"Remove blockages from inflow structures and/or forebays"

Any trash or debris that is blocking or impeding operation of an inflow structure and/or forebay shall be removed. In addition, landscape trimmings shall be properly disposed of to prevent clogging by the vegetative debris. Blockages have the ability to raise the design water level in the facility. Be aware of potential sources of illicit discharges within the debris. If there is potential for an illicit discharge or evidence of one occurring, please refer to the VDOT IDDE Manual for proper reporting procedures.

This trash or debris, either "natural or "man-made", shall be disposed of in accordance with the waste classification and hazard level. If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads, etc. This would allow VDOT to examine anything requiring more resources and cost.

4.3 FACILITY CORRECTIVE MAINTENANCE HEADINGS

"Broad leaf application"

All broad leaf applications shall be applied by a qualified VDOT employee or representative with the appropriate VDACS certifications and endorsements. All chemicals shall be applied only when necessary, appropriate and in accordance with the label, in addition to any state or federal laws that govern use.

"Seeding"

Any seeding that takes place shall be in accordance with Section 603 of VDOT's current Road and Bridge specifications (Section 603) and VDOT's adopted Nutrient Management Plan that governs seeding. Seeding shall be done to stabilize areas and prevent erosion. A 90% vegetative cover shall be maintained.

"Herbicide"

All herbicide applications shall be applied by a qualified VDOT employee or representative appropriate VDACS certifications and endorsements. All chemicals shall be applied only when necessary, appropriate and in accordance with the label, in addition to VDOT's adopted Nutrient Management Plan and any state or federal laws that govern use.

"Remove Sediment"

All facility forebays, micropools, and stormwater storage areas shall be cleaned of sediment to return the area to original design grades and ensure functionality.

All facility forebays, micropools, and stormwater storage areas shall be cleaned of sediment to return the area to original design grades and ensure functionality. Sediment shall be disposed of in accordance with local, state and federal requirements. Care shall be taken to minimize the extent of any land disturbance and to leave the site in non-erosive pre- maintenance condition. This will likely involve some type of stabilization and seeding operation. Operations shall follow any state ESC standard and VDOT"s adopted Nutrient Management Plan. Removing sediment in a bioretention facility may be more problematic due to the plantings. For more detailed information on seeding requirements please refer to the topic above labeled "Seeding".

"Restore Access"

All steps and measures shall be followed to ensure that the access to the facility meets maintenance needs. Establishing and maintaining access to the pretreatment cell, grass filter area and outlet are imperative for proper upkeep of the facility. Access will most commonly be needed for mowing; however, access for heavier machinery may be required for sediment removal, grading, and check dam repair. This may include removing brush or trees, grading, seeding, or installing gravel. If the disturbed area exceeds 2500 sq. ft. in a Chesapeake Bay Preservation Area or 10,000 sq. ft. outside of a Chesapeake Bay Preservation Area consult the appropriate VDOT department to determine if an E&S Plan is required.

"Replace filtration media"

When replacement of the media is warranted, the plantings (if any) in the facility, the mulch layer, and the underlying filter media or amended soil shall be removed and stored or disposed of properly. The engineered soil or filter media shall be replaced to meet all of the approved plan specifications and the plantings shall be replaced or re-installed. Note if materials are being reused they must meet the original design specifications to ensure functionality. Care shall be taken in the operation not to damage the underdrain (if present) in the facility, as it is vital for proper operation. The contractor shall certify that the soil or media installed meets the original plan specifications, including filtration rates, as specified in the original approved design plans. Note that lab testing may be required to verify that in-field conditions meet the specified rates. Care shall be taken to work from the sides of the facility so the soils in the footprint are not compacted, which affects their ability to infiltrate run off. Inspection of the observation well is a good indicator of proper function of the replacement or in situ media and any clogging or related issues.

- Filtration media clogged by sediment and debris will typically need to be replaced. Identifying the source of the impacts and taking measures to

remedy the upstream issues is critical to the success and function of the facility and its filter media.

- While stabilization of the facility is occurring, ESC measures may be appropriate to prevent additional impacts to the downstream area.

"Remove woody vegetation"

All woody vegetation not included in the design shall be removed, including the roots when possible, and disposed of appropriately.

All woody vegetation not included in the design shall be removed, including the roots when possible, and disposed of appropriately. Remove any trees that may create a canopy in the vicinity of the infiltration facility to prevent clogging of the media with dead vegetation. All areas shall be returned to the original design conditions. Removing the root system is critical to maintaining system functionality because it will halt further growth and limit clogging of the media, which slows or prevents infiltration.

"Repair animal burrows"

All animal burrows shall be filled and compacted.

All animal burrows shall be filled and compacted. Attention should be given to ensure that the burrow has not affected the structural integrity of the infiltration facility. If the structural integrity is comprised, a qualified VDOT representative shall be contacted for further investigation to determine appropriate structural repair measures.

"Repair fence"

All compromised fence areas shall be repaired in accordance with the original design plans to ensure public safety. This includes locks and gates.

"Repair erosion"

Erosion can be minor or significant which affects the repair effort. Erosion includes upland drainage areas that may be controllable sources of sediment or erosion. Erosion can contribute to sedimentation in the infiltration facility and also weaken the structure depending on its severity and location.

Erosion shall be corrected by seeding, grading, and/or installation of stabilization matting to correct the deficiency. If the erosion is on a structural part of the facility, a qualified VDOT representative shall be consulted to determine the proper repair and methodology, such as soil type and compaction requirements, to ensure structural stability of the facility.

http://www.fs.edu.us/t-d/pubd/htmlpubd/ht,062328 15/images/fig3

"Repair structural deficiencies"

Repairs to all structural deficiencies shall be designed and reviewed by a qualified VDOT representative.

Repairs to all structural deficiencies shall be designed and reviewed by a qualified VDOT representative. Repairs to an underdrain system or remediation of a cracked or failing permeable pavement surface would fall into this category. Maintenance repairs shall directly follow the repair designs precisely, and in some cases, construction monitoring may be appropriate. Consult the appropriate VDOT representative to determine if an ESC Plan is required during repairs (e.g., a dewatering plan).

"Repair plants and vegetation"

Required plantings shall be installed per the approved project specifications to maintain the desired vegetation density and meet pollutant removal requirements. If the plans are not available, good judgment shall be used to determine if and where any plant mortality has occurred, warranting replacement. If plants are not available or alternative species are warranted, consult a competent VDOT representative to specify plantings. The plantings are a critical design element in bioretention facilities as the main pollutant uptake mechanism. A 90% vegetative cover shall be maintained.

"Repair outlet"

Outlet protection at the end of the outflow structure serves to slow the outflow and reduce the potential for downstream erosion. Typical maintenance items include displaced or missing riprap. If the riprap is transported downstream or displaced, it signifies that the stone size is too small, whereas erosion or scour at the edges of the riprap footprint indicate that the riprap footprint dimensions are probably too small. Note, not all infiltration facilities will have outlet protection because not all of the facilities outlet to the ground surface and instead infiltrate

drainage back into the soils within the facility.

Outlet protection shall be installed per the original approved plans including the dimensions, size of stone and placement specifications. If the original design plans are not available or if the original design is clearly inadequate, the outlet protection shall be designed by a qualified professional in accordance with the applicable specifications and design requirements. All outlet protection shall be installed per the approved E&S Annual Standards and Specifications.

5 MANUFACTURED FACILITY MAINTENANCE

5.1 TYPES OF MANUFACTURED FACILITIES

5.1.1 Model Name and Number, Proprietary, Pipe Detention, Underground Storage, and Other

These types of facilities are typically used in urbanized areas to minimize the impact to the development area. Various companies have developed manufactured BMPs and have in turn developed inspection and maintenance specifications tailored for the facility. Additionally, the manufacturer typically provides the design of the facility. The operation and maintenance specifications for these facilities should be included on the plans and available with scanned record drawings. Manufacturer's maintenance guidelines are generally described below for two common types of manufactured facilities. Please note additional items may be required by the manufacturer specific to their product.

5.1.2 Hydrodynamic Separators

This type of manufactured facility is installed within the drainage system usually inside a manhole, inlet or pipe. Hydrodynamic separators function by slowing incoming flows and creating a non-turbulent flow such that debris and oil products float to the top and sediment falls to the bottom of the facility. This sediment is typically laden with pollutants and thus the facility removes the pollution by trapping the sediment and separating it from the drainage flows. Treated water then enters the storm sewer drainage system to the outfall.

A general description of these types of manufactured facilities and general maintenance associated with them per EPA guidance can be found at:

http://www.water-research.net/Waterlibrary/Stormwater/hydrodynamic.pdf

5.1.3 Tree Box Filters

This type of manufactured facility functions as a mini bioretention cell placed within an inlet drainge structure. The visible part of the facility is the top layer of mulch, some type of planting, such as a tree, to absorb and filter pollutants and the structure is topped with a grate. The filter media is internal and beneath the tree encased in the concrete inlet structure. These MTDs are located in curblines, sidewalks and parking lot islands. Runoff passes into the structure, which filters through the plants and media, then into a catch basin and exits through an underdrain.

Tree Box Filter manufacturers typically provide, with purchase, at least a 1-year inspection and maintenance plan, which begins when the system is activated for full operation. The plan usually consists of 2 scheduled inspections of the BMP by the manufacturer's representatives, conducted seasonally. Additional visits may be provided via this plan due to excessive sediment and trash loading. Cleanup due to major contamination such as oils, chemicals, toxic spills, etc. can result in additional costs and are not typically cover under the 1-year maintenance plan.

These visits provide opportunities for VDOT maintenance staff to accompany the manufacturer's inspectors to observe their procedures. Maintenance staff should check the web site of the specific Tree Box Filter's manufacturer to obtain unit-specific maintenance procedures.

5.2 FACILITY ROUTINE MAINTENANCE HEADINGS

The main task of routine maintenance for manufactured facilities is typically removal of trash and debris from the structure. Removing accumulated sediment is also a typical task, although occurs less frequently.

Please note, the configuration of each manufactured structure varies, and thus the maintenance of each type of facility will as well. Maintenance should be conducted in accordance with the manufacturer's specification for proper operation of the specific facility type. Examples of various manufacturer's maintenance specifications are provided below as a reference only.

Hydrodynamic Separators Typical Routine Maintenance Example

Maintenance frequency and requirements for these types of MTD's are outlined in the manufacturer's specifications for each product. The inspection and maintenance frequency may need to increase based on the occurrence and amount of oil and sediment accumulation in the facility on site. Examples of an inspection and maintenance protocol as established by the manufacturer for a Hydrodynamic Separator type facility is described below.

1. Remove manhole and examine device.
2. Remove trash.
3. Measure and remove sediment. Removal is required once the sediment depth reaches a certain height in the facility as quantified on the plans and/or in the manufacturer's specifications.

    a. Sediment removal is typically performed using a vacuum truck. All removed materials must be disposed of in accordance with the appropriate regulations.
4. Inspect and perform maintenance on the unit immediately after an oil, fuel or chemical spill as recommended by the manufacturer's specifications.
5. Report the maintenance performed in the BMP Maintenance database.

