CITY OF RICHMOND, VIRGINIA
DEPARTMENT OF PUBLIC UTILITIES

STORMWATER MANAGEMENT DESIGN AND CONSTRUCTION STANDARDS MANUAL

JULY 1, 2012

CITY OF RICHMOND
Department of Public Utilities

The attached 'City of Richmond, Virginia Department of Public Utilities Stormwater Management Design and Construction Standards Manual," dated July 1, 2012, is hereby adopted as a City of Richmond Department of Public Utilities regulation for the purpose of setting applicable minimum standard and guidelines for stormwater management control within the City of Richmond, pursuant to Section 106-32 of the Code of the City of Richmond and other authority. The regulation shall be effective July 1, 2012, and at that time shall superseded all conflicting Departmental rules, regulations and policies.

Approved: _____
Robert C. Steidel, Director of Public Utilities, City of Richmond

Date: 30 August 2012

CITY OF RICHMOND
Department of Public Utilities

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Design and Construction Standards Manual
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Chapter 1 – General

1.1 Introduction

The City of Richmond has developed a Stormwater Management Design and Construction Standards Manual to provide City staff and design and construction professionals a valuable reference and tool for the design and specification of the City's stormwater infrastructure. This manual documents policies and procedures and provides guidelines for standard stormwater design, construction, and maintenance. It outlines the standard requirements and procedural sequence and provides uniformity for the submittal, review and permitting of construction documents.

1.2 Scope

The manual offers primary guidance regarding basic hydrology and water quality, stormwater hydraulics, stormwater best management practice design and efficiency, and administrative guidelines to support compliance with stormwater regulations enforced within the City's jurisdiction. It outlines instruction and criteria for the hydrologic and hydraulic analysis of pre-developed and post developed site conditions, selection and installation of individual components and layout of the stormwater utility network.

The City encourages the use of innovative design and professional judgment to develop better solutions to complicated technical problems; however it acknowledges the need to keep design plans consistent to obtain economies and expedite plan review and permitting through the use of standard structures and construction methods familiar to local contractors and field inspection personnel.

In addition, there are required standards of form, size of drawings, scale and presentation of plans and computations which have evolved over the years. Such information is specified herein and enforced by applicable design plan checklists and engineering calculation worksheets. Refer to Appendix A for the checklist required for any stormwater management design.

It is not the intention of this manual to replace existing ordinances and regulations. Whenever any provision of this manual imposes a greater requirement or higher standard than is required by any State or Federal statute, the provision of this manual shall govern. The user where appropriate, should reference other source documents that provide more detailed information on design and analysis criteria and methodology. These include and are not limited to the current editions of the following:

- VDOT Drainage Manual
- Virginia Stormwater Management Handbook
- Virginia Erosion and Sediment Control Regulations
- Virginia Erosion and Sediment Control Handbook
- Chesapeake Bay Preservation Act

- City of Richmond Roadway Geometric Design Manual
- City of Richmond Right of Way and Construction Manual
- City of Richmond Code of Ordinances, Amended to October 2007 and in particular Chapter 50; Flood Plain Management, Erosion and Sediment Control and Chesapeake Bay Preservation Areas.

1.3 Objectives

The City has identified the relationship between the stormwater management system and protection of the region's natural resources including the James River and Chesapeake Bay and has established the following objectives for the Stormwater Management Program.

- Protection of people and property from flood hazards
- Prevention of infrastructure failures
- Improvement of water quality by the reduction of non-point source pollution
- Prevention of stream bank erosion
- Collection, conveyance and treatment of stormwater in the combined sewer system

The objectives of this manual are to:

- Establish City of Richmond policies and procedures for drainage design, construction, quality control and maintenance
- Provide guidelines to facilitate the process of stormwater design submittals and permitting.
- Provide electronic access of this manual, available on the World Wide Web for viewing and downloading
- Provide a standard City reference for training and a platform for technical stormwater design improvement

1.4 General Design Policies

This chapter describes the general course of action selected to guide and determine design criteria for the City of Richmond stormwater infrastructure. The purpose of establishing design policy is to assure that structures are designed to meet or exceed standard engineering practice and that the design is prepared by competent professionals.

1.4.1 Hydrologic Analysis

The designer must review existing watershed characteristics and determine through comparative assessment the effects of proposed post developed site conditions. The storm structure must be adequately designed for proposed and future watershed conditions and include contributing off-site and on-site drainage basins. Reference must be made to current rainfall data and the design methodology should apply state-of-practice formulas

and models for estimating storm frequency, intensity, duration and peak flows. To account for errors in methods based on statistical analysis of historical rainfall events and runoff records the City will establish certain safety consideration such as freeboard, emergency spillway and exit discharge velocity requirements. Design must take into consideration the unique nature of the City of Richmond's waterways, flood plains and other receiving natural waters or existing stormwater facilities.

1.4.2 Hydraulic Analysis

The designer will develop preliminary engineering design alternatives based on selected values of applicable hydrologic parameters. Design calculations will exhibit due diligence in data collection and be representative of sufficient iterations to reasonably mimic expected hydraulic behavior of storm structures under selected design flows.

1.4.3 Engineering Evaluation

The assessment of design alternatives and selection of the "best fit" option involves consideration and balancing of a number of factors without compromising the physical and structural integrity of the design. These include (in no order):

- Legal considerations
- Health and safety
- Flood hazards to highway users and neighboring property owners
- Costs
- Schedule constraints
- Environmental and social concerns
- Operations and maintenance
- Other site concerns

1.4.4 General Policies on Design and Permitting

It is the designer's responsibility to provide an adequate drainage structure to handle stormwater peak flows for anticipated site conditions.

The detail of the design studies should be commensurate with risk associated with the encroachment and with other economic, engineering, social or environmental concerns. The design should not adversely affect adjacent or neighboring properties.

The predicted value of the 100-year or base flood serves as the present engineering standard for evaluating flood hazards and as the basis for regulating flood plains under the National Flood Insurance Program. The designer must make a professional judgment as to the degree of risk that is tolerable for the base flood on a case by case basis. Flows higher than the 100-year base flood may be considered for complex, high risk or unusual

cases that require special studies or risk analysis.

1.4.5 Adequate Channel

All storm drainage systems shall outfall to an adequate channel. An adequate channel is defined as a watercourse or wetland that will convey the designated frequency storm event without overtopping its banks or causing erosive damage to the channel bed, banks, or overbank sections of the same. An existing channel qualified as stated above, shall be considered to remain adequate at any point where the total contributing drainage area is at least 100 times greater than the drainage area of the development site or if the peak rate of runoff from the site during a ten-year frequency storm will not be increased after development.

