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1 Introduction

The stormwater management provisions of the Orange County Code were adopted to establish requirements for the management and control of stormwater runoff from developed properties in the County during and after their construction. This manual contains guidance for designers to assist them in meeting those requirements. It serves as a supplement to State and Federal design manuals that govern stormwater management design including the following:

- Virginia Department of Transportation (VDOT) Drainage Manual, prepared by the Hydraulics Section of the Virginia Department of Transportation dated 2002, as amended.

Collectively, these are referred to in this manual as the Design Manuals. These manuals should be used by designers to ensure that standard, acceptable design practices are used in developing their stormwater management designs. This manual provides further guidance where local conditions and requirements differ from the State and Federal manuals. The manual is structured to provide guidance throughout the development process, from the development of a stormwater management plan to post-construction (as-built) requirements.
CHAPTER 1

applicable Programs and Regulations

The designer is responsible for knowing the details of all applicable ordinances and regulations before submitting a stormwater pollution prevention plan. The developer is responsible for securing applicable Federal and State permits and should keep the County informed as to their status. The following is a list of some local, State, and Federal programs and regulations related to stormwater management and erosion & sediment control that may be applicable to land development projects in the County. This list is not intended to be all-inclusive and there may be other programs and regulations that are applicable to a particular development site in the County, depending upon its specific location.

- Virginia Stormwater Management Act and Regulations administered by the Virginia Department of Environmental Quality
- Virginia Erosion & Sediment Control Act and Regulations administered by the Virginia Department of Environmental Quality
- Virginia Stormwater Management Program (VSMP) Construction General Permit administered by the Virginia Department of Environmental Quality
- Virginia Dam Safety Act and Regulations administered by the Virginia Department of Conservation and Recreation
- Section 404 of the Clean Water Act administered by the US Army Corps of Engineers (USACE) and the US Environmental Protection Agency
- Virginia Water Protection Permits administered by the Virginia Department of Environmental Quality
- National Flood Insurance Program administered by the Federal Emergency Management Agency
- Chapter 26, Erosion and Sediment Control, Orange County Code administered by Orange County, Virginia
- Proposed Chapter 27, Stormwater Management, Orange County Code administered by Orange County, Virginia

Virginia Stormwater Management Program Permit

Orange County administers the Virginia Stormwater Management Program for the Towns of Orange and Gordonsville, and all unincorporated areas of the County. The applicant must register on the Department of Environmental Quality e-permitting system prior to applying for a land disturbing permit.

No permit shall be issued by the Administrator, until the following items have been submitted to and approved by the Administrator as prescribed herein:

- A permit application that includes a general permit registration statement; and
- Stormwater Pollution Prevention Plan that includes the following:
An erosion and sediment control plan in accordance with the Orange Erosion and Sediment Control Ordinance;

- A stormwater management plan in accordance with the Orange Stormwater Management Ordinance; and
- A pollution prevention plan in accordance with the VSMP Construction General Permit.

No permit shall be issued until the fees required to be paid, are received.

No grading, building or other permit shall be issued for a property unless a stormwater permit has been issued by the Administrator.

**Plan Review and Approval**

The County is responsible to ensure that permanent BMPs built in the County comply with regulatory requirements. It does this by reviewing stormwater management plans at every stage of development.

Applicants must demonstrate compliance with requirements in their plan submissions. It is significant to note that compliance with technical design requirements alone is not sufficient for approval. Compliance must be demonstrated during the review process. Failure to do so shall be cause for rejection of the plan. Plans submitted for County review should be comprehensive, organized and presented so that compliance is evident to someone familiar with requirements but unfamiliar with the project, project site, or surroundings.

Some common barriers to effective plans are:

- The use of values in supporting computations not evident in drawings. These often include drainage areas, land uses, and time-of-concentration flow path segments,
- The inclusion of computer output which is not summarized, cross-referenced, or indexed to indicate its relevance in the design,
- The depiction of information unrelated to stormwater management design which detracts from or obscures stormwater management information,
- Reliance upon information contained in other plans to support the presented concept or design,
- Failure to obtain and present information required to support elements of design, e.g., geotechnical recommendations for design and construction of a pond embankment,
- Depiction of drainage divides that are incomplete, do not honor the underlying topography, or do not show the underlying topography at all,
- Reliance upon off-site facilities without demonstrating their adequacy to meet the code requirement.
CHAPTER 1

**Conditions of Plan Approval**

Once approved, a Stormwater Pollution Prevention Plan carries the following conditions:

- The provisions of the approved plan must be adhered to during and after construction;
- No changes to the approved plan may be made without review and written approval by the program administrator. The program administrator shall have 60 calendar days to respond in writing either approving or disapproving such request;
- The Administrator may require that an approved stormwater management plan be amended, within a time prescribed by the Administrator, to address any deficiencies noted during inspection;
- Recordation of a final plat for a section of a multi-section subdivision (or initiation of construction in a section) does not vest the approval of the design plan for the remainder of the subdivision. If the design plan expires, the applicant must file for re-approval;
- The effects of approval of any plan shall not transfer to any other plan. Enforcement or non-enforcement of any specific requirement during review and approval of any plan shall not constitute a precedent to be relied upon during preparation of any other plan;
- The operator may be required to report inspection and monitoring logs to the administrator;
- The Administrator shall require the submission of a construction record drawing or as-built survey for permanent stormwater management facilities.
7  Stormwater Drainage System Design

Introduction

This chapter discusses stormwater drainage design in Orange County. Stormwater drainage means the collection and conveyance of storm and other surface flows through the land development project in a manner to prevent flooding of structures associated with properties and erosion of channels. Stormwater drainage systems include stormwater conveyance channels, storm sewers, and culverts. Drainage systems do not include facilities for storage, treatment, or disposal of stormwater runoff. Design of those systems is discussed in Chapter 2 in this manual.

General Requirements

Stormwater drainage systems are to be designed and constructed in accordance with Virginia Department of Transportation (VDOT) design standards as provided for in the latest edition of the VDOT Drainage Manual and the VDOT Road and Bridge Standards except as noted in this chapter.

The method(s) of drainage (i.e. constructed channels, storm sewer system, etc.) proposed for the site must be in accordance with an approved Stormwater Management Plan as detailed in Chapter 6 of this Manual.

All drainage systems must be designed and sized based on ultimate development conditions in compliance with minimum standard 19 of the Erosion and Sediment Control Regulations (4VAC50-30-40). They must be designed to convey both onsite and offsite surface waters. In addition, an adequate and safe overflow path for the 100-year flow must be provided when discharging into a FEMA floodplain.

Easements must be provided for stormwater drainage systems in accordance with requirements in Chapter 9 of this Manual.

Hydrologic Computations

There are a variety of hydrologic computation methods available to the designer. It is the designer's responsibility to know the limitations of each method and to select the method that is most appropriate for a particular design or analysis and provide their reasoning for choosing the particular design analysis.
<table>
<thead>
<tr>
<th>Calculations</th>
<th>Application</th>
<th>Allowable Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Flows</td>
<td>Adequate Channel; Stormwater Drainage Systems</td>
<td>Rational Method; Modified Rational Method; Runoff Curve Number Method</td>
</tr>
<tr>
<td>Runoff Volume</td>
<td>Stormwater Management Facilities; IMPs</td>
<td>Runoff Curve Number Method; SCS Dimensionless Unit Hydrograph; or equivalent method</td>
</tr>
</tbody>
</table>

11  **Rational Method and Modified Rational Method**

The Rational Method may be allowed for drainage areas less than 20 acres that have uniform soil conditions and high impervious cover. The Rational Method provides peak flows for use in sizing drainage structures used in a stormwater conveyance system and verifying adequate channel. The Modified Rational Method may be used to determine the temporary ponding volume for drainage structures such as inlets and culverts.

**Due to the limitations of the Rational Method and Modified Rational Method, these methods should not be used for hydrologic routings.**

See the latest edition of the Virginia Stormwater Management Handbook for more details on this hydrologic method.

12  **Runoff Curve Number Method**

The Runoff Curve Number Method developed by the Natural Resource Conservation Service’s (NRCS) in TR-55 can be used for any size watershed of mixed land cover and soil conditions, up to the limiting time of concentration of 10 hours. The Curve Number Method can be used to produce a flood hydrograph. The Curve Number Method as described in TR-55 calculates runoff based on the 24-hour precipitation which complies with local and state requirements for stormwater management.

**The Runoff Curve Number Method and subsequent models (TR-55, TR-20 or equivalent) shall be used for hydrologic routing.**

A composite curve number should be computed for disconnected impervious surfaces separately from areas where impervious surfaces are connected to a stormwater conveyance system. The runoff volumes computed from each area should be added to determine the runoff volume for the entire site.

hydrographs.

13 Rainfall Data for Orange County

Table 2.1 Orange Rainfall Data (Site 44-6712; NOAA Atlas 14, 2010)

<table>
<thead>
<tr>
<th>Duration</th>
<th>1-Year</th>
<th>2-Year</th>
<th>10-Year</th>
<th>25-year</th>
<th>100-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 hour</td>
<td>2.78</td>
<td>3.37</td>
<td>5.10</td>
<td>6.28</td>
<td>8.42</td>
</tr>
</tbody>
</table>

15 Flow Condition

For design, pipe systems and man-made (or threshold) channels are assumed to have uniform and steady flow. Uniform flow has a constant depth and discharge of flow along the entire channel cross section and steady flow has no change in discharge over time. Natural (or alluvial) channels and large drainage systems may consider non-uniform and unsteady flows.

Flow conditions can also be subcritical and supercritical. The Froude (Fr) number is used to determine critical flow. The Froude (Fr) number measures the ratio of inertial forces to gravitational forces. Subcritical flows are the preferred flow condition for open channels since transition through the turbulent critical zone will not occur. Supercritical flows tend to dissipate energy downstream and may cause head cuts as flow transitions through the critical zone.

\[ Fr = \frac{V}{\sqrt{32.2d}} \]  
\[ (E Q. \ 2.4.1.1) \]

\[ V = \text{Flow velocity, fps} \quad d = \text{Flow Depth, ft.} \]
Subcritical Flow; Fr < 1.0  
Supercritical Flow, Fr > 1.0

16  Manning’s and Continuity Equations

Manning’s equation is used to evaluate the velocity at a given slope and flow depth. The continuity equation is used to determine the capacity of the channel. A channel rating curve (stage-discharge table) could be used to determine channel capacity at various flow depths.

Manning’s Equation: \( V = \frac{1.49}{n S^{0.5} R^{2/3}} \)  
(EQ. 2.4.2.1)

Where \( V \) = velocity, fps, \( n \) = manning’s roughness coefficient, \( S \) = slope of channel, ft/ft, \( R \) = hydraulic radius (cross sectional area/wetted perimeter), ft

Continuity Equation: \( Q = VA \);  
(EQ. 2.4.2.2)

Where \( Q \) = discharge, cfs. and \( A \) = cross section area, ft^2.

17  Permissible Velocity

The lining of minor channels shall use the permissible velocity methodology. Appropriate channel linings must be selected using procedures in either the VDOT Drainage Manual or the Virginia Erosion and Sediment Control Handbook (latest edition). Temporary channel linings will be verified based on manufacturer’s permissible velocities. Permanent vegetative lining will be verified based on retardance class. Gravel and riprap lining can be verified based on the critical velocity calculated with Isbash equation.

Isbash Equation for gravel and riprap lining:
\( V_c = C \times (2 \times 32.2 \times (\gamma_s - 62.4) / 62.4)^{0.5} \times (D_{50})^{0.5} \)  
(EQ. 2.4.3.2)

Where, \( V_c \) = critical velocity, fps 
\( C \) = 0.86 for supercritical flow and 1.2 for subcritical flow 
\( \gamma_s \) = stone density, lbs/ft^3, usually 165 lbs/ft^3 
\( D_{50} \) = median stone diameter. ft.

18  Permissible Shear Stress

The lining of major channels shall use the permissible shear stress or tractive force methodology. The tractive force, which is the boundary shear stress between the flowing water and the materials forming the channel bed and side slopes, is compared with the permissible shear stress of the channel lining. The advantages of this method is that the failure criteria for a particular lining is represented by a single permissible shear stress value applicable over a wide range of slopes and flow depths, and shear stresses are easily calculated with the following equations.

The mean boundary shear stress applied to the wetted perimeter is equal to:
\( \tau_o = 62.4 \times R \times S \)  
(EQ. 2.4.4.1)

\( \tau_o \) = boundary shear stress, lbs/ ft^2
S = slope, ft/ft  
R = hydraulic radius, ft.

The maximum bottom shear stress is used for trapezoidal channels where the ratio of the width to depth is greater than 4.

\[ \tau_d = 62.4*d*S \]  
(EQ. 2.4.4.2)

Where \( d \) is the maximum depth of flow.

The permissible shear stress for various lining materials, including cohesive and non-cohesive soils can be found in Table 2.3 of FHWA HEC-15. Additional guidance for using tractive force method for rip rap lining design may be found in VESCH Rip Rap Specification 3.19.

19  Headwater, Tailwater and Freeboard

Culvert Headwater:

The allowable headwater is the depth of water that can be ponded at the upstream end of the culvert during the design condition, as measured from the culvert inlet invert. The design condition is usually the 10-year storm event.

The allowable headwater depth shall be limited by the following conditions:

- Public and Private culverts shall have adequate headwater capacity that will not cause upstream property damage;
- Headwater does not increase the 100-year flood elevation, as mapped by FEMA's National Flood Insurance Program;
- During a design storm event, the water surface shall be a minimum of 18 inches below the shoulder of the road at the point where the culvert crosses under, or the low point of the road grade where the water would overtop the road;
- Headwater depth shall not exceed 1.5 times the diameter or height of the culvert barrel;
- Headwater depth shall not be such that stormwater flows to other ditches or terrain, which permits the flow to divert around the culvert.

Tailwater Conditions:

Tailwater (Tw) is the water surface elevation into which a culvert or storm sewer system outfall discharges. Culvert design shall be based on anticipated tailwater conditions during the design condition.

If an upstream culvert outlet is located near a downstream culvert inlet, the headwater elevation of the downstream culvert may establish the design tailwater depth at the upstream culvert.

If the culvert discharges into a lake, pond, stream, or other body of water, the maximum water elevation of the body of water during the design storm may establish the design tailwater elevation at the upstream culvert.

Channel Freeboard:
For temporary channels no freeboard is necessary. However, a steep gradient channel should have a freeboard height equal to the flow depth to compensate for the large variations in flow caused by waves, splashing, and surging.

Minor Channels shall have a minimum of 6" of freeboard above the design water surface elevation, unless flow is supercritical. Where flow is supercritical, a minimum of 12" of freeboard is required.

Major Channels shall have a minimum of 12" of freeboard above the calculated design water surface elevation. At bends and curves, the freeboard shall include the increased depth due to the super elevation of the water surface.

\[
h = \frac{V T}{(32.2 R_c)} \geq 0.5 \text{ ft.} \quad (\text{EQ. 2.4.5.1})
\]

- \( h \) = super elevation, ft.
- \( T \) = top width of channel, ft.
- \( V \) = average channel velocity, fps
- \( R_c \) = centerline radius, ft.

### 21 Minor and Major Channels

Orange County with guidance from the VDOT drainage manual recognizes open channels as minor channels or major channels. See chapter 8 for drainage easement widths and requirements. Low flow sections are recommended in the design of channels with large cross sections.

Minor channels collect sheet flow from small areas and convey runoff to collection points. Designed to convey more frequent storm events, flows are generally 50 cubic feet per second (cfs) or less in minor channels. These include roadside ditches and man-made open channels.

Major channels collect drainage from minor channels, pipe systems, and off-site areas, and convey that flow to an adequate discharge point on- or off-site. Designed to convey less frequent storm events, flows are generally greater than 50 cfs in major channels. These include emergency spillways, collection channels and all natural channels.

### 22 Design Criteria

Both Minor and Major channels that are constructed shall convey the 10-year peak flow and resist erosion from the 2-year peak flow.

### 23 Channel Lining

Temporary and permanent lining materials shall be analyzed for each channel in accordance with section 7.5.2.2 of the VDOT Drainage Manual. **Temporary channel lining shall be required for all channels with supercritical flows.**
24 Water Surface Profile

When uniform flow cannot be reasonably assumed and, therefore, a single cross section cannot represent the channel segment, then a hydraulic routing method must be used to compute the water surface profile. This is common for natural and major channels. The method requires definition of the geometry and roughness of each cross section as discussed previously. Manning’s n values can vary both horizontally and vertically across the section. Expansion and contraction head loss coefficients, variable main channel and overbank flow lengths and the method of averaging the slope of the energy grade line can all be specified. Please refer to section 7.5.3.2 of the VDOT Drainage Manual for computation guidance.

26 Design Criteria

Storm sewer inlets, pipes, and culverts shall be designed to convey at least the 10-year peak flow rate and discharge into an adequate channel with appropriate energy dissipation measures.

27 Culvert Buoyancy

When water is displaced by embankment material or by a culvert, a buoyant or upward force exists. If the buoyant force is greater than the weight of the object displacing the water, flotation will occur. Pipe flotation (or hydrostatic uplift) can be a problem where the following conditions exist:
- Lightweight pipe is used (i.e., corrugated metal or plastic)
- Pipe is on a steep grade (usually inlet control)
- There is little or no weight on the end of the pipe (i.e., flat embankment slopes, minimal cover and/or no endwalls)
- High headwater depths (HW/D > 1.0)

If the summation of the weight of the pipe, weight of the water in the pipe (based on normal depth) and the weight of the fill over the pipe is less than the hydrostatic uplift (buoyant) forces acting upon the pipe, additional weight must be added to the pipe in order to stabilize it for the design conditions. The normal depth for determining buoyancy protection should be either the 100-year headwater depth or the depth of overtopping, whichever is less. Refer to section 8.5.3 of the VDOT drainage manual for buoyancy protection design procedure.

In a major channel, the culvert pipe should always be slightly submerged or countersunk to prevent head-cuts and allow for low flows. If multiple pipes are to be installed, the invert of at least one pipe should be countersunk at least 6 inches below the other pipes. Countersinking of culverts can also be used to provide buoyancy protection.
28 Hydraulic Grade Line

The hydraulic grade line represents the free water surface elevation within a pipe system. Where the hydraulic grade line is above the top of a pipe, the pipe is flowing under pressure. Hydraulic grade lines shall be calculated and evaluated for all storm sewer systems. The hydraulic grade line shall be calculated using VDOT methods and equations described in section 9.4.9 of the VDOT Drainage Manual.

The hydraulic grade line shall not exceed any critical elevation during the design storm. Critical elevations include rising above the ground elevation at inlets or other structures, or reaching an elevation where storm flow could back-up to cause localized flood damage.

The calculation of the hydraulic grade line begins at the system outfall and proceeds upstream to each structure on the system. At this point the hydraulic grade line shall be the actual tailwater elevation or the elevation of 0.8 times the diameter of the outlet pipe, whichever is higher. If the system discharges into a stormwater management facility, the hydraulic grade shall start at the 10 year water surface elevation.

29 Overland Relief

When connecting into an offsite storm sewer system or underground facility, an adequate and safe overland flow path for the one hundred-year storm must be calculated and shown on design plans in case of storm sewer blockage. Use the following blockage parameters for storm sewers and culverts.

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Blockage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;24 inches</td>
<td>100 %</td>
</tr>
<tr>
<td>24-48 inches</td>
<td>50 %</td>
</tr>
<tr>
<td>&gt;48 inches</td>
<td>25 %</td>
</tr>
</tbody>
</table>

30 Material Specifications

Storm sewers and culverts shall use reinforced concrete pipe (RCP). RCP shall meet the three-edge bearing strength test requirements for ASTM C76 Class III RCP of better. All RCP pipes within the VDOT right of way shall be in accordance with VDOT standards. The following specifications shall apply to pipes outside of the right-of-way:

- The minimum size allowed is 12".
- The minimum cover shall be 18 inches.

Corrugated metal pipes (CMP) shall not be used for permanent storm sewers and culverts without a detailed maintenance plan and inspection schedule.

High Density Polyethylene (HDPE) or Polyvinyl Chloride (PVC) pipes could be used for stormwater drainage with the following specifications:

- The maximum size allowed is 48". However, in locations within the state right-of-way and where approved by VDOT, maximum culvert size may be sixty (60) inches.
• The minimum size allowed is 12". Sub-drains and footing drains may be a minimum of 6".

• The maximum depth of trench, when measured from final grade, shall be ten (10) feet, and the minimum cover shall be twenty-four (24) inches.


• Installation of HDPE and PVC pipe and fittings shall be in accordance with the more stringent of the following two: (a) ASTM D2321, “Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications”. This section of ASTM includes foundation, embedment and backfill material requirements, trench excavation, installation, joints, inspection, handling and storage of pipe material. (b) The current VDOT standards.

• Bond release and acceptance shall require visual inspection. County may choose to require mandrel testing during visual inspection. Pipe shall be replaced where deflection exceeds 7.5% of the initial inside diameter.

• A residential project with more than ninety (90) percent of the total storm sewer located in the state right-of-way, when measured in length, may use HDPE or PVC pipe outside the state right-of-way with prior approval from Program Administrator. The requirements for bond release of HDPE or PVC storm sewer, when used in a subdivision outside the state right of way, shall be consistent with the bond release of storm sewers in segments of the subdivision within the state right of way.
Chapter 3

31 Best Management Practices (BMPs) Design

Introduction

This chapter discusses stormwater management facility design in the County. Stormwater management means the collection, conveyance, storage, treatment, and disposal of stormwater runoff in a manner to prevent accelerated channel erosion, increased flood damage, and degradation of water quality.