5.2.1 Tree Box Filters Typical Routine Maintenance Example

Examples of generic maintenance procedures applicable to most MTD, such as a tree box type filter, are described as follows:

1. Remove the tree grate and erosion control aggregates for access to the facility.
2. Remove debris, trash and deteriorated mulch.
3. Replace filter media as necessary.
4. Mulch replacement as necessary.
5. Clean and replace erosion control aggregates, as necessary

6. Evaluate plant health and prune or replace as necessary.
7. Clean area around the Tree Box Filter.
8. Report the maintenance performed in the BMP Maintenance database.

Routine owner (VDOT) maintenance items include adequate irrigation for installed plant materials during dry periods, minor trash removal and, periodically, a full replacement of the mulch layer.

6 MISCELLANEOUS FACILITY MAINTENANCE

6.1 TYPES OF MISCELLANEOUS FACILITIES

6.1.1 Grassed Swales and Grassed Channel CH

These vegetated channels are designed to decrease flow rates, increase pollutant removal through filtration and infiltration, and enhance runoff storage. They are also used as pre-treatment practices, carrying runoff to other treatment facilities. Primarily, facilities of this type are designed to receive relatively clean stormwater runoff and are not suitable for direct sedimentation from disturbed areas or runoff from hotspots.

The swales should be situated adjacent and parallel to the drainage area, and should be at least as long as the drainage area. Channel side slopes should be 2:1 or less. The channel longitudinal slope should be 4% or less, ideally 1-2%.

Grassed swales are typically used to treat runoff from small drainage areas (less than 5 acres). These channels can be used in roadways in the place of a typical conveyance channel, but are likely to have a larger footprint. They may, however, reduce the size of other required onsite stormwater management applications.

6.1.2 Level Spreaders and Check Dams – Permanent E&S Measures

Level spreaders and check dams slow runoff flow, and thereby decrease erosion and increase the opportunities for pollutant absorption. Additionally, they are erosion control measures and can filter debris and sediment out of the run off through their stone construction.

A level spreader is an outlet with an excavated depression that disperses concentrated runoff as sheet flow across a stabilized, vegetated surface. It reduces erosion potential and impacts to downstream channels and other erosion control measures. Depression depth may be increased to improve debris removal and sediment settling, and to increase the level spreader's temporary storage capacity.

Check dams are small, temporary dams constructed of rock and used in channels to slow runoff and trap sediment. Outlet stabilization measures, such as riprap or geotextile lining, should be in place after the final check dam in a channel to protect against these erosion generating flows.

Typical Routine Maintenance for Miscellaneous Facilities:

- Mow any applicable areas
- Remove any trash or debris
- Remove blockages from outflow structures
- Remove blockages from inflow structures and/or forebays

Typical Corrective Maintenance:

- Broad leaf application
- Seeding
- Herbicide
- Restore access
- Remove sediment
- Repair filter media
- Repair outlet protection/erosion
- Remove woody vegetation
- Repair animal burrows
- Repair fence
- Repair erosion
- Repair structural deficiencies
- Repair plantings and vegetation

6.2 FACILITY ROUTINE MAINTENANCE HEADINGS

"Mowing"

All applicable areas shall be mowed to a recommended cutting height based on the adopted VDOT Annual Standards and Specifications approved by DEQ.

All applicable areas shall be mowed to a recommended cutting height based on the adopted VDOT Annual Standards and Specifications approved by DEQ. Care shall be taken to minimize the disturbance to any man-made or natural channels or native sites. Grass clippings shall be removed to prevent clogging of the associated facility.

"Remove any trash or debris"

Any trash or debris, either "natural" or "man-made" (i.e. bottles, tires, brush, etc.), shall be removed from the site. Trash shall be disposed of in accordance with the waste classification and hazard level. Be aware of potential sources of illicit discharges within the debris. If there is potential for an illicit discharge or evidence of one occurring, please refer to the VDOT IDDE Manual for proper reporting procedures.

If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads, etc. This would allow VDOT to examine anything requiring more resources and cost. Trash and debris can clog the filter and increase the water level in the facility beyond design levels, thus their impacts are more significant than just aesthetics.

"Remove blockages from outflow structures"

Any trash or debris, either "natural or "man-made," that is blocking or impeding operation of an outflow structure shall be removed so that the outflow is fully functional again. Blockages have the ability to raise the design water level in the facility. Be aware of potential sources of illicit discharges within the debris. If there is potential for an illicit discharge or evidence of one occurring, please refer to the VDOT IDDE Manual for proper reporting procedures.

If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads, etc. This would allow VDOT to examine anything requiring more resources and cost.

"Remove blockages from inflow structures and/or forebays"

Any trash or debris that is blocking or impeding operation of an inflow structure and/or the forebay shall be removed. In addition, landscape trimmings shall be properly disposed of to prevent clogging by the vegetative debris. Blockages have the ability to raise the design water level in the facility. Be aware of potential sources of illicit discharges within the debris. If there is potential for an illicit discharge or evidence of one occurring, please refer to the VDOT IDDE Manual for proper reporting procedures.

This trash or debris, either "natural or "man-made", shall be disposed of in accordance with the waste classification and hazard level. If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads, etc. This would allow VDOT to examine anything requiring more resources and additional cost.

"Spot weeding and invasive plant removal using recommended control methods"

Invasive plants and weeds shall be removed to restore the area to its original design conditions.

Invasive plants and weeds shall be removed to restore the area to its original design conditions. Weeds and invasive plant roots shall be removed to ensure that the plant does not re-establish and to prevent clogging. In some cases the growth and/or root mat can get so thick that it impacts the storage volume in the facility and raises the design water levels.

6.3 FACILITY CORRECTIVE MAINTENANCE HEADINGS

"Broad leaf application"

All broad leaf applications shall be applied by a qualified VDOT employee or representative with the appropriate VDACS certifications and endorsements. All chemicals shall be applied only when necessary, appropriate, and in accordance with the label, in addition to any state or federal laws that govern use.

"Seeding"

Any seeding that takes place shall be in accordance with Section 603 of VDOT's current Road and Bridge Specifications and VDOT's adopted Nutrient Management Plan, which governs seeding. Seeding shall be done to stabilize areas and prevent erosion. A 90% vegetative cover shall be maintained.

"Herbicide"

All herbicide applications shall be applied by a qualified VDOT employee or representative with the appropriate VDACS certifications and endorsements. All chemicals shall be applied only when necessary, appropriate, and in accordance with the label, in addition to VDOT's adopted Nutrient Management Plan and any state or federal laws that govern use.

"Remove Sediment"

All facility features including pretreatment cells and inflow points shall be cleaned of sediment to return the area to original design grades and ensure functionality.

- To prevent future sedimentation, the source must be identified and remedied.
- While stabilization is occurring, ESC measures may be appropriate to prevent further impacts to the downstream areas.

All facility features including pretreatment cells and inflow points shall be cleaned of sediment to return the area to original design grades and ensure functionality. The areas upstream of check dams and the troughs of level spreaders are particularly prone to sediment buildup and, therefore, shall be regularly monitored and cleaned. Sediment shall be disposed of in accordance with local, state and federal requirements. Care shall be taken to minimize the extent of any land disturbance and to leave the site in non-erosive pre-maintenance conditions. This will likely involve some type of stabilization and seeding operation. Operations shall follow any state ESC standards and VDOT's adopted Nutrient Management Plan. For more information on seeding requirements, please refer to the topic above labeled "Seeding."

"Restore Access"

All steps and measures shall be followed to ensure that the access to the facility meets maintenance needs. Establishing and maintaining access to any pretreatment cells, grass filter areas and outlets are imperative for proper upkeep of the facility. Access will most commonly be needed for mowing; however, access for heavier machinery may be required for sediment removal, grading, and check dam repair. This may include removing brush or trees, grading, seeding, or installing stone base. If the disturbed area exceeds 2500 sq. ft. in a Chesapeake Bay Preservation Area or 10,000 sq. ft. outside of a Chesapeake Bay Preservation Area, consult the appropriate VDOT department to determine if an E&S Plan is required.

"Repair filtration media"

N/A None of the Miscellaneous facilities have filter beds.

"Remove woody vegetation"

All woody vegetation not included in design specifications shall be removed, including the roots when possible, and disposed of appropriately.

All woody vegetation not included in design specifications shall be removed, including the roots when possible, and disposed of appropriately. All areas shall be returned to the original design specifications. Removing the root system is critical to maintaining the system functionality because it will halt further growth and limit clogging of the media which slows or prevents filtration. Roots in Check Dams and Level Spreaders can threaten the structural integrity of the facility.

"Repair animal burrows"

All animal burrows shall be filled and compacted.

All animal burrows shall be filled and compacted. Attention shall be given to ensure that the burrow has not affected the structural integrity of the facility. If the structural integrity is comprised, an appropriate qualified VDOT representative shall be contacted for further investigation and to determine appropriate structural repair measures.

"Repair fence"

All compromised fence areas shall be repaired in accordance with the original design plans to ensure public safety. This includes locks and gates.

"Repair erosion"

Erosion can be minor or significant which affects the repair effort. Erosion includes upland drainage areas that may be controllable sources of sediment or erosion. Erosion can contribute to sedimentation in the facility, which impacts is proper function and also weakens the structure depending on its severity and location.

Both the upstream and the downstream side of all check dams shall be inspected for signs of undercutting and erosion. Erosion shall be corrected by seeding, grading, and/or installation of soil stabilization matting to correct the deficiency. If the erosion is compromising the BMP's structural stability, a competent VDOT representative shall be consulted to determine the proper repair and methodology, such as soil type and compaction requirements, to ensure structural stability of the facility.

"Repair structural deficiencies"

Repairs to all structural deficiencies shall be designed and reviewed by a competent VDOT representative. Repairs to an underdrain would fall into this category. Maintenance repairs shall follow any repair designs precisely, and in some cases, construction monitoring may be appropriate. Consult the appropriate VDOT representative to determine if an ESC Plan is required during repairs, based on the amount of disturbed area.

"Repair plants and vegetation"

If the plans are not available, good judgment shall be used to determine if and where any plant mortality has occurred that warrants replacement. Grassed channels shall be checked for any salt-killed vegetation and species shall be replaced in kind. If plants are not available or alternative species are warranted, consult a competent VDOT representative to specify alternate plantings. A 90% vegetative cover shall be maintained.

"Repair outlet"

Outlet protection at the end of the outflow structure serves to slow the outflow and reduce the potential for downstream erosion. Typical maintenance items include displaced or missing riprap. If the riprap is transported downstream or displaced, it signifies that the stone size is too small, whereas erosion or scour at the edges of the riprap footprint indicate that the riprap footprint dimensions are probably too small. Note, not all infiltration facilities will have outlet protection because not all of the facilities outlet to the ground surface and instead infiltrate drainage back into the soils within the facility.

Outlet protection shall be installed per the original approved plans including the dimensions, size of stone and placement specifications. If the original design plans are not available or if the original design is clearly inadequate, the outlet protection shall be designed by a qualified professional in accordance with the applicable specifications and design requirements. All outlet protection shall be installed per the approved E&S Annual Standards and Specifications.