1.4.6 Subdivisions and Individual Lot Developments

Where new development or redevelopment of single lots and parcels are below the threshold that would trigger review and permit process for land disturbance activities; the developer will be deemed responsible to ensure that properties and waterways downstream from the development are protected from sediment deposition, erosion and damage due to increase in volume, velocity and peak rate of stormwater runoff. The City may require that the site demonstrate compliance to Minimum Standard (MS-19) of the ESC Regulations which provides criteria for downstream protection measures.

1.4.7 Analysis of Existing Storm Sewer Systems

If the existing storm or combined sewer system into which proposed project is draining is not adequate, as defined in Chapter 13, and the development controls the majority of drainage area, the development is responsible for upgrading system or providing detention. If a development does not control the majority of the drainage area, the development must meet existing conditions for the ten-year design storm.

The developer shall be responsible for upgrades to existing stormwater facilities that are required to adequately detain/retain or convey stormwater as a direct result of the new construction. The developer/owner shall also dedicate and obtain any necessary easements and variances required to install and maintain proposed stormwater facilities.

1.4.8 Variances

There are certain specific requirements based on Federal Code, State Code, City Code regulations, resolutions and policies, as well as specific standards of VDOT, from which variances may not be granted by Departmental officials at a local level.

These standards are considered guidelines rather than mandates unless the language clearly specifies otherwise. The City staff may allow for variation of a given standard where the effect of such variation is in keeping with established engineering practice and procedure after reviewing recommendations from designated departments, authorities, boards and committees.

This document will be revised as new technology and design criteria become available and accepted practice and take into considerations changes in structure and regulations of governing agencies at Local, State or Federal levels.

Chapter 2 – Floodplain Management

The 100-year floodplain is used to delineate areas subject to inundation and to restrict construction of buildings within an area subject to flooding as a result of major storms. Floodplain requirements for land development shall be in accordance with Chapter 50 of the City Code. The Federal Emergency Management Act (FEMA) flood insurance study for the City of Richmond is dated December 15, 1978 and revised effective July 20, 1998, and revised effective April 2, 2009. Information for FEMA floodplain mapping is available on their website: www.FEMA.gov or through the customer service center of the National Flood Insurance Program at 1-800-638-6620.

2.1 Floodplain Mapping

Floodplains shall be determined for all major drainage areas which have a contributing watershed in excess of 100 acres or where the offsite drainage area is greater than 50 acres. However, where conditions so dictate, smaller drainage areas may require floodplain calculations as directed by the Director of Public Utilities or their designee. All floodplains shall be determined based on a 100-year design flood unless a higher flood frequency is advisable or if required by the Director of Public Utilities or their designee. In the event that a FEMA flood plain is shown to exist on the FEMA panel for the area being developed, or the drainage area is sufficient to justify a FEMA flood plain, the floodplain study shall meet the requirements for development within a FEMA flood plain in addition to any City requirements. Whenever a FEMA floodplain exists on a site proposed for development, the required amendments and revisions to the FEMA floodplain must be approved prior to approval of the Plan of Development or issuance of a land disturbance or building permit.

Floodplains shall be determined by a qualified professional engineer. The developer's engineer shall use the backwater analysis for floodplain engineering design to determine flood flows and calculate cross sections for determining floodplain limits. Cross sections, stream bed profiles, water surface profiles, topographic maps and any other information required for FEMA submittals shall be prepared by the developer's engineer and submitted to the Department of Public Utilities for review.

For the purposes of regulation, a distinction is made between major floodplains and minor floodplains, as defined below;

(1) The major floodplain shall include areas subject to inundation by waters of the one hundred (100)-year flood, and shall include all lands shown on the FIRM Map, as amended, that are located in Zones A, AE, AH, or AO. The Approximated Zone A floodplain, shown as Zone A on the FIRM Map, is that major floodplain area for which no detailed flood profiles or elevations are provided, but where a one hundred (100)-year floodplain boundary has been approximated.

(2) The minor floodplain shall include areas subject to inundation by waters of the one hundred (100)-year flood with average depths of less than one foot or with drainage areas of less than one square mile, and shall include all lands shown on the FIRM Map, as amended, in the shaded Zone X. The Approximated Zone X floodplain, shown as shaded Zone X on the FIRM Map, is that minor floodplain area for which no detailed flood profiles or elevations are provided, but where a Zone X boundary has been approximated.

The finished floors of all structures adjacent to a floodplain shall comply with Section 50 of the code.

2.2 Floodplain Improvements

All substantial improvements to existing structures within any floodplain district shall conform to the applicable sections of the Virginia Uniform Statewide Building Code.

New construction or land disturbance of 4,000 square feet or greater for any existing commercial, industrial, or non-residential building (or manufactured home) shall have the lowest floor, including basement, elevated no lower than one foot above the base flood elevation. A registered Professional Engineer or Architect shall certify that this standard is met.

The engineer or developer shall consult the Department of Public Utilities prior to planning any project adjacent to rivers, streams, watercourses, lakes and drainage ways to verify general requirements, restrictions and improvements that may apply to a particular property.

2.3 Subdivision Requirements

For any proposed subdivision and any portion of a proposed subdivision that lies within a floodplain district the following shall apply:

- The 100-year floodplain shall be delineated on the tentative and final subdivision plats.
- Residential building lots shall be provided with adequate buildable area outside of the 100-year floodplain.
- The design criteria for utilities and facilities in City of Richmond Code, Chapter 50 of the ordinance shall be met.

Chapter 3 – Hydrology

The designer must review existing watershed characteristics and determine through comparative assessment the effects of proposed post developed site conditions. Storm sewer structures must be adequately designed for proposed and future watershed conditions and include contributing off-site and on-site drainage basins. Reference must be made to current rainfall data and the design methodology should apply state-of-practice formulas and models for estimating storm frequency, intensity, duration and peak flows.

3.1 Hydrology in General

Hydrologic analysis will generally conform to the provisions contained in the current edition of the following references:

- Virginia Stormwater Management Handbook
- Virginia Department of Transportation Drainage Manual
- National Resource Conservation Service Technical Release Number 55 Urban Hydrology for Small Watershed

3.2 Design Frequency

3.2.1 All storm sewers will be designed using a minimum rainfall event of 10-year design frequency. The storm sewer drainage system shall be reviewed for the 100-year design frequency to ensure the safety of nearby development. No damage to life, health, or real property for the 100-year design frequency shall occur as a result of the storm sewer systems.

3.2.2 Inlets shall be sized and located to limit the spread of water on travel lanes in accordance with the design criteria specified in Section 9.3.1 VDOT Drainage Manual.

