Stormwater Management

Design Manual

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1 Introduction

1.1 Authority

The stormwater management provisions of the Clarke 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:

A) Virginia Stormwater Management Handbook, Volumes I and II, prepared by the Virginia Department of Conservation and Recreation dated 1999 and subsequent modifications and updates thereof.

B) Low-Impact Development Design Strategies: An Integrated Design Approach, United States Environmental Protection Agency, Office of Water, EPA 841-B-00-003 dated June 1999 and subsequent modifications and updates thereof.

C) 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.

D) Northern Shenandoah Valley Regional Urban Manual for Low Impact Design, Northern Shenandoah Valley Regional Commission, October 2005.

E) Low Impact Development Design Strategies—An Integrated Design Approach, prepared by Prince Georges County, Maryland, January 2000 .

F) LarBranche, Adrienne, Hans-Otto Wack, David Crawford, Ed Crawford, Nickolas J. Sojka, Cabell Brand. 2007. Virginia Rainwater Harvesting Manual. Salem, Virginia. The Cabell Brand Center.

G) Chesapeake Stormwater Network Technical Bulletin No. 4:Technical Support for the Bay-wide Runoff Reduction Method , version 2.0 and subsequent modifications and updates thereof.

H) Chesapeake Stormwater Network Technical Bulletin No. 1: Stormwater Design Guidelines for Karst Terrain in the Chesapeake Bay Watershed, Version 1 October 24, 2008.

Collectively, these are referred to in this manual as the Design Manuals.[1] These manuals should be used by designers to ensure that standard, acceptable design practices are employed 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 concept to a stormwater management design to post-construction (as-built) requirements.

[1] Should information among these documents conflict or differ, the stricter on this list takes precedence.

1.2 Applicable Programs and Regulations

The designer is responsible for knowing the details of all applicable ordinances and regulations before submitting a stormwater management concept or design 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.

A) Virginia Stormwater Management Act and Regulations administered by the Virginia Department of Conservation and Recreation

B) Virginia Erosion & Sediment Control Act and Regulations administered by the Virginia Department of Conservation and Recreation

C) Virginia Stormwater Management Program (VSMP) administered by the Virginia Department of Conservation and Recreation

D) Virginia Dam Safety Act and Regulations administered by the Virginia Department of Conservation and Recreation

E) Section 404 of the Clean Water Act administered by the US Army Corps of Engineers (USACE) and the US Environmental Protection Agency

F) Virginia Water Protection Permits administered by the Virginia Department of Environmental Quality

G) National Flood Insurance Program administered by the Federal Emergency Management Agency

H) Chapter 148, Erosion and Sediment Control, Clarke County Code administered by Clarke County Virginia

I) Chapter 147, Stormwater Management, Clarke County Code administered by Clarke County, Virginia

J) Chapter 188, Zoning and Subdivision, Clarke County Code administered by Clarke County, Virginia

1.3 Stormwater System Design Basics

Stormwater systems in the County are comprised of two parts:

1. Drainage systems to convey storm and other surface flows through the land development project; and,

2. Stormwater management facilities to minimize the adverse impact of increased stormwater runoff on downstream properties.

The ultimate objective of drainage systems and stormwater management facilities is to convey and control stormwater from a developed site so that the site itself and the downstream areas are not adversely affected by the increased runoff caused by the development and to reduce the amount of pollutants leaving the site.

Traditionally, stormwater drainage systems have consisted of natural streams and swales, engineered open conveyance channels, storm sewers, and road culverts while stormwater management facilities consisted of detention ponds, infiltration facilities, and other best management practices (BMPs). These BMPs reduce peak runoff rates from a developed site to pre-development condition. They also detain runoff which allows pollutants to settle out before being released.

These measures release cleaner runoff at rates no more likely to cause flooding downstream than before development, but they do not address the erosion potential posed by the shear increase in runoff volume from a developed site. To address this, stormwater management systems are designed to detain the volume of runoff from the most frequent storms (1-year, 24-hr) on site and release it over the entire 24-hour period of the event.

Ultimately, however, these measures allow almost all the increased runoff caused by the development to leave the site. A "relatively recent" development in stormwater control systems is runoff reduction. Under this approach, runoff reduction practices are used to control and actually retain stormwater at the source of the runoff and more closely replicate pre-development hydrology. Typical runoff reduction practices include bioretention facilities, dry wells, filter strips, buffer strips, grassed swales, rain barrels, cisterns, and infiltration facilities.

1.4 Stormwater Management Design Review and Approval

The County is responsible to ensure that stormwater management features built in the County comply with regulatory requirements. It does this by reviewing stormwater management plans at every stage of development. Specific points at which review and approval is required are concept, design, individual lot grading, and post-construction as-built.

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 plan presentations are:

A) The use of values in supporting computations that are not evident in drawings. These often include drainage areas, land uses, and time-of-concentration flow path segments,

B) The inclusion of computer output which is not summarized, cross-referenced, or indexed to indicate its relevance in the design,

C) The depiction of information unrelated to stormwater management design which detracts from or obscures stormwater management information,

D) Reliance upon information contained in other plans to support the presented concept or design,

E) Failure to obtain and present information required to support elements of design, e.g., geotechnical recommendations for design and construction of a pond embankment,

F) Depiction of drainage divides that are incomplete, do not honor the underlying topography, or do not show the underlying topography at all,

G) Reliance upon off-site facilities without demonstrating their adequacy to meet the code requirement.

1.5 Conditions of Stormwater Management Design Plan Approval

Once approved, a Stormwater Management Design Plan carries the following conditions:

A) The provisions of the approved plan must be adhered to during and after construction.

B) No changes to the approved plan may be made without review and approval by the program administrator. Examples of allowable changes are:

- Use of a higher class pipe than proposed.
- Slight realignment of drainage system having no impact on hydraulic grade line.

C) 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.

D) 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.

2 Stormwater Drainage System Design

2.1 Introduction

This chapter discusses stormwater drainage design in Clarke 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 3 in this manual.

2.2 General Requirements

Stormwater drainage systems are to be designed and constructed to conform to 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 Concept Plan as detailed in Chapter 4.

All drainage systems must be designed and sized based on ultimate development. Ultimate development is defined as proposed development, existing zoning, or comprehensive plan land use; whichever is more restrictive, within the contributory watershed. 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 should the drainage system be inoperable due to blockage.

Easements must be provided for stormwater drainage systems in accordance with requirements in this manual.

2.3 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.

2.4 Runoff Computations

Five methods for calculating runoff are available. Selection of the appropriate method is based upon the size of the drainage area and the output information required. The following table lists acceptable calculation methods for different drainage areas and output requirements.

AVAILABLE METHODS[2]	
1) Rational Method 2) Modified Rational Method	3) Graphical Peak Discharge Method 4) Tabular Method 5) Unit Hydrograph Method

Output Requirements	Drainage Area	Appropriate Method
Peak Discharge Only	Up to 200 acres	1, 3, 4, 5
	Up to 2000 acres	3, 4, 5
	Up to 20 square miles	4, 5
Peak Discharge and Total Runoff Volume	Up to 200 square miles	2, 3, 4, 5
	Up to 20 square miles	4, 5
Runoff Hydrograph	Up to 20 square miles	4, 5

[2] The rainfall data shall be according to the latest NOAA or VDOT Hydraulic Design Advisory.

When designing a storm sewer network for multiple drainage basins, the designer may compute and tabulate flows using the Rational Method provided that flows to all entrance structures with a drainage area greater than 200 acres are computed using other acceptable hydrologic methods and the time of concentration is computed using the NRCS (SCS) method.

2.5 Stormwater Conveyance Channels

Stormwater conveyance channels must be designed to convey the peak discharge from a ten-year storm with a minimum freeboard of 1.5 times the flow depth or one foot, whichever is less and have non-erosive velocities for 2-year storm peak flows. Channel linings must be selected using procedures in either the VDOT Drainage Manual or the Virginia Erosion and Sediment Control Handbook (latest edition). Low flow sections are recommended in the design of channels with large cross sections.

2.6 Storm Sewers and Culverts

2.6.1 Pipe Types

Storm sewers and culverts shall use Reinforced Concrete Pipe (RCP), High Density Polyethylene (HDPE) or Polyvinyl Chloride (PVC) Ribbed Pipes .

Storm sewer pipe shall comply with the following specifications:

A) RCP

1. RCP shall meet the three-edge bearing strength test requirements for ASTM C76 Class III RCP or better.
2. Higher class shall be used when pipe cover is less than 2'. Refer to VDOT standards for maximum depth of cover for a pipe class.
3. Non-residential projects shall be in accordance with VDOT standards.

B) HDPE and PVC Pipes

1. The maximum size allowed is forty eight (48) inches. However, in locations within the state right-of-way and where approved by VDOT, maximum culvert size may be sixty (60) inches
2. The maximum cover shall comply with VDOT standards. The minimum cover (not including any asphalt pavement section within roads or driveways) shall be eighteen (18) inches under roads and six (6) inches under driveways.
3. HDPE pipe shall conform to ASTM F2306/F2306M-05 "Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications". PVC Pipe shall meet the requirements of ASTM F949, "Standard Specification for Polyvinyl Chloride Corrugated Sewer Pipe with Smooth Interior and Fittings."
4. Joints for HDPE and PVC shall conform to ASTM D3212, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals". Gasket shall meet or exceed the requirements of ASTM F477-07, "Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe."
5. 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.
6. In residential installations, 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. Pipe in non-residential setting shall require visual inspections to ensure proper installations with requirements similar to residential installations.
7. HDPE and PVC pipes will be the materials of preference in sites of proven acidity or alkalinity with potential adverse effects on concrete pipes.

2.6.2 Overland Flow

An adequate and safe overland flow path for the one hundred-year ultimate condition storm must be shown on design plans in case of storm sewer blockage. . If requested by the County, detailed cross sections and a water surface profile computation shall be provided where flooding of structures could be possible. For storm sewers, use 100 percent inlet blockage (non-operative inlet) to model overland relief. For culverts, use the following blockage parameters.

Culvert Inlet Diamete	Blockage
< 24 inches	100 %
24-48 inches	50 %
> 48 inches	25%

2.6.3 Culvert Placement

In a channel used by anadromous fish, the outlet end of the culvert pipe should always be slightly submerged. If multiple pipes are to be installed, the invert of one pipe should be at least 6 inches below that of all the other pipes on the inlet end, and the outlet end of that pipe should be slightly submerged.

2.7 Residential Lot Drainage

A) A lot grading plan must be approved by the County prior to issuance of a building permit. Drainage for single family lots must be designed to function with the drainage system plan for the entire development site. When possible, grading plans for single lots should be incorporated in the construction or site plan for the project.

B) Lots must be graded to provide positive drainage away from the house. A minimum drop of 6 vertical inches must be provided within 10 horizontal feet measured at a right angle to the wall of the house.

C) Natural streams and improved channels must not be erosive. Where possible, open unimproved streams on lots smaller than one acre must be avoided.

D) Lots generally must be graded to divert runoff to a ditch or swale along lot lines. Large volumes of runoff in swales between houses should be avoided. Drainage systems should be designed so that runoff passing between a pair of houses originates on those two lots rather than bringing large volumes of runoff from several lots together before passing it between two houses.

E) In general, runoff exceeding 3 cfs for the ten-year storm event that flows through lots must be piped when average lot size is less than 30,000 square feet. The Program Administrator may approve an open channel system in order to preserve a natural drainage way or when it can be shown that use of an open channel will not interfere with the use of the property. This requirement does not apply to Runoff Reduction sites that utilize a full runoff reduction design as described in Section 3.8.

F) Residential lots in which lot size is less than 30,000 square feet must be graded so that surface runoff does not cross more than three lots before it is collected in an underground storm sewer system or engineered stormwater conveyance channel which provides required freeboard. Where lot layout does not permit the design of an appropriate channel and easement, an underground storm sewer must be provided.

G) Yard inlets for storm sewer systems must be designed for the ten-year storm event. Any area subject to water ponding must be within a storm drainage easement.

H) Except for driveway culverts, headwalls constituting the beginning of the underground storm drain system shall not be allowed within residential lots.

I) Lot grading, siting and elevations of residential structures must be such that no flooding of structures will result from ponding or overflow of pipe systems during the one hundred-year storm. Proposed lowest floor elevations and wall penetrations must be no less than one foot above the 100-year flood elevation.

3 Stormwater Management Facility Design

3.1 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.

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.

3.2 On-Site Stormwater Management Facilities

In general, 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 Concept Plan.

Conventional SWM facilities must be designed and constructed to conform to the Virginia Stormwater Management Handbook, Volumes I and II, prepared by the Virginia Department of Conservation and Recreation dated 1999, as amended. Integrated management practices must be designed and constructed to conform to those handbooks and the Low Impact Development Design Manuals. Conventional SWM facilities shall be platted on separate tracts intended for that purpose.

For SWM ponds that will initially serve as temporary sediment basins during construction, it is required that they be constructed in accordance with the design for stormwater management and then modified to serve temporarily as sediment basins. The outlet structure modifications usually involve partial blocking of the weir opening(s) and a larger orifice shall be designed to accommodate dewatering device for sediment basin. After the sediment has been removed the required diameter for water quality orifice is achieved, usually by installing (a) a metal orifice plate attached to interior of the outlet structure, (b) a PVC cap w/hole of proper size, (c) grouting a short segment of PVC pipe.

All riser structures must be concrete unless a substitute material has been specifically approved by the Program Administrator.

Easements must be provided for stormwater management facilities in accordance with requirements in Chapter 6 of this manual.

3.3 Stream Channel Erosion Control and Flood Protection

Channel protection and flood protection shall be addressed in accordance with the minimum standards set out in Clarke County Stormwater Ordinance, Section 147-4-D, which are established pursuant to the requirements of Virginia Stormwater Management Law §10.1-603.4(7).

3.4 Water Quality

The BMPs listed in Table 1 in Appendix 1 or the BMPs available on the Virginia Stormwater BMP Clearinghouse website (http://www.vwrrc.vt.edu/swc/) shall be utilized to effectively reduce the pollutant load in accordance with the Pollutant-Runoff Reduction Spreadsheet.

The specific criteria to determine if Level 1 or Level 2 design factors apply can be found in Appendix C of Technical Bulletin No 4 "Technical Support for the Bay-wide Runoff Reduction Method" developed by the Chesapeake Stormwater Network (http://www.chesapeakestormwater.net/stormwater-research-highlights/)

3.5 Regional Stormwater Management Facilities

Regional SWM facilities must be implemented in accordance with Regional SWM Study and adopted stormwater management plans and must be designed and constructed to conform Clarke County Chapter 147-4-C and the Stormwater Management Ordinance and to the Virginia Stormwater Management Handbook, Volumes I and II, prepared by the Virginia Department of Conservation and Recreation dated 1999, as amended.

Easements must be provided for stormwater management facilities in accordance with requirements in this manual.

3.6 Geotechnical Study Requirements

A geotechnical study, as described in Section 6-H-14. Sinkhole and Karst Features of the Zoning Ordinance and Code Section 143-9-H, Subsurface Investigations, consisting of a field investigation, laboratory testing, and a geotechnical engineering analysis with recommendations is required as part of the design for all detention basins, retention basins, infiltration facilities, bioretention facilities, constructed wetlands, and underground detention facilities. Geotechnical studies for other types of BMP facilities may be required on a case-by-case basis depending upon the complexity of the proposed facility design 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 Design 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:

A) Identification and description of the proposed facility.

B) Site map showing locations of soil borings and test pits.

C) Soil logs containing unified soil classification system (USCS) by depth.

D) Depth to seasonal water table and bedrock.

E) Degree of mottling and chroma of mottles.

F) Presence of porous or fractured bedrock, mica schist, and iron pyrite.

G) Other soil properties as deemed appropriate by the geotechnical engineer.

H) Geotechnical engineer's recommendations.

For infiltration practices, including bioretention facilities associated with runoff reduction designs, 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.

Appropriate subsoil infiltration rates are 0.52 – 8.27 inches per hour (Virginia Stormwater Management Handbook Section 3.10, page 3.10-5); however, the Handbook also requires that a factor of two be applied to the minimum infiltration rate as a margin of safety against clogging over the lifetime of the facility (Virginia Stormwater Management Handbook, Section 3.10, page 3.10-14). Therefore, the report must indicate a subsoil infiltration rate between 1.04 and 8.27 inches per hour.

3.7 Stormwater Management Plan Elements and Submission Requirements

3.7.1 Concept Plan

During the concept phase, the engineer shall demonstrate, conceptually, how the runoff reduction practices with bioretention and/or other environmentally sensitive site design practices will be incorporated into the Plan.

During the conceptual phase, the engineer shall evaluate the feasibility of creating a hydrologically functional site design that satisfies the overall objective by completing the Runoff Reduction Site Design Checklist found in Appendix 1 and Runoff Reduction Computations Worksheet http://www.dcr.virginia.gov/lr2f.shtml. The procedures in the checklist are aimed at disconnecting and minimizing the impervious areas and planning drainage flow paths so that the post development time of concentration can be maintained as close as possible to the predevelopment conditions. Maximizing the runoff travel time to closely approximate the predevelopment conditions is among the very first steps in runoff reduction design. The concept phase should occur concurrently with the preliminary plan submission, when applicable.

The engineer should provide general information on preliminary soil test results to confirm the suitability of onsite soils for runoff reduction practices with the Concept Plan. The Soil Survey of Clarke County, Virginia, may be used during the conceptual stages, with other supplemental information as needed.

For details on concept plan requirements, refer to Chapter 4.