7 BASIN FACILITY MAINTENANCE

7.1 TYPES OF BASIN FACILITIES

7.1.1 Wet Basin, Wet Pond I & II (CH), Extended Detention I & II (CH)

These basins have at least one inflow channel, an embankment/dam, typically (although not always) a riser within the basin, a principal spillway structure to route the drainage through the embankment, an outlet structure and an emergency spillway. Wet ponds consist of a permanent pool of standing water that promotes pollution removal and reduces flooding. Runoff from each storm enters the pond and raises the normal water level, and the outlet structure releases the drainage at a slower rate over a longer period of time. This “draw down”, or holding time, allows pollutants to settle out of the stormwater and lessens the impact of the flow volume on the outlet channel.

7.1.2 Dry Basin and Extended Detention Basin

These basins also have at least one inflow channel, an embankment/dam, a bottom level orifice, sometimes a riser within the basin, a principal spillway structure to route drainage through the dam, an outlet structure and an emergency spillway. These basins do not have a normal pool, and remain dry except during and shortly after storm events. Some extended detention facilities may have a wet marsh with plantings in the bottom for additional pollutant removal. On rare occasions, the extended detention basin may be designed to have a wet normal pool, in which case the inspector shall verify that it isn’t abnormal ponding from clogging and refer to the above topics.

7.1.3 Sand Filter Basin

Sand filters in this BMP Category are for above ground systems. Underground systems are categorized under the “Manufactured” BMP category. These filters capture, temporarily store, and treat stormwater runoff by passing it through a sand or organic media filter, collecting the filtered water in an under drain, and then returning it back to the storm drainage system or receiving channel. The filter consists of two chambers: the first is devoted to settling, and the second serves as a filter bed consisting of the sand or organic filter media.

Typical Routine Maintenance for Basin Facilities:

- Mow any applicable areas such as grass filter strips or turf cover
- Remove any trash or debris including clippings from maintenance
- Remove blockages from outflow structures
- Remove blockages from inflow structures and/or forebays
- Prune trees and shrubs
- Exercise the gate valve
- Inspect the principle spillway

Typical Corrective Maintenance:

- Broad leaf application
- Seeding
- Herbicide
- Restore access
- Remove sediment
- Replace filter media
- Repair outlet protection/erosion
- Remove woody vegetation
- Repair animal burrows
- Repair fence
- Repair erosion
- Repair structural deficiencies
- Repair plantings and vegetation

7.2 FACILITY ROUTINE MAINTENANCE HEADINGS

"Mowing"

All applicable areas shall be mowed to a recommended cutting height based on the adopted VDOT Annual Standards and Specifications approved by DEQ.

All applicable areas shall be mowed to a recommended cutting height based on the adopted VDOT Annual Standards and Specifications approved by DEQ. Care shall be taken to minimize the disturbance to any man-made or natural channels or native sites. Grass clippings shall be removed to prevent clogging of the media if applicable.

"Remove any trash or debris"

Any trash or debris, either "natural" or "man-made" (i.e. bottles, tires, brush, etc.), shall be removed from the site.

- If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads, etc. This would allow VDOT to examine anything requiring more resources and cost.

Any trash or debris, either “natural” or “man-made” (i.e. bottles, tires, brush, etc.), shall be removed from the site. Trash shall be disposed of in accordance with the waste classification and hazard level.

“Remove blockages from outflow structures”

Any trash or debris that is blocking or impeding operation of an outflow structure shall be removed so that the outflow is fully functional again.

- If the blockage extends into the outlet structure requiring physical entry inside the structure, please observe any Confined Space Requirements.
- If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads, etc. This would allow VDOT to examine anything requiring more resources and cost.

Any trash or debris that is blocking or impeding operation of an outflow structure shall be removed so that the outflow is fully functional again. This is particularly important at the water quality orifice where blockages commonly occur. The trash or debris, either “natural or “man-made”, shall be disposed of in accordance with the waste classification and hazard level.

“Remove blockages from inflow structures and/or forebays”

Any trash or debris that is blocking or impeding operation of an inflow structure and/or forebay shall be removed to restore proper function.

- If the blockage extends into the outlet structure requiring physical entry inside the structure, please observe any Confined Space Requirements.
- If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads, etc. This would allow VDOT to examine anything requiring more resources and cost.

Any trash or debris that is blocking or impeding operation of an inflow structure and/or forebay shall be removed to restore proper function. This trash or debris (either "natural or "man-made") shall be disposed of in accordance with the waste classification and hazard level.

"Exercise the gate valve"

Gate valves are used in extreme storm events to regulate flows and can engage additional outflow measures to accommodate the increased volume, or they can close off certain outflow structures to decrease the outflow, change the outflow path, or cut it off completely in the case of hazardous spills.

Gate valves are used in extreme storm events to regulate flows and can engage additional outflow measures to accommodate the increased volume, or they can close off certain outflow structures to decrease the outflow, change the outflow path, or cut it off completely in the case of hazardous spills. Most gate valves are not used during daily operations, so it is imperative that they are exercised periodically to prevent them from locking up and/or rusting in place. This can be of particular concern when the gate valves are only used during large storm events to prevent flooding.

7.3 FACILITY CORRECTIVE MAINTENANCE HEADINGS

"Broad leaf application"

All broad leaf applications shall be applied by a qualified VDOT employee or representative with the appropriate VDACS certifications and endorsements. All chemicals shall be applied only when necessary, appropriate and in accordance with the label, in addition to any state or federal laws that govern use.

"Seeding"

Any seeding that takes place shall be in accordance with Section 603 of VDOT's current Road and Bridge Specifications and VDOT's adopted Nutrient Management Plan, which governs seeding. Seeding shall be done to stabilize areas and prevent erosion. A 90% vegetative cover shall be maintained.

"Herbicide"

All herbicide applications shall be applied by a qualified VDOT employee or representative with the appropriate VDACS certifications and endorsements. All chemicals shall be applied only when necessary, appropriate and in accordance with the label, in addition to VDOT's adopted Nutrient Management Plan and any state or federal laws that govern use.

"Remove Sediment"

All facility forebays, micropools, and basin areas shall be cleaned of sediment to return the area to original design grades and ensure functionality.

All facility forebays, micropools, and basin areas shall be cleaned of sediment to return the area to original design grades and ensure functionality.

Forebays shall be cleaned out once every 5-7 years or when 50% of the capacity is full. Sediment shall be disposed of in accordance with local, state and federal requirements. Care shall be taken to minimize the extent of any land disturbance and to leave the site in non-erosive conditions in accordance with the approved plans. This will typically involve some type of stabilization and seeding operation. Such operations shall follow any state ESC standards and VDOT's approved Nutrient Management Plan. For more detailed information on seeding requirements, please refer to the topic above labeled "Seeding".

"Restore Access"

Access to the facility, including construction equipment access, must be provided to ensure maintenance can be achieved to ensure proper function. Establishing and maintaining access to the impoundment and outlet is imperative for proper upkeep of the facility. This may include removing brush or trees, grading, seeding, or installing a stone base. If the disturbed area exceeds 2500 sq. ft. in a Chesapeake Bay Preservation Area or 10,000 sq. ft. outside of a Chesapeake Bay Preservation Area, consult a competent VDOT department to determine if an ESC Plan is required.

"Replace filtration media"

Except for the Sand Filter Basin, filter media is not typically a part of basin facilities. If there is filter media in the basin, it is typically in a "filter bed" area in the bottom of the basin near the control structure. When replacement of the media is warranted, the plantings (if any) in the facility, the mulch layer and amended soil shall also be removed and disposed of properly. The amended soil shall be replaced to meet all of the plan specifications and the planting shall be re-installed. Care shall be taken in the operation not to damage the underdrain (if present) in the facility as it is vital for proper operation. The contractor shall provide verification that the proposed media meets the approved specifications, including filtration rates, as specified in the original approved design plans. Note that lab testing may be required to verify that the in-field conditions meet the specified infiltration rates.

- Filtration media clogged by sediment and debris will typically need to be replaced. Identifying the source of the impacts and taking measures to remedy the upstream issues is critical to the success and function of the facility and its filter media.

- While stabilization of the facility is occurring, ESC measures may be appropriate to prevent additional impacts to the downstream area.

"Remove woody vegetation"

All woody vegetation not included in design specifications shall be removed, including the roots when possible, and disposed of appropriately.

All woody vegetation not included in design specifications shall be removed, including the roots when possible, and disposed of appropriately. All areas shall be returned to the original design specifications. Removal of the root system is critical to maintaining system functionality of the BMP because it will halt further growth and limit clogging of the media, which slows or prevents filtration. If the woody growth is on or in the vicinity of the impoundment, consult a competent VDOT representative regarding removing the root structure and potential impacts to the structural integrity of the dam.

"Repair animal burrows"

All animal burrows shall be filled and compacted.

All animal burrows shall be filled and compacted. Attention shall be given to ensure that the burrow has not affected the structural integrity of the basin. If the structural integrity is comprised, an appropriate qualified VDOT representative shall be contacted for further investigation and to determine appropriate structural repair measures.

"Repair fence"

All compromised fence areas shall be repaired in accordance with the original design plans to ensure public safety. This includes locks and gates

"Repair erosion"

This includes upland drainage areas that may be controllable sources of sediment or erosion.

This includes upland drainage areas that may be controllable sources of sediment or erosion. Erosion can contribute to sedimentation in the basin and also may weaken the structure, depending on its severity and location. Erosion shall be corrected by seeding, grading, and/or installation of soil stabilization matting to correct the deficiency. If the erosion is on the embankment (abutments, face, top, or rear), a competent VDOT representative shall be consulted to determine the proper repair and methodology, such as soil type and compaction requirements, to ensure structural stability of the facility. In many cases, erosion on the embankment is indicative of other more critical problems.

"Repair structural deficiencies"

Repairs to all structural deficiencies shall be designed and reviewed by a competent VDOT representative. Maintenance repairs shall follow the repair design precisely, and in some cases, construction monitoring may be appropriate. Consult the appropriate VDOT representative to determine if an ESC Plan is required during repairs (e.g., a dewatering plan).

"Repair plants and vegetation"

Required plantings shall be installed per the approved project specifications to maintain the desired vegetation density and meet pollutant removal requirements. In wet ponds/basins, the growth of wetland plants, trees and shrubs shall be monitored. If the plans are not available, good judgment shall be used to determine if and where any plant mortality has occurred, warranting replacement. If plans are not available or alternative species may be warranted, it may be appropriate to consult a competent VDOT representative to specify plantings. A 90% vegetative cover shall be maintained

"Repair outlet"

Outlet protection shall be repaired/installed per the original approved plans, including include riprap footprint dimensions, size of stone and placement specifications.

Outlet protection shall be repaired/installed per the original approved plans, including include riprap footprint dimensions, size of stone and placement specifications. If the original design plans are not available or if the original design is clearly inadequate, which is evident by the presence of erosion and scour, the outlet protection shall be designed by a qualified VDOT representative or employee and repaired in accordance with the applicable specifications and design requirements.