In accordance with the County's stormwater management ordinance, there are three methods of addressing the stormwater management (SWM) requirements: On-site SWM Facilities; Regional SWM Facilities; and Integrated Stormwater Management Practices (IMPs). These facilities and practices must be designed and constructed to conform to the Stormwater Management Design Manuals and other guidance documents listed in Chapter 1 of this manual except as noted in this chapter.

Stormwater BMP Performance Standards

BMPs may be sized to satisfy one or more of the following stormwater criteria. Hydrologic routings shall be provided to verify BMP design.

34 Low Impact Development (27-20)

Low Impact Development provides groundwater recharge mitigation for the areas within the limits of disturbance. The BMP(s) are sized to provide retention and detention volumes for the 1-year, 24-hour storm. Stormwater management plans developed consistent with the LID requirements shall satisfy the Water Quality and Channel Protection performance criteria.

In no case shall the LID storage volume be less than the treatment volume required for water quality.

See appendix 12.1.3 for the LID performance worksheet.
35 Adequate Channel

Concentrated stormwater flow shall be released into a stormwater conveyance system that meets the criteria in section 2.4, 2.5, 2.6 and 5.5.2 of this manual, from each point of discharge to a point at the limits of analysis. The BMP(s) are sized to provide detention volume necessary to maintain non-erosive flows and hydraulic capacity of stormwater conveyance systems.

36 Channel Protection (27–25)

Concentrated stormwater flows from each point of discharge into a natural channel shall maintain the peak flow from the 1-year, 24-hour storm in accordance with the Energy Balance equation of section 6.9.4 of this manual. The BMP(s) are sized to provide a combination of retention and detention volumes for the 1-year, 24-hour storm. The BMP(s) do not need to be sized to control runoff volume from offsite contributing drainage area.

37 Flood Protection (27–24)

Concentrated stormwater flow from New Development shall maintain the pre-developed 10-year peak flow rate at the point of discharge to a point at the limits of analysis. Concentrated stormwater flow from Redevelopment experiencing localized flooding (i.e. inadequate stormwater conveyance system) must reduce the post-developed peak flow rate from the 10-year, 24-hour storm to 20 percent less than the pre-developed peak flow rate.

The BMP(s) are sized to provide the necessary detention volume to control the 10-year, 24-hour peak flow rate. The BMP(s) are also sized to provide a maximum water surface elevation for the 100-year, 24-hour storm that does not compromise the structural stability of the BMP(s).

38 Water Quality (27/21:22)

Stormwater from the area of disturbance for New Development shall reduce pollutant loads to 0.41 lbs. per acre. Stormwater from the area of disturbance for Redevelopment projects shall reduce pollutant loads of new impervious cover to 0.41 lbs. per acre and reduce the remaining pollutant load by 20 percent for existing impervious cover greater than one acre; or 10 percent for existing impervious cover less than one acre.

The BMP(s) are sized to provide the necessary Treatment Volume in accordance with the BMP Clearinghouse specifications to insure the pollutant removal performance of the BMP(s).

Storage Volume

Volume control is typically provided through detention facilities with storage volume above the retention volume or permanent pool and below the required freeboard. Some
BMPs do not have the capability to provide this volume control due to their design and others include storage within the pores of an engineered soil media.

Figure 2.3: Schematic of BMP Storage Volume

* Spillway should meet the design storm peak runoff rate. Size appropriately to ensure adequate channel.

**Detention Volume** is the amount of "dry" storage available for maintaining peak flow rate.

**Retention Volume** is the amount of "dead" or "wet" storage available for maintaining the volume of runoff and sometimes the peak flow rate.

**Treatment Volume** is the amount of storage (either retention or detention) available for pollutant removal to achieve the necessary BMP efficiency.

**MP Components**

41 Pretreatment Devices

Most of the approved BMPs on the Virginia Stormwater BMP Clearinghouse require the use of one or more pretreatment devices that provide filtering and settling of sediments and debris. Pretreatment shall be provided in accordance with the relevant BMP specifications and section 4.6.1 of this Manual.
42 Risers

Risers are the principal spillway standpipe structures that contain the orifice and Weir. Permanent Risers shall be concrete or HDPE material. Temporary risers may be CMP or equivalent. CMP Risers for permanent structures require detailed maintenance and inspection plans with performance guarantees.

43 Antivortex and Trash Racks

Antivortex devices are required for wet ponds and extended detention basins whenever the riser is submerged during high flow events to improve the efficiency of the riser structure. Trash Racks are required for all risers and culvert barrels that provide detention.

44 Seepage Controls

Antiseep collars are required for wet ponds and extended detention basins when appropriate. Concrete Cradles are required for HDPE barrels and whenever appropriate. Filter Diaphragms are required for wet ponds with a design high water elevation over 8 feet or when appropriate.

45 Emergency Spillways

Vegetated emergency spillways are preferred in accordance with specifications on the BMP Clearinghouse. Appropriate temporary stabilization matting will be required for vegetated spillways. A riprap or concrete emergency spillways will be evaluated case-by-case.

Stormwater Management Facilities

Stormwater Management Facilities (SWMF) shall include any centralized structural practice(s) that provides pollutant treatment and peak flow control. These facilities shall be platted on separate tracts intended for stormwater management.

SWM facilities must be designed and constructed in accordance with the latest edition of the Virginia Stormwater Management Handbook and the Virginia Stormwater BMP Clearinghouse.

All land development must provide for stormwater management on site. Exceptions to this include cases in which stormwater management requirements are met by an existing or proposed off-site facility. In any case, methods of stormwater management proposed for the site must be in accordance with an approved Stormwater Management Plan.

SWM facility design and construction should meet the following specifications:

- All riser structures must be concrete unless a substitute material has been specifically approved by the Program Administrator.
• Construction of stormwater management impoundment structures or facilities within wetlands and perennial streams will be avoided to the maximum extent practicable.

• Construction of stormwater management facilities within a Federal Emergency Management Agency (FEMA) designated 100-year floodplain will be avoided to the maximum extent practicable. When this is demonstrated to be unavoidable, all stormwater management facility construction will be in compliance with all applicable requirements under the National Flood Insurance Program, 44 CFR Part 59 and local floodplain ordinances.

• Encroachment of stormwater management facilities within a designated riparian buffer, as required by local ordinance, shall be avoided to the maximum extent practicable. Mitigation for encroachment may be required by the administrator.

• Impoundment structures that are not covered by the Impounding Structure Regulations (4VAC50-20) will be engineered for structural integrity for the 100-year storm event. In no case will the design standard be less than the 100-year storm event for any impoundment structure.

• For SWM facilities that will initially serve as temporary sediment traps or basins during construction, Orange County requires that they be constructed in accordance with the design for stormwater management and then modified to serve temporarily as sediment traps or basins. The principal exception is the water quality orifice. A larger orifice may be installed initially to serve as an outlet for the perforated tubing encased in gravel and wrapped in filter fabric. After the sediment has been removed, the water quality orifice is installed.

• Easements must be provided for stormwater management facilities in accordance with requirements in Chapter 9 of this manual.

Integrated Stormwater Management Practices

Integrated stormwater management practices or IMPs are small scale practices implemented on individual lots or incorporated as part of building and pavement design. IMPs include environmental site design techniques, runoff reduction practices and pollutant removal measures that provide source control to reduce the generation of runoff and pollutants. IMPs will address pretreatment and prevention, distribution, disconnection, and dispersion of stormwater runoff volume.

The design criteria for environmental site design techniques and IMPs are discussed in chapter 4 of this manual. The IMP implementation should follow these specifications:

• Construction within wetlands and perennial streams will be avoided to the maximum extent practicable.

• Encroachment within a designated riparian buffer, as required by local ordinance, shall be avoided to the maximum extent practicable. Mitigation for encroachment may be required by the administrator.
• IMPs that provide detention will be engineered for structural integrity of the applicable design standards. In no case will the design standard for IMPs be less than the 10-year storm event.

• Easements will be considered on a case-by-case basis in accordance with requirements in Chapter 9 of this manual.

Geotechnical Study Requirements

A geotechnical study consisting of a field investigation, laboratory testing, and a geotechnical engineering analysis with recommendations is required as part of the design for all SWM facilities. Geotechnical studies for IMPs may be required on a case-by-case basis depending upon the complexity of the proposed practice and the extent to which its proper design and performance may be affected by the geotechnical properties of the site.

Results of the geotechnical study are to be documented in a geotechnical report prepared by a licensed geotechnical engineer. This report is to be submitted with the Stormwater Management Plan and geotechnical recommendations must be identified on the design plan.

Information to be included in the geotechnical report will vary depending upon the facility type and the designer should consult the Virginia Stormwater Management Handbook (and its associated references) and the project geotechnical engineer for more specific guidance on pertinent geotechnical information needs by BMP type. However, at a minimum the following information should be provided in the report:

• Identification and description of the proposed facility.
• Site map showing locations of soil borings and test pits.
• Soil logs containing unified soil classification system (USCS) by depth.
• Depth to seasonal water table and bedrock.
• Degree of mottling and chroma of mottles.
• Presence of porous or fractured bedrock, mica schist, and iron pyrite.
• Other soil properties as deemed appropriate by the geotechnical engineer.
• Geotechnical engineer’s recommendations.

For infiltration practices, the report must indicate appropriate subsoil infiltration and at least two feet depth to seasonal water table and bedrock to allow the facility to operate as designed.
Orange County encourages the use of low-impact development (LID) techniques to the maximum extent practicable complimented by the use of conventional stormwater management, where applicable. Stormwater design with an LID approach is fundamentally different from conventional design approaches and challenge traditional thinking regarding development standards, watershed protection, and public participation. LID combines fundamental hydrologic concepts with many of today's common stormwater strategies, practices and techniques to reshape development patterns in a way that maintains natural watershed hydrologic functions. The principles of LID are:

- Conserve Natural Vegetation and Topographic Features;
- Minimize Earthwork;
- Reduce Impervious Surfaces;
- Maintain Open and Vegetative Conveyance Systems;
- Decentralized Integrated Stormwater Management Practices (IMPs); and
- Maintenance and Pollution Prevention

The stormwater management goal for LID is to mimic predevelopment runoff conditions for runoff volume, peak runoff rate, and frequency. To accomplish this, stormwater is managed in small landscape features located on each lot rather than in large facilities located at the outlet of drainage areas. Hydrologic functions such as infiltration, frequency and volume of discharges, and ground water recharge can be maintained in several ways. Examples are: the use of reduced impervious surfaces, functional grading, open channel sections, disconnection and utilization of runoff, and the use of infiltration /filtration landscape areas. This source control concept is quite different from conventional end-of-pipe treatment.

Since every aspect of site development affects the hydrologic response of the site, implementing LID also affects every aspect of site development. There is a wide array of impact reduction and site design techniques that allow the planner/engineer to create BMPs that function with the site natural features. A fully successful LID design will mimic the watershed's water balance among volumes of runoff, infiltration, storage, ground water recharge, and evapotranspiration. With the LID approach, receiving waters experience little change in the volume, frequency, or quality of runoff.
Low Impact Development is an iterative design process that includes the following components:

- **Natural Resource Assessment**: A map and narrative description of all natural features currently existing on the site. This assessment identifies the sources of existing onsite and offsite discharges, the location of wetland and stream channels, the condition of open space and riparian buffers, and significant soils. See Appendix 10.2.1.

- **Environmental Site Design (ESD)**: Nonstructural techniques and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources. See section 4.3 and the Environmental Site Design Checklist in Appendix 10.2.2.

- **Runoff Reduction (RR)**: The total annual runoff volume reduced through canopy interception, soil infiltration, evaporation, transpiration, rainfall harvesting, engineered infiltration, or extended infiltration to maintain the pre-development runoff volume. The storage volume determination is based on the design charts and nomographs included in the LID Performance Worksheet in Appendix 10.2.3.

- **Pollutant Removal (PR)**: The change in the average concentration of a pollutant as runoff flows into and out of a control measure. Includes the use of traditional and manufactured treatment devices that treat the reduced amount of runoff to remove nutrients and sediments. Pollutant removal is achieved with the reduction of runoff volume, filtering and biological uptake.

- **Integrated Stormwater Management Practices (IMPs)** are a combination of Environmental Site Design, Runoff Reduction, and Pollutant Removal measures that are found on individual residential lot or commercial building pads to reduce the generation of pollution and mitigate increases in stormwater runoff.

- **LID can satisfy stormwater analysis**:

- **Peak flow rate Control**: LID is designed to maintain the predevelopment peak runoff discharge rate for the selected design storm events. This is done by maintaining the predevelopment Time of Concentration and then using runoff reduction practices to control runoff volume. If the runoff reduction practices are not sufficient to control the peak flow rate, additional detention practices are implemented to control the peak flow rate. Detention is temporary storage that releases excess runoff at a controlled rate. The use of retention and detention to control the peak flow rate is defined as a hybrid approach.

- **Flow Frequency/Duration Control**: Since LID is designed to emulate the predevelopment hydrologic regime through both volume and peak flow rate controls, the flow frequency and duration for the post-development conditions will be almost identical to those for the predevelopment conditions. The hydraulic impacts of development can be minimized downstream of the site.

- **Water Quality Control**: LID is designed to provide water quality treatment using runoff reduction and pollutant removal practices. The storage required for water
quality control is compared to the storage required to control the increased runoff volume. The greater of the two volumes is the required treatment volume for runoff reduction.

51 LID Design

This chapter applies only to the design of IMPs and the use of LID design techniques. When a site is designed in combination with conventional SWM practices, this Section applies only to the design of IMPs and use of LID design techniques.

1) Stormwater management design plans developed consistent with the requirements of this section and which meet the requirements given in section 6.2.3 of this manual for a Full LID Design shall be considered an equivalent method for satisfying the water quality and channel protection performance criteria of the Orange County Stormwater Management Ordinance.

2) Planting for bioretention facilities in parking lot islands may be credited towards meeting the interior parking lot landscaping requirement in nonresidential areas. Applicants should reference the County's current landscaping requirements (Orange County Zoning Ordinance, Article V., Division 5, Sec. 70-673 “Parking Lot Landscaping”).

52 Hybrid Design & Partial LID

A hybrid design incorporates detention storage to control the 1-year, 24-hour peak flow rate. A Partial LID design does not provide enough retention storage to control the volume of runoff due to site limitations. A modified hybrid approach is used to increase the detention storage to maintain the 1-year, 24-hour peak flow rate.

Once LID site design strategies and practices have been evaluated and employed to the greatest extent practicable, and; where needed, additional BMPs have been added, the engineer shall provide computations for the target performance of the design in satisfying requirements in accordance with section 6.9 of this manual.

53 Design Guides and Manuals for LID

The following documents and manuals may be used for the design of ESD and RR practices. Other available design documents may also be used as a reference, subject to approval of the Program Administrator.


3) Low-Impact Development Hydrologic Analysis, United States Environmental Protection Agency, Office of Water, EPA 841-B-00-002 dated June 1999 and subsequent modifications and updates thereof.

**CHAPTER 4**

**Determination of Design Storm Event**

A fundamental LID design objective for stormwater management is to keep runoff volumes and peak flow rates for the developed site at or below the runoff volumes and peak flow rates for the same site prior to development. These volumes and rates are associated with a specified design storm event.

The criteria used to select the design storm event for LID are based on the goal of maintaining the equivalent of a forested hydrologic condition for the site. The hydrologic approach of LID is to retain the same amount of rainfall within the development site as that retained by woods, in good condition, and then to gradually release the excess runoff as woodlands would release it. By doing so, we can emulate, to the greatest extent practical, a hydrologic regime to protect watershed and natural habitats.

The CN for the predevelopment condition is to be determined based on the land cover being woods in good condition and the existing hydrologic soil group (HSG). The design storm is to be the 1-year 24-hour storm event.

**Environmental Site Design (ESD)**

56 **Conserved Open Space**

- Woods and other vegetated areas provide many opportunities for storage and infiltration of runoff. By preserving the natural coverage to the greatest extent possible, the amount of storage needed for runoff management is minimized. Conserved Open Space is protected by restrictive easements and covenants. See Chapter 9, subsection 9.5 for more details on the easement requirements.

57 **Minimize Land Disturbance**

- This approach includes site planning techniques such as minimizing the disturbance of soils—particularly in vegetated areas—that have high infiltration rates (Hydrologic Soil Groups A and B) and placement of infrastructure and impervious areas such as houses, roads, and buildings on more impermeable soils (Hydrologic Soil Groups C and D). Care must be taken when determining the suitability of soils for the proposed construction. Adequate geotechnical information is required for planning practices. The natural topography is used in the design of roads, utilities and buildings.

58 **Reduce Impervious Cover**

- Reducing the amount of imperviousness on the site will have a significant impact on the amount of compensatory BMP storage required. See Green Roof (Specification 5) and Permeable Pavement (Specification 7) at the Va. BMP
Clearinghouse website for more details.

59 Disconnection

- Impervious areas are considered disconnected if they do not connect to a storm drain system or other impervious areas through direct or shallow concentrated flow. Directing runoff from impervious areas onto vegetated areas as sheet flow will increase infiltration, resulting in a direct reduction in runoff and corresponding storage volume requirements. By increasing the ratio of disconnected impervious areas to pervious areas on the site, the CN and the resultant runoff volume can be reduced. See Downspout Disconnection (Specification 1) at the Va. BMP Clearinghouse website for more details.

60 Vegetative Stormwater Conveyance System

- Vegetative channels are a preferable alternative to both curb and gutter and storm drains as a stormwater conveyance system where development density, topography and soils permit. Vegetative channels are earthen channels covered with a dense growth of hardy grass that can be used to filter and reduce runoff within the conveyance system. See Grass Channels (Specification 3) at the Va. BMP Clearinghouse website for more details.

61 Soil Restoration Techniques

- Soil Restoration (SR) uses techniques that enhance compacted soils to improve their porosity and nutrient retention. SR includes biological (worms) and mechanical aeration, mechanical loosening (tilling), planting dense vegetation, and applying Soil Compost Amendments (SA). SA involves the spreading and mixing of mature compost into disturbed and compacted urban soils. These soil amendments can reduce the generation of runoff from compacted turf and may enhance the runoff reduction performance of downspout disconnection, grass channels, filter strips, and aquatic buffers.

62 Creation of Transition Zones

- Transition zones are vegetated areas that can be used to store and infiltrate runoff from impervious areas before the runoff is discharged from the site. Providing these areas will not only affect the characteristics of site runoff, but also affect the computation of CN values. Transitions shall be a minimum of 1,000 square feet of contiguous meadow or landscaped mulch beds.

### Runoff Reduction (RR)

Retention storage temporarily ponds water for release through infiltration, evaporation, and transpiration, rather than through surface runoff during a storm event. Strategic use of retention storage to supplement the runoff reductions achieved by selective land cover
choices allows the predevelopment runoff volume to be maintained. Runoff Reduction measures for maintaining the predevelopment volume include, but are not limited to, the following:

- Green Roof
- Rainwater Harvesting
- Permeable Pavement
- Bioretention
- Infiltration
- Dry Swale

In some cases, the amount of storage that maintains the predevelopment runoff volume will also be sufficient to maintain the predevelopment peak runoff rate. Where it is not, additional storage is required in the form of detention storage. Many Runoff Reduction practices can also provide detention storage. If detention storage cannot be provided in the RR practice, then a downstream detention facility may be needed.

**Pollutant Removal (PR)**

Pollutant Removal uses traditional and manufactured stormwater management practices to treat the reduced amount of runoff to remove nutrients and sediments. PR is achieved with the reduction of runoff volume, filtering and biological uptake. PR practices include, but are not limited to, the following:

- Wet Swales
- Filters
- Constructed Wetlands
- Wet Ponds
- Extended Detention Ponds
- Manufactured Treatment Devices (MTDs)

**Integrated Stormwater Management Practices (IMPs)**

**66 Flow Dispersal and Pretreatment Techniques**

**Gravel Diaphragm**

Gravel diaphragm maintains overland sheet flow from a parking lot or downspout. The gravel diaphragm is composed of an open graded gravel trench a minimum of 2 feet in width and 1 feet in depth that runs on the same contour at the top of the filter strip. The diaphragm serves two purposes. First, it acts as a pretreatment device, settling out sediment particles. Second, it acts as a level spreader that maintains sheet flow.

- The flow should travel over the impervious area and to the practice as sheet flow and then drop at least 2 inches onto the gravel diaphragm. The drop helps to
prevent runoff from running laterally along the pavement edge, where grit and debris tend to build up.

- A layer of filter fabric should be placed between the gravel and the underlying soil trench.
- If the contributing drainage area is steep (6% slope or greater), then larger stone (clean gravel that meets VDOT #57 grade) should be used in the diaphragm.
- If the contributing drainage area is solely turf (e.g., lawn), then the gravel diaphragm may be eliminated.

**Figure 4.1: Gravel Diaphragm – Sheet flow Pretreatment**
(Source: Va. DEQ Stormwater Design Specification No. 2: Sheet flow to Filter or Open Space)

**Grass Filter**
Filter strips are typically bands of close-growing vegetation, usually grass, planted between pollutant source areas and a downstream receiving water body or BMP. Used when runoff is sheet flow, and is often enhanced with a gravel diaphragm when the minimum length is not achievable. **Table 4.1** provides sizing guidelines as a function of inflow approach length, land use, and slope. The minimum filter strip length (flow path) should be 10 feet. Filter Strips should be installed with adequate stabilization matting and straw.