3.2.3 Man-made open channels shall be sized to provide adequate capacity for a 10-year design frequency and protective lining for a 2-year design frequency. Natural channels must convey and resist erosion from the 2-year design frequency. Open channels that serve as floodways may require capacity to accommodate storms of greater magnitude in order to be considered adequate at the discretion of the Director DPU or their designee.

3.2.4 Culverts shall be sized per the following VDOT requirements: 25-year design frequency on Principal Arterials, and 10-year design frequency on Minor Arterial, Collector, or Local Roads.

3.3 Peak Discharge Method Selection

3.3.1 Rational Method

The Rational Method is the recommended method for the design of storm drain systems and will be used to determine the peak stormwater runoff for drainage areas less than 200 acres. Drainage systems involving detention storage, pumping stations, and large complex storm systems require the development of a runoff hydrograph and use of more appropriate methods of determining the peak discharge. For drainage areas more than 200 acres, the TR-55 method shall be applied. Other methods may be approved on a case by case basis and should be calibrated to local conditions and verified for accuracy and reliability.

The Rational Method formula is as follows:

$Q = CI_fA$

Where:
Q = Maximum rate of runoff, cubic feet per second (CFS), and
C = Runoff coefficient representing a ratio of runoff to rainfall (dimensionless),
I_f = Rainfall intensity for a given recurrence interval "f", in inches/hour, and
A = Drainage area (acres).

Less frequent, higher intensity storms will require adjustment of the runoff coefficient because infiltration and other losses have a proportionally smaller effect on runoff (Wright-McLaughlin 1969) with the effect of increasing runoff. To account for this, the right side of the rational method can be multiplied by a saturation factor C_f for storms with a recurrence interval greater than 10 years.

$$\text{Hence } Q_{>10} = C_fCI_fA$$

Where:

$Q_{>10}$ = Maximum rate of runoff for design frequencies greater than 10 years

C_f = Saturation factor

The product of C_f and C should not be greater than 1. This is attributed to the fact that the rational method becomes more accurate as the percentage of impervious cover approaches 100%.

The saturation factors for the Rational Method are the following:

Design Frequency (years)	**C_f**
2, 5, and 10	1.0
25	1.1
50	1.2
100	1.25

*Source: VDOT Drainage Manual

The U.S. National Oceanic & Atmospheric Administration (NOAA) released their "Atlas 14: Rainfall Precipitation Frequency Data" which covers the Ohio River basin and surrounding states (including Virginia) in 2005. This new data supersedes and replaces that which is contained in Technical Paper No. 40 "Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years". All of the information currently contained in the VDOT Drainage Manual was predicted on TP-40 and/ or HYDR-35. All such information is no longer valid. VDOT requires that its implementation of this data be employed for the design of all drainage facilities for which hydrologic design is customarily predicted on rainfall data. To avoid confusion and to simplify the implementation and application of the new rainfall data, VDOT has developed a set of "B, D & E" factors for each county and major city throughout the state.

Rainfall intensity shall be determined by the VDOT B, D, & E factors through the following equation:

$I_f = B/(T_C + D)^E$

Where:
Tc = Watershed time of concentration (assumed equal to the storm duration), in minutes.

The B, D & E factors for the City of Richmond are as follows:

	2-Year Storm	5-Year Storm	10-Year Storm	25-Year Storm	50-Year Storm	100-Year Storm
B	57.69	54.99	47.91	41.66	36.88	33.15
D	11.50	10.75	9.25	7.75	6.50	5.25
E	0.85	0.78	0.72	0.65	0.60	0.56

*Source: VDOT Hydraulic Design Advisory HDA 05-03, dated June 21, 2005

The time of concentration shall be determined by calculating the sum of various consecutive flow path segments travel duration from the most hydraulically remote point of the drainage basin to the location being analyzed. The total flow path cumulatively constitutes the overland flow, shallow concentrated flow and channel flow. The maximum allowable length for overland sheet flow is 200 feet. Flow paths must be identified on all submittals.

The runoff coefficient (C) will be calculated using a 25-year land-use planning projection based on impervious cover requirements for zoning classification. The following runoff coefficients will be used for the Rational Method site specific runoff coefficient calculations:

RUNOFF COEFFICIENTS FOR THE RATIONAL METHOD (C) HYDROLOGIC SOIL GROUP AND SLOPE RANGE												
	A			B			C			D		
Land Use	0-2%	2-6%	6%±	0-2%	2-6%	6%±	0-2%	2-6%	6%±	0-2%	2-6%	6%±
Cultivated, Pasture	0.07	0.09	0.10	0.18	0.20	0.22	0.27	0.29	0.31	0.32	0.34	0.35
Open Space, Lawn	0.08	0.12	0.15	0.11	0.16	0.21	0.14	0.19	0.24	0.20	0.24	0.28
Meadow	0.06	0.08	0.10	0.10	0.14	0.19	0.12	0.17	0.22	0.15	0.20	0.25
Wooded	0.05	0.07	0.08	0.08	0.11	0.15	0.12	0.17	0.22	0.15	0.20	0.25
Gravel, Parking, Other Impervious	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Residential, Commercial, Industrial and Other "Developed"	Runoff coefficients should be calculated based upon weighted average of impervious area coefficients and pervious area coefficients from above based on soil type, slope and the particular development proposal.											

3.3.2 TR-55

Drainage areas greater than 200 acres shall utilize the National Resource Conservation Service Technical Release Number 55 (TR-55) method to determine the peak stormwater runoff. Runoff curve numbers shall be according to the TR-55 Table 2.2a, *Runoff curve numbers for urban areas.* A copy can be found in Appendix D.

The following City of Richmond 24-hour Rainfall Depths shall be used with the TR-55 method:

Frequency (years)	1	2	5	10	25	50	100
Rainfall Depth (inches)	2.76	3.34	4.28	5.08	6.27	7.29	8.42

3.3.3 Modified Rational

The Modified Rational Method may be used for the analysis and design of retention/detention basins that serve a drainage area less than 20 acres.

Chapter 4 – Open Channels, Ditches, and Culverts

It is the designer's responsibility to provide an adequate drainage structure to handle stormwater peak flows for anticipated site conditions.

The detail of the design studies should be commensurate with risk associated with the encroachment and with other economic, engineering, social or environmental concerns. The design should not adversely affect adjacent or neighboring properties.

The developer shall be responsible for upgrades to existing stormwater structures that are required to adequately detain/retain or convey stormwater as a direct result of the new construction and/or redevelopment. The developer/owner shall also apply and obtain any necessary easements and variances required to install and maintain proposed stormwater structures.