3.7.2 Design or Construction Plan

Once the SWM concept has been approved by the County, the engineer may submit a Stormwater Management Design Plan to address SWM. In this phase, the engineer will determine how to distribute the bioretention and other environmentally sensitive design practices uniformly across the site by emphasizing on a source control approach. In this iterative phase, the engineer shall develop a plan to meet the SWM requirements. A detailed geotechnical report is performed at this time, or earlier, to evaluate the on-site soils for runoff reduction suitability.

In situations where bioretention facilities are proposed within individual lots, the engineer shall describe the coordination process between the developer and the builder in reference to the construction of bioretention facilities within individual lots. For properties with bioretention facilities and runoff reduction components within individual lots, the County will not issue the building occupancy permits until these facilities and any other runoff reduction facilities shown on the plan within the lots are constructed.

The storm water management plan shall include a hydrologic/hydraulic analysis of the downstream watercourse for all concentrated surface waters that will be discharged from a developed property.

As a minimum, the final storm water management plan shall contain the following:

1. **Stormwater Management Design Plan**: A stormwater management design plan containing all appropriate information as specified in this Manual shall be submitted to the Program Administrator in conjunction with the final subdivision plat, final site plan, construction plan, or any other land development plan subject to this ordinance.

2. **Application Requirements:** The stormwater management design plan submittal shall contain a completed application form provided by the Program Administrator, the fee required by Section 147-3-I, a stormwater management design plan that satisfies the requirements of this section and the Stormwater Design Manual, a stormwater maintenance plan, and a certification stating that all requirements of the approved plan will be complied with. Failure of the owner to demonstrate that the project meets these requirements, as determined by the Program Administrator, shall be reason to deny approval of the plan.

3. **Consistency between Concept & Design Plans:** Any discrepancies between the concept and design plans should be documented by the applicant.

4. **Stormwater Management Design Plan Content:** The stormwater management design plan shall contain maps, charts, graphs, tables, photographs, narrative descriptions, explanations, citations to supporting references, a record of all major permit decisions, and other information as may be necessary for a complete review of the plan, and as specified in the latest version of the Chapter 5 of the Stormwater Design Manual.

3.7.3 Plan Processing and Approval

1. Stormwater management plans shall be submitted for review and be approved prior to commencement of land-disturbing activities. Stormwater management plan review shall begin upon submission of a complete plan. A complete plan shall include the all elements described in Chapters 4 and 5 of this Manual.

2. Elements of the stormwater management plans shall be appropriately sealed and signed by a professional in adherence to all minimum standards and requirements pertaining to the practice of that profession in accordance with Chapter 4 of Title 54.1 of the Code of Virginia and attendant regulations.

3. Completeness of a plan and required accompanying information shall be determined by the Program Administrator, and the applicant shall be notified of any determination, within 15 calendar days of receipt.

    a. If within those 15 days the plan is deemed to be incomplete based on the criteria set out in Section 147-3-B-5, the applicant shall be notified in writing of the reasons the plan is deemed incomplete.
    b. If a determination of completeness is made and communicated to the applicant within the 15 calendar days, an additional 60 calendar days from the date of the communication will be allowed for the review of the plan.
    c. If a determination of completeness is not made and communicated to the applicant within the 15 calendar days, the plan shall be deemed complete as of the date of submission and a total of 60 calendar days from the date of submission will be allowed for the review of the plan.
    d. The Program Administrator shall act within 45 days on any plan that has been previously disapproved and resubmitted.

4. During the review period, the plan shall be approved or disapproved and the decision communicated in writing to the person responsible for the land-disturbing activity or their designated agent. If the plan is not approved, the reasons for not approving the plan shall be provided in writing. Approval or denial shall be based on the plan's compliance with the requirements of this chapter as determined by the Program Administrator.

5. If a plan meeting all requirements of this chapter and the Program Administrator is submitted and no action is taken within the time specified above, the plan shall be deemed approved.

6. Notwithstanding the requirements of Section 147-3-B-5, if allowed by the Program Administrator, an initial stormwater management plan may be submitted for review and approval when it is accompanied by an erosion and sediment control plan, preliminary stormwater design for the current and future site work, fee form, and 50% of the fee

required by Section 147-3-I. Such plans shall be limited to the initial clearing and grading of the site unless otherwise allowed by the Program Administrator. Approval by the Program Administrator of an initial plan does not supersede the need for the submittal and approval of a complete stormwater management plan and the updating of the erosion and sediment control plan, Virginia Stormwater Management Permit and/or SWPPP prior to the commencement of activities beyond initial clearing and grading and other activities approved by the Program Administrator. The initial plan shall include information detailed in Section 147-3-B-10 to the extent required by the Program Administrator and such other information as may be required by the Program Administrator.

7. Each approved plan may be modified in accordance with the following:

a. Modifications to an approved stormwater management plan shall be allowed only after 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 requests.

b. Based on an inspection, the Program Administrator may require amendments to the approved stormwater management plan to address the noted deficiencies and notify the permittee of the required modifications.

4 Stormwater Management Concept Plans

4.1 Introduction

The Clarke County Zoning Ordinance requires all site plans to include a Stormwater Management Concept Plan describing, in general, how stormwater runoff through and from the development will be conveyed and controlled. 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 intended to depict only the elements of a workable stormwater management concept for the proposed development.

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).

Stormwater Management Concept Plans for non-residential development should be prepared in accordance with this chapter and presented in five copies to the Department of Planning and Zoning. Concept Plans for residential development should be prepared in accordance with this chapter and submitted to the Department of Planning and Zoning in conjunction with the Subdivision Preliminary Plan. Application and review fees will apply. A deposit must be paid at the time of application with the balance due before second review or upon final disposition of the application.

4.2 Stormwater 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.

A Stormwater Management Concept Plan contains four main components; a summary, a narrative, illustrative drawings, and computations. The following paragraphs describe the information to be provided as a minimum for all sites.

4.3 Summary

This section of the Stormwater Management Concept Plan is a one-sheet synopsis of the project containing essential information about the project to be included in the plan set. Provide an information summary sheet with at least the following information included:

A) A vicinity map including north-orienting arrow

B) A summary table of all drainage outfalls, their contributing drainage areas, and the percentages of existing and proposed impervious cover.

C) A summary table of all the soil types found on the project site (including % of cover). Do not include types not found on the site.

D) Identification of the FEMA FIRM Panel Number(s) for the entire site and a copy of such maps showing site location.

E) A statement as to whether any waiver requests apply or are being sought for the project and the nature of any such requests.

F) A statement as to how runoff reduction site planning to the maximum extent practicable was utilized during development of the stormwater management concept and whether it resulted in a full, partial, or limited runoff reduction design concept for the site.

G) A list of all other State and Federal permits expected to be required for the project.

H) Text size on all plans shall be at least 0.1 inch.

I) Schematic sketch on which hydrologic and hydraulic analyses are based.

4.4 Narrative

This section of the Stormwater Management Concept Plan consists of a narrative description used to describe and relate the other components of the plan to each other. The narrative, not the drawings, is the centerpiece of the plan. It should address the features shown in the illustrative drawings provided. The narrative must include the following as a minimum:

A) A description of existing land use and drainage at the site, including natural drainage and any existing constructed drainage and stormwater management systems.

B) A description of wetlands on the site. Delineate these in the illustrative drawing section of the plan.

C) The location of all points of stormwater discharge, receiving surface waters or karst features into which the stormwater discharges.

D) The number and a general description of conveyances at each point where shallow concentrated flow or channel flow crosses the project limits. Show these points in the illustrative drawing section of the plan.

E) A description of existing hydraulic conditions of the conveyances downstream of each point identified above.

F) A description of the proposed development and, in general, its impact upon the existing drainage as described above. In addition, include:

1. A description of the impacts upon wetlands presented by the proposed project. Illustrate these impacts, as appropriate, in the illustrative drawing section of the plan.
2. A description of the impacts upon one hundred-year floodplains areas presented by the proposed project. Illustrate these impacts, as appropriate, in the illustrative drawing portion of the plan.

3. A statement as to whether a full, partial, or limited runoff reduction design is proposed for the site.
4. A description of on-site drainage and stormwater management features proposed for required control of water quantity and water quality. Show locations of these in the illustrative drawing section of the plan. Provide initial design data and computations in the computations section of the plan to indicate that the proposed siting is likely to work (e.g., large enough area, great enough infiltration rate, etc.).
5. If off-site facilities will be relied upon to provide all or part of the required control, provide a description of those facilities and demonstrate on the plan that they will meet the requirements. Provide a drawing in the illustrative drawing section of the plan that shows the location of the off-site facility relative to the site and the conveyance features that transport runoff from the site to the facility. Provide data and computations to indicate the adequacy of these conveyance features to transport runoff from the site to the facility.

G) A description of conveyances downstream of each outfall including an initial determination as to whether the conveyance will be adequate. Support this assessment in the calculations section of the plan.

H) Contact Information including the name, address, and telephone number of the property owner and the tax reference number and parcel number of the property or properties affected.

I) A discussion of any local, state, or federal permits necessary for the proposed development.

J) For multi-phase projects, a schedule of facility construction indicating stormwater management and drainage requirements will be met as each phase of construction is completed.

K) A copy of any request for exception to stormwater management requirements being sought pursuant to Section 147 of the Clarke County Code. See the Section 147-4-L for additional information.

L) A description of parties that will be responsible for maintenance of runoff reduction practices located on individual building lots and the legal documents that will be recorded to ensure such maintenance. See Section 8.3 herein for additional information.

4.5 Illustrative Drawings

4.5.1 Existing Conditions

This section of the Stormwater Management Concept Plan consists of one or more drawing(s) used to illustrate conditions at the site at the start of the project. Provide one or more drawing(s) of the site at a clearly legible scale including the following, as a minimum:

A) The property lines of the proposed site. If the property lines do not describe the project limits, show the project limits. Indicate in the narrative the authority required to work outside the property limits.

B) The boundaries of each soil type on the site. The scale of the soils map shall be the same as that used in the site plan or construction plan. Label each area with soil symbol and provide a table with soil name, hydrologic soil group, and whether or not the soil is hydric. All the types shown in the table in the summary section of the plan should be shown. (Soil borings may be required where infiltration facilities are proposed. If so, show boring locations, as well.).

C) Geologic formations, karst features, forest cover, and other vegetative areas.

D) Boundaries of wetlands found on the site.

E) Boundaries of the one hundred-year floodplains as shown on the most current FEMA Flood Insurance Rate Maps for Clarke County with the project limits shown and with a reference to the map panel numbers.

F) A statement as to whether a Floodplain Study may be required. Note: 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.

G) Current land use including existing structures, roads, and locations of known utilities and easements.

H) Site topography with contours at least every five feet in elevation. Contours must be clearly labeled. Electronic versions of such topography generally available for site in Clarke County from the Department of Planning and Zoning.

I) All points where shallow concentrated flow or channel flow crosses the project limits. Number or letter these for cross-reference.

J) Receiving surface waters or karst features into which stormwater will be discharged.

K) Drainage areas to each point described above. Drainage area boundaries must indicate flow direction and must respect the underlying contours upon which they are drawn. Refer to each area using the number or letter given to its point of analysis. Label each area as to its size in acres. When drainage areas delineated in this way extend beyond the project boundaries, these off-site areas, and the underlying topography, must be shown.

L) The location of any existing water supply wells and septic systems.

M) DO NOT SHOW ANY PROPOSED DEVELOPMENT on drawings depicting existing conditions.

4.5.2 Proposed Conditions

This section of the Stormwater Management Concept Plan consists of one or more drawing(s) of the site at a clearly legible scale including the following, as a minimum:

A) The property lines of the proposed site as shown on drawings for existing conditions.

B) The boundaries of each soil type with soil symbols on the site as shown on drawings for existing conditions.

C) Boundaries of wetlands found on the site as shown on drawings for existing conditions. Show changes in boundaries caused by proposed development using different, more prominent line weight, style or shading.

D) Site topography as shown on drawings for existing conditions. Show proposed changes to existing contours using a different, more prominent line weight and style. Proposed changes should honor natural drainage divides to the maximum extent practicable. Contours must be clearly labeled.

E) All points where shallow concentrated flow or channel flow crosses the project limits. Label these with a number or letter for cross-reference. To honor natural drainage divides, these points should be the same as those for existing conditions to the maximum extent practicable.

F) Drainage areas to each point described above. Delineation of existing and proposed onsite drainage divides which use outfalls from the site as study points. Drainage area boundaries must indicate flow direction and must respect the underlying contours upon which they are drawn. Refer to each area using the number or letter given to it's point of analysis. Label each area as to its size in acres. When drainage areas delineated in this way extend beyond the project boundaries, these off-site areas, and the underlying topography, must be shown.

G) Delineation of the location of the one hundred-year floodplain limits overlaid on a drawing of the site development.

H) If private water or sewer systems are proposed, the location of proposed water supply wells and septic filter fields when infiltration facilities are proposed.

I) Sufficient information on adjoining parcels to assess the impacts of stormwater from the site.

J) The limits of clearing and grading, and the proposed drainage patterns on the site, proposed buildings, roads, parking areas, utilities.

K) Locations and type of proposed stormwater management facilities and runoff reduction integrated management practices needed to provide required stormwater quantity and quality control including the location of proposed access to facilities.

L) Proposed land use with tabulation of the percentage of surface area to be adapted to various uses, including but not limited to planned locations of utilities, roads, and easements.

4.6 Computations

This section of the Stormwater Management Concept Plan consists of data and computations, which support the drainage and stormwater management elements proposed. Computations showing a completed design are not required; however, those computations shown must be

complete and according to the Pollutant - Runoff Reduction Method contained within the Virginia Stormwater Management Handbook Runoff Reduction Method.

4.7 Requests for Exception

Exceptions to the minimum stormwater management requirements of the Clarke County Code[1] may be granted by the Program Administrator, upon receipt in writing from the applicant or property owner. Such requests are best made in conjunction with the Stormwater Management Concept Plan since they must be accompanied by descriptions, drawings, calculations, and other information necessary to evaluate the request—all of which are to be included in the Stormwater Management Concept Plan.

The request must be made in writing (separately from the Stormwater Management Concept Plan submission) and must be signed by the applicant or property owner. Exceptions may be granted as outlined in Clarke County SWM Ordinance §147-4-L.

4.7.1 Minimum Conditions

To grant an exception to the stormwater management provisions of the Clarke County Code, the applicant must show at least one of the following:

A) That the proposed development is not likely to impair the attainment of the objectives of the stormwater management provisions of the Clarke County Code.

B) That meeting the minimum on-site requirements is not feasible due to the natural or existing physical characteristics of the site.

C) That the location of the project in the watershed is such that on-site stormwater management may result in increased flows on the main stream. (This must be supported by hydrologic analysis or demonstration that the entire project site is less than 1 percent of the drainage area to a point of analysis on the property.)

D) That proposed development will cause no more than a ten-percent increase in the two-year and ten-year discharge rates AND the on-site and off-site receiving channels are adequate.[2]

E) That an *existing* on-site facility provides the required controls.

F) That an *existing* regional stormwater management facility provides the required controls and the property owner agrees to a pro-rata share contribution.[3]

G) That a regional stormwater management facility has been identified for construction in the Clarke County Land Use Plan which will provide the required controls, AND the property owner agrees to construct all necessary interim stormwater management controls deemed necessary by the Program Administrator, AND the property owner agrees to a pro-rata share contribution.[3]

4.7.2 Submission Requirements

Requests for exception must:

A) Specify the specific provision(s) of Clarke County Code from which relief is being sought.

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

1. Stipulate which one or more of the condition(s) necessary to grant the waiver is true for the exception being requested.
2. Demonstrate with descriptions, drawings, calculations, and other information that the condition(s) necessary to grant the waiver exists in fact.

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

1 Chapter 147, Stormwater Management

2 Refer to Minimum Standard 19 (4VAC50-30-40.19) for adequate channel definition.

3 See Section 147 of the Clarke County Code.

5 Stormwater Management Design Plans

5.1 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 Stormwater Management Design Manuals and other guidance documents listed in Chapter 1 of this manual should be consulted for details of these requirements. Requirements for stormwater management facilities other than storm drainage, retention and detention basins and bioretention and biofilter facilities are not summarized in this chapter. The designer must provide all the information needed to support the stormwater management design. The Design and Plan Review Checklists provided in the Chapter 3 Appendix of the Virginia Stormwater Management Handbook and in Chapter 9 of this Manual should be utilized to ensure all the necessary information is included.

5.2 Stormwater Management Design Plan Requirements

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 plans. Information which is unclear, ambiguous, or overcrowded may be rejected as though it were not presented in the plan.

The following is the suggested contents and order of a Stormwater Management Design Plan:

1) A copy of the approved Stormwater Management Concept Plan for the project
2) Summary Sheet (including Project Description)
3) Overall Development Plan
4) Drainage Area Map(s)
5) Plan View(s) of proposed drainage and stormwater management
6) Profile View(s) of proposed drainage and stormwater management with computations
7) Construction details for non-standard drainage structures and stormwater management facilities
8) Erosion and Sediment Control Plan
9) Maintenance plan for stormwater management facilities and recommendations from geotechnical study report
10) Computations

5.3 Summary Sheet

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

A) General information including project name, plan preparer, date of drawing, legend, graphic scale and north arrow.

B) A narrative description of project and proposed design indicating how site drainage, water quality, and water quantity requirements are addressed in the stormwater management design. Highlight areas where the SWM Design Plan differs from the approved SWM Concept Plan.

C) A description of any areas of the SWM Design Plan that depart from the proposal shown in the approved SWM Concept plan.

5.4 Overall Development Plan

Provide a drawing of the overall development at a scale to contain the project development on a single sheet. Include the property line of 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 authority to develop. Include a project schedule including sequence of construction. If this is included in the erosion and sediment control narrative, reference it in this section of the plan.