**Table 4.1: Pretreatment Filter Strip Sizing Guidance (Source: Claytor and Schueler, 1996)**
Grass Channel

For applications where concentrated runoff enters the practice by surface flow, such as through a slotted curb opening, a grassed channel, often equipped with a gravel diaphragm to slow the velocity and spread out the flow. The length of the grassed channel depends on the drainage area, land use, and channel slope. Table 4.3 provides recommendations on sizing for grass channels leading into a practice for a one acre drainage area. Contributing drainage areas over 1 acre require multiplying the minimum length in the table by the drainage area. See the Virginia BMP Clearinghouse website for more details under Specification 3.

Table 4.3 Grass Channel Sizing Guidance for a 1.0 Acre Drainage Area (Source: Claytor and Schueler, 1996)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>&lt;33% Impervious</th>
<th>Between 34% and 66% Impervious</th>
<th>&gt;66% Impervious</th>
<th>Notes</th>
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<tr>
<td>Slope</td>
<td>&lt;2%</td>
<td>&gt;2%</td>
<td>&gt;2%</td>
<td>Max. = 4%</td>
</tr>
<tr>
<td>Minimum Length</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>(feet)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Engineered Level Spreader with Forebay

An engineered level spreader (ELS) is an energy dissipater device that is used to convert concentrated stormwater runoff to sheet flow. A forebay is constructed to allow sediment/debris to settle from the incoming stormwater runoff before it is delivered to the treatment or control practice. The engineered level spreader should be located at each point of concentrated incoming flow of the stormwater BMP. Storm drain piping or other conveyances may be aligned to discharge into one forebay or several, as appropriate for the particular site. ELS should be installed in a location which is accessible by maintenance equipment.
The following are design guidelines for using an ELS with forebay:

- The Length of the level spreader lip shall be 10 feet per every 1 cfs of the contributing 10-year peak flow.
- The width of the level spreader channel on the up-stream side of the level lip should be three times the diameter of the inflow pipe, and the depth should be 9 inches or one-half the culvert diameter, whichever is greater.
- The level spreader lip may be set at the treatment volume elevation if no other pretreatment is provided and velocities are non-erosive.
- The forebay section of the level spreader shall be excavated as shown in Figure 4.3.
- The forebay should be sized to hold 0.25 inches of runoff per impervious acre of contributing drainage area, with a minimum of 0.1 inches per impervious acre.

Figure 4.3: Level Spreader: Pipe or Channel Flow to Pretreat
(Source: Va. DEQ Stormwater Design Specification No. 2: Sheet Flow to Filter or Open Space)
The use of ELS at a stormwater treatment or control measure outfall requires a variance to satisfy Minimum Standard 19 of the Erosion and Sediment Control Regulations. As part of the variance, the Level Spreader needs to meet the following criteria:

- Describe maintenance responsibilities
- The Level Spreader lip needs to be adequately designed to maintain a non-erodible overland sheet flow (2-year velocity is 1.5 fps or less and/or have the peak flow discharged at a depth of 0.1 feet).

### 67 Disconnection Techniques

Disconnection methods aim to manage runoff close to its source by intercepting, infiltrating, filtering, or reusing as it moves from impervious surfaces to receiving drainage system. Disconnection practices promote overland sheet flow into pervious areas (i.e. lawn or grass swale). See the Virginia BMP Clearinghouse website for design guidance for Disconnection in Specification 1. Disconnection practices include, but not limited to, simple, soil amended flow path, dry well, rain garden, rain barrel or cistern, and stormwater planter.

- Rain barrels operate by retaining a predetermined volume of rooftop runoff. An overflow pipe provides some detention beyond the retention capacity of the rain barrel. Rain barrels also can be used to store runoff for later reuse in lawn and garden watering. A cistern is used to store more volume and is usually connected to the water supply system for non-potable uses. See specification 6 on the Clearinghouse website for more details.
- Rain Gardens are small, distributed practices designed to treat runoff from small areas, such as individual rooftops, driveways and other on-lot features in single-family detached residential developments. Inflow is typically sheet flow or can be concentrated flow with energy dissipation. See specification 9 on the Clearinghouse website for more details.
- Dry wells are underground rock or precast storage chambers covered with a sod (See appendix 10.4). Rock infiltration trenches are small excavated trenches backfilled with open graded stone. Design and construction considerations are similar to Rain Gardens and Bioretention (section 4.6.6). See specification 8 on the Clearinghouse website for more details.

### 68 Vegetated Roof

A vegetated roof is an alternative roof surface that reduces stormwater runoff and pollution by providing a vegetated surface that intercepts rainfall. There are two types of VRs: intensive and extensive. Intensive VRs are deeper than 3 inches and support larger types of vegetation such as trees and shrubs. Extensive VRs are shallower and rely on herbaceous vegetation. See specification 5 on the Clearinghouse website for more details.
69  **Rainwater Harvesting**

Rainwater harvesting systems intercept, divert, store and release rainfall for future onsite use. Rainwater harvesting systems consists of a catchment surface (usually roof), collection system (usually gutter, conduits and downspout), pretreatment filter, storage container, and outlet system (usually pump with overflow pathways). See specification 6 on the Clearinghouse website for more details.

70  **Permeable Pavement**

Permeable pavement is an alternative paving surface that promotes infiltration into an underlying stone reservoir where it is detained or infiltrated. Permeable pavement includes Porous Asphalt, Pervious Concrete and Interlocking Pavers. Each system of permeable pavement consist of four layers; a pervious surface layer, a bedding layer, a stone reservoir and a filter layer. An under drain system is typically provided to maintain positive drainage through the system. As an IMP, permeable pavement reduces impervious cover, filters runoff and can provide detention storage. See specification 7 on the Clearinghouse website for more details.

71  **Step Pool Stormwater Conveyance System (SPSC)**

Step pool stormwater conveyance is an open channel conveyance structure that converts, through attenuation pools with sand seepage filter, surface stormwater to shallow groundwater flow. This structure uses a series of constructed pools and riffles with an underlying sand/woodchip engineered filter media. These systems provide energy dissipation and extreme flood conveyance on steeply sloped sites. See specification 11 and 13 on the Clearinghouse website for more details. The pretreatment, recharge and water quality sizing criteria is found in Anne Arundel County, Maryland design guidelines: 
http://www.aacounty.org/DPW/Watershed/StepPoolStormConveyance.cfm
Identifying opportunities for Pollution Prevention is the most important component for effectively managing stormwater. Nonstructural practices can be employed during and after construction to minimize runoff and the risk of stormwater pollution to the greatest extent practicable. The implementation of pollution prevention practices involves looking for opportunities to reduce the exposure of pollutants to rainfall and runoff at the development site. Pollution prevention practices could be incorporated into Homeowners/Landowner Association documents and covenants and restrictions. Below are some examples of Pollution Prevention Practices:

<table>
<thead>
<tr>
<th>Residential Developments</th>
<th>Non-Residential Developments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Substitution</td>
<td>Covered Loading Areas</td>
</tr>
<tr>
<td>Natural Landscaping</td>
<td>Fuel Containment Areas</td>
</tr>
<tr>
<td>Tree Planting</td>
<td>Covered Vehicle Storage Areas</td>
</tr>
<tr>
<td>Yard Waste Composting</td>
<td>Storm Drain Disconnection</td>
</tr>
<tr>
<td>Septic System Maintenance</td>
<td>Downspout Disconnection</td>
</tr>
<tr>
<td>Driveway Sweeping</td>
<td>Street Sweeping</td>
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<tr>
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Source: Table 5.2. 2014 Virginia Stormwater Management Handbook

Review these other sources:
73 Erosion and Sediment Control Plans

**Introduction**

The Stormwater Pollution Prevention Plan (SWPPP) must include an approved Erosion and Sediment Control Plan in accordance with the guidance and requirements in Chapter 6 of the Virginia Erosion and Sediment Control Handbook and Chapter 8 of the Orange County Code.

Plan preparers should keep in mind that a complete and comprehensive narrative including multi-phasing and sequence of construction is essential.

Erosion and Sediment can be managed on a site using three types of best management practices:

**Cover Practices** prevent erosion from occurring by protecting the soil from raindrops and erosive flows. Prevention of erosion is the most preferable and cost-effective approach. These practices include: temporary covering of exposed soil by mulching, matting, or gravel; and permanent site stabilization by topsoiling, seeding, and/or sodding;

**Structural Practices** physically prevent sediment transport by controlling runoff and capturing or filtering sediments. These practices include check dams, sediment traps/basins, silt fence and other perimeter controls; and

**Management Measures** are construction methods that prevent or reduce the erosion potential and ensures practices are functioning. These measures include, but not limited to the following:

- Preserving existing vegetation;
- Revegetating as soon as possible;
- Locating stockpiles and staging areas away from critical areas;
- Limit the tracking of mud and debris onto paved surfaces;
- Removing sediment and debris from paved surfaces;
- Installing downspout extenders to prevent erosion from roof runoff;
- Maintaining practices through sediment removal, repair and replacement;
- Slope Design and Phasing of Site Disturbance
The Erosion and Sediment Control plan shall incorporate everything needed by the owner and operator to successfully construct site improvements and stabilize denuded areas. At a minimum the E&S Control plan shall include the following:

- Plan Narrative
- Illustrative Drawings
- Details and Specifications
- Computations
- Certified Responsible Land Disturber (RLD)

**Narrative**

- Plan narrative should include a qualitative evaluation of the activities being performed and how stabilization will occur.
- Components:
  - Purpose of activity with disturbed acreage
  - Describe the existing conditions
  - Describe neighboring areas
  - Describe the soils
  - Describe the critical areas
  - Describe any local, state or federal permits obtained or applied.
  - Describe the control measures
  - Describe how site will be stabilized
  - Describe borrow area, and soil stockpiles
  - Describe schedule of regular maintenance inspections
  - Describe the strategy to control stormwater runoff
- Special Notes:
  - 19 Minimum Standard (required)
  - General E&S Notes (i.e. management practices)
  - Slope Protection Notes
  - Site Stabilization Notes
Drawings of the proposed scope of work is needed for review.

- Provide engineer (s) and/or plan preparer(s) name and contact
- Provide the owner (s) and/or developer (s) name and contact
- Identify the Responsible Land Disturber (RLD)
- Provide copy of applicable local, state and federal permits
- Provide a vicinity map locating the site (and access)
- Provide original plan dates and all revision dates
- Provide titles and numbering for all sheets
- Provide plan scale sufficient to clearly convey the site characteristics
- Show temporary and permanent drainage easements
- Provide existing contours at intervals no greater than five (5) feet.
- Provide final contours at intervals no greater than two (2) feet
- Show existing vegetation
- Show boundary of different soil types
- Provide a north arrow
- Clearly show critical areas
- Provide drainage maps of existing and proposed conditions
- Provide a construction sequence
- Show the Location and Description of all existing and proposed drainage structures
- Show locations of erosion and sediment control practices
- Show limits of disturbance
- Show locations of stockpile and borrow areas

This section of the Erosion and Sediment Control Plan consists of data and computations which support the elements of the design.

Computations must be provided which support all the hydrologic and hydraulic elements of the design.

- Soil Loss (RUSLE) and Sediment Yield (MUSLE)
- Adequate Channel computations showing design storm capacity and adequate channel lining (REQUIRED).
Predicting Soil Losses and Estimating Sediment Yield

Predictions of soil loss are planning tools. The predictions guide planners on the degree of erosion and sediment control at specific sites. Predicted soil losses also create awareness among developers, local governments and others of the urgent need to install erosion and sediment control measures before, during and after construction activity.

The design of control measures on critical slopes and adjacent critical areas shall use the soil loss and sediment yield methods described below:

Soil losses can be predicted for a whole year or part of a year on the basis of rainfall amounts. The Revised Universal Soil Loss Equation (RUSLE) is used to estimate soil losses on construction sites from sheet and rill erosion. The equation uses site-specific rainfall intensity, soil erodibility and slope factors. Other soil losses, such as gully erosion or wind erosion, are calculated separately.

Sediment yield involves both soil erosion on the site and the transport mechanism acting to carry the eroded material off the site. Sediment yields are recommended for estimating the wet storage volumes needed from sediment basins with over 50 contributing acres or will treat a multi-phased project over its 18 month life span. At a minimum, sediment traps and sediment basins must have a wet storage volume of 67 cubic yards per contributing acre and a dry storage volume of 67 cubic yards per contributing acre.

Sediment yields can also be used as a planning guide to show that structural practices have adequate storage capacity over the life of the practice.

The Modified Universal Soil Loss Equation (MUSLE), developed by Williams and Berndt, 1976, can be used to calculate sediment yields from drainage basins for single storm event. Runoff is assumed to be a superior indicator of sediment yield than rainfall, i.e. there can be rainfall with little or no runoff. Williams replaced the R (rainfall erosivity) factor with a runoff factor.

Adequate Channel

Minimum standard 19 of the Erosion and Sediment Control Regulations (9VAC25-840-40) states: "Properties and waterways downstream from development sites shall be protected from sediment deposition, erosion and damage due to increases in volume, velocity and peak flow rate of stormwater runoff". Stormwater drainage systems must be designed to have adequate capacity to mitigate flooding and control flow velocity to minimize downstream erosion. Channel adequacy must be determined for all drainage systems that convey concentrated runoff and where BMPs outlet.

The following criteria shall be used to determine adequate channel:

- Man-made stormwater conveyance channels must be designed to convey the peak discharge from a ten-year design storm. The channel must also be stable with a temporary and permanent channel lining that is non-erosive for the two-year design storm. Freeboard and water surface profiles in accordance with section 2.4 and 2.5 of this manual may be used to demonstrate adequacy.
• Storm sewer systems and culverts must be designed to convey the peak discharge from the ten-year design storm or be sized to minimize localized flooding. Hydraulic grade line, headwater and buoyancy computations in accordance with VDOT Drainage Manual may be used to demonstrate adequacy.

• Natural channels shall be evaluated based on the 2-year design storm. The 2-year capacity and flow velocity shall be maintained. The shear stress shall be analyzed when the capacity is exceeded. The following data is needed for the analysis of a natural channel:

  a. Analyze the downstream channel reach. A reach is defined as the channel length between two successive riffles at least 100 feet and no more than twenty times the channel width. The reach shall start and end at a riffle, and include at least two (2) riffle cross sections and one (1) pool cross section.

  b. Survey enough cross-sections at right angles to the centerline in each reach to determine the average cross-section. Channel top of bank should be well defined and identifiable by field parameters such as flattening or change in bank slope. When top of bank is not obvious, a hydrologic analysis of the contributing drainage area and the corresponding 2-year undeveloped peak discharge may be used to define the channel cross-sectional area.

81 Limits of Analysis

Outfall analysis may be based on the land area. Analysis is conducted at a point in the watershed where the site’s contributing drainage area is less than or equal to one percent (1%) of the total watershed area.

Alternatively, the outfall may be analyzed based on peak flow rate. Analysis is conducted at a point in the watershed where the site’s peak flow rate from the design storm is less than or equal to one percent (1%) of the existing peak flow rate.

Variance Requests

As per 9VAC25-840-50 of the Virginia Erosion and Sediment Control Regulations, a variance for any minimum standard may be requested in writing on the E&S plan. The variance request should provide a description, justification and applicable modifications to comply with the intent of the Erosion and Sediment Control Regulation’s 19 minimum standards (9VAC25-840-40).

  1. Description

• Specify the specific provision(s) of the Erosion and Sediment Control standards and specifications from which relief is being sought.

• Describe the project condition (other than economic) that makes compliance with the provision(s) impossible or impracticable.

• Identify acceptable mitigation measures that can provide reasonably equivalent level of erosion and sediment control and the requested variance constitutes the minimum deviation necessary to afford relief.
2. Justification
   - Demonstrate that meeting the minimum requirements is not feasible due to the natural or existing physical characteristics of the site.
   - Demonstrate that the proposed variance will not impair or damage adjacent and downstream properties.

3. Modifications to BMPs
   - Demonstrate that the omission or modification of a BMP standard or specification will not cause immediate downstream properties will not be damaged by erosion and sedimentation from the project activities.
   - Provide all necessary supporting descriptions, drawings, computations, and other information necessary to demonstrate compliance.
83 Stormwater Management Plans

Introduction

A Stormwater Management Design Plan is a set of drawings and supporting documents provided in conjunction with the construction plan or final site plan. It comprises all of the information and specifications for the systems and structures to be used to convey and control stormwater runoff. It is complete, separate, and distinct from other elements of the construction plan and is intended only to depict a workable stormwater management design.

This chapter presents an overview of submission requirements for technical review and approval of Stormwater Management Design Plans. The Design Manuals and other guidance documents listed in Chapter 1 of this manual should be consulted for details of these requirements. The designer must provide all the information needed to support the stormwater management design. The Stormwater Management Plan Review Checklist provided in Appendix 12 should be utilized to ensure all the necessary information is included.

Stormwater Management Concept Plan

[Proposed] Chapter 27 of Orange County Code requires all preliminary plans of subdivision and when determined by the County, conditional use permits and rezoning application shall submit a Stormwater Management Concept Plan.

The purpose of a Stormwater Management Concept Plan is to assess the hydrologic and hydraulic conditions of the site before any development and to describe, in a general way, the stormwater management practices and features needed to meet applicable requirements and minimize the downstream impacts of the proposed development. A Stormwater Management Concept Plan is a complete and distinct plan.

The Stormwater Management Concept Plan is intended to be the basis for preparing a Stormwater Management Design Plan. It should be submitted and approved before significant resources are expended to prepare a Stormwater Management Design Plan and must be approved before a Stormwater Management Design Plan may be submitted. A copy of the approved Stormwater Management Concept Plan must be included with the final site plan or subdivision construction plan. A revised concept plan may be required if changes to a development proposal are made (i.e., a Preliminary Subdivision Plan is revised).
Construction details should not be included in a Stormwater Management Concept Plan. In fact, approval of the stormwater management concept plan does not provide approval of any construction or land disturbance. Approval of these is done with the Stormwater Management Design Plan.

Stormwater Management Concept plans should be prepared in accordance with this chapter and two (2) copies submitted to the Department of Planning and Zoning. Application and review fees may apply.

### 86 Stormwater Management Concept Plan Requirements

Complete design is not required in the Stormwater Management Concept Plan; however, sufficient analyses must be performed to show the plan is workable. The amount of analyses required will vary depending on the size and complexity of the site and the development.

At a minimum, the stormwater management concept plan will include:

- A drainage map with accompanying Natural Resource Assessment that identifies the existing conditions of the site and the surrounding areas;
- A layout showing the location of existing and proposed improvements including BMPs. The layout will clearly show post development drainage divides, proposed land use tabulation of the different land cover conditions, and proposed drainage easements;
- The Environmental Site Design Checklist from Appendix 12.2 indicating LID site planning to the maximum extent practicable;
- The LID performance worksheet from Appendix 12.2 indicating the retention and/or detention storage volumes necessary to control the volume and peak flow rate from the 1-year, 24-hour storm event in forested condition;
- Hydrologic computations showing the 2- and 10-year, 24-hour peak flow rates, and/or the runoff reduction spreadsheet to show water quality compliance;
- Additional information may be required, as deemed necessary by the Administrator to evaluate the concept plan.

Refer to Appendix 12 for a more detailed Stormwater Management Concept Plan Checklist.
87 Stormwater Management Exceptions

Exceptions to the technical requirements of Chapter 27 of the Orange County Code may be granted by the program administrator, upon receipt of a written request from the owner or designated agent. Such requests are best made early in the design process such as in conjunction with the Stormwater Management Concept Plan.

The request must be made in writing and must be signed by the owner or designated agent. Exceptions may be granted provided the request is the minimum necessary to afford relief, comply with reasonable and appropriate conditions, will not confer any special privileges, is not self-imposed, and is not solely based on economic hardship.

Conditions may be imposed upon an exception granted so the intent of the stormwater management provision of the Orange County Code is preserved. Economic hardship is not sufficient reason to grant an exception.

An exception request includes, but is not limited to the following:

1. Description
   - Specify the specific provision(s) of Orange County Code from which relief is being sought.
   - Describe the project condition (other than economic) that makes compliance with the provision(s) impossible or impracticable.
   - Identify acceptable mitigation measures that can provide reasonably equivalent level of stormwater management and the requested exception constitutes the minimum deviation necessary to afford relief.

2. Justification
   - Demonstrate that meeting the minimum requirements is not feasible due to the natural or existing physical characteristics of the site.
   - Demonstrate that the proposed development is not likely to impair the attainment of the objectives of the stormwater management provisions of the Orange County Code.
   - Identify legal conflicts where site conditions are such that stormwater compliance will conflict with existing local, state, or federal laws, ordinances, regulations or policies.

3. Stormwater Management Compliance
   - Ensure that compliance with the water quality requirements is not impaired by the proposed exception. If applicable, indicate approved offsite compliance options.
   - Demonstrate that the immediate downstream waterways will not be subject to (1) accelerated deterioration of existing culverts, bridges, dams and other structures; (2) deterioration of biological functions or habitat; (3) accelerated stream bank or stream bed erosion or siltation; and (4) increased threat of flood damage to public health, life and property.
• Provide all necessary supporting descriptions, drawings, computations, and other information necessary to demonstrate compliance.

Copies of any approved requests for exception which apply or which are being sought must be included in the Stormwater Management Design Plan submission.

88 Low Impact Development Exceptions

Orange County Code requires SWM plans to utilize LID to the maximum extent practicable. The extent practicable of LID design is decided during review and approval of the SWM Concept Plan. This measure is subjective; however, the following guidelines will be applied to determine compliance with this requirement.