4.1 Open Channels and Ditches

4.1.1. All open channels and roadside ditches must be designed and constructed in accordance with the current approved version of VDOT's *Drainage Manual, Road and Bridge Standards,* and *Road and Bridge Specifications* unless otherwise specified in this manual or by the Director DPU or their designee.

4.1.2. The side slopes of vegetated open channels and roadside ditches must not be steeper than two feet horizontal to one foot vertical (2:1) provided soils are acceptable.

4.1.3. The Manning's Equation or the appropriate methodology must be utilized to calculate the velocity and discharge of an open channel or roadside ditch with a steady, uniform flow.

4.1.4. Recommended n Values to be used with Manning's equation are included in Appendix E.

4.1.5. All channels and ditches must be analyzed according to Minimum Standard 19 of the *Virginia Erosion and Sediment Control Handbook* for adequate receiving channels. Channel adequacy must be analyzed using cross sections at 100, 200, 300-feet downstream of the point of interest and at any critical downstream control points or until the channel reaches its natural state. In addition, channel adequacy must be analyzed at the confluence of major tributaries downstream of the project site if the receiving channel is an open channel or roadside ditch, or at the first offsite receiving pipe of a combined sewer system or storm sewer system. Discharges of stormwater from construction activities shall be enforced as required under the Virginia Stormwater Management Regulations and associated Permits (VSMP).

4.1.6. All storm sewer systems shall outfall to an adequate channel. An adequate

channel means a watercourse, wetland, storm sewer system or combined storm sewer system that will convey the designated frequency storm event without overtopping its banks or causing erosive damage to the channel bed, banks, or overbank sections of the same. Adequate channel shall be analyzed using the following design storm frequencies:

Natural Channel:	2-year (erosion & conveyance)
Man-made Channel:	2-year (erosion) and 10-year (conveyance)
Pipe and storm sewer system:	10-year

4.1.7. If the existing channel, storm sewer system, or combined sewer system is not adequate, the project shall provide a combination of channel improvements, site design, stormwater detention, or other measures to prevent downstream erosion and/or flooding.

4.1.8. Existing natural watercourses or unlined open channels and roadside ditches may be considered waters of the U.S. and jurisdiction must be confirmed by the U.S. Army Corps of Engineers prior to improvement.

4.1.9. **Permissible Velocity**

Permissible velocity and tractive force methods shall be applied to determine whether a channel is stable from an erosion standpoint. The flow velocity at the outlet of energy dissipating measures at design capacity must not exceed the permissible velocity of the receiving channel as noted in Tables 3.18-A and 3.18-B of the Virginia Erosion and Sediment Control Handbook, Third Edition, 1992. The values for permissible velocities for grass and earth linings are indicated in the tables following this section.

Using the permissible velocity approach, the channel is assumed to be stable if the mean velocity is lower than the maximum permissible velocity (MPV). Mannings equation shall be used to compute the flow velocity in the channel for the design storm. The flow velocity is then compared with the maximum permissible velocity for the channel bed and bank soils and the lining material. If the computed velocity is less than the maximum permissible velocity, the channel should be stable.

PERMISSIBLE VELOCITIES FOR GRASS LINED CHANNELS

Channel Slope	Lining	Velocity, fps
0 - 0.5%	Bermuda grass	6
	Reed canarygrass Tall fescue Kentucky bluegrass	5
	Grass-legume mixture	4
	Red fescue Redtop Sericea lespedeza Annual lespedeza Small grains Temporary vegetation	2.5
5 – 10%	Bermuda grass	5
	Reed canarygrass Tall fescue Kentucky bluegrass	4
	Grass-legume mixture	3
Greater than 10%	Bermuda grass	4
	Reed canarygrass Tall fescue Kentucky bluegrass	3
* For highly erodible soils, decrease permissible velocities by 25%		

PERMISSIBLE VELOCITIES FOR EARTH LININGS

Soil Types	Velocity fps
Fine Sand (noncolloidal)	2.5
Sandy Loam (noncolloidal)	2.5
Silt Loam (noncolloidal)	3.0
Ordinary Firm Loam	3.5
Fine Gravel	5.0
Stiff Clay (very colloidal)	5.0
Graded, Loam to Cobbles (noncolloidal)	5.0
Graded, Silt to Cobbles (colloidal)	5.5
Alluvial Silts (noncolloidal)	5.0
Alluvial Silts (colloidal)	5.0
Coarse Gravel (noncolloidal)	6.0

Cobbles Shingles	5.5
Shales and Hard Plans	6.0

4.2 Culverts

4.2.1. Culverts shall be sized per the following VDOT requirements: 25-year design frequency on Principal Arterials, and 10-year design frequency on Minor Arterial, Collector, or Local Roads or Streets.

4.2.2. Culverts must be designed in accordance with VDOT Culvert Design Methodology.

4.2.3. Storm sewer pipe installation shall be in accordance with VDOT Road and Bridge Standards Manual. Bedding and Backfill material shall adhere with section 302 of the Road and Bridge VDOT specifications. Method "A" pipe bedding shall be used for all types of pipe culverts within the applicable height of cover range noted in the standard PC-1 VDOT tables unless otherwise noted on plans.

4.2.4. The minimum class of concrete pipe used in the right-of-way, parking areas, driveways and all other areas subject to vehicular traffic shall be ASTM, C-76 Class III pipe. Concrete pipe ASTM, C-76 Class II for sizes up to 24" diameter may be used in easements and areas outside the right-of-way not subject to vehicular traffic. All pipe culvert types shall be specified by the Engineer as appropriate to the application and location, and reviewed by the Department of Public Utilities.

4.2.5. The minimum depth of cover is 2 feet to top of pipe or one half the diameter of the pipe whichever is greater unless otherwise specified by the manufacturer. Driveway culverts shall be considered on a case by case basis for size and slope.

4.2.6. All pipe culverts will be 15" minimum unless approved by the Department of Public Utilities.

4.2.7. All culverts shall be designed and installed to terminate with the appropriate pipe end treatment as specified by the Engineer. All specified pipe end treatments including flared end sections, end walls, head walls and wing walls shall be in accordance with VDOTs Road and Bridge standards or per the manufacturer's specifications.

4.2.8. In order for the City to grant a permit to perform the installation of pipe culvert within an existing street right of way, the applicant must submit four sets of engineering drawings for approval. These drawings shall be prepared by a professional engineer and provide the following information details:

a. Site layout plan of the proposed improvements;

b. Plan and profile views of the proposed pipe, with adequate elevations to indicated gradients;

c. Final surface grade contours and/or elevations which assures the collection and distribution of existing roadside drainage. Inlet structures will be required when necessary to prevent water from running in and along the existing road surface; and

d. Description of the methods intended to achieve stabilization.