5.5 Drainage Map

Include a map showing onsite and offsite drainage areas at a scale of 1 inch to 200 feet or larger. A smaller scale may be used when a large offsite area is involved. The following items are required as a minimum:

1. **Property Line of Development 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 develop.
2. **Existing Contours**. Show the existing contours of the site at one- or two-foot intervals. Contours must be clearly labeled.
3. **Final Contours**. Show changes to the existing contours using different line weight and style. Contours must be clearly labeled.
4. **Stormwater Outfalls**. Indicate the points along the property line or project limits where stormwater runoff leaves the site.
5. **Land Uses**. Delineate existing and proposed land uses. Indicate the size of each area delineated in acres.
6. **Soils**. Show the boundaries of different soil types and soil symbols.
7. **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.
8. **Existing and Proposed Drainage**. Show stormwater outfalls and drainage areas for both existing and proposed conditions.

9. **Drainage to Structures**. Delineate the drainage areas to all existing and proposed drainage structures and stormwater management facilities.
10. **Structure Labels**. Provide structure numbers and labels for drainage system and stormwater management facility structures for cross-referencing computations.
11. **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.
12. **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.

5.6 Plan View

The stormwater management design must be illustrated in plan view(s) showing, as a minimum, the following information:

5.6.1 General

A) The property line of development project.

B) Name of adjacent and confronting property owner(s) and tax map parcel number(s).

C) Sufficient information on adjoining parcels to assess the impacts of stormwater from the site, including locations of septic fields and wells.

D) Existing and proposed contours at one- or two-foot contour intervals.

E) Floodplains as shown on the most recent FEMA map.

F) The extent of wetlands, geologic formations, karst features, forest cover, and other vegetative area.

G) Proposed buffers and conservation easements.

H) Soils information with hydrologic soil groups identified.

I) Current land use including existing structures, roads, and locations of known utilities and easements.

5.6.2 Storm Drainage Systems

A) Structure numbers.

B) Existing and proposed storm drainage and access easements.

C) Drainage pipes showing diameter.

D) Proposed roads showing high and low points locations and elevations.

E) Grading and spot elevations at outflows, headwalls, and over storm sewer systems.

F) Path of overland relief using arrows.

G) House locations where critical to assess adequacy of drainage.

H) The one hundred-year headwater pool at proposed culverts and storm drainage structures except driveway culverts.

I) Spot elevations showing the limits of the 100-year flood elevations resulting from blocked conditions at inlets.

J) The location of existing and proposed utilities.

K) Required easement(s).

5.6.3 Stormwater Management Detention and Retention Facilities

A) The location and topography of the facility including impoundment, embankment(s), primary outlet structure elements.

B) The location and topography of all emergency spillways and outlet channels of the design.

C) Outlet protection and outfall channel details.

D) The location of soil borings made to support soils studies and geotechnical recommendations.

E) Delineation of one-, two-, ten-, and one hundred-year pools in detention and retention basins. Also delineate the Water Quality elevation.

F) Delineation of the "normal pool" in retention basins.

G) Dry and wet weather flow paths in extended detention basins and stormwater wetlands which eliminate short circuiting. Flow paths shall be indicated with spot elevations and slopes and shall have adequate gradient to ensure positive flow to outlet structure.

H) Maintenance access.

I) Location of required easements.

5.6.4 Bioretention and Biofilter Facilities

A) The location and topography of the facility including impoundment, berms and overflow structure.

B) The location and distances to adjacent pavements, buildings, septic fields and wells.

C) The location of soil borings and infiltration test pits.

D) Delineation of ten-year water elevations and Water Quality pools.

E) Maintenance access.

F) Location of required easements.

5.7 Profile View

The stormwater management design must be illustrated in profile view(s) showing, as a minimum, the following information:

5.7.1 Storm Drainage Systems

A) Structure numbers

B) Size, type, class, length and slope of pipe or structure

C) Existing ground and proposed grade at channel centerline and both banks

D) Ten-year discharge, velocity and friction slope

E) Ten- and one hundred-year water surface elevations at entrances and outfalls

F) Outfall protection length, depth and class

G) Pipe inverts and drainage structure top and bottom elevations.

H) Utility crossings and inverts. Indication of required clearances with utility lines

I) Ten-year hydraulic grade line

J) Typical cross section(s) for stormwater conveyance channels and storm drain outfalls

K) Bottom width, height, existing ground side slope and type of stabilization and ten-year water surface elevation for channels

L) Scale for profile(s) shall be no less than 1”:50’ and 1”:5’ horizontal and vertical respectively

5.7.2 Stormwater Management Facilities

A) Principal spillway profile shall be drawn to scale and include the following:

B) Existing ground and proposed grade

C) Dam side slopes and Top width

D) Core and cut-off trench showing bottom width, side slopes and depth

E) Riser Structure

F) Barrel including materials and class, inlet and outlet invert, size and slope, location of phreatic line, seepage control elements

G) Elevations of top of dam (constructed and settled), crest of emergency spillway, crest of riser structure, and inverts of orifices and weirs

H) Water quality, one-, two-, ten-, and one hundred-year pool elevations

I) Bottom of pond elevations

J) Profile along embankment centerline shall include

K) Existing ground and proposed grade

L) Core and cut-off trench showing depth and top elevation

M) Elevations of top of dam (constructed and settled), crest of emergency spillway

N) Location and elevation of principal spillway

O) Preferred scale for profile and cross-sections of embankments shall be 1”=20’ and 1”=2’ horizontal and vertical respectively

5.7.3 Bioretention and Biofilter Facilities

A) The following must be shown to scale in profile, as a minimum;

B) Elevation of excavation bottom

C) Elevations, materials of all backfill materials, including mulch layer

D) Underdrain pipe size, type, and length

E) Weir and orifice invert elevations

F) Observation well / cleanout pipe

G) Slopes of adjacent ground along the overland flow path

5.8 Construction Details

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

A) Design detail when not using standard structure

B) Site preparation notes

C) Sequence of construction if not included on ESC plan

D) Dam construction notes including Material and compaction specifications

E) Concrete construction notes

F) Riser Structure detail including materials, dimensions and elevations for all elements, weir length and width, and orifice diameter

G) Trash rack detail as required for construction

H) Anti-vortex detail as required for construction

I) Structure footing and Outlet pipe bedding detail,

J) Outfall protection with section detail as required for construction showing rip-rap size, class, bottom width, side slope, filter cloth, etc.

K) Bioretention planting plan and schedules and planting details

L) Soil mix specification for bioretention

M) Underdrain type, size and perforation size and spacing

N) Site stabilization notes

O) Schedule of required inspections

5.9 Erosion and Sediment Control Plan

The Stormwater Management Design Plan must include a complete Erosion and Sediment Control Plan in accordance with the suggestions and requirements in Chapter 6 of the Virginia Erosion and Sediment Control Handbook and Chapter 148 of the Clarke County Code. Information required elsewhere (soils information, for example) need not be duplicated in the Erosion and Sediment Control portion of the Stormwater Management Design Plan.

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

5.10 Maintenance Plan for Stormwater Management Facilities

Maintenance plans must be provided for all stormwater management facilities and integrated management practices. These plans must be included in the stormwater management design plan. Sample plans are located in appendices 13 through 19 to this manual, 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 stormwater management design. 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.

Maintenance plan shall include identification of financially responsible parties, through which the facilities will be operated and maintained during and after construction activity.

5.11 Computations

This section of the Stormwater Management Design Plan consists of data and computations, which support the drainage and stormwater management elements of the design. Computations showing a completed design according to accepted engineering practices given in the design manuals listed in Chapter 1 are required.

Computations must be provided which support all the hydrologic and hydraulic elements of the design and shall include as a minimum:

A) Good engineering practices and calculations verifying compliance with the water quality and quantity requirements of this chapter.

B) A completed Runoff Reduction Site Design Checklist and Runoff Reduction Calculations Worksheet for each drainage area in which a full or partial runoff reduction design is to be utilized.

C) Compiled information on predevelopment conditions such as soils, slopes, land use, and imperviousness (connected and disconnected).

D) A narrative that includes a description of current site conditions and proposed development and final site conditions, including proposed stormwater management facilities and the mechanism.

E) Evaluated site planning alternatives, the locations of bioretention facilities, if applicable and comparison with baseline predevelopment conditions.

F) Evaluated Runoff Reduction Practices. The location of runoff reduction practices should be identified on the site. Comparison with the baseline by accounting for the hydrologic mitigation from runoff reduction practices.

G) Evaluation of whether supplemental measures are needed to control peak or volume of runoff.

H) Hydrologic and hydraulic computations for storm drains including HGL computations.

I) Hydrologic and hydraulic computations of the pre-development and post-development runoff conditions for the required design storms, and water quality computations for stormwater management facilities.

J) Design computations as required by design guidelines being followed, *e.g.* buoyancy computations for riser structures, emergency spillway and conveyance channel computations, outfall analyses, etc.

K) Geotechnical Report prepared by a licensed geotechnical engineer including soil boring locations and logs.

L) A completed checklist for stormwater detention ponds (see Virginia Stormwater Management Handbook checklists).

6. Easements

6.1 Stormwater Drainage Systems

Within any land development project, stormwater drainage easements must be provided for all improved stormwater drainage systems. Storm drainage easements must be provided for existing or improved swales and channels receiving runoff from more than two lots or flows >3 cfs .

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 drainage systems.

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

Adequate access easements must be provided to any storm drainage easement.

6.2 Easement Width Requirements

6.2.1 Open Systems

Easements must be provided in accordance with the following table:

Top Width of Channel (ft)	Minimum Easement Width (ft)
Less than 2	15
2 – 5	20
5 -10	25
Greater than 10	15 ft greater than top width of channel

A minimum of 10 feet of the above easement must be on one side of the channel.

6.2.2 Storm Sewers

Diameter of Pipe (in)	Minimum Easement Width (ft)
15 - 18	15
21 -33	20
36 - 48	25
54 - 72	30

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 60 inches in diameter, the easement width must be increased by 5 feet. For dual pipes each greater than 60 inches in diameter, the easement width must be increased by 10 feet.

Storm drainage easement for inlets shall encompass 10-year ponding elevation.

6.2.3 Stormwater Management Facilities

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

Storm drainage easements must be shown on the record plat and on the Stormwater Management Design Plan.

A) Easements for conventional retention, detention and infiltration basins must encompass pond area, embankment and outlet structures. The easement must be located a minimum of 25 feet horizontal distance outside of the one hundred-year pool area.

B) For bioretention facilities, the easements shall correspond to the 9" ponding elevation over these facilities plus a width of 10 feet around the facilities.

C) A 10-foot-wide access easement, clear of any obstructions, shall be provided for the maintenance of bioretention facilities except when the facility shares a minimum 10-foot-long boundary with a public right-of-way and drainage easement.

D) Easements for underground storage facilities are required. The Program Administrator must determine easement size for pipes larger than 72 inches and for underground storage chambers

The Program Administrator may require provisions within the Home Owners' Association (HOA) document to facilitate the County's inspection of in-lot bioretention facilities. The homeowners will be required to conduct minor maintenance of bioretention and associated drainage areas leading into or out of bioretention areas. Also, specific language needs to be incorporated into HOA document that identifies an approach to encourage the homeowners to adhere to minor maintenance of bioretention facilities. The County may seek periodic assistance from HOA to notify homeowners of County's inspection dates for the bioretention facilities.

6.2.4 Access Easements

Access to stormwater management facilities and integrated management practices from public routes must be provided. These must be within access easements with minimum width of 15 feet.

A minimum 12-foot-wide access road with a maximum grade of 15% and accompanying access easement should be provided to allow vehicular access to both the outlet structure area and at least one side of the basin. The road's surface material should be selected to support the anticipated frequency of use and the anticipated vehicular load without excessive erosion or damage. Refer to Appendix 21.

7. Construction Inspections and As-Built Plans

7.1 Inspections

Construction inspections are required to ensure that stormwater management facilities and stormwater drainage systems are being constructed in accordance with the approved design plan. It is critical that these inspections be scheduled to allow for inspection of subsurface components that will be impossible to visually inspect after backfilling. At a minimum, the inspections shall be conducted at all stages identified in sections 7.2 and 7.3 below. The developer is responsible for maintaining a written report or log containing dates and times of inspections and comments concerning verbal communications relating to the project throughout the course of construction. All reports shall be submitted to the County on a weekly basis and shall be included as a background documentation for project record drawing submission. Variations from the approved design plan shall be discussed with Clarke County's Program Administrator before any variation is implemented and may require submission of a revised design plan.

7.2 Geotechnical Inspections

Geotechnical inspections under the direction of a geotechnical engineer shall be performed during the construction of a stormwater management facility.

7.2.1 Inspection Requirements

7.2.1.1 Detention and Retention Basins

No fill may be placed in a core (cutoff, key) trench until the geotechnical engineer has inspected the trench and approved the location, shape and depth of the trench. The geotechnical engineer shall inspect all fill placed in the core trench and in the dam and shall ensure use of proper compaction methods for all materials placed. The geotechnical engineer shall ensure that no objectionable materials are placed in the trench or in the dam. 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. The geotechnical engineer shall ensure that fill materials under the barrel and the riser are compacted in accordance with the design plan and ensure use of proper compaction methods for all materials placed in the trench and in the dam.

The geotechnical engineer will also inspect special features such as toe and blanket drain and verify type and proper placement of filter fabric (if required or specified) and type of granular material including VDOT number or size and gradation of drainage materials and compaction by a vibratory compactor will also be verified.

7.2.1.2 Infiltration Facilities, Underground Detention Storage Facilities, Runoff Reduction Practices and Other BMPs

Geotechnical engineer shall inspect the subgrade condition for all facilities having infiltration component and verify that the subgrade soils were not compacted by construction equipment and was not exposed to siltation prior to placement of any backfill materials.

7.2.2 Inspection Reports

7.2.2.1 Detention and Retention Basins

After completion of the required inspections and associated tests and analyses, a report shall be prepared by a licensed geotechnical engineer for all retention basins. A report shall be prepared for all detention basins with greater than four feet dam height. A written report is not required for small structures; however, the inspections shall still be performed in accordance with this chapter. 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 include:

A) 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.

B) 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.

C) The report shall include details of special features such as toe/blanket drains, filter materials, etc.

D) Field visit daily reports shall be included in final report appendix.

7.2.2.2 Infiltration Facilities, Underground Detention Storage Facilities, Runoff Reduction Practices and Other BMPs

The report shall be submitted with the as-built plans. Each report shall include:

A) Statement about condition of subgrade layer

B) Test reports for on-site mix planting media for bioretention

C) If other geotechnical inspections were required based on the initial soils investigation, an appropriate geotechnical inspection report shall be prepared and submitted by a licensed geotechnical engineer.

7.3 County Inspections

The contractor must notify the stormwater management inspectors at least 24 hours in advance of starting work on each of the following:

7.3.1 Stormwater Conveyance Channels

A) Completion of excavation

B) Construction of check dams (vegetated swales)

C) Final stabilization

7.3.2 Storm Sewers and Culverts

A) At beginning of excavation

B) During pipe laying and backfill

C) Placement of concrete structures

D) Prior to finalization; structure must be cleaned

7.3.3 Detention and Retention Facilities

A) Core trench fully excavated and no fill in place

B) Core trench backfill

C) Bedding and installation of barrel

D) Installation of toe drains and other seepage control features , etc.

E) Pouring of concrete for riser base or weir wall

F) Construction of embankment

G) Final stabilization

7.3.4 Underground Detention Systems

A) Installation and backfill of pipe

B) Placement of concrete

C) Prior to finalization

7.3.5 Bioretention, Biofilter, and Infiltration Facilities

A) Installation of sedimentation protection measures

B) Completion of excavation

C) Construction of embankment (infiltration basin)

D) Placement of concrete

E) Installation of filter fabric

F) Installation of underdrains and observation wells

G) Placement of each layer of backfill

H) Installation of final cover and plantings

I) Final stabilization

7.3.6 Porous Pavement Facilities

A) Completion of sub-grade section

B) Placement of aggregate base course and/or underdrain piping

C) Placement of the aggregate filter course

D) Placement of porous asphalt or concrete surface course

E) Testing of infiltration

Periodic inspections of the stormwater management system construction will be conducted by County staff at the discretion of the Inspector. However, the developer must be responsible for

performing the required inspections in accordance with Sections 7.1, 7.2 and 7.3 and providing the professional certification of construction in accordance with Section 7.5.

7.4 As-Built Requirements

An as-built plan is required for all stormwater management structures (i.e., drainage systems, stormwater management facilities, filters, and infiltration facilities).

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 provide at a minimum all of the information on the as-built plan checklists in the Virginia Stormwater Management Handbook and this manual. As-built plans must consist of a copy of the approved construction plans with as-built elevations and dimensions shown in red and boxed in. Design elevations and dimensions must not be changed.

All invert elevations and contours for detention and retention basins must be field surveyed.

For all buried features of facility that require Geotechnical verification per Section 7.2, geotechnical inspection report is required with the as-built documents.

If a structure is built differently from the Stormwater Management Design Plan (see acceptable construction requirements on checklist), the Program Administrator must be contacted to determine whether the variation is acceptable or modifications to the structure will be required. The designer must provide hydrologic and hydraulic computations to verify that the structure functions as intended.

7.5 Certification

Each as-built plan must have a certification statement 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 to the approved design plan except as shown hereon 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.

All certifications (as-built plans and reports) shall be submitted as one package to the County within 60 days of completion of the SWM Facility. Failure to submit the required as-built certifications in a timely manner may be justification for (1) issuance of a Stop Work Order, (2) not performing further County site or building inspections, or (3) not issuing any building temporary or final CO.