8 LID FACILITY MAINTENANCE

8.1 TYPES OF LID FACILITIES

8.1.1 Vegetated Roofs Level 1 and 2 (CH)

These are building roof surfaces that support plant growth in an engineered growing media underlain with drainage materials and waterproofing. The growing media captures and stores stormwater. A portion of the stormwater is taken up by the plant roots or evaporates, thereby reducing peak runoff rates, runoff volume, and pollutant loads. The remainder is conveyed into a drain system. There are two types of vegetated roofs: intensive and . Extensive vegetated roofs have growing media 2 to 6 inches deep, and have drought tolerant vegetation. Extensive roofs are much more common than intensive vegetated roofs, which have deeper growing media (6 to 48 inches) and typically support a wide variety of plants, including shrubs and trees.
Intensive roofs are heavier and more expensive.

8.1.2 Rainwater Harvesting / Rain Barrels (CH)

This practice catches, redirects, stores and ultimately releases rainfall for later use in non-potable applications, including irrigation, toilet flushing, fire suppression systems, exterior washing (including vehicle washing, street sweepers, etc.), and other activities. Rainwater harvesting system runoff volume reduction rates are user determined, based on tank size, configuration, and demand drawdown. They can be combined with a variety of down gradient runoff reduction practices, including swales, infiltration, bioretention, and rooftop disconnection. Rainwater harvesting systems have six main components: a roof surface, collection and conveyance system, pre-screening and first flush diverters, storage tank (cistern or rain barrel), distribution system, and overflow/ filter path/ secondary runoff reduction practice.

Typical Routine Maintenance for LID Facilities:

- Mow any applicable areas such as grass filter strips or turf cover
- Remove any trash or debris including clippings from maintenance
- Remove blockages from outflow structures
- Remove blockages from inflow structures and/or forebays
- Spot weeding and invasive plant removal using recommended control methods
- Ensure that there is no vegetative canopy above LID element

Typical Corrective Maintenance:

- Broad leaf application
- Seeding
- Herbicide
- Restore access
- Remove sediment

- Replace filter media
- Repair outlet protection/erosion
- Remove woody vegetation
- Repair animal burrows
- Repair fence
- Repair erosion
- Repair structural deficiencies
- Repair plantings and vegetation

8.2 FACILITY ROUTINE MAINTENANCE HEADINGS

"Remove any trash or debris"

Any trash or debris, either "natural" or "man-made" (i.e. bottles, tires, brush, etc.), shall be removed from the site.

Any trash or debris, either "natural" or "man-made" (i.e. bottles, tires, brush, etc.), shall be removed from the site. Trash shall be disposed of in accordance with the waste classification and hazard level.

"Remove blockages from outflow structures"

Any trash or debris that is blocking or impeding operation of an outflow structure shall be removed so that the outflow is fully functional again.

- If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads of materials. This would allow VDOT to examine anything requiring more resources and cost.

Any trash or debris that is blocking or impeding operation of an outflow structure shall be removed so that the outflow is fully functional again. Inspect the condition of overflow pipes, the overflow filter path and/or secondary runoff reduction practices. This trash or debris, either "natural or "man-made," shall be disposed of in accordance with the waste classification and hazard level.

"Remove blockages from inflow structures and/or forebays"

Any trash or debris that is blocking or impeding operation of an inflow structure shall be removed.

- If this is under contract as a routine maintenance item, it may be beneficial to specify a maximum amount of removal in the contract, such as 4 wheelbarrow loads of materials. This would allow VDOT to examine anything requiring more resources and cost.

Any trash or debris that is blocking or impeding operation of an inflow structure shall be removed. With these types of LID structures a "forebay" typically is not used. However, any type of pretreatment process or structure would qualify for this criteria. Inspect and clean pre-screening devices and first flush diverters a minimum of twice a year. This trash or debris, either "natural or "man-made", shall be disposed of in accordance with the waste classification and hazard level.

"Spot weeding and invasive plant removal using recommended control methods"

Invasive plants and weeds shall be removed to restore the area to its original design conditions.

Invasive plants and weeds shall be removed to restore the area to its original design conditions. Weeds and invasive plant roots shall be removed to ensure that the plant does not re-establish. Be sure to consult the design and planting plans. If plant substitutes are warranted, contact a competent VDOT representative for approval.

"Ensure that there is no vegetative canopy above LID element"

For Vegetated Roofs, remove leaf litter from trees that may have canopies above the roofs (or are planted on the roofs) and other debris that is blocking roof drains, so that they function properly.

For Vegetated Roofs, remove leaf litter from trees that may have canopies above the roofs (or are planted on the roofs) and other debris that is blocking roof drains, so that they function properly. For rainwater harvesting, be aware of root systems and their proximity to the pipes and storage devices, especially if underground. Any canopy above the LID device shall be trimmed back beyond the BMP, and vegetative litter shall be removed as necessary.

http://www.uky.edu/~jast239/courses/biogeo/Trees?Sycamore.jpg

8.3 FACILITY CORRECTIVE MAINTENANCE HEADINGS

"Broad leaf application"

Level Spreaders and Check dams (Permanent E&S Measures):
All broad leaf applications shall be applied by a qualified VDOT representative with the appropriate VDACS certifications and endorsements. All chemicals shall be applied only when necessary, appropriate and in accordance with the label, in addition to any state or federal laws that govern use.

Vegetated Roofs Level 1 & 2 (CH):
Not applicable. Broad leaf applications shall not be applied to Vegetated Roofs (CH) due to potential damage to the waterproof liner.

"Seeding"

Vegetated Roofs Level 1 & 2 (CH), Rainwater Harvesting (CH), Level Spreaders and Check Dams (Permanent E&S Measures):
Any seeding that takes place shall be in accordance with Section 603 of VDOT's current Road and Bridge Specifications and VDOT's adopted Nutrient Management Plan which governs seeding. Seeding shall be done to stabilize areas and prevent erosion. A 90% vegetative cover shall be maintained.

"Herbicide"

Level Spreaders and Check dams (Permanent E&S Measures):
All herbicide applications shall be applied by a qualified VDOT representative with the appropriate VDACS certifications and endorsements. All chemicals shall be applied only when necessary, appropriate and in accordance with the label, in addition to any state or federal laws that govern use.

Vegetated Roofs Level 1 & 2 (CH):
Not applicable. Herbicide applications shall not be applied to Vegetated Roofs (CH) due to potential damage to the waterproof liner.

Rainwater Harvesting (CH):
Not applicable.

"Remove Sediment"

Rainwater Harvesting (CH):
Sediment needs to be kept out of rainwater harvesting cisterns/storage containers and plumbing pipes and valves. Sediment levels may be visible as shadows or dark areas on the sides on the container. The sediment takes up storage volume for runoff such that the facility cannot hold the original design amounts. Sediment discovered inside a storage container shall be removed from the structure to ensure proper functionality. Properly designed systems should have a pre-treatment filter to block sediment from entering the storage chamber.

Vegetated Roofs Level 1 & 2 (CH):
Sediment of concern on Vegetated Roofs is generally dislodged growing medium that may be blocking the roof drain. This sediment shall be removed and the drain flushed to ensure it is functioning properly.

Level Spreaders and Check Dams (Permanent E&S Measures):
Level Spreaders and Check Dams are permanent E&S features that serve to reduce the velocity at the outlet to prevent erosion and damage. Check dams filter runoff and can act as a semi-control structure that can throttle back flows during large storm events with its weir like structure. Level spreaders take concentrated flow and dissipate the energy and spread it back out to sheet flow. Both of the riprap structures rely on the angular rock surfaces and riprap construction techniques to properly perform. Sediment reduces their functionality over time by filling in the angular surface to make it smoother while also filling in

the voids for filtration. In addition, sediment would allow woody vegetation and brush to take root over time which is another costly maintenance item. All excess sediment shall be removed from the structures. Sediment shall be disposed of in accordance with local, state and federal requirements. Care should be taken to minimize the extent of any land disturbance and to leave the site in non-erosive pre-maintenance conditions.

"Restore Access"

Vegetated Roofs Level 1 & 2 (CH), Rainwater Harvesting (CH), Level Spreaders and Check Dams (Permanent E&S Measures):
Access to the facility, including construction equipment access, must be provided to ensure maintenance can be achieved to ensure proper function. Establishing and maintaining access to the BMP is imperative for proper upkeep of the practice. This may include removing brush or trees, grading, and seeding. If the disturbed area exceeds 2500 sq. ft. in a Chesapeake Bay Preservation Area or 10,000 sq. ft. outside of a Chesapeake Bay Preservation Area, consult the appropriate VDOT department to determine if an E&S Plan is required.

"Remove woody vegetation"

Level Spreaders and Check Dams (Permanent E&S Measures):
All woody vegetation shall be removed from level spreaders and check dams to ensure their structural integrity and proper functionality. Removing the root system is critical to maintaining the functionality of the system because it will halt further growth and increased impacts to the measures.

Rainwater Harvesting (CH): Not applicable.

"Repair animal burrows"

Vegetated Roofs Level 1 & 2 (CH), Rainwater Harvesting (CH), Level Spreaders and Check Dams (Permanent E&S Measures):
Not applicable.

"Repair fence"

Vegetated Roofs Level 1 & 2 (CH), Rainwater Harvesting (CH), Level Spreaders and Check Dams (Permanent E&S Measures):
All compromised fence areas shall be repaired to ensure public safety.

"Repair erosion"

Vegetated Roofs Level 1 & 2 (CH) and Rainwater Harvesting (CH):
Look for erosion at the inflow or outflow points of the structure, particularly if it is losing soil or clogging the media within the BMP structure. Because vegetated roofs use soils and media as a main design component, erosion can affect not only the functionality but also the stability of the structure. Erosion shall be corrected by seeding, grading, and/or installation of soil stabilization matting to correct the deficiency.

Level Spreaders and Check Dams (Permanent E&S Measures):
Both the upstream and the downstream side of all check dams and level

spreaders shall be inspected for signs of undercutting and erosion. Erosion shall be corrected by seeding, grading, and/or installation of soil stabilization matting to correct the deficiency. Note key preventative components of these features as shown on the details are filter fabric under to riprap (level spreaders) and keying in the structure to the banks (check dams) to prevent scour and undermining.
This includes upland drainage areas that may be controllable sources of sediment or erosion. Erosion shall be corrected by seeding, grading, and/or installation of soil stabilization matting to correct the deficiency.

"Repair structural deficiencies"

Vegetated Roofs Level 1 & 2 (CH), Rainwater Harvesting (CH), Level Spreaders and Check Dams (Permanent E&S Measures):
Repairs to all structural deficiencies, such as outflow structures, bypassing flows, the storage tank, plumbing, or the waterproof roof membrane shall be designed and reviewed by a qualified VDOT representative. Maintenance repairs shall follow the repair designs precisely, and in some cases, construction monitoring may be appropriate.

"Repair plants and vegetation"

Vegetated Roofs Level 1 & 2 (CH):
Required plantings shall be installed per the approved project specifications to maintain the desired vegetation density and meet pollutant removal requirements. If the plans are not available, good judgment shall be used to determine if and where any plant mortality has occurred, warranting replacement. If plans are not available or alternative species may be warranted, it may be appropriate to consult a competent VDOT representative to specify plantings. A 90% vegetative cover shall be maintained.

Level Spreaders and Check Dams (Permanent E&S Measures): Not applicable.