4.3 Outlet and Channel Protection

4.3.1 Culverts:

Culverts discharging to natural channels or water courses must be analyzed in order to ensure stability for the 2-year storm and existing soil types. Appropriate design measures must be indicated accordingly. The following Culvert Outlet Protection shall be used according to design storm outlet velocity:

Maximum Outlet Velocity (feet per second)	**Culvert Outlet Protection**
6	EC-1 Class 1
8	EC-1 Class 2
14	EC-1 Class 3
19	EC-1 Class 4
Greater than 19	Special Design per VDOT Standards

4.3.2 Riprap Aprons:

Outlet protection riprap aprons must be analyzed according to Minimum Standard and Specification 3.18 of the Virginia Erosion and Sediment Control Handbook,Third Edition, 1992.

Where flow is excessive for the economical use of an apron, excavated stilling basins may be used. Acceptable designs for stilling basins may be found at the following sources:

- Hydraulic Design of Energy Dissipators for Culverts and Channels, Hydraulic Engineering Circular No. 14, U.S. Department of Transportation, Federal Highway Administration (83).
- Hydraulic Design of Stilling Basins and Energy Dissipaters, Engineering Monograph No.25, U.S. Department of the interior – Bureau of Reclamation, (74).

In all cases, filter cloth shall be placed between the riprap and the underlying soil to prevent movement into and through the riprap. The material must exceed the physical properties filter cloth found in Std. Spec 3.19 of the Virginia Erosion and Sediment Control Handbook,Third Edition, 1992..

4.3.3 Paved Channel Outlets:
The end of a paved channel shall merge smoothly with the receiving channel section. There shall be no overfall at the end of the paved section. Where the bottom width of the paved channel is narrower than the bottom width of the receiving channel, a transition section shall be provided. The maximum side divergence of the transition shall be 1 in $3F_r$ where;

$F_r = V/(gd)^{0.5}$

Where,

F_r = Froude Number

V = Velocity beginning of transition (ft/sec)

d = depth of flow at beginning of transition (ft)

g = 32.2 ft/sec^2

Bends or curves in the horizontal alignment at the transition are not allowed unless the Froude number (F_r) is 1.0 or less, or the section is specifically designed for turbulent flow.

4.3.4 Vegetated linings:
Erosion resistant vegetation should be used whenever possible along channels/ ditches to reduce erosion and may in some locations require the use of either a temporary protective covering (VDOT Standard EC-2) or a permanent soil stabilization mat (VDOT Standard EC-3, Type A, or Type B).

Maximum Flow Velocity (feet per second)	Vegetative Stabilization
< = 4	EC-2 Jute Mesh/ Soil Retention Mat

4.3.5 Geotextile linings:
Geotextile materials designated as VDOT Standard EC-3 (Type A and B) Soil Stabilization Mat is intended to be used as a protective ditch lining material to be applied when the design velocity exceeds the allowable velocity for EC-2.

Maximum Flow Velocity (feet per second)	Geotextile Stabilization
4-7	EC-3 Type A
7-10	EC-3 Type B
Cut / Fill Slopes	EC-3 Type C

A Manning's n-value of 0.05 should be used with Standard EC-3. When the design velocity exceeds the allowable velocity for standard EC-3, a paved (or riprap) lining is required.

4.3.6 Tractive Force:

The tractive force (permissible shear) method provides a more physically based and realistic model for particle detachment and erosion processes *(FHWA's HEC-15, Design of Roadside Channels with Flexible Linings.)*. It is recommended that the permissible velocity method be used for roadside ditches and that the tractive force method be used for major channel analyses.

The material on the side slope may establish the limiting condition for permissible tractive force rather than the material on the bed. The resistance to movement of the material on the side slope is reduced by the downward sliding force due to gravity. The ratio of critical shear on the side slope to critical shear on the bottom is expressed as factor K_1.

Note: K_1 in HEC-11 is the same variable as K_2 in HEC-15.

$$K_1 = \sqrt{1-\left(\frac{\sin^2\theta}{\sin^2\phi}\right)}$$

Where:

θ = Side slope angle (measured from the horizontal), deg.

ϕ = Natural angle of repose of material under consideration (measured from the horizontal), deg.

The angles of repose for various sizes of non-cohesive materials, applicable riprap size and the permissible tractive force can be determined from Chapter 7 of the *VDOT Drainage Manual.*

The average tractive force formula is:

$$\tau_o = 62.4RS_o$$

Where:

τ_o = Average tractive force, lbs/ft^2

R = Hydraulic radius, ft.

S_o = Channel slope, ft/ft.

In channels whose width (B) to depth (d) ratio is 10 or more, the depth of flow (d) may be substituted for R, thus obtaining the maximum tractive force on the channel bed.

$$\tau_{max} = 62.4dS_o$$

Where:

d = Depth of flow, ft

Chapter 5 – Storm Drainage Design

It is the designer's responsibility to provide an adequate drainage structure to handle stormwater peak flows for anticipated site conditions.

The detail of the design studies should be commensurate with risk associated with the encroachment and with other economic, engineering, social or environmental concerns. The design should not adversely affect adjacent or neighboring properties.

The overtopping and design storm may serve as criteria for evaluating the adequacy of the proposed design. The "overtopping storm" is the smallest hypothetical recurrence interval storm which will cause a water surface elevation that exceeds the height of the road, designed embankment, or other watershed boundary. The "design storm" is a selected rainfall hyetograph of specified amount, intensity, duration and frequency that is used as a basis for design; that a stormwater management system must be designed to accommodate, convey or hold stormwater to assure no significant detriment to public infrastructure, public health and safety and natural resources. The overtopping storm and design storm may vary widely depending on-site characteristics, including topography, watershed characteristics, road classification and intended use of the storm structure.

The predicted value of the 100-year or base flood serves as the present engineering standard for evaluating flood hazards and as the basis for regulating flood plains under the National Flood Insurance Program. The designer shall make a professional judgment as to the degree of risk that is tolerable for the base flood on a case by case basis.

If the existing storm or combined sewer system is not adequate and the development controls the majority of drainage area, the development is responsible for upgrading system or providing detention. If development does not control majority of drainage area, the post development shall not exceed existing conditions peak flow from the ten-year frequency storm.

The developer shall be responsible for upgrades to existing stormwater structures that are required to adequately detain/retain or convey stormwater as a direct result of the new construction and/or redevelopment. The developer/owner shall also apply and obtain any necessary easements and variances required to install and maintain proposed stormwater structures.

5.1 General Requirements

5.1.1. All drainage design plans for proposed development shall be prepared by a Professional Engineer, qualified land surveyor or landscape architect registered in Virginia.