8. Maintenance

8.1 Maintenance Agreements

A maintenance agreement must be entered into between the landowner and the Board of Supervisors for all proposed private stormwater management facilities. The maintenance agreement must be executed and recorded in County land records prior to approval of the Stormwater Management Design Plan. The agreement must obligate the landowner to provide maintenance to ensure proper performance of the facility in accordance with an approved maintenance plan.

The maintenance agreement may be legally conveyed to Homeowners Associations for residential subdivisions where HOA are legally established and responsible for common space maintenance.

Runoff reduction sites shall require legal information and instruments to ensure that the facilities are properly maintained. These may include easements, maintenance agreements, and homeowners' association (HOA) covenants depending on the type of development. Similar to conventional stormwater management facilities, a maintenance agreement between the landowner and the County must be executed and recorded in the County land records prior to approval of the Stormwater Management Design Plan.

For runoff reduction practices 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 runoff reduction practices to provide maintenance and access for maintenance. For runoff reduction practices 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 maintenance of a runoff reduction practice 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. These documents shall be made a prominent part of each lot sale contract.

For runoff reduction practices 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 runoff reduction practices.

A sample copy of the maintenance agreement is at Appendix 12.

8.2 Maintenance Plans

Property owners or organizations of property owners (i.e. HOA) will ultimately be responsible for maintenance of stormwater management systems. 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.

A maintenance plan must be prepared for all stormwater management systems. The plan must describe the system and list facilities and items to be maintained. The plan must be tailored to the specific structure for which it applies.

The maintenance plan must be prepared in conjunction with the SWM Design Plan and a copy of the plan must be attached to the maintenance agreement. The maintenance plan must address applicable State regulations (e.g., Virginia Dam Safety Act, etc.). Plans must be prepared to address maintenance as outlined in the applicable sections of the Virginia Stormwater Management Handbook.

The maintenance plan must specify a schedule of inspections in accordance with the operation and maintenance inspection checklists provided in the Virginia Stormwater Management Handbook. For facilities designed to accumulate sediment, the maintenance plan must provide a schedule for sediment cleanout. Sediment accumulation should be removed often enough to ensure that storage available below any primary outlet is not less than 80 percent of the designed BMP storage.

The maintenance plan must specify that any modifications to the structure must be approved by the Program Administrator before such work is undertaken.

8.3 Maintenance of Runoff Reduction Practices

Public outreach and education is a key component of runoff reduction and must be integrated into the entire development process. The developer is responsible for preparing and distributing public outreach materials to builders and construction managers, potential buyers and homeowners' associations explaining the responsibilities, benefits, function, and importance of community participation for the long-term performance of runoff reduction facilities. The County will assist developers, builders, real estate professionals, property managers, and homeowners' associations to convey the importance of runoff reduction and how they can make it work. The Design Manuals contain information on runoff reduction public outreach programs.

Where runoff reduction designs incorporate runoff reduction practices on individual lots and homeowners will be primarily responsible for their maintenance, the maintenance plan must incorporate a means to ensure homeowners:

A) Are made aware of their responsibilities for maintaining the runoff reduction practice including the requirement that modification of the runoff reduction practices not be made without the permission of the County,

B) Are provided materials adequately explaining the purpose, design, inspection, and maintenance aspects of the runoff reduction practice located on their lot,

C) Perform or provide for required inspection and maintenance of their runoff reduction practices.

D) See sample maintenance plans for runoff reduction practices in Appendix 14, 16 and 19.

8.4 Maintenance Inspections

The County will perform periodic maintenance inspections of stormwater management facilities and provide copies of maintenance inspection reports to the landowner or agent(s). These inspections will be performed with the landowner or agent(s) of the landowner, if available.

The landowner shall inspect stormwater management facilities within 24 hours after each rainfall event of one inch or more. The owner shall keep written records of these inspections and any necessary repairs, and furnish records to the County upon request.

9 Appendices

9.1 Appendix 1 Runoff Reduction Site Design Checklist and Runoff Reduction Computations Worksheet

9.1.1 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 enhancements to 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.

9.1.1.1 Site Design Technique 1

Minimize direct stormwater impacts to streams and wetlands 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. Practices from Section 9.1.2, Table 1, which apply include 1.1, 1.2, 2.1, 4.1, 7.1, & 7.2.

Achieved	Not Achieved	Practice
		Stormwater facilities located outside of streams and wetlands
		Natural drainage routes maintained on site.
		Required riparian buffers preserved
		Distributed "Runoff Reduction Practices" used in lieu of centralized ponds

Describe actions taken:

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9.1.1.2 Site Design Technique 2

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.

Achieved	Not Achieved	Practice
		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, the provision of necessary access, and fire protection.
		Avoid impacts to wetlands or vegetated riparian buffers
		A & B Soils preserved in natural cover. Provide pre- and post-development areas (SF) below

Describe actions taken:

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_____

9.1.1.3 Site Design Technique 3

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 and site hydrology. For runoff reduction sites, managing the imperviousness contributed by road and parking area pavement is an important component of the site planning and design process. There are several methods that can be used to achieve a reduction in the total runoff volume from impervious surfaces. Practices from Section 9.1.2. Table 1, which apply include 4.1, 6.1, 7.1, 7.2, 9.1, 9.2, 10.1, & 10.2.

Achieved	Not Achieved	Practice
		Utilize the minimum required width for streets and roads.
		Utilize street layouts that maximize the number of homes per unit length
		Where permitted, minimize cul-de-sac diameters, use doughnut cul-de-sacs, or use alternative turnarounds
		Minimize excess parking space construction, utilize pervious pavers in low-use parking areas
		Utilize structured or shared parking
		Reduce home setbacks and frontages
		Where permitted, minimize sidewalk construction by utilizing sidewalks on one side only, utilizing "skinny" sidewalks, or substituting sidewalks with pervious trails through common greenspace.
		Substitute pervious surfaces for impervious wherever possible
		Where permitted, avoid the use of curb and gutter. Utilize vegetated open swales, preferably "engineered swales" with a permeable soil base.
		Minimize compaction of the landscape. In areas where soils will become compacted due to construction equipment, specify that the soils will be "disked" prior to seeding, and amended with loam or sand to increase absorption capacity.

Describe actions taken:

_____

_____

_____

_____

9.1.1.4 Site Design Technique 4

Locate infiltration practices on HSG A and B soils wherever possible. HSG A & B soils are valuable resources on a site for facilitating infiltration of the increased runoff volume. Every effort should be made to utilize areas with these soils for runoff reduction practices that promote infiltration.

Achieved	Not Achieved	Practice
		Utilize areas of Soils A (preferred) for BMP
		Utilize areas of Soils B) for BMP

Describe actions taken:

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_____

_____

_____

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_____

9.1.1.5 Site Design Technique 5

Locate impervious areas on less permeable soils (HSG C and D). Placement of impervious areas on lower permeability soils minimizes the potential loss of infiltration/recharge capacity on the site.

Achieved	Not Achieved	Practice
		Utilize areas of Soils C and D for impervious areas

Describe actions taken:

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_____

9.1.1.6 Site Design Technique 6

"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.

Achieved	Not Achieved	Practice
		Downspouts not connected to SD system and discharging over green areas
		Driveways and patios to sheet flow onto grassy areas

Describe actions taken:

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9.1.1.7 Site Design Technique 7

Increase the travel time of water off of the site (Time of Concentration). Replicating the pre-development Time of Concentration is a key aspect in maintaining pre-development flow regime, and minimizing downstream impacts. Practices from Section 9.1.2. Table 1, which apply include 6.1.

Achieved	Not Achieved	Practice
		Flatten grades for stormwater conveyance to the minimum sufficient to allow positive drainage. (2.0%)
		Increase the travel time in vegetated swales by using more circuitous flow routes, rougher vegetation in swales, and check dams.
		Utilize "engineered" swales in lieu of pipes or hardened channels. These swales will have shallow grades and will have a sand or gravel substrate below the sod to promote infiltration.

Describe actions taken:

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_____

9.1.1.8 Site Design Technique 8

Utilize soil management/enhancement techniques to increase soil absorption. Practices from Section 9.1.2. Table 1, which apply include 4.1, 9.1, & 9.2.

Achieved	Not Achieved	Practice
		Delineate soils on site for the preservation of infiltration capacity. Mark these areas in the field and restrict heavy equipment access.
		Require compacted soils in areas receiving sheetflow runoff (such as yards, downslope of downspouts) will be "disked" and amended with loam or sand prior to seeding/sodding.

Describe actions taken:

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_____

9.1.1.9 Site Design Technique 9

Revegetate all cleared and graded areas. Revegetating graded areas, planting, or preserving existing vegetation can reduce hydrologic impacts by creating added surface roughness as well as providing for additional volume storage.

Achieved	Not Achieved	Practice
		Preserved existing vegetation – list SF below
		Revegetate graded areas (non lawn) – list SF below

Describe actions taken:

9.1.1.10 Site Design Technique 10

Use "engineered swales" for conveyance in lieu of curb and gutter wherever possible. Engineered swales utilize a sand substrate to maximize infiltration. Maintaining the predevelopment time of concentration (Tc) minimizes the increase of the peak runoff rate after development by lengthening flow paths and reducing the length of the runoff conveyance systems. Practices from Section 9.1.2. Table 1, which apply include 6.1, 9.1, 9.2, 10.1, & 10.2.

Achieved	Not Achieved	Practice
		Grass Channels – list lengths and contributing DA below
		Dry Swale – list lengths and contributing DA below
		Wet Swale – list lengths and contributing DA below

Describe actions taken:

9.1.1.11 Site Design Technique 11

Utilize level spreading of flow into natural open space. Wherever buffers or other areas of open space are preserved, ensure that they are made hydrologically functional by making them receiving areas for sheet flow, not concentrated flow. Use level spreaders on lot or pavement edges to help spread water into the preserved areas. Ensure that flow volumes do not cause channelized flow and erosion in receiving buffers. Practices from Section 9.1.2. Table 1, which apply include 11.1, & 11.2.

Achieved	Not Achieved	Practice
		Utilize level spreader at concentrated flow discharge points List contributing DA below

Describe actions taken:

_____

_____

_____

_____

_____

_____

9.1.2 Runoff Reduction Calculations Worksheet

1. Pollutant - Runoff Reduction Method contained within the Virginia Stormwater Management Handbook or another methodology that is demonstrated to achieve equivalent or more stringent results and is approved by the Program Administrator.
2. The BMPs listed in Table 1 or the BMPs available on the Virginia Stormwater BMP Clearinghouse website (http://www.vwrrc.vt.edu/swc/) shall be utilized to effectively reduce the pollutant load in accordance with the Pollutant-Runoff Reduction Method.
3. Design specifications for the BMPs listed in Table 1 can be found at http://www.vwrrc.vt.edu/swc/NonProprietaryBMPs.html
4. The specific criteria to determine if Level 1 or Level 2 design factors apply can be found in Appendix C of Technical Bulletin No 4 "Technical Support for the Bay-wide Runoff Reduction Method" developed by the Chesapeake Stormwater Network at http://www.chesapeakestormwater.net/stormwater-research-highlights/

Table 1
BMP Pollutant Removal Efficiencies

Practice Number	Practice	Removal of Total Phosphorus by Runoff Volume Reduction (RR, as %) (based upon 1 inch of rainfall -- 90% storm)	Removal of Total Phosphorus by Treatment – Pollutant Concentration Reduction (PR, as %)	Total Mass Load Removal of Total Phosphorus (TR, as %)
1.1	Vegetated Roof 1	45	0	45
1.2	Vegetated Roof 2	60	0	60
2.1	Rooftop Disconnection [2]	25 or 50[1]	0	25 or 50[1]
3.1	Rainwater Harvesting	up to 90 [3, 5]	0	up to 90 [3, 5]
4.1	Soil Amendments	Can be used to decrease runoff coefficient for turf cover at site. See designs for Rooftop Disconnection, Sheet Flow, and for Grass Channel practices.		
5.1	Permeable Pavement 1	45	25	59
5.2	Permeable Pavement 2	75	25	81
6.1	Grass Channel	10 or 20[1]	15	23
7.1	Bioretention 1 (also applies to Urban Bioretention)	40	25	55
7.2	Bioretention 2	80	50	90
8.1	Infiltration 1	50	25	63
8.2	Infiltration 2	90	25	93
9.1	Dry Swale 1	40	20	52
9.2	Dry Swale 2	60	40	76
10.1	Wet Swale 1	0	20	20
10.2	Wet Swale 2	0	40	40
11.1	Sheet Flow to Open Space 1	25 or 50[1]	0	25 or 50[1]
11.2	Sheet Flow to Open Space 2 [5]	50 or 75[1]	0	50 or 75[1]
12.1	Extended Detention Pond 1	0	15	15
12.2	Extended Detention Pond 2	15	15	31
13.1	Filtering Practice 1	0	60	60
13.2	Filtering Practice 2	0	65	65
14.1	Constructed Wetland 1	0	50	50
14.2	Constructed Wetland 2	0	75	75
15.1	Wet Pond 1	0	50 (45[4])	50 (45[4])
15.2	Wet Pond 2	0	75 (65[4])	75 (65[4])

[1] Lover rate is for Hydrologic Soil Group (HSG) class C and D soils; higher rate is for HSG class A and B soils.
[2] The removal can be increased to 50% for C and D soils by adding soil compost amendments, and may be higher yet if combined with secondary runoff reduction practices.
[3] Credit up to 90% is possible if all water from storms 1" or less is used through demand, and tank is sized such that no overflow occurs. Total credit is not to exceed 90%.
[4] Lower nutrient removals in parenthesis apply to wet ponds in costal plain terrain.
[5] See BMP design specification of how additional pollutant removal can be achieved.

9.2 Appendix 2 Determination of Channel Adequacy

Channel protection shall be addressed in accordance with the minimum standards set out in this section, which are established pursuant to the requirements of §10.1-603.4(7).

1. Channel Protection: Concentrated stormwater flow from the site and off-site contributing areas shall be released into a stormwater conveyance system and shall meet one of the following criteria as demonstrated by use of accepted hydrologic and hydraulic methodologies:
   - **a.** Concentrated stormwater flow to manmade stormwater conveyance systems. The point of discharge releases stormwater into a manmade stormwater conveyance system that, following the land-disturbing activity, conveys the post- development peak flow rate from the 2-year 24-hour storm without causing erosion of the system.
   - **b.** Concentrated stormwater flow to restored stormwater conveyance systems. The point of discharge releases stormwater into a stormwater conveyance system that (i) has been restored and is functioning as designed or (ii) will be restored. The applicant must demonstrate that the runoff following the land-disturbing activity, in combination with other existing stormwater runoff, will not exceed the design of the restored stormwater conveyance system nor result in instability of the system.
   - **c.** Concentrated stormwater flow to stable natural stormwater conveyance systems. The point of discharge releases stormwater into a natural stormwater conveyance system that is stable and, following the land-disturbing activity, (i) will not become unstable as a result of the discharge from the one-year 24-hour storm, and (ii) provides a peak flow rate from the one-year 24-hour storm calculated as follows or in accordance with another methodology that is demonstrated by the Program Administrator to achieve equivalent results and is approved by the board:

     $Q_{Developed} * RV_{Developed} \leq Q_{Pre\text{-}Developed} * RV_{Pre\text{-}Developed}$, where

     $Q_{Developed}$ = The allowable peak flow rate of runoff from the developed site.

     $Q_{Pre\text{-}Developed}$ = The peak flow rate of runoff from the site in the pre-developed condition.

     $RV_{Pre\text{-}Developed}$ = The volume of runoff from the site in the pre-developed condition.

     $RV_{Developed}$ = The volume of runoff from the developed site.
   - **d.** Except as set out in subsection e, concentrated stormwater flow to unstable natural stormwater conveyance systems. Where the point of discharge releases stormwater into a natural stormwater conveyance system that is unstable, stormwater runoff following a land-disturbing activity shall be released into a channel at or below a peak flow rate ($Q_{Developed}$) based on the one year 24-hour storm, calculated as follows or in accordance with another methodology that is demonstrated by the Program Administrator to achieve equivalent or more stringent results and is approved by the board:

     QDeveloped* RVDeveloped ≤ QGood Pasture * RVGood Pasture, where

     QDeveloped = The allowable peak flow rate from the developed site.

     QGood Pasture = The peak flow rate from the site in a good pasture condition.

     RVGood Pasture= The volume of runoff from the site in a good pasture condition.

     RVDeveloped = The volume of runoff from the developed site.

     However, in case that a pre-developed conditions is forested, both the peak flow rate and the volume of runoff from the developed site shall be held to the forest condition.
   - **e**. This subsection shall apply to concentrated stormwater flow to unstable natural stormwater conveyance systems from: i) a land disturbing activity less than five acres on prior developed lands, or ii) a regulated land disturbing activity less than one acre for new development. Where the point of discharge releases stormwater into a natural stormwater conveyance system that is unstable, stormwater runoff following a land-

disturbing activity shall provide a peak flow rate from the one-year 24-hour storm, calculated as follows or in accordance with another methodology that is demonstrated by the Program Administrator to achieve equivalent or more stringent results and is approved by the board:

$Q_{Developed} * RV_{Developed} < Q_{Pre\text{-}Developed} * RV_{Pre\text{-}Developed}$, where

$Q_{Developed}$ = The allowable peak flow rate of runoff from the developed site. Such peak flow must be less than $Q_{Pre\text{-}Developed}$

$Q_{Pre\text{-}Developed}$ = The peak flow rate of runoff from the site in the pre-developed condition.

$RV_{Pre\text{-}Developed}$ = The volume of runoff from the site in the pre-developed condition.