Physical Constraints

• New development on sites where critical slopes (15% or greater) or poor soils (hydrologic groups C and D) occupy 50% or more of the site need not attempt a full LID design.
• Redevelopment projects exceeding 65% impervious cover need not attempt a full LID design.
• Setback space and utility conflicts

Inability to Infiltrate

• Geotechnical and Engineering analysis (data and computations) of a site indicates unsuitable soils, contaminated soils, shallow water table or shallow bedrock; and
• No level of engineering can mitigate the unsuitable conditions.

Potential Adverse Impacts

• Projects which propose to improve existing inadequate downstream channels may be exempt from the requirement to attempt a full LID design subject to the approval of the Program Administrator.
• Unstable or unsustainable water balance for the site (e.g. impacts on existing infrastructure on- or offsite).

A Full LID design must be considered in every case.

A “full LID design” is one which:

1) Provides a combination of environmental site design techniques and runoff reduction practices so that the 1-year, 24-hour runoff volume is no more than would be expected in the forested condition;
2) Provides detention practices, as needed, so that the 1-year, 24-hour peak flow is no more than would be expected in the forested condition;
3) Provides pollutant removal practices that satisfy the treatment volume;
4) Honors existing drainage divides and maintains times of concentration to each drainage outfall to at least that of the existing site; and
5) Employs measures that disconnects impervious surfaces and disperses concentrated runoff as overland sheet flow in accordance with section 4.6 of this manual.

Stormwater Management Design Plan consistent with Full LID shall be deemed an equivalent method that satisfies water quality and channel protection requirements listed in Orange County Code Sections 11A-22 through 11A-24 and Section 11A-27.

A “partial LID design” is one which:

1) Provides a combination of environmental site design techniques and runoff reduction practices so that the volume reduction is at least 50 percent of the retention volume for the 1-year, 24-hour storm in the forested condition;
2) Provides detention practices, as needed, so that the 1-year, 24-hour peak flow is no more than would be expected in the forested condition;
3) Provides pollutant removal practices that satisfy the treatment volume;
4) Honors existing drainage divides and maintains times of concentration to each drainage outfall to at least that of the existing site; and
5) Employs measures that disconnects impervious surfaces and disperses concentrated runoff as overland sheet flow in accordance with section 4.6 of this manual.

The Stormwater Management Design Plan shall meet any remaining requirements for water quantity and quality criteria listed in the Orange County Code Sections 27-21:22.

**Stormwater Management Plan Contents**

All Stormwater Management Design Plans must include, as a minimum, the information described in this section. Information must be shown clearly and unambiguously. Consider scale, line weight, line style, typeface size, shading, information crowding, and other such factors when preparing sheets. Information which is unclear, ambiguous, or overcrowded may be rejected as though it were not presented in the plan.

The following are the required contents of a Stormwater Management Design Plan:

1) Contact information for the owner, operator and plan preparer; including name, address, and telephone number.
2) Information on the type and location of stormwater discharges; information on the receiving surface water to which the stormwater is being discharged; and pre and post development drainage areas.
3) A narrative that describes the current and final site conditions
4) A detailed description of proposed stormwater management facilities and integrated stormwater management practices being implemented. Including a detailed operation and maintenance plan for each.
5) Information on the proposed stormwater management facilities, including type of practice, geographic coordinates of the location, acres treated and receiving surface water with name and 6th order hydrologic unit code (HUC).
6) Hydrologic and hydraulic computations
7) Documentation and calculations verifying compliance with the technical requirements of Article IV of the Orange Stormwater Ordinance.
8) Illustrative drawings and drainage area maps

**Stormwater Management Summary Sheet**

Provide a summary sheet with at least the following information included:

- General information including project name, Engineer's Seal and signature, date of drawing, legend, and contact information for the owner, operator and plan preparer.
- Identify approved variances and exceptions for the project
- Statement and certification of using offsite compliance mechanisms, if applicable.
- Notes that address all permitting requirements for the Contractor. Including but not limited to the Construction General Permit, Stream and Wetland Permits, Waste Management Permits, etc.
- A narrative description of the project indicating
- Describe the current and final site conditions including changes in the pre and post development drainage areas, soils, land use, and vegetation cover
- Type (sheet flow, shallow or channel) and location of each stormwater discharge
- Describe the proposed stormwater management facilities and integrated stormwater management practices. Document how these measures satisfy the requirements of LID and/or water quality treatment and flood and channel protection.
- Highlight and describe areas where the SWM Plan differs or departs from the approved SWM Concept Plan.

**Illustrative Drawings**

Provide a drawing of the overall development at a scale to contain the drawing on a single sheet. If the scale required is smaller than 1 inch to 50 feet, include additional sheets at a scale of 1 inch to 50 feet or larger showing the entire development. Include the property line of the development project. If for any reason, property lines do not accurately reflect the limits of the project, provide a line indicating those limits and documentation of necessary authority to develop.

**Existing Conditions**

Existing conditions are those existing prior to development or redevelopment. On the existing condition drawings include the following:
• **North Indicating Arrow.** Provide an arrow indicating north and a graphic scale for each plan view included. If more than one plan view is shown on a single sheet of the plan set, include a north-indicating arrow and graphic scale for each.

• **Property Boundaries.** Show the property lines of the project site. Include the name of adjacent property owner(s) and tax map parcel number(s).

• **Existing Contours.** Show the existing contours of the site at one- or two-foot intervals. Contours must be clearly labeled at 5 foot intervals or less.

• **Wetlands.** Boundaries of wetlands found on the site.

• **Floodplains.** Boundaries of the one hundred-year floodplains as shown on the most current FEMA Flood Insurance Rate Maps for Orange County.

• **Water and Sanitary.** The location of any existing water supply wells and septic systems.

• **DO NOT SHOW ANY PROPOSED DEVELOPMENT** on drawings depicting existing conditions.

93  **Proposed Conditions**

Proposed conditions are the final land use and vegetative cover resulting from the land disturbing activities. On the proposed conditions include the following:

• **Limits of the Project:** If for any reason, property lines do not accurately reflect the limits of the project, a line indicating those limits and documentation of authority to work outside the property limits.

• **Final Contours:** Show changes to the existing contours using different line weight and style. Contours must be clearly labeled at 2 foot intervals or less.

• **Wetlands:** Show changes in boundaries caused by proposed development using different, more prominent line weight, style or shading.

• **Floodplain:** Show all encroachment from land disturbing activities. If grading is anticipated within the 100-year floodplain or if construction is proposed which may significantly affect the location of the 100-year water surface elevation, a study will be required pursuant to County Code.

• **Stream Buffers and Open Space.** Show proposed buffers and open space. Buffers and open space used as an IMP must be in easement (see Chapter 8 on Easements).

• **Stormwater Drainage Systems:** Show location of structures and easements. Include pipe diameter, type and class; the extent of channel linings; and any other information necessary to show flooding potential.
• **SWMF:** Locations and type of BMP including the easements for access and maintenance. Show the dimensions of the pretreatment devices, primary and emergency spillways; show the water surface elevations of the design storms; and show locations of plantings.

• **IMPs:** Locations and type of BMP including easements if required. Show the dimensions and spot elevations of structural elements.

• **Water and Sanitary.** If applicable, show the location of proposed water supply wells and septic systems. Indicate appropriate setbacks for infiltration practices.

### Drainage Map

The Stormwater Management Design Plan must include a map(s) showing onsite and offsite drainage (the area upstream to the point of analysis within the same watershed). Scale should be appropriate to size of area. The following items are required as a minimum:

- **Drainage Areas.** Delineate the drainage areas to the stormwater outfalls as indicated above. Indicate the size of each drainage area in acres. Label drainage areas for cross-referencing computations.

- **Stormwater Outfalls.** Indicate the points along the property line or project limits where stormwater runoff leaves the site as shallow concentrated flow or channel flow.

- **Land Uses.** Delineate existing and proposed land uses. Indicate the size of each area delineated in acres.

- **Soils.** Show the boundaries of different soil types. Label each area with soil name and hydrologic soil group.

- **Times of Concentration.** Show time of concentration flow paths for both existing and proposed drainage areas. Identify sheet flow, shallow concentrated flow, and channel flow segments for each flow path.

- **Existing and Proposed Drainage.** Show stormwater outfalls and drainage areas for both existing and proposed conditions.

- **Drainage to Structures.** Delineate the drainage areas to all existing and proposed stormwater conveyance structures and stormwater management facilities. Provide appropriate labels for cross-referencing with computations.

### Cross Section and Profile View

The stormwater management design must be illustrated in cross section and profile view(s) showing, as a minimum, the following information:
96 **Storm Drainage Systems**

- Structure symbols and numbers.
- Size, type, class, inverts, length and slope of pipe or structure
- Existing ground and proposed grade at channel centerline and both banks
- Ten- and one hundred-year water surface elevations at pipe entrances and outfalls
- Outfall protection dimensions
- Utility crossings and inverts
- Typical cross section(s) for stormwater conveyance channels and pipe outfalls
- Bottom width, height, existing ground side slope and type of stabilization lining (note: temporary and permanent)
- Ten-year water surface elevation and freeboard for stormwater conveyance channels

97 **Stormwater Management Facilities**

- Principal spillway profile and associated details, including riser structure, trash rack, anti-vortex, and structural footing as per appendix B on the Clearinghouse website.
- Embankment profile and associated details, including side slopes, top width, core trench, and barrel as per appendix A on the Clearinghouse website.
- Typical cross section of the emergency spillway as per appendix C on the Clearinghouse website.
- Outlet protection and outfall channel with section detail as required for construction showing rip-rap size, bottom width, side slope, filter cloth, etc.
- Elevations of top of dam (constructed and settled), crest of emergency spillway, crest of riser structure, and inverts of orifices and weirs
- Treatment Volume (Tv), one-, two-, ten-, and one hundred-year pool elevations
- Impoundments should provide bottom width, side slopes, depth
- Infiltration practices should include elevations of all backfill materials, including mulch layer.
- Infiltration practices should provide under drain pipe size, type, and perforation pattern; and Observation / cleanout pipe
- Identify pretreatment measures
Integrated Stormwater Management Practices (IMPs)

- The following must be shown to scale in cross section or profile, as a minimum;
- Typical detail showing dimensions and elevations
- Identify pretreatment measures
- If applicable, under drain pipe size, type, and perforation pattern

Construction Details

In addition to the other information required to be shown specifically in plan or profile views, the following information must be provided.

- Typical detail showing dimensions, elevations and material specifications
- Geotechnical report prepared by a licensed geotechnical engineer including soil boring locations and logs.
- Site preparation notes
- Sequence of construction, including critical times
- Earthen Embankment construction notes
- Concrete construction notes
- Schedule of required inspections

Maintenance Plan

Maintenance plans must be provided for all stormwater management facilities and integrated stormwater management practices. These plans must be submitted for approval along with the stormwater management design plan. Sample plans and inspection resources are located in Chapter 10 which may serve as a starting point for preparation of maintenance plans for the most common facility types.

Plan preparers should view the maintenance plan as an “owner and operator manual” for the proposed BMP. Therefore, it should contain physical and functional descriptions of stormwater management features so the owner can identify the elements, appreciate their importance, and understand how they are intended to work.

Calculations

This section of the Stormwater Management Plan consists of data and computations which support the drainage and stormwater management elements of the design.

Computations must be provided which support all the hydrologic and hydraulic elements of the design. At a minimum:
• A completed Environmental Site Design Checklist and LID Performance Worksheet for the disturbed areas of the site.

• Hydrologic and hydraulic computations for stormwater conveyance system including pipe, culvert and open channels.

• Hydraulic grade line computations for pipe systems.

• Hydrologic, hydraulic, and water quality computations for each BMP.

• All necessary computations to comply with BMP design specifications.

102  “Complete” Computations

In order to be “complete,” a computation must use an equation, methodology, or algorithm from the design manuals and must be reproducible and verifiable using information shown on the plan or drawn from a reference to the design manuals. All values used in a computation must be sourced to an acceptable reference (e.g., one of the design manuals) or to an illustration on the plan.

Output from computer programs may be used, but it must be clearly annotated and cross referenced so its relevance in the design is transparent and it must be a complete computation as defined here.

All performance standards of the Orange County Code shall be addressed with computations.

103  Low Impact Development (Sec. 27-20)

Use of LID design to the maximum extent practicable is required.

An Environmental Site Design Checklist and LID Performance Worksheet (See Appendix 12.1.2 and 12.1.3) for the site is required as a minimum. A single checklist and worksheet may be used which accounts for the entire site; however, times of concentration must be computed for each drainage area separately.

104  Channel Adequacy

The purpose of investigating channel adequacy in the Stormwater Management Design Plan is to document the condition of outfalls upon completion of the proposed development to ensure they will be adequate when the project is complete. Compliance computations consistent with section 5.5.2 of this manual shall be referenced for all onsite and receiving stormwater conveyance systems.

An outfall into an undefined channel or undisturbed vegetative area is allowed with the following guidelines:

1. The dispersed flow shall be non-erosive with a permissible 2-year peak flow velocity less than 1.5 feet per second and/or a flow depth of 0.1 feet.

2. Point of discharge is at least 100 feet from the property line.
3. The area receiving flow must have vegetative cover that is uniform, mature enough to survive and will inhibit erosion, and its permanence is provided for with a permanent drainage easement or deed restriction as per section 8.5 of this manual.

4. A variance request for minimum standard 19 of the Erosion and Sediment Control Regulations is submitted and approved. When the post-development peak flow rate and volume does not meet the requirements for channel protection, the downstream receiving channel shall be analyzed in accordance with 5.5.2 of this manual per minimum standard 19 of the Erosion and Sediment Control Regulations.

105 Stormwater Management

Water Quality (Sec. 27-21:22):

The Runoff Reduction Spreadsheet is needed to show the site complies with the water quality standard. Each BMP should be shown to provide the necessary treatment volume for BMP performance and meet the specifications on the Virginia Stormwater BMP Clearinghouse.

Post Development pollutant loads shall be determined with the Simple Method equation:

\[ L_{post} = 2.28 \times (0.05 + 0.009 \text{Imp}) \times A \]

Imp = percent impervious cover

A = Site Area being developed

Channel Protection (Sec. 11A-27):

The Energy Balance equation is needed to show the site complies with the channel protection standard. Sites that satisfy Full LID design do not have to verify the Energy Balance since the runoff volume and peak flow rates are that of a forested condition. The energy balance equation uses the one-year 24-hour storm for each point of discharge.

\[ \text{I.F. (Improvement Factor)} = 0.8 \]

Q_{post} = allowable peak flow rate from the developed site

RV_{post} = runoff volume from the developed site

Q_{pre} = peak flow rate from the site in pre-developed condition

RV_{pre} = runoff volume from the site in pre-developed condition

Under no condition shall Q_{post} be greater than Q_{pre} nor shall Q_{post} be required to be less than that calculated in the equation \((Q_{forest} \times RV_{forest})/RV_{post}\);  

Flood Protection (sec. 11A-25 & 26):

Hydraulic routing computations are needed to show that downstream properties are protected from flooding from the 2- and 10-year, 24-hour storm. Additional computations of the 100-year, 24-hour storm is needed for impoundment structures and floodplain assessments.
106 Stream Buffers

Introduction

A Stream Buffer is an area of land managed to provide a vegetative filter to protect the water quality of state waters from land disturbing activities. The purpose of the stream buffer is to retard runoff, prevent erosion, filter pollutants from runoff, moderate stream temperature, and provide for the ecological integrity of the stream corridors and networks. Stream buffers have been recognized as a cornerstone for long term protection of the Chesapeake Bay watershed and forests are the natural cover for most streams in this region.

Criteria

109 Buffer Width

The Hazel, Rapidan, Rappahannock, and Thornton Rivers shall maintain a 100 foot buffer. Perennial stream channels, as depicted as a continuous blue line on the USGS 7.5' topographic quadrangle map, shall maintain a 50 foot buffer. Intermittent stream channels, as depicted as a dashed blue line on the USGS 7.5' topographic quadrangle map, shall maintain a 25 foot buffer.

Width shall be measured horizontally from edge of contiguous wetland or the top of stream bank if no wetlands exist.

110 Overland Flows

How runoff enters the stream buffer affects filtering capacity and pollutant removal. The following guidelines are recommended when the stream buffer is used as a BMP:

- Adjacent steep slopes (>15%) shall be undisturbed.
- Disturbed slopes receiving overland sheet flow shall be less than 5 %.
- The maximum overland sheet flow length shall be 150 feet for disturbed areas.
- The maximum overland sheet flow velocity of 1.5 feet per second shall be maintained.
- Runoff is maintained as overland flows with effective use of flow dispersal techniques.
111  Functional Buffer Composition and Density

Indigenous vegetation shall be preserved to the maximum extent possible. The target vegetative cover in the stream buffer shall be indigenous forest with ground cover, shrub, and tree canopy layers. If the stream buffer is used as a BMP, each trophic layer shall remain intact where present or established in accordance with section 7.3.3 of this manual.

Trophic layers include: Canopy Tree is a tree of over 35 feet high; Sub Canopy is an immature canopy tree; Understory tree is a tree between 12-35 feet high; Large Shrub is over 10 feet high; Small shrub is less than 10 feet; and Woody groundcover is considered to be a woody spreading shrub that remains close to the ground, to 18” high. Vines may not be considered “woody groundcover” for the purpose of vegetation replacement.

Typical Stream Buffer Planting Density at Maturity

<table>
<thead>
<tr>
<th>Trophic Layers</th>
<th>Canopy (25%)</th>
<th>Sub-Canopy/Understory (25%)</th>
<th>Shrubs/Sapling (50%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 stems per acre</td>
<td>110 stems per acre</td>
<td>270 stems per acre</td>
<td></td>
</tr>
</tbody>
</table>

Source: Modified from DCR - Division of Natural Heritage (2002) Unpublished data on stand structure and stocking.

113  Stream Buffer Maintenance Plan

If the Stream Buffer is used as a BMP, the long-term maintenance of the buffer shall be in accordance with a recorded Operation and Maintenance agreement. At a minimum the following management activities should be performed:

- Dead, diseased or dying trees should be removed if it would improve the health and vitality of the buffer.
- Thinning of trees to improve the health and vitality of the buffer is allowed pursuant to some horticultural practice.
- Fallen trees that are blocking the stream channel or trees with undermined root systems in imminent danger of falling may be removed where pending stream bank erosion is a potential problem.
- Do not deposit or allow the accumulation of any trash, refuse or debris in the buffer.
• Control invasive species and noxious weeds. Measures include mulch, geotextiles, mechanical removal, chemical applications, tree shelters or other means as necessary until plantings are established.
• Ground cover needs to be maintained to prevent erosion.
• Use of native plants requires no fertilization.
• Signs or fencing may be necessary to prevent mowing.

114 Replacement Plantings

For incidental loss of vegetation during construction, trees are to be replaced in accordance with the following table. For stream buffers used as a BMP and covered under a maintenance agreement, the following table should be used for replacement of dead, diseased or dying trees. Replacement plantings shall be considered established after surviving one year of growth.

**Vegetation Replacement Rates:**

<table>
<thead>
<tr>
<th>Vegetation Removed</th>
<th>Preferred Replacement Vegetation</th>
<th>Acceptable Alternative Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 tree or sapling ½&quot; - 2 ½&quot; caliper</td>
<td>1 tree @ equal caliper or greater</td>
<td>OR 2 large shrubs @ 3'-4' OR 10 small shrubs or woody groundcover @ 15&quot;-18&quot;</td>
</tr>
<tr>
<td>1 tree &gt; 2 ½&quot; caliper</td>
<td>1 tree @ 1 ½&quot; - 2&quot; caliper, or 1 evergreen tree @ 6' min. ht., per every 4&quot; caliper of tree removed</td>
<td>OR 75 % trees @ 1 ½&quot;-2&quot; caliper and 25 % large shrubs @ 3'-4' per every 4&quot; caliper of tree removed. OR 10 small shrubs or woody groundcover @ 15&quot;-18&quot; per 4&quot; caliper of tree removed</td>
</tr>
<tr>
<td>1 large shrub</td>
<td>1 large shrub @ 3' - 4'</td>
<td>OR 5 small shrubs or woody groundcover @ 15&quot;-18&quot;</td>
</tr>
</tbody>
</table>

115 Afforestation and Reforestation

Reforestation or afforestation of vegetation must address each trophic layer. Reforestation is required when large amounts of vegetation are removed during temporary encroachment activities or as part of a stream bank erosion control project. Afforestation occurs when the stream buffer is used as a BMP and does not have adequate vegetative cover.

**Reforestation /Afforestation Rates**

<table>
<thead>
<tr>
<th>Location</th>
<th>Preferred Vegetation</th>
<th>Acceptable Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seaward 50 percent With 2-year Performance Guarantee</td>
<td>Vegetation</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>For every 400 square-foot unit (20' x 20') or fraction thereof plant:</td>
<td>OR one (1) understory tree and two (2) large shrubs @ 3' - 4'</td>
<td></td>
</tr>
<tr>
<td>One (1) canopy tree @ 1 ½&quot; - 2&quot; caliper or large evergreen @ 6'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two (2) understory tree @ ¾&quot; - 1 ½&quot; or evergreen @ 4'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Three (3) small shrubs or woody groundcover @ 15&quot; - 18&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Landward 50 percent With 2-year Performance Guarantee | Bare Root seedlings or whips at 1,210 per acre, approximately 6' x 6' on center (minimum survival required after two growing seasons: 600 plants) | OR Container grown seedling tubes at 700 per acre approximately 8' x 8' on center (minimum survival required after two growing seasons: 490 plants) |

*Natural Regeneration may be an appropriate method of reforestation or afforestation for areas over 1 acre if performed in accordance with a Forest Stewardship Plan prepared by a trained forestry professional.*

If the applicant is willing to enter into a 5-year performance guarantee, the entire stream buffer may be planted with bare root seedlings.