5.1.2. All on-site and off-site drainage structures (inlets, junction boxes, manholes, storm sewer, etc.) shall be designed and constructed in accordance with the current approved version of VDOT's *Drainage Manual, Road and Bridge*

Standards, and *Road and Bridge Specifications* unless otherwise specified in this manual or by the Director DPU or their designee.

5.1.3. All site plans, subdivision plans, and stormwater plans for building permits or land disturbance permits shall be submitted to the City of Richmond and reviewed for approval.

5.1.4. The plans will be reviewed to ensure there are adequate provisions by the developer to convey drainage across and/or off the site. Such drainage improvements shall be adequate for a minimum 10-year design frequency, unless a 100-year flood study is required. The 100-year design frequency shall be documented for design approval.

5.1.5. All inlets shall be designed to intercept drainage based on a rainfall intensity of 4 inches per hour for spread.

5.1.6. A 100-year flood plain study shall be required when the offsite drainage area within the watershed is greater than 50 acres. In the event that a FEMA flood plain is shown to exist on the FEMA panel for the area being developed, or the drainage area is sufficient to justify a FEMA flood plain, the study shall meet the requirements for development within a FEMA flood plain in addition to any City requirements. Required flood studies and flood plain amendments shall be approved prior to approval of site development plans.

5.1.7. The 100-year backwater elevation must be shown on plans for all stormwater conveyance systems in proximity to buildings to ensure protection from real property damage and loss of human life.

5.1.8. Permanent drainage easements shall be required to convey stormwater from public rights of way across private property.. Such easements necessary for the storm drainage improvements must be located in accordance with *Chapter 10 – Easements*, and recorded prior to issuance of land disturbance or building permits. Flood plains for the 100-year flood event shall be shown on recorded plats for all land development. Copies of recorded deeds shall be submitted to the Department of Public Utilities within ten (10) days of recordation.

5.2 Drop Inlets

5.2.1. All inlets shall be designed to intercept drainage based on a rainfall intensity of 4 inches per hour.

5.2.2. Inlets are desirable at point of curvature of roads, entrances before discharging into intersection or into the right-of-way.

5.2.3. Inlets shall be located at the low point of all sag vertical curves and on continuous grades. The spread for all road types should not exceed a maximum of 8-feet of water onto the pavement.

5.2.4. Where vertical alignment is at a sag point in grade and that point is confined the 100-year storm shall be analyzed to ensure that the road is not inundated to a degree that human life and real property is endangered by inundation within the right of way. Maximum ponding depth shall be 1.5 feet. However, where the road is a single means of ingress/egress, the maximum depth of ponding shall be 1 foot or additional access shall be provided.

5.2.5. Where the actual curb and gutter grade is less than 0.3 percent, flanking inlets shall be provided subject to terrain conditions.

5.2.6. New inlets shall not be permitted in the curb radius of an intersection.

5.2.7. Drainage inlets are required to intercept yard drainage in lieu of open pipe. Front yard drainage structures shall be limited to VDOT Standard DI-1, DI-5, DI-7, and DI-12 structures. All yard inlets and grate inlets must be located at an elevation to drain, with appropriate grading limits shown on the construction plan. When DI-5 and DI-7 structures are utilized, Grate Type III shall be installed in pedestrian areas and Grate Type I shall be installed in wooded areas. Load carrying grates (Grate B) shall be used in areas subject to vehicular traffic.

5.3 Storm Sewer

5.3.1. The minimum design frequency for storm sewer shall be the 10-year design frequency.

5.3.2. The minimum pipe size within road right-of-way and public easements will be 15 inches in diameter.

5.3.3. Pipe Diameter must not reduce in size downstream.

5.3.4. The minimum allowable slope in pipes will be 0.3% or 0.003 ft/ft. The minimum desirable design velocity in any storm drainage pipe is three (3) feet per second based on the 10 year storm frequency analysis for the storm drainage system.

5.3.5. Radial pipe is generally discouraged; however it may be considered for storm water systems 36" diameter or greater if approved by the Director DPU or their designee. Manhole or drop inlet access points should be required in storm sewer systems where angular (bends) changes and grade changes occur in the system.

5.3.6. All new connections to existing storm sewer systems shall be made via manholes or drop inlets. Blind connections will not be permitted.

5.3.7. Manholes or drop inlets shall be provided at a maximum of 300 feet spacing within the system for maintenance purposes.

5.3.8. Hydraulic grade lines are required with all proposed storm sewer calculations. The proposed storm sewer system must contain the design storm.

5.3.9. Hydraulic grade lines shall be shown on all proposed storm sewer profiles.

5.3.10. Discharge points for enclosed drainage systems should be analyzed for stability in the receiving water course. Stability should be documented commensurate of soil types and velocities. Appropriate erosion control methodologies should be identified.

5.3.11. Storm sewers with outlet velocities greater than 6.0 feet per second for the design storm or the 2-year design storm culvert outlet velocity is greater than the allowable velocity for the swale or channel material shall have end treatment designed in accordance with VDOT Standards.

5.3.12. The following Pipe Outlet Protection shall be used according to design storm outlet velocity:

Maximum Outlet Velocity (feet per second)	**Pipe Outlet Protection**
6	EC-1 Class 1
8	EC-1 Class 2
14	EC-1 Class 3
19	EC-1 Class 4

5.3.13. All storm sewers shall discharge into an adequate outfall channel, or pipe system, which has positive gravity flow to a natural water course. If such an outfall is not available, it shall be the responsibility of the developer to obtain permanent easements needed to construct an adequate outfall channel.

5.4 Installation

5.4.1. All drainage structures shall be of concrete and/or reinforced concrete construction (poured-in-place or precast) and shall be designed in accordance with the VDOT standards and requirements

5.4.2. All pipe material used for the construction of drainage systems and/or Stormwater facilities shall be in accordance with the most recently published version of VDOT's Drainage Manual, Road and Bridge Standards, and Road and Bridge Specifications; provided, however, all such pipes shall meet the most recently published VDOT, ASTM and AASHTO standards and specifications for use, storage, placement, installation and maintenance. Any such pipes shall be used, consistent with such standards and specifications, in road right-of-way, parking areas, driveways, and all other areas subject to vehicular traffic.

5.4.3. All drainage pipes and structures shall be installed on a firm foundation. A minimum of 6 inches of pipe bedding shall be required under all storm sewer pipes, paved ditches, and drainage structures.

5.4.4. The minimum depth of cover is 2 feet to top of pipe or one half the diameter of the pipe whichever is greater unless otherwise specified by the manufacturer. Maximum depth of cover is as specified in PC-1 tables of the VDOT Road and Bridge Standards.