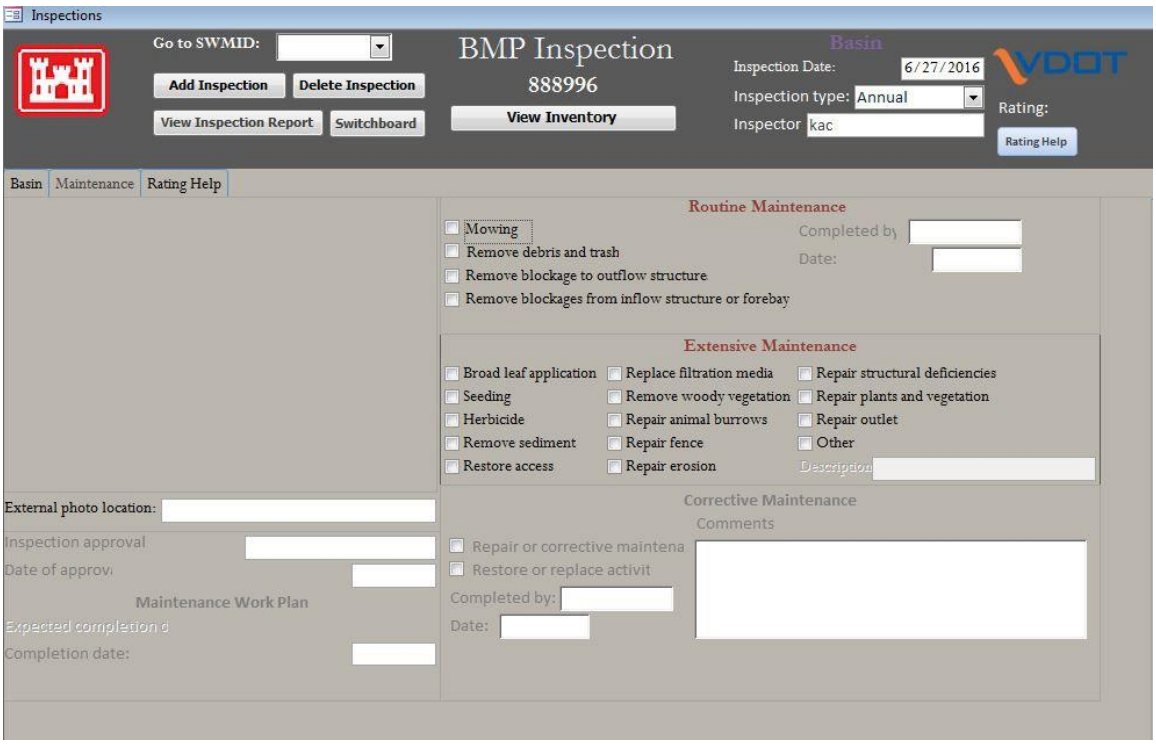
"Repair outlet"

Outlet protection may not be part of the LID set of BMPs.

Outlet protection may not be part of the LID set of BMPs. Vegetated Roof drains are often connected to a storm drainage system of pipes, and Rainwater Harvesting cisterns typically discharge to some type of plumbing system (e.g., lawn irrigation, indoor plumbing, etc.). Where these practices discharge onto the ground, some appropriate type of protection against erosion (roof gutter splash guard, stone surface treatment, etc.) shall be installed and maintained per the original approved plans. If the original design plans are not available or if the original design is clearly inadequate, the outlet protection shall be designed by a qualified professional in accordance with the applicable specifications and design requirements.

APPENDIX A.
STORMWATER BMP DATABASE MAINTENANCE FORMS

Maintenance Form for all BMPs



This is the maintenance request form for the Stormwater BMP Inventory Database used by VDOT for BMP Inspections. This lists form lists all types of maintenance activities for the BMPs included in the BMP Inventory Database. The BMP inspection results in a maintenance request for the facility. For further maintenance information please see VDOT's BMP Maintenance Manual.

APPENDIX B.
BMP MAINTENANCE CHECKLIST BASED ON INSPECTIONS

ANNUAL BMP INSPECTION FOR: FILTERING PRACTICES

BMP Element	Observation	Indicator	Repair
Filter Media	Clogged	Standing water, noticeable odor, algal growth, trash/debris lines	Consult MS4 Coordinator regarding media replacement
Underdrain	Underdrain is not functional	Standing water in observation well visible 2 days after a storm event	Clean out the pipe either manually or with a high-pressure hose; replace underdrain if it is structurally damaged at direction of MS4 Coordinator
Structural Components	Structural deterioration	Corrosion, cracking, structural damage	Repair and replace per approved plans, consult MS4 Coordinator if repairs require modification
Contributing Drainage Area and Side Slopes	Erosion , trash, or debris		Remove, repair and stabilize with seed, mulch, and matting as needed
Pre-Treatment	Sediment accumulation	Deposits are 50% or more of forebay volume	Remove sediment to bottom elevation per approved plans (every 5 years minimum)
	Erosion and/or dead vegetation		Repair and stabilize erosion, replace plantings per approved plans; consult MS4 Coordinator regarding alternative plantings as needed
	Clogged	Standing water, noticeable odors, water stains, algae	Remove blockage and clean/replace the clogged material per approved plans; consult MS4 Coordinator regarding proper materials

BMP Element	Observation	Indicator	Repair
Inlets	Blocked with trash, debris, sediment, or vegetation		Remove, stabilize , and properly dispose of waste
	Erosion at or around inflow	Exposed soil	Repair erosion and stabilize with seed, mulch, and matting as needed
Outlet	Flow bypassing facility	Flow path evident as sheet or concentrated flow, that goes around the treatment facility	Repair per approved plans, additional measures may be warranted
	Outlets blocked or eroding	Exposed soil, standing water in end section	Remove blockages, repair erosion, stabilize per approved plans, and properly dispose of waste, additional measures may be warranted
Sedimentation Chambers	Sediment or debris accumulations	6" or more of sediment in the chamber	Remove sediment to design levels per approved plans and/or manufactures specifications and properly dispose of waste
Overall	Inadequate access	Access not passable or security hardware not operational	Remove woody vegetation and restore access, make hardware operational
	Excessive trash/debris		Remove and properly dispose of waste

ANNUAL BMP INSPECTION GUIDANCE FOR SHEET FLOW TO VEGETATED FILTER AREAS AND CONSERVED OPEN SPACE

BMP Element	Observation	Indicator	Repair
Vegetation	Inadequate vegetative cover	Less than 90% cover in filter area	Stabilize per approved plans
	Dead vegetation and/or exposed soil		Replace dead vegetation per approved plans, repair and stabilize; consult MS4 Coordinator regarding alternative plantings
Overflow Area	Clogged/blocked	Eroded channels, short-circuit flows, overflow into control section	Clean out debris/trash and sediment, re-stabilize, establish positive drainage and properly dispose of waste
Level Spreader	Level spreader not properly functioning	Standing water, concentrated flows, erosion at outfall	Repair and restore per approved plans; if additional measures are needed consult the MS4 Coordinator
Channel	Scour or erosion	Exposed soil, channel deterioration	Repair damage, stabilize with seed, mulch and matting as needed
	Debris and sediment accumulation		Remove and properly dispose of waste, stabilize with seed, mulch and matting as needed
Contributing Drainage Area	Erosion or exposed soil		Repair damage, stabilize with seed, mulch and matting as needed
	Excessive trash, debris, excessive yard waste		Remove and properly dispose of waste
Inlet	Inlet conditions deteriorating	Erosion, undercutting, structural damage	Repair and stabilize per approved plans; additional measures as preventative may be warranted, consult MS4 Coordinator as needed

BMP Element	Observation	Indicator	Repair
Outlet	Outlet blocked	Excessive trash, debris or sediment accumulation at the outlet or standing water in end section	Remove, stabilize and ensure positive drainage per approved plans
Overall	Inadequate access	Access not passable or security hardware not operational	Remove woody vegetation and restore access, repair hardware
	Standing water	Flow/trash lines, algal growth, noticeable odors	Repair to establish positive drainage per approved plans
	Excessive trash and debris		Remove and properly dispose of waste

ANNUAL BMP INSPECTION GUIDANCE FOR CONSTRUCTED WETLANDS

BMP Element	Observation	Indicator	Repair
Vegetation	Weeds, invasive species and undesired vegetation	15% or more undesired vegetation in wetland cell area	Remove undesired vegetation and replace according to approved plans
	Vegetation is dead, dying, or diseased	15% or more unhealthy vegetation requires replacement	Remove and replace vegetation per approved plans. Consult MS4 Coordinator regarding alternative plantings as needed
Riser/Principle Spillway and Low- Flow Orifice(s)	Structural deterioration	Structures cracked, misaligned or damaged	Repair per approved plans, consult MS4 Coordinator if additional measures are needed
	Blockages	Trash, debris, obstructions or higher than normal pool elevation	Remove blockages and repair per approved plans and properly dispose of waste
Contributing Drainage Area	Erosion, trash, debris		Remove trash and debris, stabilize with seed, mulch and matting as needed
Pre-Treatment	Erosion and/or dead vegetation		Repair erosion, replace vegetation and stabilize per approved plans
	Sediment accumulation	Deposits are 50% or more of forebay volume	Remove sediment to bottom elevation per approved plans (every 5 years minimum)
Inlets	Inlet erosion and/or blockage	Undercutting, blockage, standing water in inlet or end section	Remove blockage and establish positive drainage; repair erosion and stabilize per approved plans
	Forebay dam inadequate	Dam not visible, erosion, rip rap displacement/absent, or woody growth	Repair per approved plans and restore, if additional measures are warranted contact the MS4 Coordinator

BMP Element	Observation	Indicator	Repair
Outlet	Excessive sediment deposits		Remove sediment and stabilize
	Erosion at/or around the outlet	Undercutting, scour and/or displaced rip-rap	Repair, reinforce or replace rip rap as needed, and re-stabilize; additional measures may be warranted as a preventative.
	Woody growth at the barrel pipe outlet	Growth blocking or slowing the outflow, standing water	Remove vegetation affecting flows and re-stabilize per the approved plans
Berm/Dam/Embankment and Abutments	Settlement, cracking, misalignment, erosion	Sunken areas, erosion rills deeper than 2"	Repair, backfill with compacted fill and stabilize per approved plans
	Soft spots, seepage, boggy areas or sinkholes present		Contact MS4 Coordinator immediately
	Woody vegetation on the embankment		Wood growth, including stumps should be removed
Wetland Cells and Pools	Sediment accumulation		Remove sediment, take care not to impact plantings, which may require handwork
	Evidence of floating debris, sparse vegetative cover, or erosion		Remove debris, repair and stabilize per approved plans
	Excessive vegetation		Manage vegetation to ensure it is not affecting the storage volume; monitor root mat growth on the bottom
Overall	Inadequate access	Access not passable or security hardware not operational	Remove woody vegetation and restore access, make hardware operational

BMP Element	Observation	Indicator	Repair
	Evidence of nuisance animals	Burrows, soft soil	Animal burrows must be backfilled and compacted, burrowing animals should be humanely removed from area; if burrows are located on the dams, consult the MS4