**117  Temporary and Permanent Encroachments**

Permanent Stormwater Management Facilities, Temporary Erosion Control Measures, Private Roads and Private Utilities:

- To the extent practicable, the location of temporary and permanent control measures shall be outside of the stream buffer.
- There are no reasonable alternatives as determined by a Natural Resource Assessment and Environmental Site Design Checklist.
- No more land shall be disturbed than is necessary to provide for construction and maintenance.
The overall layout will minimize additional permanent encroachments into the stream buffer.

- Erosion Control measures are based on controlling soil loss predicted using the RUSLE approach.
- Water quality impacts have been minimized by equivalent treatment in the form of stormwater treatment or mitigation measures.

Equivalent treatment will be considered in the form of stream buffer enlargement; use of disconnection and dispersion techniques; runoff reduction practices; or enhanced vegetative plantings.

118 Passive Recreation

Trails, boardwalks and paths for non-motorized activities shall be designed to minimize erosion within the stream buffer. The following guidelines will be followed:

- Restrictions: Avoid 25-foot seaward of the buffer; short paths for access only; avoid soft/waterlogged soils; follow contours; out-slope tread; avoid critical slopes; and minimize stream crossings at stable slopes and minimal width.
- Design: intensity of use determines the tread (paved, mulch, natural); limit vertical clearing; size according to intended use.
- For more details refer to the DCR Virginia Greenways and Trails Toolbox 2012; and the CBLAP Riparian Buffer Modification and Mitigation Guidance Manual 2006.
119 Pollution Prevention Plan

Introduction

The Pollution Prevention Plan includes a suite of good housekeeping practices that are designed to prevent contamination of stormwater from a range of materials and wastes occurring at a construction site. Even though sediments are typically the pollutant of concern in stormwater discharges from construction sites, other potential pollutants might be discharged from the site during construction. These pollutants include material solid waste, wash water, and spills of fuels and other hazardous chemicals. The PPP developed according to this chapter will help operators at the construction site maintain building materials and limit the discharge of pollutants.

Requirements

The Pollution Prevention Plan (PPP) must detail the design, installation, implementation and maintenance of effective pollution prevention measures to minimize the discharge of pollutants. At a minimum, the PPP must describe measures to:

- **Wash Water Containment.** Minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters. Wash water shall be treated in a sediment basin or alternative control that provides equivalent or better treatment prior to discharge.

- **Material Storage, Handling, and Disposal.** Minimize the exposure of building materials and products, construction waste, trash, landscape materials, fertilizer, pesticides, herbicides, detergents, sanitary waste and other materials present on the site to precipitation and to stormwater runoff.

- **Spill Prevention, Control and Countermeasures.** Minimize the discharge of pollutants from spills and leaks, and implement chemical spill and leak prevention and response procedures.

Pollution Prevention Plan Summary Sheet

Provide an information summary sheet with at least the following information included as a minimum:
• General information including project name, plan preparer, date of drawing, legend, graphic scale and north arrow

• Identify and describe all pollutant-generating activities at your site (e.g. paving operations; concrete, paint and stucco washout and waste disposal; solid waste storage and disposal)

• For each pollutant-generating activity, include an inventory of pollutants or pollutant constituents associated with that activity (e.g. sediment, fertilizers and/or pesticides, paint, solvents, fuels), which could be exposed to rainfall and could be discharge from your construction site. Take into account where potential spills and leaks could occur that could contribute pollutants to stormwater discharges.

• At a minimum, the PPP shall include effective control measures that prohibit the following discharges:
  
  - Wastewater from concrete washout, unless managed by appropriate control;
  
  - Wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds and other construction materials;
  
  - Fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance; and
  
  - Soaps or solvents used in vehicle and equipment washing

**Good Housekeeping Practices**

The six principals described below are designed to help identify the construction practices that should be described in the Pollution Prevention Plan (PPP) and implemented at the site.

124 Provide for waste management and disposal

Describe all solid and/or liquid waste that will be generated on site. Construction and domestic waste shall be provided waste containers (e.g. dumpster or trash receptacles) of sufficient size and number to contain all solid waste. Provide the following components:

• Designate trash and bulk waste collection areas on site;

• Recycle materials whenever possible;

• Clean up litter and debris from the construction site daily;

• Locate waste-collection activities away from surface waters and stormwater inlets or conveyances. Waste-collection areas are best located near construction entrances to minimize traffic on disturbed soils; and

• Consider secondary containment around waste collection areas to further minimize the likelihood of contaminated discharges.
Hazardous or toxic waste shall be separated from construction and domestic waste and disposed according to the following:

- Store waste in sealed containers, which are constructed of suitable materials to prevent leakage and corrosion, and which are labeled in accordance with applicable Resource Conservation and Recovery Act (RCRA) requirements and all other applicable federal, state, or local requirements; and
- Dispose of hazardous or toxic waste in accordance with the manufacturer's recommended method of disposal and in compliance with federal, state or local requirements;

Treat and/or dispose of sanitary and septic waste in accordance with state or local regulations.

### 125 Establish proper material handling and staging area

Designate storage areas and handling procedures for building products, pesticides, herbicides, fertilizer, and landscape materials. Provide either a cover to prevent contact with rainwater or similarly effective means designed to prevent discharge of pollutants from these areas.

Designate storage areas and handling procedures for storage of fuels, oils, hydraulic fluid, other petroleum products and other chemicals. Store in water-tight containers and provide either cover to prevent contact with rainwater or similarly effective controls designed to prevent discharge of pollutants (e.g. spill kits).

Designate storage areas and handling procedures for hazardous or toxic materials. Store all containers that will be stored outside within appropriately sized secondary containment (e.g. spill berms, decks, containment pallets) to prevent spills from being discharged or provide similarly effective means designed to prevent the discharge of pollutants (e.g. covered storage area or spill kit available onsite).

Cleanup spills immediately using dry cleanup methods where possible and dispose of used material properly as defined in 8.4.1. Do not clean surfaces or spills by hosing. Eliminate sources of spill to prevent discharge or the continuation of an ongoing discharge.

Designate responsible party with appropriate training certifications for handling each type of stored materials. Provide all necessary emergency contact information.

### 126 Designate paint and concrete washout areas

Provide an effective means of eliminating the discharge of water from the washout and cleanout of stucco, paint, concrete, form release oils, curing compounds, and other construction materials.

Direct all wash water into a leak-proof container or leak-proof pit. The container or pit must be designed so that no overflows can occur due to inadequate sizing or precipitation.
Handle washout or cleanout wastes as follows:

- Do not dump liquid wastes in storm sewers
- Dispose of liquid wastes in accordance with applicable requirements for construction wastes in part 8.4.1.
- Remove and dispose of hardened concrete waste consistent with your handling of other construction wastes in part 8.4.1.

Locate washout or cleanout activities as far away as possible from surface waters and stormwater inlets or conveyances, and, to the extent practicable, designate areas to be used for these activities and conduct such activities only in these areas.

127 Establish proper equipment/vehicle fueling and maintenance practices

Describe equipment and vehicle fueling and/or maintenance activities occurring on site. Provide an effective means of eliminating the discharge of spilled or leaked chemicals, including fuels, from the area where these activities occur.

- Locate activities away from surface waters and stormwater inlets or conveyances;
- Providing secondary containment (e.g. spill berms, decks, and spill containment pallets) and cover where appropriate;
- Have spill kits readily available. Ensure adequate supplies are available at all times to handle spills, leaks, and disposal of used liquids;
- Use drip pans and absorbents under or around leaky vehicles;
- Dispose of or recycle oil and oily wastes in accordance with other federal, state and local requirements;
- Clean up spills or contaminated surfaces immediately, using dry clean up measures where possible, and eliminate the source of the spill to prevent a discharge or a furtherance of an ongoing discharge; and
- Do not clean surfaces by hosing the area down

128 Control equipment/vehicle washing and allowable non-stormwater discharges

Describe equipment and vehicle washing activities occurring during on site. Provide practices that will be implemented to minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other types of washing. Examples of effective control include, but not limited to:

- Locate activities away from surface waters and stormwater inlets or conveyances;
- Directing wash waters to a sediment basin or sediment trap using filtration devices such as filter bags or sand filters, or other similarly effective controls.

Describe how discharges of soaps, detergents and solvents are prevented. Provide cover (e.g. plastic sheeting or temporary roofs) to prevent contact with rainwater, or a similarly effective means designed to prevent the discharge of pollutants from these areas.
129 Develop a spill prevention and response plan

Describe procedures used to prevent and respond to leaks, spills and other releases. These procedures shall demonstrate the expeditious stopping, containing and cleaning up spills, leaks and other releases. Identify the name or title of the individual responsible for detection and response.

Include procedures for notification of appropriate emergency response agencies, and regulatory agencies where a leak, spill, or other release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity occurs during a 24-hour period. Contact information must be in locations that are readily accessible and available.

Some projects and sites may be required to develop a Spill Prevention Control and Countermeasure (SPCC) plan under a separate regulatory program (40 CFR 112). If a SPCC plan is developed or already exists, include references to the relevant requirements from the plan.

Construction Inspection and Maintenance

All control measures identified must be maintained in effective operating condition in accordance with good engineering practices and where applicable manufacturer specification. When site inspections identify control measures that are not operating effectively, maintenance shall be performed as soon as practicable. Site inspections shall identify existing control measures that need to be modified or if additional control measures are necessary for any reason, implementation shall be completed as soon as practicable.

Identify routine maintenance activities and provide a maintenance schedule. Keep a written record of site inspections and follow up maintenance that is required and performed.

The following are inspection requirements for the General Construction Permit.

131 Responsibilities (9VAC25-880-70 Section II Part F. 1.)

Required inspections shall be conducted by the Qualified Personnel identified by the Operator on the SWPPP. Operator is responsible for ensuring that the Qualified Personnel conducts inspections at frequency required by the General Construction Permit.

132 Inspection Schedule (9VAC25-880-70 Section II Part F. 2.)

Inspections shall be conducted at least once every 7 days and no later than 48 hours after a measurable storm event per jurisdictions within the Chesapeake Bay watershed in accordance with the Chesapeake Bay TMDL.
Areas that are temporarily stabilized or runoff is unlikely due to winter conditions (e.g. the site is covered with snow or ice or continuous frozen ground exists), the inspection frequency may be reduced to once every 30 days. If unexpected weather conditions such as above freezing temperature or rain events make discharges likely, the operator shall resume regular inspection frequency.

133 Inspections (9VAC25-880-70 Section II part F. 3.)

The Qualified Personnel shall:

1. Record the date and time of the inspection and the amount of cumulative rainfall since the last inspection.
2. Record the information and a description of any discharges occurring at the time of inspection.
3. Record any land-disturbing activities that have occurred outside of the approved erosion and sediment control plan.
4. Inspect the following in accordance with the approved erosion and sediment control plan, identify the maintenance needs and evaluate the effectiveness in minimizing sediment discharge including whether the control measure has been appropriately used.
   a. All perimeter erosion and sediment controls
   b. Soil stockpiles and borrow areas for stabilization or sediment trapping measures
   c. Completed earthen structures, such as dams, dikes, ditches and diversions for stabilization
   d. Cut and fill slopes for appropriate stabilization
   e. Sediment basins and traps, sediment barriers and other control measures installed to control sediment discharge from concentrated stormwater
   f. Temporary and permanent channel, flume or other slope drain structures installed to convey concentrated runoff flowing down cut and fill slopes
   g. Storm inlets and outlets that have been made operational to ensure that sediment laden stormwater does not enter without being filtered or prevent scouring at the outlets
   h. Construction vehicle access routes that intersect or access paved roads
5. Inspect areas that have reached final grade or that will remain dormant for more than 14 days for initiation of stabilization activities.
6. Inspect areas that have reached final grade or that will remain dormant for more than 14 days for completion of stabilization activities within seven days of reaching grade or stopping work.
7. Inspect for evidence that the E&S plan has not be implemented properly. Evidence may includes the following:
   a. Concentrated stormwater flows such as rills, riverlets or channels that cause erosion when such flows are not filtered, settled or similarly treated prior to discharge.
   b. Sediment laden or turbid flows of stormwater that are not filtered or settled to remove sediments prior to discharge.
   c. Deposits of sediment in areas that drain to unprotected stormwater inlets or to catch basins that discharge to surface waters. Failing sediment
controls due to improper installation, lack of maintenance or inadequate design are considered unprotected.

d. Deposits of sediment from the construction activity on any property outside of the construction activity covered by the General Permit.

e. Portions of the site where required stabilizations has not been initiated or completed.

f. Sediment basins without a dewatering device allowing discharge from below the designed wet pool elevation

g. Sediment traps without adequate wet and dry storage and without restricted discharge from the drawdown of dry storage portion of the trap

h. Land disturbance outside the delineated area to be disturbed

8. Inspect pollutant generating activities in the pollution prevention plan for proper implementation, maintenance and effectiveness.

9. Identify any pollutant generating activities not identified in the pollution prevention plan

10. Identify and document the presence of any evidence of a discharge of pollutants prohibited by the General Permit. Including but not limited to the following:
   a. Wastewater from washout of concrete, unless managed by an appropriate control;
   b. Wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds, and other construction materials;
   c. Fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance;
   d. Oils, toxic substances, or hazardous substances from spills or other releases; and
   e. Soaps and solvents used in equipment and vehicle washing.

134 Reporting and Recordkeeping (9VAC25-880-70 Section II part F.4.)

A record of each inspection and of any corrective action must be retained by the operator as part of the SWPPP for at least three years from the date that permit coverage expires or is terminated. The inspection reports shall identify any incidents of noncompliance. Where a report does not identify any incidents of noncompliance, the report shall contain a certification that the facility is in compliance with the SWPPP. The report shall be signed by Qualified Personnel.

Inspection Reports and major observations should include:

- Date and time
- Inspector Name, qualifications and certification statement
- Summary of findings
- An estimate of the amount of rainfall at the construction site (in inches) from the runoff producing storm event requiring the inspection, or if inspecting on a seven-day schedule, the amount of rainfall (in inches) since the previous inspection; and
- A description of any discharges occurring at the time of inspection.
The location(s) of discharges of sediment or other pollutants from the site;
Location(s) of control measures that need to be maintained;
Location(s) of control measures that failed to operate as designed or proved inadequate for a particular location;
Location(s) where additional control measures are needed that did not exist at the time of inspection;
List of corrective actions required including any changes to the SWPPP that are necessary to implement as a result of the inspection and in order to maintain permit compliance; and
Documentation of any corrective actions required from prior inspections.

135 Corrective Action (9VAC25-880-70 Section II Part G)

The Operator shall implement corrective action(s) identified as a result of an inspection as soon as practicable but no later than 7 days after the inspection findings.

Resources:
136 Easements

Applicability

Within any land development project, stormwater drainage easements must be provided for all improved stormwater conveyance systems and BMPs. Stormwater drainage easements must be provided for existing or improved swales, channels and pipes draining runoff across two (2) or more lots.

Stormwater drainage easements must be extended to upstream property lines to permit future development to have reasonable access for connections to on-site drainage ways or stormwater conveyance systems.

Stormwater drainage easements must be shown on the record plat and on the Stormwater Management Design Plan. New stormwater drainage easements shown on lot grading plans must be properly recorded.

The stormwater management facilities must provide adequate access.

Stormwater Drainage Easements

139 Stormwater Conveyance Channels

For open channels, easement width shall generally be based on the width required to carry the design flow plus five (5) feet on each side. Open channels will be in a minimum drainage easement of fifteen (15) feet with a minimum of 10 feet on one side of the channel.
**140 Culverts and Storm Sewer Systems**

<table>
<thead>
<tr>
<th>Diameter of Pipe (in)</th>
<th>Minimum Easement Width (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 - 18</td>
<td>15</td>
</tr>
<tr>
<td>21 - 33</td>
<td>20</td>
</tr>
<tr>
<td>36 - 48</td>
<td>25</td>
</tr>
<tr>
<td>54 - 72</td>
<td>30</td>
</tr>
</tbody>
</table>

All storm sewer pipes must be located in the middle one-third of the easement. Beginning at 10 feet in depth, an additional five feet of easement must be required for each five foot increment of additional depth.

For dual pipes each less than or equal to 48 inches in diameter, the easement width must be increased by 5 feet on each side. For dual pipes each greater than 48 inches in diameter, the easement width must be increased by 10 feet on each side.

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**Example. 4’ Dual Pipes at 15’ Depth**

EASEMENT = 25’ + 10’ + 5’ = 40’

Adapted from Prince George’s County, MD Stormwater Management Design Manual

**141 Stormwater Management Facilities**

Stormwater drainage easements must be provided for all stormwater management facilities located within any land development project.

Easements for above ground facilities must encompass the ponding area, embankment and outlet structures. The easement must extend a minimum of 25 feet horizontal distance outside of the one hundred-year pool area.

Easements for underground facilities are required. The Program Administrator will determine final easement size for underground storage chambers in accordance with section 9.2.2 and as determined by site conditions.
142 Integrated Stormwater Management Practices

Stormwater drainage easements shall be recorded to identify the location of integrated stormwater management practices (IMPs) on lots or parcels. Some IMPs may not require an easement as identified by the County during plan review. The property owner shall not remove or structurally alter these facilities except in accordance with an approved operation and maintenance plan.

The Program Administrator may require provisions within the Home Owners’ Association (HOA) document to facilitate the County’s inspection of on-lot IMPs. The homeowners will be required to conduct minor maintenance of IMPs and associated drainage areas leading into or out of IMP areas. Also, specific language needs to be incorporated into HOA document that identifies an approach to encourage the homeowners to adhere to the operation and maintenance plans.

For development projects utilizing a LID design, storm drainage easements must be recorded as follows:

- For IMPs located adjacent to public rights-of-way, the drainage easement must contain the facility and share a border with the right-of-way.
- For IMPs located in common areas, easements must be located in the same manner as conventional SWM ponds.
- For IMPs located on private lots, easements must be recorded to identify the location of IMPs.

**Access Easements**

Access to a public route must be provided for each BMP.

**9.3.1 Stormwater Management Facility Access Easement**

Minimum easement width is 20 feet. Access easements must include the full width of land needed to construct the road with the resulting slopes on each side no steeper than one foot of rise or fall in 3 horizontal feet. Minimum access road width is 12 feet. Maximum (steepest) grade for access roads shall be 12 percent.

**9.3.2 Integrated Stormwater Management Access Easement**

A 10-foot-wide access easement, clear of any obstructions, shall be provided for the inspection and maintenance of Integrated Stormwater Management Practices (IMPs) except when the facility shares a minimum 10-foot-long boundary with a public right-of-way and drainage easement.

**Conservation Easements**

Undisturbed open space incorporated as a BMP must be placed in a protective conservation easement shown on the record plat and Stormwater Management Design Plan. The conservation easement must encompass the open space and include
restrictive language for the perpetual protection. In addition to record platting, and restrictive language; the conservation easement must reference a recorded maintenance agreement (see chapter 10 Maintenance) that includes an operation and maintenance plan for maintaining a uniform, mature stand of native vegetation that will improve water quality.

Restrictive language for private conservation easements should include, at a minimum, the following:

- Removal of vegetation within the easement must be performed in accordance with the operation and maintenance plan.
- Encroachment of buildings, structures and impervious cover is restricted to the approved building envelope.
- Slopes are not to be disturbed, except for operating and maintaining IMPs and associated stormwater drainage easements

Restrictive language for common area conservation easements should include, at a minimum, the following:

- Removal of vegetation within the easement must be performed in accordance with the operation and maintenance plan.
- The HOA and residents reserve the right to make improvements for passive recreation only.
- Slopes are not to be disturbed, except for operating and maintaining IMPs and associated stormwater drainage easements

145 Location and Composition:

Qualifying open space should encompass sensitive areas (i.e. streams, steep slopes) that receive primarily overland sheet flow. Open space must have undisturbed vegetation or include a landscaping plan to provide reforestation or afforestation of native canopy and understory vegetation.

As necessary, a minimum portion of the open space may be designated an erosion control zone or vegetated filter strip. The erosion control zone or vegetated filter strip will be composed of tall grasses and forbs that will be managed to minimize rill erosion and minor structures such as gravel diaphragms and level spreaders may be incorporated to maintain dispersed overland sheet flow.

146 Minimum Size and Connectivity:

Per the Virginia Stormwater BMP Clearinghouse specifications, the minimum width of qualifying open space shall be 35 feet for slopes of 0 to 3 percent, and 50 feet for slopes 3 to 6 percent. Designated riparian buffers may be used to meet the minimum width requirement.

A Minimum of 10,000 square feet must be connected. The qualifying open space may incorporate required landscape screening.
Construction Inspections and As-Built Plans

Construction inspections are required to ensure that stormwater management facilities, stormwater conveyance systems and integrated stormwater management practices (IMPs) are being constructed in accordance with the approved design plan and in compliance with state stormwater standards. The developer is responsible for maintaining a written log containing dates and times of inspections, inspection reports and comments concerning verbal communications relating to the project throughout the course of construction. These logs are to be included with the as-built documentation.

Earthwork Specifications

Earthwork specifications shall be verified with geotechnical testing performed under the direction of a geotechnical engineer during the construction of a stormwater management facility.