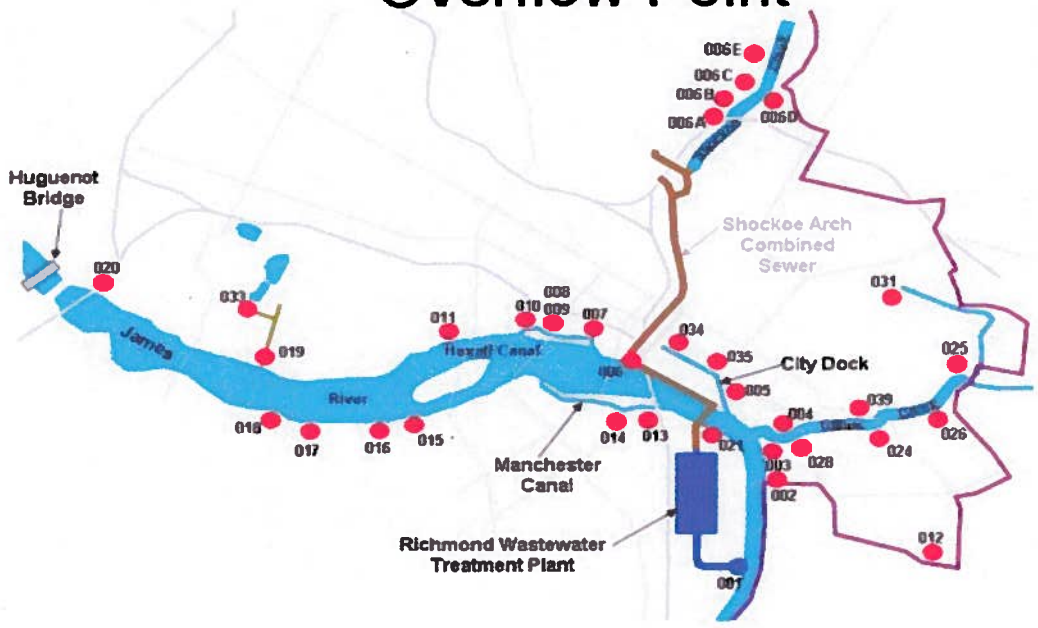
5.4.5. Smooth dowels (#4 x 8 inches) shall be provided at approximately 12 inches, on center, in all areas adjacent to abutting concrete to prevent settlement.

5.4.6. Abandoned storm sewers and drainage pipe shall be removed or plugged and filled with flowable fill in accordance with VDOT requirements.

Chapter 6 - Combined Sewer System – CSS

A Combined Sewer Overflow (CSO) is a discharge of untreated storm and wastewater from a combined sewer into the environment. CSOs typically occur when combined sewers fill up with too much water for the system to handle, most often during heavy rains, and the excess water is released into a stream or river. Richmond, Virginia's CSO system is the largest in the state of Virginia. The area serviced by Richmond's CSO system is approximately 12,000 acres.

Location of Combined Sewer Overflow Point



6.1.1. Creating a new combined sewer system is prohibited. The sanitary and storm drainage systems of a structure shall be entirely separate except where existing combined sewer systems are utilized. Where a combined sewer is utilized, the building storm drain shall be connected with the sanitary sewer exterior to the building.

6.1.2. No new stormwater runoff shall be discharged to an existing combined sewer

system. Where new development or redevelopment will increase the runoff the site is required to retain and release the 10-year post-developed flowrate at the 10-year predeveloped flowrate. No new connections shall be made to the combined sewers where those connections would cause overflows during dry-weather flow conditions. See Section 106-633 of the City Ordinance for connection fees.

6.1.3. Storm water shall not be drained into sewers intended for sewage only.

6.1.4. Roof leaders and storm drains connected to a combined sewer shall be trapped. Individual storm water traps shall be installed on the storm water drain branch serving each conductor, or a single trap shall be installed in the main storm drain just before its connection with the combined building sewer or the public sewer. See Appendix H for Trap detail.

Chapter 7 – Water Quality (Reserved)

Chapter 8 – Water Quantity (Reserved)

Chapter 9 – Stormwater Management Best Management Practices

Structural or permanent stormwater management Best Management Practices, (BMP) methods are implemented to minimize surface runoff and nonpoint source pollution associated with new construction or redevelopment of land parcels. Additional impervious areas in the watershed lead to a decreasing infiltration and recharge of groundwater and increasing runoff responsible for erosion, flooding and decreasing water quality levels.

Structural and non-structural measures may be employed individually or in combination to achieve required water quality and peak discharge requirements for the applicable watershed. These requirements are enforced under the Chesapeake Bay Preservation Act "the Bay Act", the Virginia Stormwater Management Program and the Virginia Erosion and Sedimentation Control Program.

The developer is responsible for obtaining all maintenance agreements, easements and permits required for the construction of BMP measures. Refer to Chapter 12 for permitting requirements. Manufactured BMP's require shop drawings and specifications to be submitted to and approved by the Director DPU or their designee prior to installation.

Water Quality BMP	Target Phosphorus Removal Efficiency	Percent Impervious Cover
Vegetated filter strip	10%	16-21%
Grassed swale	15%	
Constructed wetlands	20%	22-37%
Extended detention (2 x WQ Vol)	35%	
Retention basin I (3 x WQ Vol)	40%	
Bioretention basin	50%	38-66%
Bioretention filter	50%	
Extended detention-enhanced	50%	
Retention basin II (4 x WQ Vol)	50%	
Infiltration (1 x WQ Vol)	50%	
Sand filter	65%	67-100%
Infiltration (2 x WQ Vol)	65%	
Retention basin III (4 x WQ Vol with aquatic bench)	65%	
Filterra	70%	

*Innovative or alternate BMPs not included in this table may be allowed at the discretion of the Department of Public Utilities. Innovative or alternate BMPs not included in this

table which target appropriate nonpoint source pollution other than phosphorous may be allowed at the discretion of the department.

Chapter 10 – Easements

10.1 General

10.1.1. An easement is an acquired right, or interest, in a specific portion of land owned by another that entitles the holder of the easement to use the land for a certain stated purpose such as storm drainage conveyance, sanitary sewage, cable TV lines, natural gas, drinking water, etc. Unless otherwise stated, this chapter shall refer to easements dedicated to and accepted by the City of Richmond.

10.1.2. Drainage easements, which may be public or private, will be required, but not limited to the following:

- Where water leaves the City right of way and the point of exit is not an adequate natural water course. The easement ends where it intersects the centerline of the natural watercourse.
- To guarantee that upstream areas will have means to drain through the on-site property.
- In areas where no right of way drainage is involved, the Department of Public Utilities shall, at its discretion, require easements in order to place certain use limitations in areas critical to the provision of adequate drainage for lots.
- Where two or more drainage paths converge to form a natural or artificial open channel required to adequately convey flow from a specified storm event or where the discharge exceeds 3cfs for any channel.
- In any location where there is a need for a guarantee of legal and permanent passage of storm water runoff.