$RV_{Developed}$ = The volume of runoff from the developed site. Such volume must be less than $RV_{Pre\text{-}Developed}$

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9.3 Appendix 3 Guidelines for Bioretention Facilities

9.3.1 Location

1. When siting bioretention facilities, septic areas must be avoided, unless the septic field utilizes a design specifically designed to accept surface water. Otherwise, maintain a 50-foot setback from the septic field to avoid cross contamination. It is preferable to locate bioretention facilities upstream of any septic field to divert any overflow away from the field as well.
2. Bioretention areas should be placed at least 100 feet away from any source water location. Other restrictions may apply.
3. When siting bioretention on lots that will have a basement, the facility must be a minimum of 25 feet set back down-gradient from the home foundation. Where possible, the facility invert must be lower than the proposed basement floor elevation. The facility shall be located down-gradient from the building location.
4. Set back from an outermost foundation footing shall be 5 feet or greater. Basement set backs apply whenever the structure has a basement. Exceptions may be acquired for planter box bioretention facilities located on industrial or commercially zoned property. For planter box bioretention facilities, waterproofing membranes (as a minimum) adjacent to the building are required.
5. Bioretention facilities shall not be installed across property lines. Additionally, whenever possible, bioretention should be sited on the same lot that generates the runoff. Every effort shall be made to situate bioretention facilities to allow for the full 10-foot easement spacing. Where this is not possible, the perimeter of the bioretention area shall be located at least two feet away from the property line. For weep garden designs, locate at least twenty feet away from any down-gradient property boundary or line.
6. In commercial or industrial settings, design for overflow is more critical. The paved surfaces flowing into the facilities that are incorporated in the parking lot landscaping islands can generate large quantities of runoff. Therefore, overland conveyance of overflow water and flow-through bioretention facility designs is discouraged.
7. When the discharge flow exceeds 3 cfs, the engineer shall evaluate the potential for erosion to stabilized areas in and around bioretention facilities.

9.3.2 Bioretention Facility Construction Notes

1. Bioretention facility construction shall be completed after the site is stabilized.
2. When sediment traps are converted into bioretention facilities at the end of construction, the sediments must be removed and remaining surface scarified prior to constructing a bioretention facility. Wide-track equipment or light equipment with turf-type tires shall be used for the excavation to minimize unwanted compaction of in-situ soils.
3. Bioretention facilities constructed prior to site stabilization shall be protected from sedimentation by the installation of silt fence around the facility. The sediment laden runoff shall be directed away from the facility where possible.
4. Stockpiled onsite topsoil to be used for bioretention planting soil shall consist of materials suitable for planting and shall be verified for an appropriate percolation rate by a geotechnical engineer. In addition to percolation rate, the planting soil for bioretention must be checked for pH, organic matter, magnesium, phosphorous, potassium and soluble

salts. The standards are described under the state minimum standard 3.11 in the Virginia SWM Handbook. The engineer shall pick representative samples from the stockpile to conduct these tests.

5. Planting soil medium must have an infiltration rate greater than 1.5 inches per hour. If native soil is not suitable, contractor shall install typical soil medium consisting of 20 percent top soil, 20 percent leaf compost, and 60 percent construction sand (coarse grained).
6. Installation of the planting soil medium shall be in 12-18 inches depths.
7. The gravel sump shall consist of 12" of double-washed #57 blue-stone (½- to 1½-inch diameter) overlaid with 6 inches of washed pea gravel.
8. When deemed necessary by the geotechnical engineer, planting soil shall be amended with construction sand (ASTM C-33 Concrete Sand) or leaf compost.
9. Mulch may be provided by onsite vegetation, which has been shredded, stockpiled and aged for approximately 14 days. If green mulch is used, the contractor shall supplement green mulch with nitrogen fertilizer.
10. The developer shall warrant the plant materials for a minimum period of one year.
11. Perforated underdrain systems shall be installed on all bioretention basins and biofilters.

9.3.3 Maintenance Notes for Bioretention Facilities

In addition to the inclusion of a maintenance plan written in accordance with Appendix 17, the following notes shall be on the plan:

1. Mulch should be applied at least once a year uniformly for 2-3 inches total depth after application. Grass clippings are unsuitable as mulch.
2. The owner (property owner or HOA) is responsible for the periodic visual inspection, hand weeding, trimming, removal of trash and debris and recordkeeping, periodic monitoring, replacement of landscaping within the facility as needed, facility repair if the bioretention facility is located on individual lot. The HOA will be responsible for these items, if the bioretention facilities are located in common areas.

9.3.4 Bioretention Construction Sequencing

The following items shall be included in the construction notes on any plan that includes bioretention or biofilter:

1. Prior to the construction of bioretention or biofilter facilities, a meeting shall be scheduled between the contractor or his representative, and the County inspector to discuss construction sequencing in detail and to go over the inspection requirements for these facilities.
2. Bioretention and biofilter facilities shall be protected from sedimentation during individual lot grading and house construction.
3. Bioretention area shall not be placed in service until the contributing drainage area has been stabilized and approved by the County site inspector.

9.4 Appendix 4 Design of Dry Wells for Roof Water

Assessor's Parcel:_____ Subdivision _____

Address:_____ Builder: _____

9.4.1 Soil Data

mapping symbol _____ soil name _____

permeability = _____ inches per hour, permeability used: _____per hour *

depth to rock = _____ inches *

depth to water table = _____ inches *

* as determined by specific site testing

9.4.2 Volume of Gravel Required

Assuming 40% void space in the gravel, one cubic foot of gravel will store 1/2 inch of runoff from 9.6 square feet or 1 inch of runoff from 4.8 square feet of roof.

A. Phosphorous removal efficiency of 50% or less

$$\frac{\text{Roof Area (ft}^2)}{9.6} = \underline{\qquad\qquad} \text{ ft}^3$$

B. Phosphorous removal efficiency of 50% - 65%

$$\frac{\text{Roof Area (ft}^2)}{4.8} = \underline{\qquad\qquad} \text{ ft}^3$$

9.4.3 Maximum Depth of Storage

Dry wells are designed to drain out completely in thirty hours and if you removed the gravel from 2.5 feet of water filled gravel there would be 1 foot of water (based on 40% void space).

Maximum depth = 30x2.5x _____ inches per hour = _____ inches

9.4.4 Design Depth of Storage

Design depth of water may not exceed maximum depth of water. Bottom of dry well must be above water table (so it is filtered before it enters the water table) and bedrock. Bottoms of dry wells need to be level so trenches along the contour may be better than square holes on steep slopes. Equipment available and owner preferences should also be considered. Depth of storage refers to the stone =filled portion of the well; there would normally be about one foot of topsoil over the gravel. The top of the gravel should also be level so the depth of cover will vary where the adjacent land is sloping.

In a few cases, the depth to the bottom of the trench may be deeper in order to reach a more permeable soil.

Design depth of storage = _____ inches or _____ feet.

9.4.5 Area of Storage

Allocate proportionately or use the procedure below for the area of roof which drains to each dry well.

$$\frac{\text{Volume of gravel}}{\text{Depth of storage}} = \underline{\qquad\qquad\qquad} \text{ ft}^2$$

9.5 Appendix 5 Filter Strips and Easements

Clarke County accepts filter strips for areas with relatively low increases imperviousness. See Minimum Standard 3.14 in the Virginia Stormwater Management Handbook. Length of filter strip on page 3.14-4 refers to the distance from the uphill edge to the downhill edge. Where steepness of slope (of the filter strip) is 2% or less, the minimum length is 25 feet. The length should increase by 4 feet for each one percent increase above 2%. The optimum filter strip length is 80 - 100 feet.

When used to meet water quality requirements these strips are permanent features. In order to ensure that they will be permanent, Clarke County requires that these strips be placed in conservation easements.

Where roads are constructed in large lot subdivisions, rigid lip level spreaders may also be used to treat runoff from the roads by converting channel flow to sheet flow and then allowing it to flow through filter strips.

SLOPE OF STRIP IN %	MINIMUM LENGTH TOP TO BOTTOM FEET	SLOPE OF STRIP IN %	MINIMUM LENGTH TOP TO BOTTOM FEET
1	25	16	81
2	25	17	85
3	29	18	89
4	33	19	93
5	37	20	97
6	41	21	101
7	45	22	105
8	49	23	109
9	53	24	113
10	57	25	117
11	61	26	121
12	65	27	125
13	69	28	129
14	73	29	133
15	77	30	137

9.6 Appendix 6 Anti-vortex Devices on Riser Type Spillways

There are two basic types of anti-vortex devices. The most common is referred to as a vertical plate device because it uses one or more vertical plates to reduce vortex flow. The other is referred to as a sleeve-type device since, basically, it is a pipe larger than the riser being used as a sleeve over the riser.

9.6.1 Vertical Plate Devices

The tops of the vertical plates must be no lower than design high water or the elevation at which orifice flow begins, whichever is lower. The vertical plates may consist of metal (steel, stainless steel), concrete or High Density Polyethylene (HDPE). The vertical plates must project out from the outside wall of the riser by at least 6 inches. The ends may be tapered (for aesthetic reasons) but the taper shall not be steeper than 39° (4 inches of rise in 5 inches of run). Minimum thickness of steel plates is ¼ inch. Minimum thickness of concrete plates is 6 inches; calculations should include appropriate reductions in weir length. Steel plates should be painted with a rust-resistant paint. These devices are smaller and lighter than sleeve-type devices and can be fabricated on-site.

9.6.2 Sleeve Type Devices

For permanent ponds, sleeve type devices usually consist of concrete. They tend to be large and heavy. They have low maintenance requirements, tend to last a long time and, according to some people, they are more aesthetically pleasing on concrete risers.

Some people prefer concrete devices because they feel they are more aesthetically pleasing on concrete risers and because they require little or no maintenance and have a long life span. There are two basic designs. Both are essentially concrete caps that sit on the top of the riser. With all sleeve-type structures the area between the inside wall of the sleeve and the outside wall of the riser must equal or exceed the area of the inside of the riser.

Sleeves (or perhaps more accurately, caps) that sit on lintels have been available for quite some time. The two lintels must be placed towards the center of the riser in order to minimize reduction of weir length; calculations should include a weir length reduction of 4 times the width of the lintels. This device should not be used where the water elevation in the pond will exceed the top of the lintels.

Sleeves that sit on three 30° supports are relatively new. One of the disadvantages is that the weir length is reduced by 25%. One of the advantages is that the supports (and the slots) can be much higher than the lintels in the lintel type device. Use of neoprene pads to reduce damage to the concrete is required. The device and the top section of the riser are to be prefabricated.

9.6.2.1 Concrete Riser with Three 90° Slots and a Covered Sleeve

This antivortex device is essentially a length of concrete pipe with a cover over the top; this "sleeve" sits on the top of the riser. The top of the riser has three 90° slots (notches) and three 30° supports (segments of riser wall between the slots). The three slots have a combined weir length of ¾ of the circumference of the riser. When in place, the bottom of the sleeve should be at least 8" below the inverts of the three slots; this projection could be increased where subsurface

draw-off is desired. The top of the sleeve should contain a removable grate or a vented manhole cover. Neoprene pads should be placed on the top of each support to minimize chipping and spalling. Where the slots are more than one foot high, rebar should be placed across the slots to prevent children from entering the riser through the slots.

RISER DIAMETER (Ft.)	RISER AREA (Sq.Ft.)	WEIR LENGTH (Ft.)	ORIFICE POINT HEAD (Ft.)
3.0	7.07	7.07	1.60
3.5	9.62	8.25	1.88
4.0	12.57	9.42	2.14
4.5	15.90	10.60	2.41
5.0	19.64	11.78	2.67
5.5	23.76	12.96	2.95
6.0	28.27	14.14	3.21
6.5	33.18	15.32	3.48
7.0	38.48	16.49	3.75
7.5	44.18	17.67	4.01
8.0	50.27	18.85	4.28
8.5	56.75	20.03	4.55
9.0	63.62	21.21	4.81
9.5	70.88	22.38	5.08
10.0	78.54	23.56	5.35
10.5	86.59	24.74	5.62
11.0	95.03	25.92	5.88
11.5	103.87	27.10	6.15
12.0	113.10	28.27	6.42

The area of opening between the inside wall of the sleeve and the outside wall of the riser must equal or exceed the area of the inside of riser.

Orifice point head is the depth of flow at which flow changes from weir flow to orifice flow if the supports are at least as high as the head. Riser type spillways are to be designed so that orifice flow does not occur at the top of the riser. At some point below this elevation, outflows through this spillway must be controlled by the barrel (outlet control). For determining this point, the weir flow coefficient was assumed to be 3.0 and the orifice flow coefficient was assumed to be 0.6.

OUTFLOW RATES

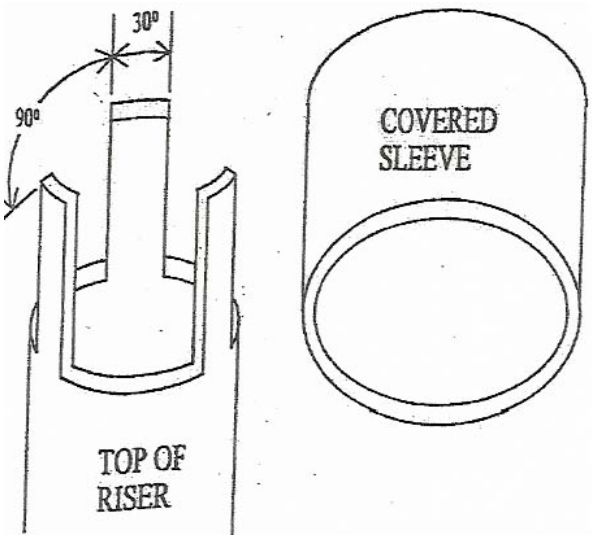
RISER	HEAD (feet)													
DIAMETER	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00
(feet)	OUTFLOW (cubic feet per second)													
3.0	2.65	7.50	13.77	21.21	38.96									
3.5	3.09	8.75	16.07	24.74	45.45									
4.0	3.53	10.00	18.36	28.27	51.94	79.97								
4.5	3.98	11.25	20.66	31.81	58.44	89.97								
5.0	4.42	12.50	22.96	35.34	64.93	99.97								
5.5	4.86	13.75	25.25	38.88	71.42	109.96								
6.0	5.30	14.99	27.55	42.41	77.92	119.96	167.65	220.38						
6.5	5.74	16.24	29.84	45.95	84.41	129.95	181.62	238.74						
7.0	6.19	17.49	32.14	49.48	90.90	139.95	195.59	257.11	323.99					
7.5	6.63	18.74	34.43	53.01	97.39	149.95	209.56	275.47	347.13					
8.0	7.07	19.99	36.73	56.55	103.89	159.94	223.53	293.84	370.28	452.39				
8.5	7.51	21.24	39.03	60.08	110.38	169.94	237.50	312.20	393.42	480.66	573.55			
9.0	7.95	22.49	41.32	63.62	116.87	179.94	251.47	330.57	416.56	508.94	607.29			
9.5	8.39	23.74	43.62	67.15	123.37	189.93	265.44	348.93	439.70	537.21	641.03	750.78		
10.0	8.84	24.99	45.91	70.69	129.86	199.93	279.41	367.30	462.84	565.49	674.76	790.29		
10.5	9.28	26.24	48.21	74.22	136.35	209.93	293.38	385.66	485.99	593.76	708.50	829.81	957.34	
11.0	9.72	27.49	50.50	77.75	142.84	219.92	307.35	404.02	509.13	622.04	742.24	869.32	1002.93	
11.5	10.16	28.74	52.80	81.29	149.34	229.92	321.32	422.39	532.27	650.31	775.98	908.84	1048.52	1194.70
12.0	10.60	29.99	55.09	84.82	155.83	239.92	335.29	440.75	555.41	678.59	809.72	948.35	1094.10	1246.64

Weir flow coefficient used above = 3.0.

MINIMUM INSIDE DIAMETERS OF SLEEVES

	CLASS III RCP		MH - 1	
RISER DIA. (feet)	WALL THICKNESS (inches)	INSIDE DIA. OF SLEEVE (inches)	WALL THICKNESS* (inches)	INSIDE DIA. OF SLEEVE (inches)
3.0	4.00	57	6	60
3.5	5.25	68	6	69
4.0	5.75	77	6	77
4.5	6.25	86	6	86
5.0	6.75	95	6	94
5.5	7.25	104	6	102
6.0	7.75	114	6	111
6.5	8.25	123	6	119
7.0	8.75	132	6	128
7.5	8.50	140	6	136
8.0	9.00	149	6	145
8.5	8.50	157	6	153
9.0	10.00	168	6	161
Wall thickness may vary from plant to plant.				

CONCEPT SKETCH



9.7 Appendix 7 Crushed Rock Classifications

9.7.1 Riprap

				MINIMUM DEPTH		
	D_{15}	D_{50}	D_{100}	SEAS	VDOT	MANNING'S
VDOT NAME	(FEET)	(FEET)	(FEET)	(FEET)	(INCHES)	n
Class AI	0.7	0.9	1.35	2.7	22	0.039
Class I	0.8	1.1	1.65	3.3	26	0.040
Class II	1.3	1.6	2.4	4.8	38	0.043
Class III	1.9	2.2	3.3	6.6	53	0.045
Type I	2.6	2.8	3.6	7.2	34	0.047
Type II	4.0	4.5	6.1	12.2	60	0.051

9.7.2 Gravel

	D_{15}	D_{50}	D_{85}	DEPTH	MANNING'S
VDOT NAME	(INCHES)	(INCHES)	(INCHES)	(INCHES)	n
1	1.48	2.48	3.54	6	0.030
2	0.75	1.48	2.48	4	0.028
3	0.75	0.98	1.48	4	0.026
357	0.49	0.75	0.98	4	0.025
5	0.49	0.75	0.98	4	0.025
56	0.37	0.67	0.98	4	0.024
57	0.19	0.49	0.98	4	0.023
68	0.19	0.37	0.75	4	0.022
7	0.19	0.31	0.49	4	0.021
78	0.19	0.31	0.49	4	0.021
8	0.19	0.29	0.37	4	0.021
9	0.09	0.14	0.19	4	0.021
10	0.01	0.04	0.19	4	0.015

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.