In zoned dams, the geotechnical engineer shall ensure that the gradation of adjacent zones is in accordance with criteria set forth in Design of Small Dams (Bureau of Reclamation. U. S. Department of Interior. 1987. www.usbr.gov/pmts/hydraulics_lab/pubs/manuals_monographs.html).

Variations from the approved design plan shall be discussed with the geotechnical engineer of record and Orange County’s Program Administrator before any variation is implemented and may require submission of a revised design plan.

Detention, Extended Detention and Wet Ponds

After completion of the required inspections and associated tests and analyses, a report shall be prepared by a licensed geotechnical engineer. If the report indicates that changes to design are needed, it shall be submitted for review at such time along with a revised design plan. Otherwise, the report shall be submitted with the as-built plans. Each report shall at a minimum include:
• Core trench depths and types of materials encountered. The description shall include the classification under the Universal Soil Classification System (USCS) in addition to a geologic description.

• Description of fill materials used, including USCS classes and presence of mica schist. The report shall verify that no objectionable materials (including OH and OL soil materials, topsoil, organic matter, stones larger than six inches, frozen soil) were placed in the dam or in the core trench. The report shall verify that fill material under the pond barrel and the riser was compacted to at least 95%. The report shall verify the compaction of the remainder of the fill, including percentage of compaction and methods used to obtain the compaction.

• The report shall include details of special features such as toe/blanket drains, filter materials, etc. Material specifications shall be provided as per design plans and section 10.2.2.

**Permeable Pavement, Infiltration, Bioretention, and Underground Storage Practices**

An appropriate geotechnical inspection report shall be prepared and submitted by a licensed geotechnical engineer. Each report shall at a minimum include:

a. Soil property description of the underlining natural soil of any excavated trench. Soil properties should include Bulk Density, Saturated Hydraulic Conductivity, presences of restrictive layers (i.e. Bedrock or Water Table) and pH. Linear Extensibility and Shrink-Swell Potential evaluation is needed for practices with under drain systems.

b. Description and certification of the engineered filter media. Including sand/clay/organic content, Bulk Density, Saturated Hydraulic Conductivity, and pH.

**151 Material Specifications**

Construction materials will be stored, and installed in accordance with specifications provided on the design plans. At a minimum the following material specifications shall be provided:

• Aggregate size and gradation in accordance with applicable VDOT specifications. Density and shape specification should satisfy design criteria of the design plans.

• Stormwater control structures shall include manufacturer specification for pre-cast materials and the contractor shall provide specifications of cast-in-place. Outlet barrel specifications should include inlet/outlet shaping, pipe dimensions, bedding and joint sealing. Trash rack specifications should include attachment methods, grate spacing and coatings.

• Geotextile shall include manufacturer specifications and installation method.

• Stormwater conveyance systems specifications to include pipe diameter, slope, inlet and grate length, and configuration.
**Consortium Inspections**

Periodic inspections of BMP construction may be conducted by County staff as discussed at the preconstruction meeting. However, the developer must be responsible for performing the required inspections in accordance with Sections 10.1 Error! Reference source not found. and provide the professional certification of construction in accordance with Section 10.4.3.

**WMF As-Built Requirements**

An as-built plan is required for all permanent BMPs (i.e., stormwater conveyance systems, stormwater treatment practices, manufactured treatment devices, and integrated stormwater management practices).

As-built plans must be submitted within 60 days after completion of the structure. As-built plans must be approved by the Zoning Administrator prior to the release of the security.

As-built plans must consist of 1) a copy of the applicant's inspection, 2) a red-line revision of the approved SWM plan sheets, and 3) a certification statement from a qualified individual regarding the conformance of the as-built to the approved plans.

As-built plans must provide at a minimum all of the information on the as-built plan checklists in the Virginia Stormwater Management Handbook and this manual.

If a structure is built differently from the Stormwater Management Design Plan (see acceptable construction requirements on checklist), the Zoning Administrator must be contacted to determine whether the variation is acceptable or modifications to the structure will be required.

**154 Construction Inspection Log and Reports**

The contractor is responsible for documenting all aspects of construction for stormwater management facilities, stormwater conveyance systems and IMPs. Any significant inconsistencies should be reported to a licensed engineer for evaluation and possible modification. Inspection logs and reports shall include the following:

a. Earthwork specifications should be documented and certified by a licensed geotechnical engineer in accordance with section 10.2.1.

b. Material specifications should be documented in accordance with section 10.2.2.

**155 Dimensions and Elevation**

The red-line revision plans should indicate any changes to the approved plan. Items that differ from the original approved plans and computations should be shown in red on both the plans and computations.

a. For changed values “line out” the design value and enter the actual value in red.
b. Elevations to the nearest 0.1’ are sufficient.

c. A stage-storage-discharge summary table comparing the design values and the as-built values should be provided for facilities with storage volume and discharge.

156 Certification

Each as-built plan must have a certification statement and stamped seal by a professional licensed in Virginia to perform such work. The certification statement is as follows:

I (submitting professional's name) certify that, to the best of my knowledge, this as-built plan represents the actual condition of the structure(s) and conforms with the approved design plan except as shown and that all aspects of the structure(s) were constructed in accordance with the approved design plans and the Stormwater Management Design Manuals.

The County may accept separate certifications for various aspects of the project provided that these certifications, when combined, cover all as-built information and construction on the site.

IMPs As-Built Requirements

IMPs will be assessed differently than stormwater management facilities. IMPs typically will have different inspection logs and survey. Depending on the IMP, the following minimum documentation shall be reported:

- Construction logs shall include measures taken to minimize disturbance, reduce lot compaction and/or promote vegetation establishment.
- Visual assessments utilizing a photographic record of construction and the completed conditions. Measurements of setbacks will be the only survey performed.
- Certification shall be provided in accordance with section 9.4.3.
158 Maintenance

Once construction is completed, the stormwater management facilities and integrated stormwater management practices (IMPs) take on the role for which they were designed. Periodic inspections are performed to conduct maintenance and monitor effectiveness of BMPs. Maintenance is a pollution prevention practice that ensures that stormwater management facilities and IMPs perform as designed to satisfy the stormwater management criteria for water quality, flooding and channel protection. This chapter will cover all aspects of maintenance from recorded agreements, reporting and record keeping, and enforcement.

Maintenance Agreements

A maintenance agreement must be entered into between the landowner and the Board of Supervisors for all permanent BMPs. The maintenance agreement must be executed and recorded in County land records prior to permit issuance. The agreement must obligate the landowner to provide maintenance to ensure proper performance of the facility in accordance with an approved maintenance plan. A maintenance agreement is not required for stormwater conveyance systems. Stormwater conveyance systems are recorded as drainage easements (see chapter 9 Easements).

For integrated stormwater management practices (IMPs) located on individual residential lots in residential developments, the developer shall draft and cause to be placed into the land records for the property, a covenant which obligates owners of lots containing IMPs to provide maintenance and access for maintenance.

A sample copy of the maintenance agreement is available in Appendix 12.3.

Operation and Maintenance Plans

Responsibility for the operation and maintenance of each BMP shall remain with the property owner or an owner’s association. All maintenance activities shall be in accordance with standard maintenance practices as identified in the approved Operation and Maintenance (O&M) Plan and the stormwater management design manuals.

To fulfill this responsibility, they must understand what the system consists of and how to properly operate, inspect, and maintain it. As the designer, the engineer must document the operation, inspection, and maintenance requirements for the system in terms owners can understand and carry out.
An O&M Plan must be prepared for all BMPs. The plan must describe the BMP and list items to be inspected and maintained. The plan must be tailored to the specific structure for which it applies.

The O&M Plan must be prepared in conjunction with the SWM Design Plan and attached to the maintenance agreement. The O&M Plan must address applicable State regulations (e.g., Virginia Dam Safety Act, etc.). At a minimum each O&M Plan must address applicable routine and non-routine activities as outlined in the applicable sections of the Virginia Stormwater Management Handbook and/or the Virginia BMP Clearinghouse.

Routine maintenance includes landscaping and aesthetic maintenance such as grass, tree and shrub care, wetland plant care, reseeding and mulching, slope stabilization, grass mowing, pruning, filling and repair of erosion, animal control caused by nuisance rodents, removal of invasive vegetation and minor sediment cleaning. It also includes removal of debris, trash, sediment, vegetation and other matter that impedes or threatens to impeded stormwater functioning or the structural integrity.

Non-routine maintenance includes the repair or replacement of structural components such as embankments, risers and outlet barrels, trash racks and anti-vortex devices, emergency spillways, pretreatment devices, seepage controls, drains, outlet protection or energy dissipaters, major sediment removal (excavation or dredging methods), and any other special operational structures.

The O&M Plan must specify a schedule of inspections in accordance with the BMP specification provided in the Virginia Stormwater Management Handbook and/or Virginia BMP Clearinghouse. At a minimum annual inspection shall be performed to address overall BMP performance and ensure maintenance operations are being performed as needed.

The O&M Plan must specify that any modifications to the structure must be approved by the Program Administrator before such work is undertaken.

**Maintenance of Integrated Stormwater Management Practices (IMPs)**

Stormwater Management Plans shall require legal information and instruments to ensure that the IMPs are properly maintained. These may include easements, individual maintenance agreements, and homeowners’ association (HOA) covenants depending on the type of development. Similar to stormwater management facilities, a maintenance agreement between the landowner and the County must be executed and recorded in the County land records prior to permit issuance.

For IMPs located on individual residential building lots, an additional legal document(s) is usually necessary to fully define the HOA’s and homeowner’s maintenance responsibilities and obligations. For example, the homeowner may be responsible for routine maintenance of an IMP that captures runoff from the rooftop and driveway with HOA’s role limited to oversight and enforcement of the maintenance plan. The particular arrangements between the HOA and lot owner could be defined in the homeowners’
association covenants. For IMPs that are designed to capture runoff from the road (a common area) and other off-lot runoff, the HOA may be solely responsible for all maintenance and upkeep of the facility. This type of arrangement also needs to be clearly defined through legal documents. The developer's attorney will typically prepare HOA covenants. The County may request review of covenants to ensure that adequate arrangements are in place to ensure long-term performance and maintenance of IMPs.

Where SWM plans incorporate IMPs on individual lots and homeowners will be primarily responsible for their maintenance, the maintenance plan must incorporate a means to ensure homeowners:

- Are made aware of their responsibilities for inspecting and maintaining the IMPs, including the requirement that modification of the IMP not be made without the permission of the County;
- Are provided materials adequately explaining the purpose, design, inspection, and maintenance aspects of the IMP located on their lot; and
- Perform or provide for required inspection and maintenance of their IMPs.

**Post-Construction Inspection Reporting**

The landowner or a representative of the owner shall conduct a minimum of one annual inspection per BMP. In addition to the annual routine inspections, stormwater management facilities are to be inspected within 48 hours after each rainfall event of three inches or more. The owner shall keep written records of these inspections and any necessary repairs, and furnish records to the County annually.

Operation and Maintenance Inspection Checklists are provided in Appendix 3 of the 1999 Virginia Stormwater Management Handbook.

**County Inspections and Enforcement**

Periodic inspections for completed BMPs will be conducted by County staff during the first year of operation and at least once every three years. However, the owner or owner's association must be responsible for performing the required inspections in accordance with the O&M Plan attached to the recorded maintenance agreement.

If the County staff determines there is a failure to comply with the recorded maintenance agreement, the County will initiate appropriate informal and/or formal enforcement procedures.
Chapter 12

164 Appendices
Natural Resource Assessment, ESD Checklist, and LID Performance Worksheet

166 Natural Resource Assessment

Provide a Qualitative Narrative describing the existing conditions of selected natural resources. Include any quantification that may support this assessment.

Components of the Resource Assessment Narrative:

1. Stream Channels: describe the current conditions including size estimates of width and depth, current stability of channel banks and bed, entrenchment, bed materials, and bank vegetation cover conditions;
2. Wetlands: describe locations, size, type and relationship to other hydrologic features;
3. Current drainage features of the site interior (i.e. slopes, watershed size, etc.);
4. Ponds: describe existing condition of the embankment, riser, and outfall area;
5. Buffers: describe type and condition of vegetation within required buffer width; and
6. Significant Soils: provide soil survey and soil reports from http://websoilsurvey.nrcs.usda.gov. Include extent of each soil type, typical depth to bedrock, typical depth to water table, and any know limitations (slopes, infiltration rates, linear extensibility, etc.).

Provide a Natural Resource Assessment Map:

- Identifies water bodies, floodplains, riparian buffers, wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural features.
- Do not count any area twice, for example an area that is both a floodplain and wetland may only be considered once.

<table>
<thead>
<tr>
<th>Sensitive Resource</th>
<th>Mapped (Yes or N/A)</th>
<th>Total Area (acres)</th>
<th>Protected/Undisturbed (Acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodplains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wetlands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riparian Buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woodlands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steep slopes (&gt;15%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Areas (acres)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
167 Environmental Site Design Checklist

Prior to developing any structural stormwater practices on a site, significant reductions in stormwater quantity and quality impacts can be made through Environmental Site Design. Below is a checklist of site design and planning practices that can be used to minimize stormwater impacts. Please check the practices that you are applying to your development, and note the extent to which each selected practices was implemented.

Site Design Standard Technique 1: Conserve Open Space

Minimize direct stormwater impacts to streams, wetlands and other natural features to the maximum extent practicable. This can be accomplished by siting stormwater facilities outside of streams and wetlands, maintaining natural drainages, and preserving riparian buffers.

<table>
<thead>
<tr>
<th>Achieved</th>
<th>Percent of Site Area</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stormwater facilities located outside of streams, wetlands and buffers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Riparian Buffer Width maintained along the entire stream. (25 feet for intermittent streams, 50 feet for perennial streams and 100 feet for Hazel, Thornton, Rappahannock and Rapidan River)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maximize contiguous areas to avoid habitat fragmentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Legally protect areas by permanent conservation easement prescribing allowable uses and activities and preventing future development</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Integrated Stormwater Management Practices (IMPs) placed at the source of runoff in lieu of centralized SWMFs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Open Space accepts and treats stormwater runoff from the development site per the BMP Clearinghouse Specifications.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Runoff Reduction Volume:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Open Space adjacent to a wetland, mature forest or otherwise enhances the riparian buffer.</td>
<td></td>
</tr>
</tbody>
</table>

Site Design Standard Technique 2: Minimize Land Disturbance

Preserve the natural cover on as much of the site as possible, especially for areas located on hydrologic soil groups (HSG) A and B. Natural vegetation helps maintain and preserve predevelopment hydrology on a site, thereby reducing the reliance on large-scale stormwater ponds. Natural cover on highly permeable soils increases filtration and infiltration.
Utilize clustered development designs that preserve a significant portion of the site in a natural state.

Utilize “fingerprint” clearing, limit the clearing and grading of forests and native vegetation to the minimum area needed for the construction of the lots, necessary access, and fire protection.

The plan includes detail on construction methods and sequencing to minimize compaction of natural and future stormwater areas.

Prevent compaction of key soils, protect steep slopes (>15%) and maintain drainage features.

Minimize total site area cleared and graded at any one time.

**Site Design Standard Technique 3: Reduce Impervious Cover**

**Minimize the overall impervious cover.** Roadways, sidewalks, driveways and parking areas are the greatest sources of site imperviousness. Impervious areas alter runoff and recharge values which affect site hydrology. For LID sites, managing the imperviousness contributed by road and parking area pavement is an important component of the site planning and design process.

<table>
<thead>
<tr>
<th>Achieved</th>
<th>Percent of Site Area</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Utilize the minimum required width for streets and roads.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Utilize street layouts that reduce total street length by increasing the number of homes per unit length.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimize cul-de-sac diameters, use doughnut cul-de-sacs, or use alternative turnarounds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimize excess parking space construction, utilize structured or shared parking.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduce home setbacks and frontages.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Where permitted, minimize sidewalk construction by utilizing sidewalks on one side only, utilizing “skinny” sidewalks, or substituting sidewalks with pervious trails through common area.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Substitute pervious surfaces for impervious wherever possible in accordance with the BMP Clearinghouse Specifications.</td>
</tr>
</tbody>
</table>

**Runoff Reduction Volume:**

**Site Design Standard Technique 4: Disconnection**

“**Disconnect impervious areas.**” “Disconnecting” means having impervious cover drain to pervious cover (i.e. downspouts draining to the yard, not the driveway). This decreases both the runoff volume and Time of Concentration. Disconnected parking lots, for example, can provide sheet flow into bioretention areas or engineered infiltration swales.

<table>
<thead>
<tr>
<th>Achieved</th>
<th>Percent of Site Area</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>
## Site Design Standard Technique 5: Vegetated Stormwater Conveyance Systems

### Increase the Time of Concentration.
Repeating the pre-development Time of Concentration is a key aspect in maintaining pre-development flow regime, and minimizing downstream impacts.

<table>
<thead>
<tr>
<th>Achieved</th>
<th>Percent of Site Area</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maintain predevelopment flow paths by increasing flow length, dispersing and redirecting flows.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Increased Tc:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Where permitted, avoid the use of curb and gutter. Utilize Grass Channels per the BMP Clearinghouse Specification 3.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Runoff Reduction Volume:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Utilize permanent Check Dams to detain and prolong the Time of Concentration.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Increased Tc:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flatten grades for stormwater conveyance to the minimum sufficient to allow positive drainage.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Increased Tc:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Utilize Dry Swales with engineered soils per the BMP Clearinghouse Specifications.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Runoff Reduction Volume:</strong></td>
</tr>
</tbody>
</table>

## Site Design Standard Technique 6: Soil Restoration Techniques

**Utilize soil restoration/enhancement techniques to improve soil properties.** Amend soils that are compacted or poorly drained to improve infiltration and vegetation establishment.
Achieved Percent of Site Area Practice
Minimize compaction of the landscape. In areas where soils will become compacted due to construction equipment, specify soil amendments as per BMP Clearinghouse Specification 4.

Curve Number Adjustment:

Delineate soils on site for the preservation of infiltration capacity. Mark these areas in the field and restrict heavy equipment access.

Utilized engineered soils for SWMFs and IMPs located on unsuitable native soils

**Site Design Standard Technique 7: Creation of Transition Zones**

Create transition zones to buffer managed turf from existing vegetated areas. Reduce hydrologic impacts by creating added surface roughness as well as providing for additional filtering and volume storage.

<table>
<thead>
<tr>
<th>Achieved</th>
<th>Percent of Site Area</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maximize overland sheet flow with use of gravel diaphragm, vegetated filter strips, level spreaders and other dispersion techniques.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Increased Tc:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reconnect vegetated areas by establishing meadows, stream buffers or a minimum of 1,000 square feet of contiguous mulched planting beds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Curve Number Adjustment:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clearly delineate the transition zone and provide a management plan for long-term maintenance.</td>
</tr>
</tbody>
</table>
168 LID Performance Worksheet

Definitions

**Detention** – The collection of runoff in a ponding area, depression, or storage chamber followed by its gradual release through an outlet into a receiving water body. Detention reduces peak runoff rate to its pre-development peak rate, but is not an effective way to reduce the runoff volume.

**Retention** – The collection of runoff in a ponding area or receptacle where water is released through infiltration, evaporation, and transpiration. Retention reduces the volume of runoff from a site and can also be effective in reducing the peak runoff rate if the retention volume is sufficiently large.

**Connected Impervious Surface** - Hard surfaces such as rooftops, pavement/concrete and compacted gravel that is directly conveyed within a pipe or channel.

**Disconnected Impervious Surface** - Where hard surfaces such as rooftops, pavement/concrete and compacted gravel disperses stormwater into pervious areas in accordance with BMP Clearinghouse Specifications.

**Curve Number (CN) Adjustment** - The modification of the post development CN by reducing impervious areas, disconnecting impervious runoff and preserving open space. Consequently, this will lessen the amount of storage that would otherwise be required to maintain the predevelopment runoff volume.

**Time of Concentration (Tc)** – The time for runoff to travel from the hydraulically most distant point in a catchment to the watershed outlet or study point.

Instructions

Before beginning the LID Performance Worksheet, first evaluate your site design using the Natural Resource Assessment (11.1.1) and Environmental Site Design Checklist (11.1.2). The use of environmental site design techniques is a critical component in ensuring that the pre-development hydrology on a site can be maintained.

The following worksheet follows the process detailed in LID Hydrologic Analysis (see references).

Protected and Undisturbed areas should be excluded from the storage volume calculations. Ideally, each subarea shall compute storage volumes separately. Retention volume may be provided in one subarea to compensate for an uncontrolled subarea. The uncontrolled subarea must discharge stormwater as sheet flow into an undisturbed area of vegetation that is uniform and mature enough to inhibit erosion.

Note: Development projects that are unable to provide sufficient runoff reduction practices to maintain the predevelopment runoff volume should revisit the application of
the environmental site design techniques to the site. The thorough use of ESD techniques will reduce post-development curve numbers, and can result in decreased stormwater detention and retention volume requirements.

Computing Pre and Post-Development Composite Curve Numbers for LID Approach

\[ C_{N_c} = \text{Composite Curve Number} \]
\[ A_j = \text{Area of each Land Cover} \]
\[ C_{N_j} = \text{Curve Number for each Land Cover} \]

a. Forested Runoff Curve Number. The predevelopment condition is required to be woods in good condition (LID Hydrological Analysis, pg. 37). Calculate the composite curve number for the site, using woods in good condition.