ANNUAL BMP INSPECTION GUIDANCE FOR WET SWALES

BMP Element	Observation	Indicator	Repair
Vegetation	Weeds, invasive species and undesired vegetation	10% of vegetation is undesired or plants inconsistent with plans	Remove weeds, invasive species, or undesired plantings and replace per the approved plans, if alternative plantings are warranted contact the MS4 Coordinator
	Planting or vegetation cover is inadequate	Turf cover is less than 95%	Establish cover and replace plantings per the approved plans, if alternative plantings are warranted contact the MS4 Coordinator
Check Dams	Check dam inadequate	Erosion, scour, undercutting	Restore per approved plans, additional measures may be warranted as a preventative.
	Check dam clogged	Sediment, trash or debris accumulation	Remove sediment when the accumulation is 25% or greater of the height, remove all trash/debris and clear blockages and properly dispose of waste
Contributing Drainage Area	Erosion and/or exposed soil		Repair, stabilize with seed, mulch and matting as needed
Pre-Treatment	Erosion or exposed soil		Repair erosion, stabilize per approved plans, additional measures may be warranted
	Dead vegetation		Replace per approved plans and stabilize
	Sediment accumulation	Deposits are 50% or more of forebay volume	Remove sediment to bottom elevation per approved plans (every 5 years minimum)
Inlets	Erosion and/or exposed soil		Repair erosion, stabilize per approved plans, additional measures may be warranted
Outlet	Outlets blocked or eroded	Trash, debris, or sediment build up, end section holding water	Remove obstructions, repair erosion, additional measures may be warranted

Overall	Inadequate access	Access not passable or security hardware not operational	Remove woody vegetation and restore access, repair hardware

ANNUAL BMP INSPECTION GUIDANCE FOR BIORETENTION

BMP Element	Observation	Indicator	Repair
Vegetation	Plant composition differs from approved plans	Observed plantings are not shown on the approved plans	Remove undesired plantings and replace per the approved planting plan as needed
	Vegetation and mulch cover inadequate	Less than 75%-90% vegetative cover or mulch is less than 2"-3" deep	Supplement vegetation and mulch per plans, mulch to be replaced every 3 years
	Invasive species or weeds make up 10% of the facility's vegetation		Remove, re-stabilize per approved plans
	Vegetation is diseased, dying or dead	1st year: less than 85% of plants and less than100% of trees, from approved planting plan are healthy	Remove and replace plantings, increase waterings, avoid fertilizers; consult MS4 Coordinator about alternative species
Filter Media	Concentrated flows or erosion	Flow paths visible	Identify the source of erosion, stabilize and repair damage; additional measures to spread out the flow may be warranted.
	The filter bed is clogged	Standing water for 2 days+, sediment crust on surface, discoloration of media, vegetative growth other than plantings	Identify blockage and consult MS4 Coordinator to replace media per approved plans
Underdrain/Proper Drainage	Underdrain clogged	Sediment crust on surface, flow/sediment lines along basin slopes, algae growth, no outflow during storm events, high water level	Inspect underdrain and consult MS4 Coordinator. Filter media may also need replacement due to clogging
Contributing Drainage Area	Excessive trash, yard waste, debris		Remove and properly dispose of waste
Pre-Treatment	Erosion or exposed soil		Stabilize

BMP Element	Observation	Indicator	Repair
	Dead vegetation		Replace plantings as needed, stabilize with seed, mulch and matting as needed
	Sediment accumulation	Deposits are 50% or more of forebay volume	Remove sediment to bottom elevation per approved plans (every 5 years minimum)
Inlets	Inflow is blocked by trees, shrubs, or sediment		Remove woody vegetation/sediment
	Erosion at or around the inlet		Repair erosion damage and re-stabilize per approved plans; additional measures may be warranted
Outlet/Overflow Spillway	Outlets blocked	Sediment, trash, debris build up, standing water in outlet or end section	Remove obstructions, repair/stabilize and properly dispose of waste
	Erosion	Scour around sides of channel, erosion in bottom of channel, displaced riprap	Repair and stabilize per approved plans; additional measures may be warranted as a preventative
	Grates deteriorating	Rust, structural damage	Repair or replace per approved plans
Overall	Inadequate access	Access not passable or security hardware not operational	Remove woody vegetation and restore access, repair hardware

ANNUAL BMP INSPECTION GUIDANCE FOR INFILTRATION

BMP Element	Observation	Indicator	Repair
Contributing Drainage Area	Excessive trash, yard waste, debris		Remove and properly dispose of waste
Pre-Treatment Facility	Erosion and/or exposed soil		Stabilize with seed, mulch and matting as needed
	Clogged	Standing water, noticeable odors, water stains, algae or floating aquatic vegetation	Identify and eliminate the source of the problem; remove, clean, or repair as needed per approved plans, and properly dispose of waste
	Dead vegetation	Less than 90% turf cover	Re-stabilize per approved plans
	Excessive sediment	Deposits are 50% or more of forebay volume	Remove sediment to bottom elevation per approved plans (every 5 years minimum)
Vegetation	Grass overgrown	above 9"	Mow to a height of 4-9 inches and remove grass clippings
	Tree growth	Pioneer trees are spouting in the base of the facility	Remove trees to prevent roots from puncturing the filter fabric and compromising infiltration rates
Inlet	Erosion at or around the inlet	Scour, undercutting, exposed soil	Repair erosion damage and stabilize as needed, additional measures may be warranted

BMP Element	Observation	Indicator	Repair
Outlet	Outlets blocked or eroding	Scour, undercutting, exposed soil, standing water in end section	Remove obstructions and repair eroded areas per approved plans and properly dispose of waste, additional measures may be warranted
Overflow or Emergency Spillway	Inadequate conveyance	Structural damage, erosion, undercutting, scour, or blockages	Remove all blockages and properly dispose of waste, consult MS4 Coordinator regarding structural repairs, re-armour channel per approved plans
Infiltration Area/ Bed	Clogged	Standing water in observation well 3 days after a 1/2 inch rain event, vegetative growth on surface	Clear debris from the underdrain, check filter media and underdrain for blockages and properly dispose of waste, repair per approved plans and consult MS4 Coordinator
	Sediment accumulation	Vegetative growth on the stone surface, sediment crust on surface	Remove sediment and debris and properly dispose of waste
	Flow is bypassing facility	Flow paths evident outside the basin area	Repair and reroute flows to facility per approved plans
Structural Components	Structural deterioration	Rust, structural damage	Repair or replace per approved plans
Embankment, Flow Diversion Structures (e.g., Dikes, Berms, etc.) and Side Slopes	Erosion or exposed soil		Consult MS4 Coordinator if modifications are warranted, repair erosion and stabilize with proper fill according to approved plans.
	Water is not detained in the infiltration basin	Higher than normal flows, flows in dry weather	Check for a breach in the containment structure and consult MS4 Coordinator

BMP Element	Observation	Indicator	Repair
Overall	Inadequate access	Access not passable or security hardware not operational	Remove woody vegetation and restore access, repair hardware
	Excess trash/debris is present		Remove and properly dispose of waste

ANNUAL BMP INSPECTION GUIDANCE FOR ROOFTOP DISCONNECT

BMP Element	Observation	Indicator	Repair
Pipping, Gutters, Drains and Pre- Treatment Sumps	Sediment and debris accumulation		Correct the source and remove and properly dispose of waste
	Runoff bypassing treatment	Check correction spout or overflow pipe for clogs or sediment accumulation	Remove blockages and restore flow path
Manufactured Products	Structural damage	Components broken or not functional	Follow the manufacturer's maintenance recommendations for repairs, consult the MS4 Coordinator regarding modifications
Downstream Treatment	Ponding at disconnect	Standing water	Clean out manually, consult designer regarding dry wells or french drains
	Erosion		Remove the sediment/debris at outlet and properly dispose of the waste, repair and stabilize per approved plans
	Pervious area deteriorating	Dimensional footprint is not consistent with plans	Replace materials to restore dimensions and make repairs per approved plans

ANNUAL BMP INSPECTION FOR: DRY SWALES

BMP Element	Observation	Indicator	Repair
Vegetation	Weeds, invasive species and undesired vegetation	10% of vegetation is undesired or inconsistent with plans	Routine mowing should control most issues; remove invasive species, weeds, and undesired vegetation and stabilize per
	Overgrown grass	Above 9"	Mow grass to a height of 4"-9"and remove grass clippings
	Grass cover is inadequate, erosion	Less than 95% turf cover	Establish cover per approved plans, repair and stabilize eroded areas
Check Dams	Check dam inadequate	Erosion, scour, undercutting	Restore per approved plans, additional measures may be warranted as a preventative
	Check dam clogged	standing water, sediment, trash or debris accumulation	Remove sediment when the accumulation is 25% or greater of the height, remove all trash/debris and clear blockages and properly dispose of waste
Filter Media/Soil	Media is clogged	Standing water, trash/debris flow line, algal growth, discoloration of media	Remove trash, debris or sediment, and properly dispose of waste, consult MS4 Coordinator regarding replacement
Underdrain	Clogging	Soil crusting on surface, no outflow during storm events, standing water, algal growth, trash/debris flow line	Inspect underdrain and consult MS4 Coordinator, filter media may also need replacement due to clogging
Contributing Drainage Area	Erosion and/or exposed soil		Repair damage, stabilize with seed, mulch and matting as needed
Pre-Treatment and Flow Spreaders	Erosion or exposed soil		Repair and stabilize per approved plans

BMP Element	Observation	Indicator	Repair
	Dead vegetation		Replace per approved plans
	Sediment accumulation	Deposits are 50% or more of forebay volume	Remove sediment to bottom elevation per approved plans (every 5 years minimum)
	Inflow eroding, deteriorating	Erosion, trash, debris, sediment present	Repair damage and stabilize per approved plans, remove blockages and properly dispose of waste
Outlet	Outlets blocked or eroded	Trash, debris, or sediment build up, outlet holding water	Remove obstructions, repair erosion, additional measures may be warranted
Overall	Inadequate access	Access not passable or security hardware not operational	Remove woody vegetation and restore access, repair hardware

ANNUAL BMP INSPECTION GUIDANCE FOR PERMEABLE PAVEMENT

BMP Element	Observation	Indicator	Repair
Contributing Drainage Area	Excessive trash, debris, landscape waste		Remove and properly dispose of waste
Adjacent Vegetation	Leaf and tree residue on or near pavement surface	Trees and shrubs within 5 feet of the pavement surface present a potential clogging source	Consult MS4 Coordinator to determine if pruning or other actions are appropriate
Inlets, Pretreatment Cells and Flow Diversion Structures	Clogged	Excessive trash, debris, or sediment accumulation	Remove sediment or debris and properly dispose of waste, consult approved plans for proper methodology
Pavement Surface	Loose material stored on the pavement surface		Remove and vacuum the area to prevent clogging of the pavement pores, do NOT sweep
	Clogged	Surface compacted or settlement visible, media surface not level, standing water	Reference approved plans for site specific guidelines for repair and consult MS4 Coordinator
Structural Integrity	Surface deterioration	Slumping, cracking, spalling or broken surface	Repair or replace affected areas per approved plans
Underdrain	Underdrain blocked or eroding	Standing water, sunken areas over top of drain location	Consult MS4 Coordinator regarding repair plan