The common unit of measure for crushed stone is “Mean Spherical Diameter” (MSD).

This indicates the diameter of a given weight of stone if the stone was round. MSD is helpful to those who visually inspect riprap. Actually though, round stone is not desirable for use as riprap; the stone should be roughly rectangular. Round stone is more easily moved by water. Stone that is long and wide but thin (i.e. flagstone) is also more easily moved by water.

D (or 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 $D_{50}^{1/6}$

(from Training Notebook, Course C, Basic Stormwater Management in Virginia,1985).

9.8 Appendix 8 Sample Dam Construction Notes to be Modified by Designer/Geotechnical Engineer

1) Stake out the entire area to be covered by the dam and related structures.

2) Remove all topsoil, organic matter and stones from the area. Install a cofferdam or some other appropriate structure to divert runoff away from the work area during construction.

3) Excavate the core trench under the entire length of the dam. Depth to be determined by a qualified soil specialist or geotechnical engineer during excavation. Minimum acceptable bottom width is 4 feet. Minimum depth is 3 feet. The core trench should extend at least one foot into the underlying impermeable material unless that material is relatively unfractured bedrock. Side slopes should be no steeper than 1H:1V.

4) Fill in the core trench. All fill shall be placed under the supervision of a geotechnical engineer. The engineer will maintain a record of types of material used and degree of compaction achieved.

5) Install the pond barrel and the riser. The upstream 2/3 of the pond barrel will be bedded in concrete; the concrete must be plasticized or vibrated to ensure that there will be no voids. Flowable fill may be an option if so specified in the approved plans. The downstream 1/3 of the barrel will be bedded in gravel wrapped in filter fabric. If the plan includes toe drains, they may be connected to the gravel bedding. The bedding should extend to at least the mid-point (haunch) of the barrel. The fill adjacent to the pipe and the fill over the pipe are to be compacted by manually-operated equipment (not pulled by or mounted on track-type or wheel-type equipment). Tampers mounted on backhoes are not acceptable. After the depth of fill over the pipe has reached a depth of at least 2 feet, large equipment, but not vibratory rollers, may be used. Vibratory rollers may be used after the depth of fill over the pipe exceeds 3 feet.

6) Place fill as directed by the geotechnical engineer.

7) Side slopes shall be at least as flat as those shown on the approved plans. Flatter sideslopes will normally be acceptable.

8) A settling allowance of at least 5% is required. If degree of compaction is less than 95% but more than 90%, a settling allowance of 10% is required.

9) Emergency spillways consist of three sections. The control section is the high point. However, it is not a point. It is a broad, flat-bottomed weir. It should be level (all 4 corners should be at the same elevation). The distance from the upstream edge to the downstream edge should equal or exceed the top width of the dam. The distance from one side to the other should be at least the distance specified in the approved plan. The entrance channel should have a continuous slope from the pool area of the pond to the control section. It should be at least as wide as the control section. Exit channels are usually riprapped. Please note that the specified dimensions are for the channel after the riprap is in place; the riprap shall be underlain by appropriate filter fabric. If the exit channel is designed to be narrower than the control section, the transition should be gradual. Control sections are not normally riprapped. All exit channels with velocities in excess of 5 feet per second will be riprapped. The top 6 inches of the control section may be topsoil.

9.9Appendix 9 Sample Notes for Concrete Used In Construction of Dams to be Modified by Designer/Geotechnical Engineer

1) Unless otherwise specified in the approved site or construction plan, the following apply to all concrete. Minimum strength is 3,000 pounds. Minimum slump is 1" and maximum slump is 3". Cement shall be type I; if soil is found to be high in soluble sulfates, type V should be used after consulting with the design engineer (or the engineer who is to certify the structure). Exposed concrete will be water cured or covered with clear or white polyethylene film. All materials shall conform to appropriate ASTMs. Forms shall be clear of soil and other materials. Chamfer strips shall be placed in the corners of the forms and at the tops of wall placements to produce beveled edges on permanently exposed concrete surfaces. Edges of construction joints shall not be beveled except where indicated on the drawings. Consolidation of all concrete shall be by immersion-type vibrators operated in a nearly vertical position. Appropriate measures will be taken when temperatures are less than 50 degrees.

2) Unless it has been shown that the entrained air content of the concrete is at least 4%, by volume, as discharged at placement, an air entraining admixture shall be used in the concrete. The admixture shall conform to ASTM C 260; any air-entraining admixture used with type F or G chemical admixture shall be neutralized vinsol resin formulation. All admixtures will be used as specified in the designs or as approved by the design or certifying engineer. Any admixture, such as calcium chloride, or combination of admixtures which will introduce more than 0.1% chloride (to cement, by weight) shall not be used in concrete in which aluminum, galvanized metalwork or prestressing steel is to be embedded.

3) Note rebar schedule in drawings. Lubrication of forms is required unless otherwise specified.. Forms shall be removed within 24 hours after the concrete has hardened sufficiently to prevent damage by careful form removal and specified repair and curing will be commenced immediately thereafter.

4) All materials to be within the concrete shall be appropriate metal rebar, electrically welded wire fabric, mesh, ties, metal supports, etc. Interior wooden braces are not acceptable. Before reinforcement is embedded in the concrete, the surfaces of the bars, fabric and supports shall be cleaned of heavy flaky rust, loose mill scale, dirt, grease or other foreign substances which are objectionable. Heavy flake rust which can be removed by firm rubbing with burlap, or equivalent treatment, is considered objectionable. Plastic form spacers are acceptable. Where applicable, fiber reinforcement is acceptable. Embedded ties for holding forms shall remain embedded and except where F1 finish is permitted, shall terminate not less than two diameters or twice the minimum dimension of the tie, whichever is greater, from the formed surfaces of the concrete. Recesses shall be filled with appropriate material.

5) All concrete shall be vibrated or superplasticized. It shall not be "watered down" to make it flow.

6) Where concrete is used to bed pipe larger than 12 inches in diameter, it shall be vibrated or superplasticized.

7) Pond risers shall be properly supported by metal or concrete blocks prior to pouring the base. An alternative would be to pour the base to the elevation of the bottom of the riser, set the bottom unit of the riser in place and then finish pouring the base.

8) Concrete surfaces likely to be walked upon, such as channel type spillways, shall have a rough surface to improve traction.

9) Concrete shall be deposited as nearly as practical in its final position and shall not be allowed to flow in such a manner that the lateral movement will cause segregation of the coarse aggregate from the concrete mass. Methods and equipment employed in depositing concrete in forms shall minimize clusters of coarse aggregate. Clusters that occur shall be scattered before the concrete is vibrated. Placing of additional concrete in forms shall not be delayed so long that the concrete placed before the delay is not readily penetrated by vibrators. It is especially important that adequate consolidation be achieved in the concrete at the interface of the fresh concrete and the underlying concrete. The vibrator shall repeatedly penetrate and thoroughly reconsolidate the upper portion of the underlying concrete which was placed before the delay.

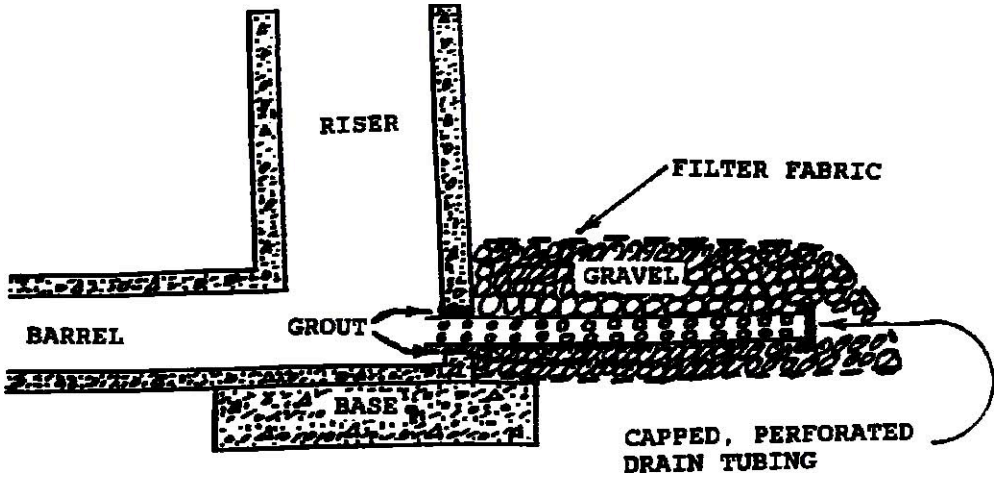
10) Where lift holes are permitted in concrete pipe, they shall be fully grouted and the surface of the grout on the inside of the pipe shall be uniform with the inside wall of the pipe. Pipe in which the smallest dimension (diameter in round pipe) is less than 36 inches shall not contain lift holes. Lift holes are not permitted in pond barrels. Where pipes enter risers, junction boxes, manholes, etc., the space between the outside wall of the pipe and the wall of the opening shall be filled with appropriate non-shrinking cement paste or cement mortar. Where the openings are large, concrete bricks may also be used. Other types (clay, cinderblock) of brick are not acceptable. All surfaces of the bricks must be covered with cement. The finished surfaces of the cement must be uniform with the inside and outside walls of the structure. The surfaces shall be smooth to minimize adverse effects of freezing and thawing and bricks shall not be visible. O-rings shall be properly lubricated and properly installed. All other types of joints shall be properly sealed. Concrete riser segments shall be connected by bolting four galvanized or stainless steel plates (6” x 18” x 1/4” min.), uniformly spaced, to each pair of adjoining segments.

11) The bottoms of all risers, manholes, junction boxes, etc. shall be shaped in accordance with VDOT’s IS-1.

9.10 Appendix 10 Modifying Stormwater Detention Ponds to Serve Temporarily as Sediment Basins

Most stormwater detention ponds are designed to serve temporarily as sediment basins. These ponds are installed before land clearing in other areas is begun. The volume of storage is based upon stormwater detention requirements rather than a fixed number cubic yards of wet and dry storage capacity per acre of disturbed land or drainage area. Although such structures generally have significantly less capacity than sediment basins, we feel that the advantages outweigh this decrease in capacity. Advantages include the "dry" storage provided to trap sediment before any significant amount of water leaves the pond. Another is that the pond can be constructed in accordance with the final, permanent design rather than constructing it in accordance with a temporary design and then modifying it to meet the design requirements for the permanent structure.

This modification can be accomplished by placing filter fabric on the ground and placing 6-12 inches of gravel on top of the filter fabric. Perforated drain tubing or perforated pipe is laid on the gravel and temporarily grouted into the orifice. This can be done with brick and mortar or some form of impermeable grout which can be removed without damaging the orifice. The end of the tubing or pipe is capped and the tubing or pipe is covered with 12-18 inches of gravel. Size of gravel is not critical if it is properly enclosed in filter fabric but numbers 7, 8, and 78 are recommended. The filter fabric is then folded around the gravel so that water must flow through the fabric before flowing through the gravel. Where drainage area is 5 acres or less, a 20-foot length of tubing or pipe is recommended. Where drainage area exceeds 5 acres, it is recommended that the tubing or pipe be so designed that design drawdown time does not exceed 48 hours.



Another option is to install the dewatering system in accordance with the Virginia Erosion and Sediment Control Handbook, Plate 3.14-15 to the pond riser structure. Locate the invert of the dewatering orifice at the "wet storage" elevation (67 cu. yds/ac).

Design calculation for the dewatering device shall be included on the plans.

9.11 Appendix 11 As-Built Plan Checklist

9.11.1 Stormwater Conveyance Channels

A. Minimum Information

____ 1. Invert elevations and top of bank elevations, side slopes at cross section locations

____ 2. Type and class of materials

____ 3. Size and depth of rip-rap, and specify that it has been underlain by filter fabric

____ 4. Type and condition of vegetation

____ 5. Location of channel

B. Acceptable Construction

____ 1. Shape of channel must be consistent with design plan

____ 2. Capacity of channel must be no less than design plan capacity

____ 3. Materials must be consistent with design plan

____ 4. All channels shall be located correctly

9.11.2 Storm Sewers and Culverts

A. Minimum Information

____ 1. Diameter and type/class of all pipe

____ 2. Invert elevations of pipe at all entrances, outfalls, and structures

____ 3. Slope of pipe

____ 4. Pipe lengths

____ 5. Location of all pipe and structures

____ 6. Type of structures, including throat width

____ 7. Elevation of structure top

____ 8. Types of material

____ 9. Length, width and depth of all riprap and other outlet protection

____ 10. Ground elevations over pipe where depth of cover might exceed allowable maximum cover depths

B. Acceptable Construction

____ 1. Pipe diameter and elevations must be correct

____ 2. Structure dimensions and elevations must be correct

____ 3. All pipes and structures shall be located correctly

____ 4. Proper bedding and backfill of pipes and structures

____ 5. Materials must be consistent with design plan

____ 6. Outlet protection shall be adequate

9.11.3 Retention and Detention Ponds

A. Minimum Information

____ 1. Profile of top of dam. Elevations at each end, intervals not to exceed 50 feet and where low points are evident

____ 2. Cross section of emergency spillway at control section

____ 3. Profile along centerline of emergency spillway

____ 4. Width and shape of emergency spillway entrance channel, control section (all four corners) and exit channel, size and depth of rip-rap, and specify that rip-rap has been underlain by filter fabric

____ 5. Elevation of principal spillway crest, inlet and outlet

____ 6. Cross section of dam through principal spillway

____ 7. Riser diameter/dimensions and riser base size

____ 8. Type of materials used

____ 9. Barrel diameter, length and slope

____ 10. Outfall protection including size and depth of rip-rap and specify that it has been underlain by filter fabric

____ 11. Location, size and number of anti-seep collars

____ 12. Type and dimensions of anti-vortex and trash rack device

____ 13. Shape and elevations of all orifices and weirs

____ 14. Length, width and depth of ponds and contours of pond bottom

____ 15. Core trench depth and types of materials

____ 16. Size of stone, type of filter fabric, and tubing of toe drain/blanket drain

____ 17. Location, dimensions and materials of any liners

____ 18. Geotechnical Inspections Report

____ 19. As-built topography and computation of all designed storage volumes

B. Acceptable Construction

____ 1. Pipe diameter, length, material and elevations must be correct

____ 2. Area of orifices correct

____ 3. Trash rack, anti-vortex device, number of anti-seep collars are correct

____ 4. Emergency spillway may be 1-2% steeper, but no flatter or narrower than design. Located and aligned as shown on approved plans

____ 5. Embankment top elevation must be no less than design elevation plus allowance for settlement

____ 6. Riser size correct

____ 7. Top width of dam and pond side slopes must meet design

____ 8. Must have proper relation in elevation between principal spillway crest, emergency spillway crest and top of dam

____ 9. Outlet protection as per design plan

____ 10. Pond storage volume at the water quality pool, 1-year, 2-year and at the 10-year storm design elevations must be equal to or greater than volume on approved design plans

9.11.4 Bioretention and Biofilter Facilities

A. Minimum Information

____ 1. Plan and profile views of facility drawn to scale

____ 2. Elevation of principal spillway crest, inlet and outlet

____ 3. Profile view of principal spillway with all dimensions shown

____ 4. Type of materials used

____ 5. Shape and elevations of all orifices and weirs

____ 6. Elevation at top of all layers of materials used and materials used for any liners

____ 7. For bioretention facilities, geotechnical report indicating infiltration rates

____ 8. Number, type, and location of plantings

____ 9. Undisturbed subsoil measured infiltration rate (for bioretention facilities)

____ 10. 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 underdrain system; and, outlet works.

B. Acceptable Construction

____ 1. Material types and top elevations correct

____ 2. Area of orifices correct

____ 3. Appropriate underdrain design

____ 4. Must have proper relation in elevation between principal spillway crest, emergency spillway crest and top of dam

____ 5. Outlet protection as per design plan

____ 6. Pond storage volume at the water quality pool, 1-year, 2-year and at the 10-year storm design elevations must be equal to or greater than volume on approved design plans

9.11.5 Underground Detention Systems

A. Minimum Information

____ 1. Size of all pipes
____ 2. Elevation and slope of all pipes
____ 3. Elevation and size of all orifices
____ 4. Elevation and thickness of weir walls
____ 5. Location and elevation of manholes
____ 6. Types of material
____ 7. Location of structure
____ 8. Geotechnical Inspections Report

B. Acceptable Construction

____ 1. Pipe diameter, elevation and materials must be correct
____ 2. Proper bedding and backfill of pipe and structures
____ 3. Dimensions and elevations of structures must be correct
____ 4. Location of structure correct

9.11.6 Infiltration Trenches

A. Minimum Information

____ 1. Type of materials
____ 2. Location of trench
____ 3. Dimensions and elevations
____ 4. Location and invert elevation of monitoring well
____ 5. Elevation of bedrock and groundwater
____ 6. Geotechnical Inspections Report

B. Acceptable Construction

____ 1. Pipe diameters and elevations must be correct
____ 2. Infiltration material as per design plans
____ 3. Dimensions and elevations of trench must be correct
____ 4. Monitoring well must be correct
____ 5. Bottom of trench a minimum of four feet above bedrock or seasonal water table
____ 6. Soil permeability acceptable

9.11.7 Other Types of Facilities

As-built plans shall provide necessary information to demonstrate that the facility as it is built conforms to all specifications and requirements of the approved design plan. As-built checklists for other types of SWM facilities are available in the Virginia Stormwater Management Handbook (Chapter 3 Appendix).