<table>
<thead>
<tr>
<th>HSG</th>
<th>CN (woods good condition)</th>
<th>Area_j</th>
<th>% of Site</th>
<th>Area_j \times C_{N_j,pre}</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>77</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ C_{N_c} = \sum C_{N_j} \times A_j \times \text{Area}_{woods} \]

b. For comparison purposes, calculate a composite curve number for the developed site, using the conventional TR-55 approach.

<table>
<thead>
<tr>
<th>Land Cover and Soil</th>
<th>CN</th>
<th>Area</th>
<th>% of Site</th>
<th>Area x CN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected/Undisturbed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Disturbed Area = Total Site Area - Undisturbed Area

Composite CN of Disturbed Area:

<table>
<thead>
<tr>
<th>Land Cover and Soil</th>
<th>CN</th>
<th>Area</th>
<th>% of Disturbed Area</th>
<th>Area x CN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
c. Calculate a composite custom LID curve number. This approach factors in the use of higher permeability soils for infiltration and the use of “disconnection”.

\[
R = \text{ratio of disconnected impervious area to total impervious area;}
\]
\[
\text{CN}_{\text{LID}} = \text{LID curve number;}
\]
\[
\text{CN}_p = \text{composite pervious CN post development pervious surface only;}
\]
\[
\text{P}_{\text{imp}} = \text{percent of impervious site area.}
\]

Calculate \( \text{CN}_p \): Use the composite CN of the pervious surfaces only from table in step “b.” above

Calculate R

\[
R = \frac{\text{Disconnected Impervious}}{\text{Total Impervious Area}}
\]

\[
\text{CN}_{\text{C,post}} = \underline{\text{_______}} \quad \text{(from step “b.” above)}
\]

\[
\text{CN}_{\text{LID}} = \underline{\text{_______}}
\]

Reduction in CN achieved with site design = \( \underline{\text{_______}} \) \((\text{CN}_{\text{C,post}} - \text{CN}_{\text{LID}})\)

d. Calculate the pre-development Time of Concentration (Tc) using TR-55 for each discrete drainage area discharging from the site. Utilize the environmental site design techniques described in section 11.1.2, such as flattening grades, lengthening flow paths, etc to maintain the Tc as much as possible. Then, calculate the post-development Time of Concentration (Tc_{LID}) for the same drainages.
NOTE: For the LID approach to function effectively, the $T_c^{LID}$ must be greater than or equal to $T_c^{PRE}$. If not, STOP here and incorporate additional practices to the maximum extent practical to maintain $T_c$. See LID Manuals for details.

e. Calculate the 1-year peak flow rate under a forested condition and with LID. SCS Curve Number Method or equivalent shall be used.

\[
q_{1\text{-year forest}} = \underline{_______} \text{ cfs}
\]

\[
q_{1\text{-year LID}} = \underline{_______} \text{ cfs}
\]
Step 1: Determine the Retention Volume Required to Maintain Pre-development Runoff Volume

a. The Design Rainfall for your site will be the 1-year, 24 hour storm. This is the assumed rainfall at which runoff would have initiated on the site, if it were vegetated with “woods in good condition”.

Orange County 1-Year, 24 hour Rainfall (NOAA Atlas 14) = 2.75 inches

b. Calculate watershed storage to Maintain Predevelopment Runoff Volume using Retention Storage.

\[
\begin{align*}
\text{Forested } C_{\text{N,woods}} &= \_\_\_ \\
\text{Post Development } C_{\text{N,LID}} &= \_\_\_ \\
\text{Forested Runoff Depth, } Q_{\text{woods}} &= \_\_\_ \text{ inch} \\
\text{LID Runoff Depth, } Q_{\text{LID}} &= \_\_\_ \text{ inch} \\
\text{Watershed Storage} &= Q_{\text{LID}} - Q_{\text{woods}} = \_\_\_ \text{ inch}
\end{align*}
\]

VR = Volume of Retention Storage

Watershed Storage = Volume of Runoff Storage Required (inches)

DA = Disturbed Drainage Area (Acres)

Step 2: Determine Storage Volume for Water Quality Protection

a. The Predevelopment Retention Storage Volume (Step 1.b) should meet or exceed the current Water Quality Standard, which is the Treatment Volume, \( T_v \) of the total site area as determined by RRM.

\[
\text{Volume of Retention Storage} = \_\_\_ \text{ cu. ft.} \\
\text{(From Step 1.b)}
\]

\[
\text{Treatment Volume, } T_v = (1/12) \times R_v \times DA = \_\_\_ \text{ cu. ft.} \\
\text{(Virginia Runoff Reduction Spreadsheet)}
\]

Enter Higher Value

Required Retention Storage Volume = \_\_\_ \text{ cu. ft.}

\[
\begin{align*}
\text{Required Retention Storage Volume} &= \_\_\_ \text{ cu. ft.} \\
\text{VR} &= \text{Volume of Retention Storage} \\
\text{Watershed Storage} &= \text{Volume of Runoff Storage Required (inches)} \\
\text{DA} &= \text{Disturbed Drainage Area (Acres)}
\end{align*}
\]

\[
\text{Estimated BMP Surface Area} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \text{ Sq. Ft.} \\
\text{Provided BMP Surface Area} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \text{ Sq. Ft.}
\]

Step 3: Determine the Storage Volume for Maintaining Peak Runoff Rate Using 100% Retention

Using the Charts starting on page 141 of this document (2 inch and 3 inch Type II 24 hour storms), determine the storage volume required to maintain peak runoff rate using 100% retention storage.

- Pre-Development $CN_{\text{pre}}$ =
- Post-Development $CN_{\text{LID}}$ =
- Watershed Storage = ____ inch

$$VR_{100} = \text{Retention Volume for Peak Flow Control (cubic feet)}$$

$Watershed \text{ Storage} = \text{Volume of Runoff Storage (inches)}$

$DA = \text{Disturbed Drainage Areas (Acres)}$

Step 4: Evaluate Need for Additional Detention Storage

Compare the volumes required for volume control and peak rate control:

$$VR_{100} = \text{______ ft}^3 \quad \text{vs.} \quad VR = \text{______ ft}^3$$

(Step 3) \quad (Step 2a)

If $VR > VR_{100}$ then:
Design IMPs or SWMFs that provides runoff reduction equivalent to the VR storage volume. No additional detention is required to control peak flow rate.

If \( VR < VR_{100} \) then a HYBRID DESIGN IS REQUIRED:

Follow Steps 5, and 6 to calculate additional detention storage volume required to meet peak flow rate. If additional detention storage within a runoff reduction practice is not practicable for the site, extended detention and wet ponds can be used to detain the additional volume.

**OR** if providing Runoff Reduction storage of the VR is unachievable due to site constraints then an Exception Request is required for Partial LID. Follow Steps 5, and 7 to calculate additional detention required to meet peak runoff rate.

**Step 5:** Determine the Storage Volume for Maintaining Peak Runoff Rate using 100% Detention

Using TR-55 storage volume for detention basins method determine storage volume required to **maintain peak runoff rate using 100% DETENTION storage**.

\[
\begin{align*}
\text{LID Runoff Depth, } Q_{\text{LID}} & = _____ \text{ inch} \\
q_{\text{1-year forest}} & = _____ \text{ cfs} \\
q_{\text{1-year LID}} & = _____ \text{ cfs}
\end{align*}
\]

Watershed Storage =

\[= _____ \text{ inch} \]

\[
\left( \frac{\text{Watershed Storage}}{12} \right) \times 43560 = V_{D_{100}}
\]

\(V_{D_{100}} = \text{Detention Volume for Peak Flow Control (cubic feet)}\)

\(\text{Watershed Storage} = \text{Volume of Runoff Storage (inches)}\)

\(\text{DA} = \text{Disturbed Drainage Area (acre)}\)
Step 6: Hybrid Design for Full LID Design

\[ X = \frac{\text{Area ratio of retention storage to total storage}}{\text{Retention Storage Required}} = \frac{\text{VR}}{X} \]

Detention Storage, \( H \) =

Retention Storage Required = \( VR = \_\_\_\_\_\_\_\_ ft^3 \)

With a Hybrid Design, IMPs and SWMFs must be provided that can meet the Additional Detention Storage (calculated above) AND Retention Storage (VR).

Step 7: Hybrid Design for Partial LID Design

Retention Storage Provided = \( VR' = \_\_\_\_\_\_\_\_ ft^3 \)

\( VR' \) = Available Retention storage volume (cubic feet) (determined by the designer by analyzing the site constraints)

**Partial LID Design:**

\[ X' = \frac{\text{Ratio of available Retention storage to Total storage}}{\text{Detention Storage Volume required to maintain peak flow}} \]

\[ H' = \frac{100}{VR'} \text{ ft} \]

**Summary of Quantitative LID Results**

**Yes / No -** Site design and impervious cover reduction practices were used to the maximum extent practicable to minimize runoff volume.

**Yes / No -** The design results in a post-development \( T_c \) equal to the pre-development \( T_c \).

**Yes / No -** The entire Retention Storage Volume will be retained and infiltrated.

**Yes / No / NA -** If the entire Retention Storage Volume is not retained and infiltrated, the plans show that every practicable effort was made to implement runoff volume reduction efforts, and all potential green space areas were made hydrologically functional for retention.
Yes / No/NA- Detention practices were used to store the additional volume required to maintain the predevelopment peak flow rate as determined by Hybrid Design.

Yes / No/NA- Detention Practices discharge the detention storage volume as overland sheet flow at a non-erosive rate. If no, concentrated flows must discharge the 1-year peak flow rate at or below the 1-year predevelopment flow rate in forested condition.

References


NOTE: The appendices to the hydrology document include a series of charts which are required to calculate LID storage volumes. They are not currently available in the downloadable version, but selected charts from that series are attached to the end of this document.
Selected Charts for Calculating LID Storage Volumes

taken from
“LID Hydrologic Analysis”
(Low Impact Development National Hydrology Manual)
Prince Georges County, Md. – June 2002
EPA 841-B-00-002
Storage Required to Maintain Pre-Development Peak Runoff Rate Using 100% Retention (hundredths of an inch)

Type II 24-hour Storm 2-inch Rainfall

Existing Runoff Curve Number

Proposed Runoff Curve Number
Riprap

<table>
<thead>
<tr>
<th>VDOT NAME</th>
<th>$D_{15}$ (FEET)</th>
<th>$D_{50}$ (FEET)</th>
<th>$D_{85}$ (FEET)</th>
<th>SEAS (FEET)</th>
<th>VDOT (INCHES)</th>
<th>MANNING'S $n$</th>
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<tr>
<td>Class AI</td>
<td>0.7</td>
<td>0.9</td>
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<td>4.8</td>
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<td>6.1</td>
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Gravel

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<th>VDOT NAME</th>
<th>$D_{15}$ (INCHES)</th>
<th>$D_{50}$ (INCHES)</th>
<th>$D_{85}$ (INCHES)</th>
<th>DEPTH (INCHES)</th>
<th>MANNING'S $n$</th>
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</thead>
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<td>0.75</td>
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</tbody>
</table>

Individual quarries also have sizes other than those specified above. One size commonly available is “gabion” (diameters of 4 to 8 inches); this is usually rather uniform in size (not well-graded) and is commonly used in gabion baskets. Another size commonly available is “clean serge”; this is usually 2 to 4 inches in diameter and size tends to be rather uniform.

“D” followed by a subscript is a symbol used to show the gradation of stone. In this case, “D” is the symbol for mean spherical diameter. The subscript indicates the percent of stone (by weight) which is smaller than the specified size of stone. For most applications, graded (having various sizes) riprap is preferred rather than uniform riprap.

Manning’s $n = 0.0395 \times D_{50}^{1/6}$ (FHWA HEC-15)

See section 2.4.3 for determining permissible velocities of crushed stone used as channel lining.
Maintenance Agreement for Stormwater Management System

OPERATION AND MAINTENANCE AGREEMENT
For
STORMWATER MANAGEMENT SYSTEM

THIS AGREEMENT, made and entered into this ______ day of ____________________, 2012, by and between ______________________, a Virginia corporation, hereinafter called the “Landowner”, and the ______________________, hereinafter called the “County”.

WITNESSETH, that

WHEREAS, the Landowner is the owner of certain real estate property located in ________________. Virginia, designated as Tax Map ____, Parcel ____, comprised of ______ acres, as more accurately described by survey of ______________________, dated __________, a plat of which is recorded in Plat Cabinet ____, Slot ____, hereinafter called the “Property”; and

WHEREAS, the County and the Landowner agree that the health, safety, and welfare of the residents of the __________, Virginia, require that a stormwater management system be constructed and maintained on the Property or on adjacent property approved by the County to serve the Property and certain neighboring properties; and

WHEREAS, Landowner has submitted to the County’s designee, the Zoning Administrator, a site plan for the development of the Property entitled _________________, prepared by __________________, consisting of sheets _____ through _____, inclusive, depicting certain improvements to be completed in connection with the development of the Property which site plan and any modifications or additions thereto as approved by Landowner and the County shall hereinafter be collectively referred to as the “Plans.”; and

WHEREAS, the Plans includes, among other features, a system that regulates the quality and quantity of stormwater (the term “system” includes any and all components designed to regulate flow, provide storage for runoff water, remove pollutants from runoff water and increase infiltration of runoff water into the soil); and

WHEREAS, the system includes __________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

WHEREAS, the Landowner, its successors and assigns, including any homeowners association shall install and maintain the system in in order to comply with one or more of the following laws, regulations and codes:

<table>
<thead>
<tr>
<th>Act</th>
<th>Regulations</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>62.1-44.15:24</td>
<td>9 VAC25-870, et seq.</td>
<td>Stormwater Management</td>
</tr>
<tr>
<td>62.1-44.15:51</td>
<td>9 VAC 25-840, et seq.</td>
<td>Erosion and Sediment Control</td>
</tr>
</tbody>
</table>

Orange County Code
Chapter 27
Chapter 26

Title of Ordinance
Stormwater Management
Erosion and Sediment Control

NOW, THEREFORE, in consideration of the foregoing premises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto agree as follows:
1. The system shall be constructed by the Landowner, its successors and assigns, in accordance with the plans and specifications identified in the Plans. The Landowner shall provide as-built data and drawings, soil/geotechnical reports, and other certifications requested by the County in order to document compliance with the approved designs and the requirements set forth in Orange County’s Stormwater Management Design Manual.

2. The Landowner, its successors and assigns, shall perform all maintenance necessary to keep these facilities in good working order as per the approved Operation and Maintenance plan(s) (see attachment A).

3. The Landowner, its successors and assigns, including any homeowners association, shall conduct an annual inspection as outlined in the approved Operation and Maintenance Plan to insure the system is maintained and performing as designed. The Landowner, its successors and assigns, shall submit an inspection and maintenance report annually to the County. Deficiencies and corrective action shall be noted in the inspection report.

4. The Landowner, its successors and assigns, hereby grant permission to the County, its authorized agents and employees, to enter upon the Property and to inspect the stormwater management facilities whenever the County deems necessary. The purpose of inspection is to confirm adequate functionality and/or to respond to citizen complaints. The County shall provide the Landowner, its successors and assigns, copies of the inspection findings and a directive to commence with the repairs if necessary. Landowner does hereby grant unto the County a non-exclusive easement for vehicular and/or pedestrian access to the stormwater management facilities over and across the parcel as more accurately shown on the Plans, a plat of which is to be attached to a Deed of Subdivision and Dedication of Easements dated ________, and intended to be recorded among the land records of Orange County, Virginia.

5. In the event the Landowner, its successors and assigns, fails to maintain the stormwater management facilities in good working condition, the County may enter upon the Property and take whatever steps necessary to correct deficiencies identified in the inspection report and to charge the costs of such repairs, including labor, to the Landowner, its successors and assigns. This provision shall not be construed to allow the County to erect any structure of permanent nature on the land of the Landowner outside of the easement for the stormwater management facilities. It is expressly understood and agreed that the County is under no obligation to routinely maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the County.

6. In the event the County pursuant to this Agreement, performs work of any nature, or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner, its successors and assigns, shall reimburse the County upon demand, within ten (10) working days of receipt thereof for all actual costs incurred by the County hereunder. If these funds are not remitted to the County within the 10 day timeframe, there shall be added to all delinquent funds due the County a penalty in the amount of ten (10) percent of the delinquent funds for each month or fraction thereof during which the failure to pay the funds continues.

7. This Agreement imposes no liability of any kind whatsoever on the County and the Landowner agrees to hold the County harmless from any liability in the event the stormwater management facilities fail to operate properly.

8. This Agreement shall be recorded among the land records of Orange County along with a copy of the approved Operation and Maintenance Plan and shall constitute a covenant running with the land, and shall be binding on the Landowner, its administrators, executors, assigns, heirs and any other successors in interests, including any homeowners association. The Landowner also stipulates, by the Agreement, that final plats for any and on which this system and/or a portion of this system is situated will include a reference to this Agreement and to its location (deed book...
WITNESS THE FOLLOWING SIGNATURES:

DEVELOPER/OWNER:  
NAME: __________________________
TITLE: __________________________
ADDRESS ____________________________  __________
ADDRESS ____________________________  __________
BY: ____________________________

COMMONWEALTH OF VIRGINIA  
COUNTY OF ORANGE, to wit:

The foregoing Agreement was acknowledged before me this _____ day of ________, 20 ____, by ____________________________
developer/owner.

My commission expires: ____________________________

__________________________  Notary Public

BOARD OF SUPERVISORS OF ORANGE COUNTY,  
VIRGINIA

By: ____________________________  
Gregg Zody  
Director of Planning and Zoning

COMMONWEALTH OF VIRGINIA  
COUNTY OF ORANGE, to wit:

The foregoing Agreement was acknowledged before me this _____ day of ________, 20 ____, by Gregg Zody, Director of Planning and Zoning on behalf of the Board of Supervisors of Orange County, Virginia.

My commission expires: ____________________________

__________________________  Notary Public

Approved as to form: ____________________________
Draft Drainage Easement Language (TBD)

Draft Open Space Easement Language (TBD)

Draft Flood Hazard Overlay District Ordinance Implementation (TBD)

12.6.1 Floodplain District (Zone AE) (TBD)

12.6.2 Approximated Floodplain District (Zone AE) (TBD)
Example Construction Inspection and As-Built Survey Checklists

Construction Inspection and As-Built Survey Checklist
Extended Detention, Constructed Wetlands and Wet Ponds
Page 1 of 2

Applicant: _______________________________ Phone No.: ______________
_______________________________

Designer: _______________________________ Phone No.: ______________
_______________________________

Project Name: __________________________________________________________
_______________________________

Location: _______________________________ Phone No.: ______________________
_______________________________

Contractor: _______________________________ Phone No.: ______________
_______________________________

Permit No.: _______________________________

Type of Facility and Identification No.: ______________________________________

A separate checklist is to be completed for separate BMPs, should more than one be used at a given project.

* Key - ( X ) If acceptable
( Inc. ) If not adequate, explain at the end of a section
(NA) If not applicable
Include dates of completion in the margins.

I. INSPECTION LOGS and TEST DOCUMENTATION

A. Earthwork
_______ The results and interpretation of geo-technical analysis including boring log data
_______ Verification of removal of all unsuitable material beneath embankment and footing
_______ Verification of fill classification/suitability for use in the embankment
_______ Verification of proper installation of cut-off trench
_______ Verification of soil impermeability for material used in the liner, and liner thickness
_______ Multiple compaction test results indicating adequacy throughout the embankment section including areas adjacent to the outlet conduit and any seepage control measures.
_______ Verification that underlying bedrock and/or the water table does not interfere with the impoundment
_______ Verification of dimensions of sub surface features such as the riser structure footing, anti-seep collars, filter and drainage diaphragm, etc.
B. Materials

- Riprap size distribution and composition
- Inlet shaping (within the control structure and system manholes)
- Trash rack construction/coatings
- Trash rack; method of installation
- Shop drawings for control structure detailing dimensions, elevations, and reinforcing information
- Verification of structure reinforcement and water tight connections
- Low-flow channel lining
- Outlet barrel size/construction type/length
- Outlet protection
- Anti-vortex device

(Comments)

II. DIMENSIONS and ELEVATIONS SURVEY (Red Lined Plan Sheets)

- Top width, and side slopes (profile) of dam embankment
- Inverts and slope (%) of outlet conduit
- Elevation and cross section of the emergency spillway
- Principal spillway profile including elevations and geometry of riser control orifices and/or weirs
- Cast-in-place control structure dimensions/elevations
- Riser crest and invert of control structure
- Outlet protection
- Contours of the ponding area
- Slope(s) of storm sewer system conduit with inlet and outlet inverts
- Slope and cross-section of all on-site channels

(Comments)

III. CERTIFICATIONS

- Certification's from manufacturers for materials used
- Seeding tickets and specifications
- Certification statement and seal by licensed professional indicating the as-built drawing is accurate, complete and constructed per the approved plan

Construction Inspection and As-Built Survey Checklist
Infiltration and Bioretention
I. INSPECTION LOGS and TEST DOCUMENTATION

A. Earthwork
- The results and interpretation of geotechnical analysis including boring log data
  - Infiltration rate of soils
  - Depth to seasonal water table
  - Depth to bedrock
- Verification of removal of all unsuitable material
- Verification that underlying bedrock and/or the water table does not interfere with the infiltration capacity
- Verification of dimensions of subsurface features such as the riser structure footing, inlet and outlet pipes, etc.