ANNUAL BMP INSPECTION GUIDANCE FOR GRASS CHANNELS

BMP Element	Observation	Indicator	Repair
Vegetation	Erosion or exposed soil		Repair erosion and stabilize per the approved plans
	Vegetation is dead, diseased, or dying	Less than 90% vegetative cover	Stabilize and/or replace dead vegetation per approved plans, consult MS4 Coordinator regarding alternative plantings as needed; increase waterings, avoid fertilizers
Check Dams	Check dam inadequate	Erosion, scour, undercutting	Repair damage and restore per approved plans, additional measures may be warranted as a preventative
	Check dam clogged	Sediment, trash, or debris accumulation	Remove sediment when the accumulation is 25% or greater of the height; remove all trash/debris, and clear blockages and properly dispose of waste
Channel Bottom	Channel bottom not properly infiltrating and/or compacted	Higher than normal flow lines, standing water, settlement, media inconsistent with approved plans	Fill in low spots, consult MS4 Coordinator regarding media replacement, stabilize per approved plans
Channel Outlet	Outlet blocked or eroded	Excessive trash, debris or sediment accumulation, outlet or end section holding water, or exposed soil	Remove blockages and ensure positive drainage per approved plans; repair erosion, stabilize, and properly dispose of waste, additional measures may be warranted
Contributing Drainage Area	Erosion or exposed soil		Repair and stabilize with seed, mulch and matting as needed

BMP Element	Observation	Indicator	Repair
Pre-Treatment	Erosion or exposed soil		Stabilize per approved plans
	Dead vegetation	15% or more of required plants are dead	Replace per approved plans and stabilize, consult MS4 Coordinator regarding alternative planting
	Sediment accumulation	Deposits are 50% or more of forebay volume	Remove sediment to bottom elevation per approved plans (every 5 years minimum)
Overall	Excessive trash/debris		Remove and properly dispose of waste
	Inadequate access	Access not passable or security hardware not operational	Remove woody vegetation and restore access, repair hardware

ANNUAL BMP OPERATION AND MAINTENANCE GUIDANCE FOR WET PONDS

BMP Element	Observation	Indicator	Repair
Contributing Drainage Area	Erosion, trash, debris		Repair, remove and stabilize with seed, mulch, and matting as needed; properly dispose of waste
Pre-Treatment	Erosion, dead vegetation		Repair and stabilize erosion; replace plantings per approved plans, consult MS4 Coordinator regarding alternative planting or additional measures
	Sediment accumulation	Deposits are 50% or more of forebay volume	Remove sediment to bottom elevation per approved plants. (every 5 years minimum)
Inlet	Erosion at or around the inlet	Scour, undercutting or exposed soil	Repair damage and stabilize with seed, mulch, and matting as needed, additional measures may be warranted
	Blocked with debris, trash, woody growth or excessive vegetation	Standing water in inlet	Remove blockage and properly dispose of waste, and stabilize per approved plans
Dam/Embankment and Abutments	Exposed soil, settlement, cracking, bulging, misalignment, erosion, or sloughing	Sunken areas, exposed soil, loss of material, non-uniform surfaces in consistent with the approved plans	Repair with specified compacted fill and stabilize per approved plans, additional measures may be warranted, contact MS4 Coordinator for further assistance
	Soft areas, seepage, or sinkholes present	Isolated wet areas or free flowing water out of the dam, usually the backside below the normal pool.	Consult MS4 Coordinator immediately

BMP Element	Observation	Indicator	Repair
	Woody vegetation on the embankment, or within 5' of the toe		Remove woody growth, including stumps, and back fill with specified compacted fill, consult MS4 Coordinator as needed.
Overflow Spillway and/or Outlet	Erosion	Scour, undercutting, displaced rip rap or exposed soil	Repair erosion damage and stabilize per approved plans, additional measures may be warranted
	Woody growth in the spillway or within 5' of the outlet		Remove growth and stumps, ensure positive drainage
	Sediment deposits	Denuded areas and sediment transport downstream evident by discoloration	Remove sediment, stabilize and ensure positive drainage per approved plans
Riser/Principle Spillway and Low- Flow Orifice(s)	Structural deterioration	Corrosion, cracking, broken or missing sections, leaking	Repair per approved plans, consult MS4 Coordinator for any modifications
	Control valves are not operational	No movement	Repair per approved plans
	Clogged control structure	Debris, high water levels or little to no normal outflow	Unblock and restore flow per approved plans and properly dispose of waste
Vegetation	Invasive species, weeds and/or undesired plants present	10% or more of plantings differ from approved plans	Remove undesired vegetation per approved plans, consult MS4 Coordinator for alternative plantings as needed
	Vegetation is dead, diseased, or dying	Less than 90% survival	Remove and replace vegetation per approved plans, consult MS4 Coordinator for alternative plantings as needed

BMP Element	Observation	Indicator	Repair
Overall	Inadequate access	Access not passable or security hardware not operational	Remove woody vegetation and debris for proper access, and to make hardware operational
	Excessive trash/debris is present		Remove and properly dispose of
	Evidence of nuisance animals	Burrows, soft soil	Animal burrows must be backfilled and compacted; burrowing animals should be humanely removed from area

ANNUAL BMP INSPECTION GUIDANCE FOR EXTENDED DETENTION PONDS

BMP Element	Observation	Indicator	Repair
Contributing Drainage Area	Erosion and/or exposed soil		Stabilize with seed, mulch, and matting as needed
Inlet	Pretreatment not functioning properly	Erosion, structural deterioration. Deposits are 50% or more of pretreatment/forebay volume	Repair forebay per approved plans; remove sediment to approved plans (every 5 years minimum), additional measures may be warranted
	Excessive trash, debris, or sediment		Remove and properly dispose of waste
	Erosion at or around the inlet	Scour, undercutting or exposed soil	Repair erosion damage and stabilize per approved plans, additional measures may be warranted
	Woody growth and/or blockages	Standing water at or in the inlet	Remove woody growth, including stump, roots and blockages, properly dispose of waste
Dam/Embankment and Abutments	Exposed soil, settlement, cracking, bulging, misalignment, or sloughing	Sunken areas, exposed soil, loss of material, non-uniform surfaces inconsistent with the plans	Consult MS4 Coordinator immediately
	Soft spots, seepage, boggy areas or sinkholes present	Isolated wet areas or free flowing water out of the dam, usually on the backside below the normal pool	Contact MS4 Coordinator immediately
	Woody vegetation on the embankment		Remove woody growth on embankment and 5' beyond the toe of dam.
Overflow/Emergency Spillway	Evidence of erosion/undercutting		Repair erosion damage and stabilize per approved plans

BMP Element	Observation	Indicator	Repair
Outlet	Excessive sediment deposits		Remove sediment and stabilize; and properly dispose of waste
	Erosion at or around outlet	Undercutting, erosion or displaced rip-rap at or around the outlet	Repair, reinforce or replace rip rap as needed, and re-stabilize, additional measures may be warranted
Riser/Principle Spillway and Low- Flow Orifice(s)	Structural Deterioration	Corrosion, cracking , pipe separation or failure, or other structural damage	Repair per approved plans, consult MS4 Coordinator for any modifications
	Control valves are not functional	No movement	Repair per approved plans
	Spillway or trash rack clogged	Higher than normal pool levels, visible debris on riser or little to no normal outflow	Clear blockages of the riser or orifice(s) and properly dispose of
Vegetation	Invasive species are present and/or plants inconsistent with approved plans	10% or more as undesired vegetation	Remove undesired plantings and stabilize per approved plans
	Vegetation is dead, diseased or dying	1st year: less than 85% of plants and less than100% of trees, from approved planting plan are healthy	Remove and replace per approved plans, consult MS4 Coordinator if alternative plantings are needed
Overall	Inadequate access	Access not passable or security hardware not operational	Remove woody vegetation and restore access, make hardware operational
	Excessive trash/debris		Remove and properly dispose of waste

BMP Element	Observation	Indicator	Repair
	Evidence of nuisance animals	Burrows, soft soil	Animal burrows must be backfilled and compacted; Burrowing animals should be humanely removed from area, If burrows are located on the dams, consult the MS4 Coordinator

ANNUAL BMP INSPECTION GUIDANCE FOR WET SWALES

BMP Element	Observation	Indicator	Repair
Vegetation	Weeds, invasive species and undesired vegetation	10% of vegetation is undesired or plants inconsistent with plans	Remove weeds, invasive species, or undesired plantings and replace per the approved plans, if alternative plantings are warranted contact the MS4 Coordinator
	Planting or vegetation cover is inadequate	Turf cover is less than 95%	Establish cover and replace plantings per the approved plans, if alternative plantings are warranted contact the MS4 Coordinator
Check Dams	Check dam inadequate	Erosion, scour, undercutting	Restore per approved plans, additional measures may be warranted as a preventative.
	Check dam clogged	Sediment, trash or debris accumulation	Remove sediment when the accumulation is 25% or greater of the height, remove all trash/debris and clear blockages and properly dispose of waste
Contributing Drainage Area	Erosion and/or exposed soil		Repair, stabilize with seed, mulch and matting as needed
Pre-Treatment	Erosion or exposed soil		Repair erosion, stabilize per approved plans, additional measures may be warranted
	Dead vegetation		Replace per approved plans and stabilize
	Sediment accumulation	Deposits are 50% or more of forebay volume	Remove sediment to bottom elevation per approved plans (every 5 years minimum)
Inlets	Erosion and/or exposed soil		Repair erosion, stabilize per approved plans, additional measures may be warranted
Outlet	Outlets blocked or eroded	Trash, debris, or sediment build up, end section holding water	Remove obstructions, repair erosion, additional measures may be warranted
Overall	Inadequate access	Access not passable or security hardware not operational	Remove woody vegetation and restore access, repair hardware

ANNUAL BMP INSPECTION GUIDANCE FOR VEGETATED ROOFS

BMP Element	Observation	Indicator	Repair
Vegetation	Inadequate vegetative cover	Plant cover is less than 90%	During establishment period, replace dead plants as needed; during the long-term period replace once per year in the fall
	Plants are wilting		Water more frequently to promote health/growth, for first 5 years use of slow-release fertilizer is recommended in the fall
	Invasive and nuisance plant species are present		Completely remove invasive plant species, weeding must be done by hand, and without herbicides/pesticides
Structural Components	Waterproof membrane is leaking or cracked		Make necessary repairs
	Root barrier is perforated		Replace swatch
Drainage Layer/Inlet Pipes	Clogged drain inlet, scuppers or gutters	Sediment, trash/debris, or other materials clogging	Identify the source of the problem and remove, properly dispose of waste
	Drain inlet pipe is in poor condition		Repair as needed per approved plans, consult DHE regarding modifications
Soil Substrate/Growing Medium	Erosion from wind or water	Erosion channels evident	Stabilized with additional soil substrate/growth medium and stabilize per approved plans
	Growth media has become clogged with sediment	ponding water, drowned vegetation	Manually remove sediment to prevent damage to vegetation, consult MS4 Coordinator if media warrants replacement
Overall	Excessive trash/debris		Remove immediately and properly dispose of waste
	Access to vegetated roof is inadequate		Restore access per approved plans