9.12 Appendix 12 Maintenance Agreement for Stormwater Management System

MAINTENANCE AGREEMENT
for
STORMWATER MANAGEMENT SYSTEM

This Agreement is entered into this _____ day of _____, _____, by and between _____, hereinafter referred to as the "Landowner" and the Board of Supervisors of Clarke County, Virginia, hereinafter referred to as "County".

WITNESSETH:

WHEREAS, the Landowner has submitted a development plan for a project known as _____, which includes, among other features, a system that regulates peak rates of discharge and/or quality of runoff water (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 Landowner will install the system in order to comply with one or more of the following laws, regulations and codes:

Act	Regulations	Title
§10.1-603	4 VAC 3-20-10, et seq.	Stormwater Management
§10.1-560	4 VAC 50-30, et seq.	Erosion and Sediment Control

Clarke County Code	Title of Ordinance
§147	Stormwater Management
§148	Erosion and Sediment Control; and

WHEREAS, this system includes _____
_____
_____

WHEREAS, it is in the best interests of both parties and the general public to ensure proper maintenance of the system; and

WHEREAS, a maintenance plan (Attachment ____) for the system has been submitted by the Landowner and approved by the County in conjunction with this Agreement; and

Tax Map/Parcel(s) Number_____

WHEREAS, both parties desire to ensure sufficient maintenance to maintain the integrity and the

proper functioning of the system;

NOW, THEREFORE, for and in consideration of the mutual covenants stated below, the parties agree as follows:

1. The County shall:

   A. Release construction security after as-built plans and other appropriate certifications, showing adequate completion of the system, have been submitted and approved by the County and after an inspection report prepared by County staff recommends approval of the system. The certification shall be made by a Professional Engineer (or a qualified Class B surveyor or certified Landscape Architect) and shall certify that the as-built plan represents the actual condition of the structure(s) and shows that all aspects of the structure(s) conform substantially with the approved design plans and the Clarke County Stormwater Management Design Manual. Where the as-built condition varies significantly from the approved design, appropriately revised calculations shall also be provided by the professional certifying the system.

   B. Perform maintenance inspections and provide copies of the maintenance inspection reports to the Landowner. These inspections will be performed at reasonable times (between 8 A.M. and 4:30 P.M., Monday through Friday) and with the Landowner or agent(s) of the Landowner, if available. Periodic inspections may be conducted after storms producing high rates of runoff. Whenever possible, the County shall notify the Landowner prior to entering the property.

2. The Landowner shall:

   A. Construct the system in accordance with approved designs. 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 Clarke County's Stormwater Management Design Manual.

   B. Provide maintenance, which keeps the system in good working order acceptable to the County. Such maintenance shall be provided in perpetuity unless and until both parties formally enter into a revised agreement. Maintenance inspections will be performed within twenty-four (24) hours after each rainfall of one (1) inch or more.

   C. Provide a right of ingress and egress for the County and agents of the County for maintenance inspections and, if deemed by the County to be needed and not adequately done by the Landowner within a reasonable time after due notice, maintenance and repair of the system. Thirty (30) days shall normally be regarded as a reasonable time. The Landowner will reimburse the County for maintenance and repair costs within ten (10) working days after receiving a request for reimbursement. It is expressly understood and agreed that the County is under no obligation to maintain or repair said system, and in no event shall this Agreement be construed to impose any such obligation on the County.

      However, if the County performs or otherwise provides maintenance and/or repair, the

Landowner will hold harmless and indemnify the County with regard to damage to or destruction of personal or real property.

D. Keep written records of inspections and repairs and provide access to those records to the County upon request.

E. Record this Agreement in the land records of Clarke County along with a copy of the approved maintenance plan. The Landowner also stipulates, by this 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 designation, page number, etc.) in the land records of Clarke County.

F. Agree that the terms of this Agreement shall be binding upon the heirs, successors and assigns of the Landowner and that any subsequent owner of the property shall be responsible for the maintenance of the system and shall hold the County harmless from any loss, damage, injury, cost or other claim resulting from the operation of the subject system.

G. Agree that for any systems to be maintained by a property owner's association, deed restrictions and covenants will include membership in a property owner's association responsible for providing maintenance of the system.

WITNESS THE FOLLOWING SIGNATURES:

DEVELOPER/OWNER: NAME:

_____

TITLE:

_____

ADDRESS:

_____

_____

_____

BY:

_____

COMMONWEALTH OF VIRGINIA
COUNTY OF CLARKE, 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 CLARKE
COUNTY, VIRGINIA

By:

_____

Charles Johnston
Planning Director

COMMONWEALTH OF VIRGINIA
COUNTY OF CLARKE, to-wit:

The foregoing Agreement was acknowledged before me this _____ day of

_____ by Charles Johnston, Planning Director on behalf of the Board of

Supervisors of Clarke County, Virginia.

My commission expires: _____

_____

Notary Public

Approved as to form:

_____
Clarke County Attorney's Office

9.13 Appendix 13 Sample Maintenance Plan for Stormwater Detention Ponds

1) Describe the structure and the site it serves. Also describe the design functions. Example: This structure is a stormwater detention pond; it will store water during period of high intensity rainfall. Within a few hours most of the water will drain out of the pond. The development of Sections 1, 2, and 3 of subdivision"x" increased the amount of rainfall water that leaves the site because absorbent soil was covered with impervious surfaces such as building and roads. The purpose of this temporary storage is to ensure that the peak rates of flow to the channel below the subdivision were not increased. Such increases cause flooding and channel erosion downstream from the pond. This structure was also designed to be a Best Management Practice. In other words, it was designed to ensure that the amount of phosphorus and other pollutants flowing to the Chesapeake Bay were not increased by construction of Sections 1, 2, and 3 of subdivision "x". This is accomplished by holding some of the water for a longer period of time. The water from this BMP pool will drain out in about 48 hours after the detention pool has drained.

   The pond has a 36-inch reinforced concrete pipe (RCP), called a "barrel", through the bottom of the pond. In the pond there is a vertical RCP called a "riser." The small 4-inch hole in the bottom of the riser is called a "BMP orifice." The bottom of the 12-inch hole is 4 feet higher than the BMP orifice; the 4 feet of water stored in the bottom of the pond is the "BMP pool." The top of the riser is 7 feet above the bottom of the 12-inch hole. During the 10-year storm the water level would be about 1 foot above the top of the riser and the surface area of the water would be about ½ acre. There is also an emergency spillway on the left(facing downstream) end of the dam; during high intensity storms, water will also flow in this channel.

2) Mowing. All grasses should be mowed at least twice each year. Grasses such as tall fescue should be mowed in early summer after emergence of the heads on cool season grasses. They should be mowed again in the early fall to prevent seeds of annual weeds from maturing. Mowing of legumes such as Sericea lespedeza and crown vetch can be permitted to grow on the dam or in any part of the emergency spillway.

3) Liming and fertilizing. The soil should be sampled according to recommended procedures at least once every 4 years. The sample should be tested at a qualified soil testing laboratory (such as the one at VPI&SU). Lime and fertilizer should be applied in accordance with recommendations based on the tests.

4) Replanting and overseeding. If vegetation covers less than 40% of the soil surface, lime, fertilize and seed in accordance with current recommendations for new seedings. If vegetation covers most than 40% but less than 70% of the soil surface, lime fertilize and overseed in accordance with current recommendations.

5) Removing trash and debris. Trash, litter and vegetation will be removed as needed to prevent obstruction to the flow of water, to prevent movement of trash and litter to downstream

properties, to maintain the integrity of the structure, to provide an attractive appearance and to minimize water pollution.

6) Removing sediment. Soil materials (including clay, silt, sand and gravel) will be removed before the detention pool or the BMP pool loses 10% of the designed storage capacity. If forebays are included in the design, sediment should be removed before the forebay loses 10% of the design capacity of the forebay.

7) Sediment disposal. Sediment disposal should be in accordance with current procedures for disposal of sediment. Where deemed necessary or desirable, the sediment will be tested for appropriate pollutants before it is removed from the pond.

8) Repairs, Repair slides, slumps and eroded areas promptly and in a workmanlike manner Trash racks, pipes, headwalls, etc. will be maintained, repaired and/or replaced as needed to maintain the integrity of the structure. Exposed metal surfaces will be painted to minimize damage due to rust.

9) Maintenance inspections. A representative of the owner(s) will inspect each stormwater management structure after each significant rainfall. Once each year a representative of the county will jointly inspect each stormwater management structure. Appropriate action will be taken to ensure appropriate maintenance. All maintenance costs will be borne by the owner(s). Where structures are to be maintained by more than one party, allocation of costs will be in accordance with terms set forth in the maintenance agreement. Keys to locked access points shall be available to Clarke County personnel upon request.

10) Maintenance records. The landowner, or someone designated by the landowner, shall inspect the detention pond within 24 hours after each rainfall event of one inch or more of rain. The owner or the designee shall keep written records of these inspections. The records shall also include maintenance and repairs performed Copies of these records shall be provided to the county upon request.

11) System Failure. In case of failure of the pond, the landowner, or someone designated by the landowner, shall undertake repairs to return the pond to an operative condition.

12) The detention pond shall not be modified in any way without prior approval by Clarke County.

9.14 Appendix 14 Sample Maintenance Plan for Stormwater Retention Ponds

1) Also describe the structure and the site it serves. Also describe the design functions and provide information needed for proper maintenance. Example:

   This structure is a stormwater retention pond; one of its functions is to store additional water during periods of high intensity rainfall. Within a few hours most of this extra water will drain out of the pond. The development of Sections 1, 2, and 3 of subdivision "x" increased the amount of rainfall water which leaves the site because absorbent soil was covered with impervious surfaces such as buildings and roads. The purpose of this temporary storage is to ensure that the peak rates of flow to the channel below the subdivision were not increased. Such increases cause flooding and channel erosion downstream from the pond. This structure was also designed to be a Best Management Practice (BMP). In other words, it was designed to ensure that the amount of phosphorus and other pollutants flowing to the Chesapeake Bay were not increased by construction of Sections 1, 2, and 3 of Prima Natura subdivision. This is accomplished by storing a certain volume of water in the permanent pool.

   The pond has a 36-inch reinforced concrete pipe (RCP), called a "barrel," through the bottom of the pond. In the pond there is a 72-inch vertical RCP called a "riser." During the 10-year storm, the water level would be about 2 feet above the top of the riser and the surface area of the water would be about ¾ acre. There is also an emergency spillway on the left (facing downstream) and of the dam; during high intensity storms water will also flow in this channel.

   There is also a "forebay" at the inlet end of the pond; this is an area designed to trap coarse sediments before they go into the deeper water where sediment removal is more difficult and expensive.

   The permanent pool has a surface area of ½ acre (about 22,000 square feet). The volume of water in the permanent pool is 1.3 acre feet (about 490,000 gallons or 4 million pounds) of water. The average depth is about 3 feet; the maximum depth is about 7 feet. The area of land which drains to the pond is 8 acres. This information should be considered when making management decisions with regard to fish, control weeds, etc. This pond should be well suited for warm water fish such as bass; it is not well suited for cold water fish such as trout or land-locked salmon.

2) Mowing. All grasses should be mowed at least twice each year. Grasses such as tall fescue should be mowed in early summer after emergency of the heads on cool season grasses. They should be mowed again in the early fall to prevent seeds of annual weeds from maturing. Mowing of legumes such as Sericea lespedeza and crown vetch can be less frequent. Trees and shrubs should not be permitted to grow on the dam or in any part of the emergency spillway.

3) Liming and fertilizing. The soil should be sampled according to recommended procedures at least once every 4 years. The sample should be tested at a qualified soil testing laboratory

(such as the one at VPI&SU). Lime and fertilizer should be applied in accordance with recommendations based on the tests.

4) Replanting and overseeding. If vegetation covers less than 40% of the soil surface, lime, fertilize and seed in accordance with current recommendations for new seedings. If vegetation covers most than 40% but less than 70% of the soil surface, lime fertilize and overseed in accordance with current recommendations.

5) Removing trash and debris. Trash, litter and vegetation will be removed as needed to prevent obstruction to the flow of water, to prevent movement of trash and litter to downstream properties, to maintain the integrity of the structure, to provide an attractive appearance and to minimize water pollution.

6) Removing sediment. Soil materials (including clay, silt, sand and gravel) will be removed from the forebay before 25% of the capacity of the forebay is lost. Sediment will be removed from the rest of the pond before 10% of the designed storage capacity is lost in order to ensure that the pond will adequately function as a BMP. The plan includes information designed to facilitate sediment surveys; this includes a method for locating specific points in the pond and the forebay.

7) Sediment disposal. Sediment disposal should be in accordance with current procedures for disposal of sediment. Where deemed necessary or desirable, the sediment will be tested for appropriate pollutants before it is removed from the pond.

8) Repairs. Repair slides, slumps and eroded areas promptly and in a workmanlike manner. Trash racks, pipes, headwalls, etc will be maintained, repaired and/or replaced as needed to maintain the integrity of the structure. Exposed metal surfaces will be painted to minimize damage due to rust.

9) Maintenance inspections. A representative of the owner(s) will inspect each stormwater management structure after each significant rainfall. Once each year a representative of the county will jointly inspect each stormwater management structure. Appropriate action will be taken to ensure appropriate maintenance. All maintenance costs will be borne by the owner(s). Where structures are to be maintained by more than one party, allocation of costs will be in accordance with terms set forth in the maintenance agreement. Keys to locked access points shall be available to Clarke County personnel upon request.

10) Maintenance records. The landowner, or someone designated by the landowner, shall keep written records of all inspections, maintenance and repairs performed. Copes of these records shall be provided to the county upon request.

11) System Failure. In case of failure of the pond, the landowner, or someone designated by the landowner, shall undertake repairs to return the pond to an operative condition.

12) The pond shall not be modified in any way without prior approval by Clarke County.

9.15 Appendix 15 Sample Maintenance Plan for Subsurface Stormwater Detention Systems

1) Describe the structure and the site it serves. Also describe the design functions and provide information needed for proper maintenance. Example:

   This structure will store water during high-intensity rainfall. Most of the water will drain out within a few hours. The development of the Shopping Center "x" increased the amount of rainfall water that leaves the site because absorbent soil was covered by the building and the paved parking lot. The purpose of this temporary storage is to ensure that the peak rates of flow to the channel below the shopping center were not increased.

   The control structure is a large concrete box with a wall across the middle. There is a 6-inch hole (called an "orifice") in the bottom of the wall. The western end of this box is connected to a concrete pipe 48 inches in diameter and about 300 feet long. When there is more water coming in than the 6-inch hole can carry, the extra water is stored in the western side of the box and in the 48-inch pipe. During very high intensity storms the water flows over the top of the wall (when water flows over the wall, it serves as a "weir). This weir is designed to prevent flooding of the parking lot. The wall on the eastern end of the box is connected to an 18-inch concrete pipe. This carries the water that flowed through the orifice and over the weir to a channel near Parkway "x". Each side of the control box is accessible through a manhole cover. Four more manhole covers also provide access to the storage pipe.

2) Maintenance inspections. A representative of the owner will inspect the control box and the storage pipe after each significant rainfall. If water is standing in both compartments of the control structure more than 5 hours after the rain has stopped, check the outlet end of the 18-inch pipe. If it is not obstructed, check the inlet end in the eastern end of the control structure; it is recommended that no one enters the control structure when water is standing in the structure unless another adult is standing by outside the structure. While not common in storm sewer structures, it is possible that heavier-than-air gases could be trapped above the water; this is not likely if the water has drained out since the heavy air would also drain out through the 18-inch pipe unless the outlet end of the pipe is submerged in water. If only the western compartment contains standing water, the 6-inch hole in the weir/orifice wall is probably plugged. This is the maintenance problem that is most likely to occur other than simply cleaning up litter. Workers can usually clear this opening while in the eastern compartment. Once each year a representative of the owner and a representative of the county will jointly inspect the entire detention system. Appropriate action will be taken to ensure proper maintenance. All maintenance costs will be borne by the owner(s). Keys to locked access points shall be available to Clarke County personnel upon request.

3) Removing trash, debris and sediment. The control structure and the pipe should also be checked during dry weather. Litter and sediment deposits should be removed as needed to prevent obstruction to the flow of water, to prevent movement of trash and debris to

downstream properties, to minimize water pollution and to ensure that the system adequately performs the function for which it was constructed.

4) Sediment disposal. Sediment disposal should be in accordance with current procedures for disposal of sediment. Where deemed necessary or desirable, the sediment will be tested for appropriate pollutants before final disposal.

5) Property maintenance. Grass and other soil covers should be maintained in order to minimize the amount of sediment entering the system. Trash and litter should be collected on a daily basis.

6) Maintenance records. The owner, or someone designated by the owner, shall keep written records of all inspections. The records shall include maintenance and repairs performed. Copies of these records shall be provided to the county upon request.

7) System Failure. In case of failure, the landowner, or someone designated by the landowner, shall undertake repairs to return the system to an operative condition.

8) The system shall not be modified in any way without prior approval by Clarke County.