B. Materials
- Stone aggregate size, composition, and placement methods
- Filter fabric specifications
- Collector pipe specifications and hole patterns
- Engineered soil media specifications
- Plants size and variety specifications
- Mulch specifications
- Observation/Cleanout pipes specifications

C. Sequence of Construction
- E&S control measures in place
- Inflow pipe plugged prior to full site stabilization
- Compaction prevention measures

Construction Inspection and As-Built Survey Checklist
Infiltration and Bioretention
II. DIMENSIONS and ELEVATIONS SURVEY (Red Lined Plan Sheets)

- Invert and diameter/geometry of flow splitter, overflow pipes, and channels
- Dimensions of storage area
- Contours of the ponding area
- Elevation and cross section of the emergency / principal spillway
- Outlet protection
- Typical Cross Section View
- Material specifications
- Inlets with pretreatments specified
- Dimensions and elevations of layers
- Location and invert elevation of under drains and monitoring well
- Number, type, and location of plantings
- Photographs documenting construction and showing: the site before beginning construction; the excavation’s undisturbed walls and bottom before any backfill; placement of each material layer showing the final top surface of each layer; placement of the under drain system; and, outlet works.

III. CERTIFICATIONS

- Certification’s from manufacturers for materials used
- Certification statement and seal by licensed professional indicating the as-built drawing is accurate, complete and constructed per the approved plan
Construction Inspection and As-Built Survey Checklist
Filters, and Manufactured Treatment Devices
Page 1 of 2

Applicant: _______________________________ Phone No.: ________________________

Designer: _______________________________ Phone No.: ________________________

Project Name: _______________________________________________________________

Location: _____________________________________________________________________

Contractor: _______________________________ Phone No.: ________________________

Permit No.: ___________________________________________________________________

Type of Facility and Identification No. ____________________________________________

A separate checklist is to be completed for separate BMPs, should more than one be
used at a given project.

* Key - ( X ) If acceptable
( Inc. ) If not adequate, explain at the end of a section
( NA ) If not applicable
Include dates of completion in the margins.

I. INSPECTION LOGS and TEST DOCUMENTATION

A. Earthwork

_____ The results and interpretation of geotechnical analysis including boring log data

_____ Verification of removal of all unsuitable material

_____ Verification of fill classification/suitability

_____ Verification that underlying bedrock and/or the water table does not interfere with
the infiltration capacity

_____ Verification of dimensions of sub surface features such as the riser structure
footing, inlet and outlet pipes, etc.

B. Materials

_____ Precast Chamber

_____ Filter Components

_____ Collector Systems

_____ Overflow Structure

_____ Monitoring Well

_____ Inlet and Outlet

(comments)

_____________________________________________________________________________

_____________________________________________________________________________

_____________________________________________________________________________

_____________________________________________________________________________
Construction Inspection and As-Built Survey Checklist
Filters, and Manufactured Treatment Devices
Page 2 of 2

II. DIMENSIONS and ELEVATIONS SURVEY (Red Lined Plan Sheets)

- Dimensions and specifications of inlet and outlet pipes
- Inverts and slope (%) of inlet and outlet conduits
- Elevation and cross section of the overflow and bypass systems
- Principal spillway profile including elevations and geometry of riser control orifices and/or weirs
- Pretreatment practices dimensions and specifications
- Outlet protection
- Manufacturer Drawings of components

(Comments)

III. CERTIFICATIONS

- Certification’s from manufacturers for materials used
- Certification statement and seal by licensed professional indicating the as-built drawing is accurate, complete and constructed per the approved plan
As-Built Checklist: Stormwater Conveyance Channels (includes Grass Channels, Dry Swales and Wet Swales)

A. Minimum Information
   - Invert elevations and top of bank elevations, side slopes at cross section locations
   - Type and class of lining materials
   - Size and depth of rip-rap, and specify that it has been underlain by filter fabric
   - Type and condition of vegetation

B. Acceptable Construction
   - Shape of channel must be consistent with design plan
   - Capacity of channel must be no less than design plan capacity

As-Built Checklist: Storm Sewers and Culverts (Includes Underground Detention and infiltration chambers)

A. Minimum Information
   - Diameter, length, slope and material of all pipe
   - Invert elevations of pipe at all entrances, outfalls, and structures
   - Elevation and size of all control orifices and weirs
   - Location of all pipe and structures
   - Type of structures, including throat width
   - Elevation of structure top
   - Length, width and depth of all riprap and other outlet protection
   - Ground elevations over pipe where depth of cover might exceed allowable maximum cover depths

   - Geotechnical Inspection Reports

B. Acceptable Construction
   - Pipe and inlet capacity meets design
   - Structure dimensions and elevations must be correct
   - Stage-Storage-Discharge summary tables meet design
   - Outlet protection shall be adequate
Complete design is not required in the Stormwater Management Concept Plan; however, sufficient analysis must be performed to show the plan is workable. The amount of analyses required will vary depending on the size and complexity of the site and the development.

A Stormwater Management Concept Plan contains five main components; a summary, a narrative, illustrative drawings, Environmental Site Design Checklist, and LID Performance Worksheet.

I. **Summary**
   a. 
   b. Summary table of all points of discharge with contributing drainage areas, percent impervious cover, percent pervious cover and 12-digit hydrologic unit code
   c. Summary table of all Soil Map Units with physical properties such as hydrologic soil group, depth to bedrock, water table, etc.
   d. Identification of FEMA FIRM Panel Number for the site
   e. Exception request if applicable
   f. Statement of LID Design (FULL or PARTIAL)
   g. List of all Local, State and Federal permits expected
   h. Identify TMDL watershed and Water Supply Development areas

II. **Plan Narrative**
   a. Natural Resource Assessment Narrative (App. 12.1.1)
      i. Describe existing land use and drainage, include natural and manmade drainage features
      ii. Describe wetlands and surface waters on site
      iii. The number and general description of conveyances at each point of discharge.
      iv. Describe existing hydraulic conditions of the conveyances downstream of each point.
   b. General project description
   c. Describe on-site drainage and permanent BMPs proposed for required water quantity and water quality.
   d. Describe off-site facilities, if applicable
e. ___ A statement of floodplain impacts and need for flood plain study if applicable.

III. ___ Illustrative Drawings

a. ___ Provide a Pre-development and Post-development maps
b. ___ Show property line and project limits
c. ___ Natural Resource Assessment Maps
   i. ___ Soil boundaries
   ii. ___ Vegetation (existing and proposed tree line)
   iii. ___ Wetland and Surface Waters delineation
   iv. ___ Drainage with elevation contours (pre and post)
   v. ___ Critical Slopes greater than 15% (pre and post)
   vi. ___ Existing drainage structures
d. ___ 100-year floodplains from FEMA Flood Insurance Map
e. ___ Show Dam Breach Inundation zones, if applicable.
f. ___ Show Stream Buffers and Stormwater Easements
g. ___ Show all points of discharge from the project.
h. ___ Show existing and proposed wells and septic systems.
i. ___ Location and Types of permanent BMPs

IV. ___ Environmental Site Design Checklist (App. 12.1.2)

V. ___ LID Performance Worksheet (App. 12.1.3)

a. ___ Minimum BMP Surface Area
b. ___ Allowable Discharges (1-, 2-, and 10-year)
c. ___ Retention and Detention Storage Volumes
&S Checklist

EROSION & SEDIMENT CONTROL CHECKLIST
Revised July 2012

Below is a checklist of all necessary components required to complete all Erosion and Sediment Control Plans submitted to the Orange Soil and Water Conservation District (CSWCD) as in accordance with the Virginia Erosion and Sediment Control Law, Title 10, Chapter 5, Article 4 of the Code of Virginia; 10.1-563 and Virginia’s Erosion and Sediment Control Regulations (4VAC50-30 et. al.). The Plan preparer must sign, date, and attach the checklist to any Erosion and Sediment Control Plan to be reviewed by CSWCD.


I. Minimum Standards:

--- **Narrative** provides all 19 Minimum Standards (4VAC 50-30-40)
--- If a Minimum Standard is not addressed with a specific practice in the plan, the intent to satisfy must be documented in writing with a VARIANCE REQUEST.
--- **MS 1:** Temporary and Permanent stabilization.
    ---- Seeding and cover practices and limits of clearing shown on plan; Details and Seeding Specifications included
    ---- Specified in Construction Sequence and Management Strategies Narrative
--- **MS 2:** Soil stockpiles and borrow areas stabilized and protected
    ---- Specified in Management Strategies Narrative
    ---- Temporary protection and Permanent Stabilization identified
--- **MS 3:** Requirements for establishment of permanent vegetation specified
    ---- Specified in Management Strategies and Maintenance Narrative
--- **MS 4:** Perimeter control, sediment trapping measures specified as first step.
    ---- Practices shown on plan; Details and Specifications included
    ---- Specified in Construction Sequence and Management Strategies Narrative
--- **MS 5:** Earthen structures stabilized immediately after installation
    ---- Specified in Construction Sequence and Management Strategies Narrative
--- **MS 6:** Sediment traps and basins properly sized.
    ---- Detailed and Specifications provided; design calculations included
--- **MS 7:** Design of cut and fill slopes minimize erosion.
    ---- Practices shown on plan; Details and specifications included
    ---- Specified in Management Strategies Narrative
--- **MS 8:** Concentrated runoff on cut and fill slopes contained in conveyance
CHAPTER 12

MS 9: Potential water seeps from slope faces
Specified in Management Strategies Narrative

MS 10: Inlets, Culverts, and Filtering BMPs protected during construction
Practices shown on plan; Details and Specifications included

MS 11: Channel linings and outlet protection specified
Practices shown on plan; Details and Specifications included

MS 12: In-stream construction practices shown and details provided

MS 13: Temporary stream crossings provide non-erodible materials
Practices shown on plan; Details and Specifications included

MS 14: Evidence of local, state and federal permits for in-stream and wetland judicial determination; wetland permit; water withdrawal permit provided

MS 15: Stabilization of bed and banks of a live water course
Practices shown on plan; Details and Specifications included
Specified in Construction Sequence and Management Strategies Narrative

MS 16: Underground utility lines addressed
Practices shown on plan; Details and Specifications included
Specified in Construction Sequence and Management Strategies Narrative

MS 17: Transport of sediment onto public roadways controlled
Practices shown on plan; Details and Specifications included
Specified in Construction Sequence and Management Strategies Narrative

MS 18: Timely removal of temporary erosion and sediment control measures
Specified in Construction Sequence and Management Strategies Narrative

MS 19:

a. Downstream Analysis at Outfall of Open Channel and/or Pipe System
   Evaluate a minimum of three downstream cross sections
   Stage-Storage Rating Curve of natural channel (recommended)

b. Adequacy of all channels and pipes shall be verified accordingly:
   1. Total drainage area to point of analysis is 100 times greater than the contributing drainage area and;
   2a. 2-year velocity and depth maintained within banks of natural channel or;
   2b. 2-year velocity and 10-year depth maintained within banks of manmade channel or;
   2c. Pipe systems must pass the 10-year storm and have adequate discharge channel.

   c. Channel inadequate:
      1. Improve the channel to meet design storms
APPENDICES

2. Improve pipe system to meet design storms
3. Site design that provides detention that meets design storm requirements
4. Combination of measures approved by Variance
d. Evidence of permission to make improvements (Drainage/Construction Easements and Agency Permits)
e. Hydrologic analyses based on existing watershed and ultimate development
f. Plan sets forth maintenance requirements and responsible party
g. Detention outfall shall discharge to a channel and provide energy dissipaters
h. All on-site conveyances adequate (culverts, storm sewers, ditches)
i. Increase flows that may cause erosion diverted to adequate outfall or channel
j. Stormwater runoff criteria applied to whole development
k. All practices implemented to minimize impacts on the physical, chemical and biological integrity of rivers and streams of the state.
l. Plans approved prior to July 2014
m. Plans approved after July 2014

II. Plan Narrative:
(Contractors should be able to refer to all activities and specifications in the Plan Narrative).

1. Describe the nature and PURPOSE of the land disturbing activity, the amount of grading involved, and number of disturbed acres

2. Describe the EXISTING CONDITION; topography, vegetation, and drainage.

3. Describe NEIGHBORING AREAS such as rivers, streams, lakes, residential areas, roads, etc., which might be affected by the land disturbance and post development drainage patterns.

4. Describe the SOILS on site including soil name, mapping unit, erodibility, permeability, depth, texture, structure, and hydrologic group of each soil.

5. Describe the CRITICAL AREAS on site that have potential to cause erosion or water quality problems due to the proposed land disturbing activity.

6. Describe any local, state or federal PERMITS obtained or applied. This includes any permits for wetland and stream impacts or dam safety.
7. Describe the CONTROL MEASURES which will be used to control erosion, sedimentation, and excessive runoff from the site.

8. Describe how site will be STABILIZED during and after construction with permanent and/or temporary control measures.

9. Describe how the site will be balanced between cut and fill areas, off-site areas, borrow area, and SOIL STOCKPILES.

10. Describe schedule of regular MAINTENANCE inspections and repair of erosion and sediment control structures.

11. Increases in STORMWATER RUNOFF volume, velocity and peak flow rate shall discharge to an adequate stormwater conveyance system or natural channel. (4VAC50-30-40 19.)

Complete Orange SWCD STORMWATER MANAGEMENT CHECKLIST
III. SITE PLAN

1. Provide engineer(s) / surveyor(s) / landscape architect(s) / names, address, telephone number, and registration seal.

2. Provide the owner(s) and/or developer(s) name, address, and telephone number.

3. Provide copy of APPLICABLE PERMITS with authorization signatures on COVER PAGE.

4. Provide a SMALL SCALE MAP locating the site (and access) in relation to the surrounding area. Include any landmarks which might assist in locating the site.

5. Provide ORIGINAL PLAN DATES and all REVISION DATES with a brief description of the items revised.

6. Provide TITLES and numbering for all sheets.

7. Provide plan SCALE sufficient to clearly convey the characteristics of the site and control measures.

8. Show the location, width, and recordation information for all existing DRAINAGE EASEMENTS.

9. Provide EXISTING CONTOURS at intervals no greater than five (5) feet.

10. Provide FINAL CONTOURS at intervals no greater than two (2) feet.

11. Show EXISTING VEGETATION (tree lines, and unique vegetation).

12. Show boundary of different SOIL TYPES.

13. Provide a NORTH ARROW on all sheets.

14. Clearly show CRITICAL AREAS which have potential to present serious erosion or water quality problems.

15. Provide a DRAINAGE MAP showing EXISTING and FINAL DRAINAGE DIVIDES (include: number of acres, direction of flow, “C” / CN numbers, rainfall, and discharges).

16. Provide a CONSTRUCTION SEQUENCE narrative specifying
implementation of perimeter controls, sediment trapping structures, stabilization, and removal. Including how transitions from Phase I to Phase II will occur.

___ 17. Show the Location and Description of all existing and proposed drainage structures, pipes, roof drains, swales, ditches, curbs and channels and the direction of flow in each.

___ 18. Provide CALCULATIONS SUMMARY TABLE for pre and post runoff rates, and drainage structure design parameters.

___ Complete Orange SWCD STORMWATER MANAGEMENT CHECKLIST


___ 20. Show LIMITS OF LAND DISTURBANCE.

___ 21. Show locations of STOCKPILES AND BORROW AREAS with adequate protection measures included. If these locations are off-site, an addendum to the plan must be submitted to show the areas.

___ 22. Illustrate DETAIL DRAWINGS AND SPECIFICATIONS in accordance with the VESCH containing all dimensions and specifications of any structural practices used.

CERTIFICATION OF PLAN PREPARER:

I certify that the above checklist items are fulfilled in the attached erosion and sediment control plan, unless I have attached a written variance request for the omitted components.

_________________________________________  __________________________
(signature of plan preparer)  (date)

_________________________________________  __________________________
(print name)  (phone number)
stormwater Management Design Plan Checklist

Below is a checklist of all necessary components required for Stormwater Management Design Plans in accordance with the Virginia Stormwater Management Law, Title 62.1, Chapter 3.1, Article 2.3 of the Code of Virginia and Virginia’s Stormwater Management Regulations (9VAC25-870). The Plan preparer must sign, date, and attach the checklist to any Stormwater Management Plan to be reviewed by the CSWCD.


I. General Contents
   a. ___ Contact information for owner, operator and plan preparer
   b. ___ Vicinity Map; Scale; North Arrow; Sheet Identification
   c. ___ General Note: “Contractor is responsible for submitting a Construction General Permit registration statement and must provide evidence of permit coverage from the Department of Environmental Quality (DEQ) prior to applying for a land disturbance permit with the County.”
   d. ___ General Note: “Contractor is responsible for preparing and updating the Stormwater Pollution Prevention Plan (SWPPP), paying all permit fees necessary for continued coverage, and providing permit termination notification to the Department of Environmental Quality (DEQ).”
   e. ___ General Note: “The applicant is responsible for certifying that the completed stormwater management facilities and/or integrated stormwater management practices are in accordance with the approved plans and specifications. An As-Built Survey shall be provided with a written log of regular inspections sufficient to adequately document compliance.”

II. Narrative
   a. ___ Project description; including stormwater concept plan deviations
   b. ___ Natural Resource Assessment and existing site conditions
   c. ___ Describe how the site plan provides stormwater management
   d. ___ Description of all BMPs; ESD, RR, and PR
   e. ___ Project schedule, including sequence of construction and phasing

III. Illustrative Drawings
   a. ___ Property Boundaries; Wetland Boundaries; Floodplain Boundaries
   b. ___ Limits of Project; Stream Buffer; Conservation Area Boundaries
   c. ___ Existing and Proposed contours at 1- or 2-foot intervals
d. ___ Existing and Proposed Well and Septic systems

e. ___ Location of BMPs

f. ___ Pre and Post development drainage area map
   i. ___ Point of Discharges (outfalls)
   ii. ___ Land Cover coefficients
   iii. ___ Soil map unit boundaries
   iv. ___ Time of Concentration flow paths
   v. ___ Existing and Proposed Drainage Structures

IV. Best Management Practices (BMPs)

a. ___ Identify the type(s) of BMP(s)

b. ___ Identify the location including GPS

c. ___ Acres Treated Identified; Impervious, Turf and Undisturbed

d. ___ Identify receiving surface water 12-digit hydrologic unit code

e. ___ Details and Specifications as per the BMP Clearinghouse
   i. ___ Cross-Section Detail and Profile of Control Structure
   ii. ___ Construction Notes and Details: Site Preparation; Sequence of Construction; Schedule of Inspections; Geotechnical Report; and Materials Specifications
   iii. ___ Operation and Maintenance Plan

f. Stream Buffer BMPs
   i. ___ All permanent structures are excluded from the buffer area
   ii. ___ Limits of Disturbance are completely outside the buffer
   iii. ___ Recorded Easement
   iv. ___ Operation and Maintenance Plan
   v. ___ Mitigation for Temporary and Permanent Encroachments

g. Drainage Easements
   i. ___ Extended to an adequate channel
   ii. ___ Improved Drainage across 2 or more lots
   iii. ___ BMP Construction and Maintenance

V. Stormwater Management

a. Low Impact Development (LID) (if applicable)
   i. ___ Natural Resource Assessment
   ii. ___ ESD Checklist
iii. ___ LID Performance Worksheet
   1. ___ 100% of 1-year, 24-hour Runoff Volume Control
   2. ___ >50% of 1-year, 24-hour Runoff Volume Control
   3. ___ 1-year, 24-hour Peak Flow Rate Control
   4. ___ Time of Concentration maintained
   5. ___ Disconnection Ratio; Curve Number Adjustment

b. Channel Protection
   i. ___ Channel Adequacy Calculations and Cross Sections
   ii. ___ Compliance with the Energy Balance equation

c. Flood Protection
   i. ___ Ten-year post-developed peak flow rate does not exceed the ten-year pre-developed flow rate
   ii. ___ Earthen Impoundments and Underground Facilities provide stability and overland relief for the 100-year, 24-hour storm.

d. Water Quality
   i. ___ Runoff Reduction Spreadsheet
   ii. ___ Drainage Area (DA); Runoff Value (Rv); Treatment Volume (Tv)
   iii. ___ Pollution Load; Load Reductions; Runoff Reduction

e. Floodplain Management
   i. ___ Encroachments shall not increase the 100-year Base Floodplain Elevation (BFE) by no more than 1 foot from the upstream extent of the mapped floodplain to the next downstream floodway obstruction (e.g. Culvert with no overland relief).
   ii. ___ Encroachments shall not increase the 100-year floodway elevation.
   iii. ___ Mitigation Measures; Public Notification

VI. Hydraulic Design
a. ___ Drainage system outfalls at adequate channel. Adequate channel cross-section and calculations provided.
b. ___ Drainage systems provide overland relief of 100-year storm event without increasing flooding potential of nearby facilities.
c. Storm Sewers/Culverts/Ditches
   i. ___ Discharge; Velocity; Depth; Freeboard; Temporary and Permanent Channel Lining
ii. ___ Headwater; Buoyancy Protection; HGL; Outlet Protection
iii. ___ Construction Details: Materials; Size; Slope; Elevations

d. Hydraulic Control Structure
   i. ___ Construction Details: Materials; Elevations; Dimensions
   ii. ___ Embankment Detail
   iii. ___ Principal Spillway Detail
   iv. ___ Emergency Spillway Detail

e. ___ Stage-Storage-Discharge Table

f. ___ Pre and Post Development Hydrographs for each design storm (1-, 2-, 10- and 100-year, 24-hour)

CERTIFICATION OF PLAN PREPARER:

I certify that the above checklist items are fulfilled in the attached stormwater management plan, unless I have attached a written exception request for the omitted components.

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(signature of plan preparer)          (date)

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(print name)                (phone number)