ANNUAL BMP INSPECTION GUIDANCE FOR RAINWATER HARVESTING

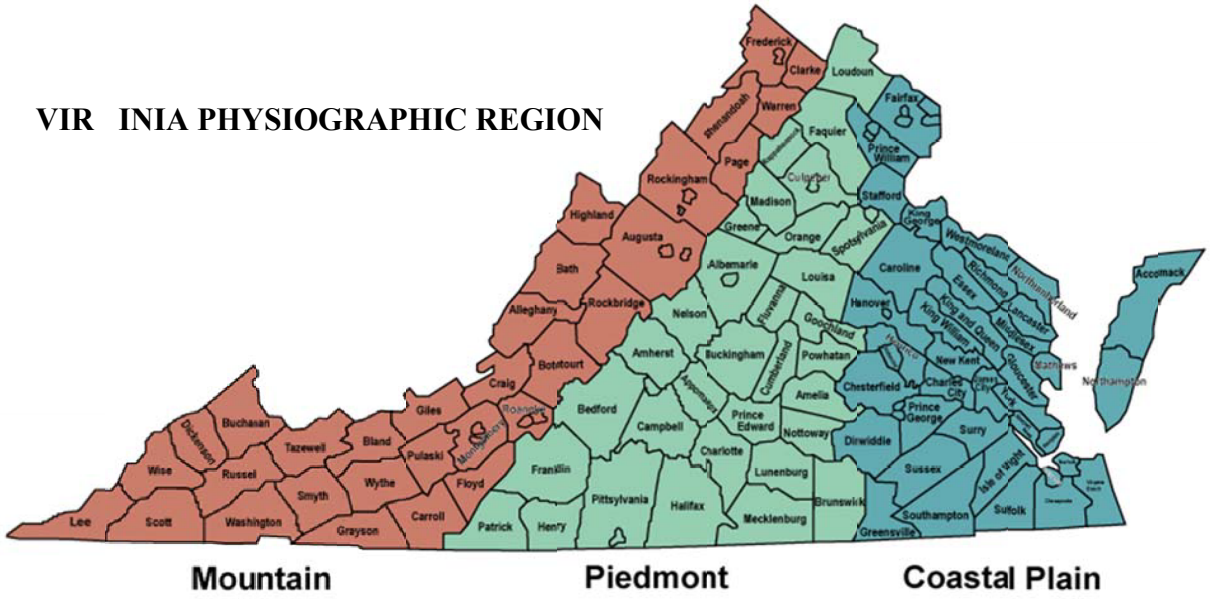
BMP Element	Observation	Indicator	Repair
Captured Roof Area	Excess debris/sediment on the rooftop		Remove debris/sediment and locate source as preventative
Gutter System	Clogging		Remove blockage, may need to install gutter screens and/or trim adjacent overhanging vegetation/trees
	Runoff is not reaching the gutter system		Correct the positioning or installation of gutters, additional measures may be warranted
	Lids, vents, or screens are damaged or clogged		Repair damage and remove blockages per approved plans and properly dispose of waste
Pump	Not operating properly		Check for clogging and flush, repair as need per approved plans
Backflow Preventer	Pressure is uneven	Causing backpressure or back-siphonage	Stop use of the indoor water supplied by the tank and consult the MS4 Coordinator
Overflow Pipe	Erosion is evident at discharge point		Repair and stabilize with seed, mulch, and matting as needed, additional measures may be warranted
	Overflow pipe deteriorating		Repair or replace pipe per approved plans, consult MS4 Coordinator regarding modifications
Overall	System is leaking or damaged		Repair or replace damaged components per approved plans
	Electric system not functional		Repair per approved plans
	Sediment in the cistern	Greater than 5% of design volume	Remove sediment and properly dispose of waste

APPENDIX C.
BMP PLANTING PALETTES

VDOT PLANT PALETTE – FIELD DESCRIPTIONS

BMP TYPE:
The type of Best Management Practice (BMP) that will provide suitable growing conditions for the selected plant. Varying structural, hydrologic, and soil conditions in different BMP types affect plant survivability depending on the plant's soil requirements, tolerance to inundation, and ability to thrive under periodic dry conditions. BMP type selections are typical, and should be reviewed by a qualified professional as each individual practice can vary hydrologically, and may not be suitable for each plant denoted in a specific category.

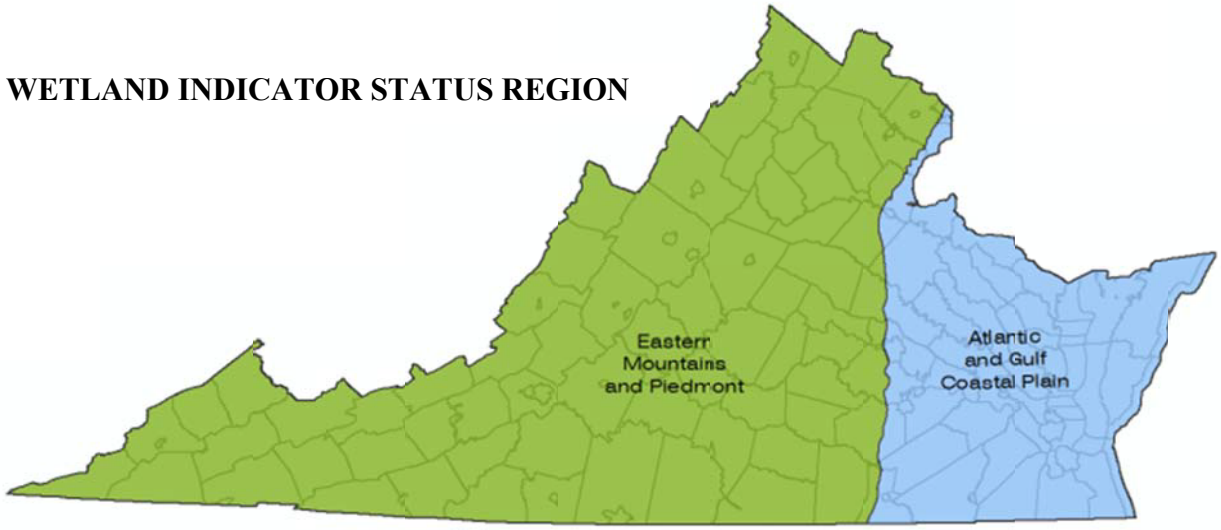
REGION:
The state of Virginia is divided into five distinct physiographic regions; The Coastal Plan, Piedmont, Blue Ridge, Ridge and Valley and Cumberland Mountains. For purposes of this list, the state has been divided into three simplified regions, with the Mountain region (as shown below) consisting of the Blue Ridge, Ridge and Valley, and Cumberland Mountains regions. Each region varies in climate, topography, soil characteristics, and hydrology. Occurrences of indigenous plant communities mapped throughout the state indicate where a species is most prevalent and well adapted. Using this information, appropriate plant selection can be made depending on where a project is located. Plants indicated as 'Non-native' are not native to Virginia; however, they are adapted to grow in one or several of the state's regions.



HYDROLOGIC ZONE:
Under HYDROLOGIC ZONE there are six categories indicating a plant's level of tolerance of periodic, regular or permanent inundation. These categories were derived from various sources including Virginia DCR Natural Heritage, USDA (Wetland Indicator Status), and the Virginia DCR Stormwater Design Specifications for Constructed Wetlands.

WETLAND INDICATOR STATUS:
The WETLAND INDICATOR STATUS field contains information taken directly from the USDA Wetland Indicator 2013 database, which details how frequently a plant is likely to be found within a wetland. The list is divided into Atlantic and Gulf Coastal Plain (AGCP) and Eastern Mountains and Piedmont (EMP) regions. These designations categorize the indicator status based on geographic location.

Indicator Code	Indicator Status	Comment
OBL	Obligate Wetland	Almost always occur in wetlands
FACW	Facultative Wetland	Usually occur in wetlands, but may occur in non-wetlands
FAC	Facultative	Occur in wetlands and non-wetlands
FACU	Facultative Upland	Usually occur in no-wetlands, but may occur in wetlands
UPL	Obligate Upland	Almost never occur in wetlands
NI	Non-Indicator	Status not yet determined (Non-native)



MOISTURE:
MOISTURE indicates level of moisture tolerance the plant will prefer for optimal growth.

SHADE TOLERANCE:
Categories are provided to indicate the amount of shade that a plant can tolerate in order to grow and thrive. The minimum or maximum amount of sunlight a plant receives throughout the day can affect its performance. It there is no indication in one or more of the categories, then selecting a plant for that type of location is not recommended.

SALINITY:
This field indicates the amount of salt exposure that the plant can tolerate. Concentrations of salt can be measured in soil, water, and air. 'Sensitive' indicates a low salt tolerance whereas 'Resistant' indicates a high salt tolerance.

MAX HEIGHT:

This represents the maximum observed height that has been documented each plant under ideal growing conditions. A selected plant may or may not achieve the maximum height as indicated depending on specific site conditions. Units are in inches for herbaceous plants and in feet for woody shrubs and trees.

LEAF TYPE:
Seasonal persistence of foliage varies among plants. Evergreens retain their leaves year-round, whereas deciduous plants loose leaves in winter and regenerate the following spring. Semi-evergreen plants may or may not loose leaves depending on climate variability and geographic location.

PH RANGE:
This provides a low point and high point for acidity/alkalinity in soils that a selected plant will tolerate. These values are intended to provide general guidance on plant adaptability, and the mid-point among these values would be considered the ideal pH level for the plant.

INUNDATION:
Permanent inundation depth as measured in a wetland or pond condition is provided in inches. This is not a measure of periodic inundation level which may occur in bioretention facilities or BMP's that are only wet during storm events.

BLOOM SEASON / SEASONAL INTEREST:
Selected months of the year are provided to indicate when a plant displays showy characteristics. These can be flowers, fruit, foliage color, stem color, bark texture, or other characteristics that would merit attention.

NOTABLE FALL FOLIAGE:
Notable fall foliage is an indication of visual interest displayed by deciduous plant foliage during the autumn months. Foliage color is provided in the 'Notable Characteristics' field.

NOTABLE CHARACTERISTICS:
This provides a more in depth description about particular characteristics for plants indicated as having seasonal interest. Flower color, fruit color, fall foliage color, and bark texture are some of the attributes provided.

REFERENCES

DCR Natural Heritage http://www.dcr.virginia.gov/natural_heritage/np.shtml

The Lady Bird Johnson Wildflower Center http://www.wildflower.org/ladybird/

USDA Forest Service Fire Effects Information System
http://www.fs.fed.us/database/feis/plants/index.html

USDA-NRCS Plant Database http://plants.usda.gov/java/

Virginia Cooperative Extension http://pubs.ext.vt.edu/category/trees-shrubs-roundcovers.html

Virginia Stormwater BMP Clearinghouse http://vwrrc.vt.edu/swc/NonProprietaryBMPs.html

Dirr, M. A. *Manual of Woody Landscape Plants*

Hightshoe, G. L. *Native Trees, Shrubs, and Vines for Urban and Rural North America; a Planting Design Manual for Environmental Designers*

U.S. Fish and Wildlife Service, *Native Plants for Wildlife Habitat and Conservation Landscaping; Chesapeake Bay Watershed*

Weakley, A. S., Ludwig, C. J., Townsend, J. F. *Flora of Virginia*