9.16 Appendix 16 Sample Maintenance Plan for Stormwater Infiltration Systems

1) Describe the structure and the site it serves. Also describe the design functions. Example:

This stormwater infiltration system will store runoff water for a period of about 48 hours after heavy rainfall. The development of Prima Natura Mini-Mall increased the amount of rainfall water that leaves the site because absorbent soil was covered by the building and the paved parking lot. This increase in impervious area also increased the amount of pollutants carried by runoff water. This structure has two purposes. It is designed to ensure that the peak rates of runoff from the 2-year and 10-year storms were not increased by construction of Mini-Mall "x". It is also designed to ensure that the amount of phosphorus (a "keystone" pollutant) leaving the site in runoff water was not increased by construction of Mini-Mall "x"; this system is a Best Management Practice constructed in compliance with the Chesapeake Bay Preservation Act.

This structure is basically a trench filled with gravel. Water is stored in the voids (spaces between the pieces of gravel) until it seeps into the soil under the bottom of the trench. This decreases the amount of runoff and the water is added to other water stored in the ground ("groundwater"). The soil also serves as a filter. When larger storms occur, the overflow will be carried to the road ditch by a broad, shallow channel. The top 12 inches of gravel is underlain by a filter fabric that is wrapped around the rest of the gravel. There are also three observation wells; these are vertical plastic pipes with removable caps. There is a 20-foot wide strip of grass (filter strip) between the pavement and the trench. The purpose of this filter strip is to remove some of the particles that would otherwise plugholes in the gravel and the filter fabric.

2) Maintenance inspections. The observation wells should be checked right after rainfall has stopped or rainfall intensity has slowed down. If the trench is full of water runoff water is getting into the gravel. If the overflow channel carries water during the rainfall and the water level in the trench is relatively low, it is very likely that the holes in the top 12 inches of gravel and/or the holes in the filter fabric have been filled or plugged. When this happens, the top 12 inches of gravel and the filter fabric under the gravel should be replaced with clean materials.

These factors will also vary with duration and intensity of rainfall; routine inspections should be done by the same person or persons in order to develop a base of knowledge about the system. The filter strip should also be inspected. Maintain a healthy stand of grass. Cut with lawnmowers at a high setting (grass should be at least 4 inches tall just after mowing) so the remaining grass can function as a filter. This grass should be bagged as it is mowed so that the cuttings will not plug up the holes in the gravel. The observation wells should also be inspected 2 to 3 days after the rain has stopped. If there is water in the bottoms of the wells it is probably time to remove all of the gravel and filter fabric and replace the filter fabric. If the gravel is dirty or dusty it too should be replaced. The system was designed to be several feet above the water table. However, if there is water in the wells 48 hours after rainfall in

April and May but not in July and August, the standing water may indicate that the seasonal high water table was higher than anticipated; discuss this with appropriate Clarke County personnel.

3) Removing trash, debris and sediment. The best was to remove sediment is to prevent it from being there. Do not allow areas of soil to be exposed to rain; plant grass or provide other ground cover. During winter, keep application of such things as sand and cinders to a minimum. Litter and sediment deposits should be removed, preferably before they get to the filter strip. If sediment deposits in the filter strip cause water to pond on the pavement, remove the sediment and the grass. Replace the grass with tall fescue sod or apply lime, fertilizer, seed and mulch and install a temporary silt fence along the edge of the trench. Collect trash and litter on a daily basis.

4) Sediment disposal. Sediment disposal should be in accordance with current procedures for disposal of sediment. Where deemed necessary or desirable, the sediment will be tested for pollutants before final disposal.

5) Maintenance records. The owner, or someone designated by the owner, shall keep written records of all inspections. The records shall include maintenance and repairs performed. Copies of these records shall be provided to the county upon request.

6) System Failure. In case of failure of the system, the landowner, or someone designated by the landowner, shall undertake repairs to return the system to an operative condition.

7) The system shall not be modified in any way without prior approval by Clarke County.

9.17 Appendix 17 Sample Maintenance Plan for Bioretention Systems

1) Describe the structure and the site it serves. Also describe the design functions. Example:

This bioretention system will store runoff water for a period of about 48 hours after heavy rainfall. The development of (*project name*) increased the amount of rainfall water which leaves the site because absorbent soil was covered less pervious materials than before development. This increase in impervious area also increased the amount of pollutants carried by runoff water. This structure has two purposes. It is designed to reduce peak rates. It is also designed to ensure that the amount of phosphorus (a "keystone" pollutant) leaving the site in runoff water is not increased by construction; this system is a Best Management Practice constructed in compliance with the Chesapeake Bay Preservation Act.

This structure is basically an excavation filled with layers of various backfill materials and with a depressed area on top where a defined volume of water can accumulate in a pond. Water is also stored in the voids within the backfill materials and seeps into the soil under the bottom of the excavation. This decreases the amount of runoff and the water is added to other water stored in the ground ("groundwater"). The soil also serves as a filter. When larger storms occur, the overflow will be carried away by (*describe any underdrain and outlet works*). There (*is*) (*are*) also (*an*) (*number*) observation well(s); these are vertical pipes with removable caps. There is also a (*number*)-foot-wide strip of grass (filter strip) between the pavement and the trench. The purpose of this filter strip is to remove some of the particles which would otherwise plug holes in the gravel and the filter fabric.

2) Maintenance inspections. The observation well should be checked right after rainfall has stopped or rainfall intensity has slowed down, If the well is full of water, runoff water is getting into the gravel. If the outlet works carries water during the rainfall and the water level in the well is relatively low, it is very likely that the holes in the backfill materials are becoming filled or plugged with sediment. When this happens, the backfill materials should be removed and replaced with clean materials.

These factors will also vary with duration and intensity of rainfall; routine inspections should be done by the same person or persons in order to develop a base of knowledge about the system. The filter strip should also be inspected. Maintain a healthy stand of grass. Cut with lawnmowers at a high setting (grass should be at least 4 inches tall just after mowing) so the remaining grass can function as a filter. This grass should be bagged as it is mowed so that the cuttings will not plug up the holes in the gravel. Do not use the clippings as mulch in the pond. The observation wells should also be inspected 2 to 3 days after the rain has stopped. The system was designed to be significantly above the water table. However, if there is water in the wells 48 hours after rainfall in April and May but not in July and August, the standing water may indicate that the seasonal high water table was higher than anticipated. If this occurs, discuss this with appropriate Clarke County personnel.

3) Removing trash, debris and sediment. The best way to remove sediment is to prevent it from being there. Do not allow areas of soil to be exposed to rain; plant grass or provide other ground cover. During winter, keep application of such things as sand and cinders to a

minimum. Litter and sediment deposits should be removed, preferably before they get to the filter strip. If sediment deposits in the filter strip cause water to pond on the pavement, remove the sediment and the grass. Replace the grass with tall fescue sod or apply lime, fertilizer, seed and mulch and install a temporary silt fence along the edge of the trench. Collect trash and litter on a daily basis. Mulch layer should be inspected to ensure it is in good condition and near the original thickness. Mulch should be removed and replaced at least annually.

4) Sediment disposal. Sediment disposal should be in accordance with current procedures for disposal of sediment. Where deemed necessary or desirable, the sediment will be tested for pollutants before final disposal.

5) Maintenance records. The owner, or someone designated by the owner, shall keep written records of all inspections. The records shall include maintenance and repairs performed. Copies of these records shall be provided to the county upon request.

6) System Failure. In case of failure of the system, the landowner, or someone designated by the landowner, shall undertake repairs to return the system to an operative condition.

7) The system shall not be modified in any way without prior approval by Clarke County.

9.18 Appendix 18 Sample Maintenance Plan for Biofilters

1) Describe the structure and the site it serves. Also describe the design functions. Example to be modified as appropriate:

   The Biofilters consist of surface landscaping a 2- to 3-inch mulch layer, approximately two feet of bioengineered soil media with a twelve-inch gravel sump, perforated underdrains are installed within the gravel sump to ensure proper drainage. The gravel sump consists of a 4- to 6-inch pea gravel layer above VDOT #57 stone. Filter fabric is placed on top of the pea gravel layer, extending 1- to 2-feet to either side of the underdrains. A low-flow orifice pipe is used to establish the water quality treatment volume. A stabilized overflow spillway will allow the runoff from larger storms to bypass the structure.

2) Maintenance inspections. The observation wells should be checked right after rainfall has stopped or rainfall intensity has slowed down, If the trench is full of water runoff water is getting into the gravel. If the overflow channel carries water during the rainfall and the water level in the trench is relatively low, it is very likely that the holes in the top 12 inches of gravel and/or the holes in the filter fabric have been filled or plugged. When this happens, the top 12 inches of gravel and the filter fabric under the gravel should be replaced with clean materials.

   These factors will also vary with duration and intensity of rainfall; routine inspections should be done by the same person or persons in order to develop a base of knowledge about the system. The filter strip should also be inspected. Maintain a healthy stand of grass. Cut with lawnmowers at a high setting (grass should be at least 4 inches tall just after mowing) so the remaining grass can function as a filter. This grass should be bagged as it is mowed so that the cuttings will not plug up the holes in the gravel. The observation wells should also be inspected 2 to 3 days after the rain has stopped. If there is water in the bottoms of the wells it is probably time to remove all of the gravel and filter fabric and replace the filter fabric. If the gravel is dirty or dusty it too should be replaced. The system was designed to be several feet above the water table. However, if there is water in the wells 48 hours after rainfall in April and May but not in July and August, the standing water may indicate that the seasonal high water table was higher than anticipated; discuss this with appropriate Clarke County personnel.

3) Removing trash, debris and sediment. The best way to remove sediment is to prevent it from being there. Do not allow areas of soil to be exposed to rain; plant grass or provide other ground cover. During winter, keep application of such things as sand and cinders to a minimum. Litter and sediment deposits should be removed, preferably before they get to the filter strip. If sediment deposits in the filter strip cause water to pond on the pavement, remove the sediment and the grass. Replace the grass with tall fescue sod or apply lime, fertilizer, seed and mulch and install a temporary silt fence along the edge of the trench. Collect trash and litter on a daily basis. Mulch layer should be inspected to ensure it is in

good condition and near the original thickness. Mulch should be removed and replaced at least annually.

4) Sediment disposal. Sediment disposal should be in accordance with current procedures for disposal of sediment. Where deemed necessary or desirable, the sediment will be tested for pollutants before final disposal.

5) Maintenance records. The owner, or someone designated by the owner, shall keep written records of all inspections. The records shall include maintenance and repairs performed. Copies of these records shall be provided to the county upon request.

6) System Failure. In case of failure of the system, the landowner, or someone designated by the landowner, shall undertake repairs to return the system to an operative condition.

7) The system shall not be modified in any way without prior approval by Clarke County.

9.19 Appendix 19 Sample Maintenance Plan for Dry Wells

One or more "dry wells" were installed in order to comply with the Chesapeake Bay Preservation Act and Clarke County's Stormwater Management Ordinance. Runoff from the roof must flow into the dry wells. These dry wells should fill up with water during heavy rainfall. There should be no water standing in the dry wells 48 hours after the rain has stopped. These wells have been designed to hold specific volumes of water until it infiltrates into the soil. If they function properly, the peak rates of runoff leaving the site will be reduced, pollutants will be removed by the filtering action of the soil and underground water supplies will be recharged.

In order for these wells to function properly, the owner is obligated to maintain them. The water should be able to get to the wells. Rainspouts should be kept clean. Remove such things as tree leaves, seeds and roof beads. Screens and wire trash racks can be helpful. The areas where the downspouts enter the plastic pipes should also be kept clean and open; the water should be able to come out here when the well is full. Each dry well has several observation wells (perforated vertical pipes). Each observation well has a removable (preferably lockable) cap. The observation wells should be checked at least once every three months. The check would consist of measuring the depth to water after heavy rainfall (if it is full, the water from the roof is getting into the well) and checking the depth to water two days later (if there is no water, it is infiltrating into the soil) The observation wells which receive water directly from rainspouts also contain cleaning rods. There is a cap (or plate) on the bottom end of each rod. Debris can be removed from an observation well by pulling the rod up and cleaning the cap. The rod should be reinstalled right after the debris has been removed from the cap.

If properly maintained, the maintenance described above may be all that is needed. If the holes in the gravel become filled with dirt and/or other debris, it may be necessary to install new stone and filter fabric in the dry well. If "fines" fill the holes in the fabric to such an extent that water will not filter out within 48 hours, the filter fabric should be replaced. In case of failure of the system, the landowner, or someone designated by the landowner, shall undertake repairs to return the system to an operative condition.

9.20 Appendix 20 Lot Grading Plan Review Checklist

Subdivision name:_____Section: ____ Lot #:___

Street name:_____ Date: _____

Area of lot:__1_____ square feet ☐ acres ☐ Permit #:_____

Plan is proper size: YES ☐ NO ☐ Plan scale is acceptable YES ☐ NO ☐

Provides boundary lines YES ☐ NO ☐ Provides courses and distances YES ☐ NO ☐

Provides 2' contours: Existing YES ☐ NO ☐ Proposed YES ☐ NO ☐

___ Complies with steep slope ordinance, 28-39(f)

___ Evaluates impacts on utilities (water, sanitary sewer, storm sewer)

___ If fill being placed over storm sewers, specifies type and class or guage of pipe, and proposed total depth of cover over the pipe.

___ Cut and/or fill within easements for water and sanitary sewer lines, to be reviewed by Department of Utilities (Keith Dayton)

___ buildings placed on fill ____ sump pump required

Retaining walls YES ☐ NO ☐ Does effective height equal or exceed 4 feet ☐ YES ☐ NO

___ If height equals or exceeds 4', lot grading plan will not be approved until wall design is approved

Has street been stoned or paved YES ☐ NO ☐ Sealed by a PE ☐ LS ☐ LA ☐

Adequacy of stone and/or pavement is determined by erosion and sediment control inspectors.

Positive drainage provided YES ☐ NO ☐ 6" min. fall within 10' of house YES ☐ NO ☐

Measured at a right angle from the wall of the house

Proposed floor elevations shown (based on NAVD 1988 if in a detailed flood zone) YES ☐ NO ☐

Plan specifies applicable: flood zone(s) YES ☐ NO ☐ BFE. YES ☐ NO ☐ N/A ☐

To check for compliance with the Flood Ordinance; 28-57 (g) (3) and 28-57 (g) (5), including 3' freeboard requirement and crawl space vents near ground

If any part of the house is in a floodplain, a note specifies that an elevation certificate is required within 10 days of establishing lowest floor elevation

100-year water elevation: shown? YES ☐ NO ☐ lowest floor 1 foot above? YES ☐ NO ☐

storm sewer inlets, culvert inlets and streams, depth of flow in channels, etc. outside flood zones

Note specifies requirement for verification that lowest floor is 1 foot above: YES ☐ NO ☐

Field verification of floor elevations (and, where applicable, inverts of lowest opening) and control points prior to framing

Walk-out basement YES ☐ NO ☐ location shown YES ☐ NO ☐ elevations YES ☐ NO ☐

Meets IRC decay requirements YES ☐ NO ☐ stairwell landing YES ☐ NO ☐ N/A ☐

MINIMUM DISTANCES: ground to BF = 8" (0.67'), ground to FF (slab) = 8" (0.67');' stair landing to BF = 4" (0.33') minimum

For houses on crawl spaces, ground must be at least 18" below bottoms of untreated joists

Shows spot elevations: corners of house YES ☐ NO ☐ road/street YES ☐ NO ☐

Existing and proposed culverts and ditches with sizes and invert elevations YES ☐ NO ☐

___ design data for proposed pipes and channels

___ for culverts, 10-year HW/D, minimum and maximum depth of cover

___ for channels, permissible and design velocity, channel lining appropriate, 10-year capacity

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Limits of clearing (land disturbance) shown YES ☐ NO ☐
Wells, filter fields and pipelines are to be included within the limits of land disturbance.

Adjacent lot numbers shown YES ☐ NO ☐ Area of lot shown YES ☐ NO ☐

Points of connection to water and sanitary sewer shown YES ☐ NO ☐

Approximate location of existing water and sewer utilities shown YES ☐ NO ☐ N/A ☐

Easements shown: YES ☐ NO ☐ (Note: storm drainage easements required for channels receiving runoff from 3 or more lots)

Proposed erosion and sediment controls adequate YES ☐ NO ☐ RLD specified YES ☐ NO ☐

On-lot water quality practices YES ☐ NO ☐
____ existing (installed by developer)
____ planned, design and design data provided (to be constructed with lot grading)

COMMENTS_____

Questions? Call Adam Crist: 540-658-8653 FAX: 540-658-4598 (4598 for 14" paper)

REFERENCES:
All items in a lot grading plan should be in compliance with the following:

International Residential Code (included by reference in Stafford County's building code)
Stafford County's erosion and sediment control ordinance (Chapter 11)
Includes by reference the Virginia Erosion and Sediment Control Handbook
Stafford County's stormwater management ordinance (Chapter 21.5)
Includes by reference Stafford County's Stormwater Management Design Manual, the Virginia Stormwater Management Handbook, and VDOT's standards and specifications manuals
Stafford County's steep slope ordinance Chapter 28-39
Stafford County's Chesapeake Bay Preservation Area Overlay District ordinance(28-62)
Stafford County's Flood Hazard Overlay District ordinance (28-57)

PLEASE NOTE: Builders familiar with Stafford County's Integrated Web Response System are aware of six review categories. This checklist is for the review titled BLDGRD2REV.

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9.21 Appendix 21 Stormwater Management Facility Access

Access to a public route must be provided for stormwater management facilities.

9.21.1 Layout Requirements

Maximum (steepest) grade for access roads is 15%. Minimum cartway width is 12 feet with any shoulders extending beyond the cartway.

9.21.2 Easement Requirements

Minimum easement width is 20 feet if no road channel is needed and if the road is not crossing a slope steeper than 12%. 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. The minimum easement width is a function of the cross slope of the original ground on which the road is built