10.1.3. Temporary or Permanent Access Easements may be required to provide a safe route to drainage facilities for the performance of construction and maintenance activities. Temporary or Permanent Access Easements shall be a minimum of 15' wide for a 12' wide access road.

10.1.4. The City has no maintenance responsibilities in these areas to the landowner through whose property the easement passes, but does have the right to enter the property in order to remediate any conditions which may detrimentally affect upstream or downstream landowners.

10.2 Drainage Easement Types

10.2.1. Storm Sewer Drainage Easement

Refer to the below matrix to determine the minimum easement width for a storm sewer:

MINIMUM EASEMENT WIDTH MATRIX
DIAMETER OF PIPE IN FEET (D)

Depth/Pipe Size	1.25	1.50	1.75	2.00	2.25	3.00	3.50	4.00	4.50	5.00
1	16	16	16	16	16	16	16	16	16	16
2	16	16	16	16	16	16	16	16	16	16
3	16	16	16	16	16	16	16	16	16	16
4	16	16	16	16	16	16	16	16	16	16
5	16	16	16	16	16	16	16	16	16	16
6	16	16	16	16	16	16	16	16	16	16
7	16	16	16	16	16	16	16	16	16	16
8	20	20	20	20	20	16	16	16	16	16
9	20	20	20	20	20	20	20	20	20	16
10	25	25	25	25	25	20	20	20	20	20
11	25	25	25	25	25	25	25	25	25	20
12	30	30	30	25	25	25	25	25	25	25
13	30	30	30	30	30	30	30	25	25	25
14	30	30	30	30	30	30	30	30	30	30
15	35	35	35	35	35	30	30	30	30	30

For pipe diameters greater than five (5) feet and/or a maximum elevation difference between the invert of a pipe and the ground greater than fifteen (15) feet, the following equation shall be applied, with the result rounded up to the next highest five (5) feet.

Easement width = $(D + 3) + 2*(H - D)$, where
D = pipe diameter in feet and
H = maximum elevation difference between invert of pipe and existing ground, in feet

10.2.2. Open Channel Drainage Easement

The width of the easement shall at a minimum be sixteen (16) feet or provide containment of the 10-year storm improvements, whichever is greater. In addition, a minimum 10 foot wide access easement shall be provided along at least one side of the channel.

10.2.3. Future Construction Easements

Where engineering can establish feasibility, easements to allow a future upstream developing area to construct improvements tying into the drainage facilities being provided by the on-site developer shall be of a width necessary to accommodate the construction of a storm sewer.

10.2.4. Off-Site Drainage Easements

The City reserves the right to require the developer to make appropriate provisions in any off-site area, including but not limited to existing City easements, where the development of the property may have a negative impact. Such arrangements shall be worked out prior to any approval of construction plans, plat recordation, building permit or issuance of a land disturbance permit.

The Department of Public Utilities has the discretion to require all developments, which are subject to City review and approval, to have drainage conveyed via easement to an adequate natural watercourse or wetland area as defined in the most current edition of the Virginia Erosion and Sediment Control Handbook, as a minimum. Easements to a greater extent may be necessary where conditions are warranted. The final determination is to be made by the Department of Public Utilities.

10.2.5. 100-year Floodplain Easements

When the proposed construction of a road fill crosses a watercourse or when the filling of the floodway will generate a backwater condition which exceeds the limits of the original flood plain, consideration as to the ownership of that additionally inundated land must be given.

- If it is land owned by the developer and is a part of the developing project, the backwater will establish the new limits of the 100 year flood plain with detail of that backwater area shown on the subdivision plat. Development in consideration of the new 100 year backwater shall then take place. Storage volume is not a consideration for becoming a backwater area.
- If the design of a culvert has taken into account the storage volume within the backwater, it shall be a storm water detention easement which restricts any activities that would reduce the existing available upstream volume.
- If the land affected by the backwater is owned by others, the storm drainage design based on ultimate upstream development, will be revised to reduce the backwater area to within a flood plain cross-section at the off-site property line established without the effect of the proposed embankment or permission in the form of a backwater easement from the affected party shall be obtained. Recordation of this easement shall connote no maintenance on the part of the City of Richmond. It will, however, serve as official

permission and permanent acknowledgment of a facility which theoretically reduces the area subject to development on the affected land and places a restriction on any future filling within the backwater area. This backwater easement will be shown on all subdivision plans and recorded plats.

10.2.6. BMP Easements

A BMP easement and maintenance agreement is required for any BMP located on private property. The BMP access and maintenance agreement shall be recorded prior to issuance of a land disturbance permit or a building permit. The access easement shall be a minimum of 16' in width and accessible from the right of way. The easement shall surround the footprint of the BMP and include the outlet structure.

10.2.7. Temporary Construction Easements

Temporary Construction easements are areas of specified width, contiguous and adjacent to a permanent easement, which allow for use by the contractor of this area for the period of time the permanent facilities are being constructed within the limits of the permanent easement. See Temporary Construction Easement Agreement in Appendix G, Template #2 and #3.

Construction easements are called for primarily adjacent to utility easements which are being recorded on the subdivision plat in anticipation of future trunks or collectors being extended upstream through the property.

As a rule, construction easements adjacent to drainage easements will not be required on subdivision plats, as all drainage construction necessary within the subdivision takes place at the time of initial development.

- Only in those locations where a variance by the Department of Public Utilities allows on-site drainage improvements necessary to accommodate the drainage of upstream properties to be constructed at a later date, will construction easements adjacent to on-site drainage easements be required.

The construction easement will generally be 10' in width to each side of the permanent easement.

10.3 Recordation

10.3.1. Easement Agreement Checklist

- Specify type and/or specific use of easement.
- Where the owners are married, both must sign the agreement.

- Owners' signatures must be notarized.
- Note holders signatures must appear but need not be notarized.
- Owner's names on the agreement must coincide with owner's name on their deed.
- The name of the firm which prepared the plat shall be the same on both the agreement and plat.
- Where multiple plats are involved, each should be designated numerically and the agreement should include language such as "Plats 1 of 3 and 3 of 3 each dated ..."
- Every revision date of the plat must be noted on the agreement.
- Any changes or deletions on the agreement must be accompanied by initials of the owner/s.
- When an additional easement is required within a previously recorded subdivision, a separate plat is required. It shall include the plat book and page number where the original subdivision plat is recorded.

10.3.2. Easement Plat Checklist

- Specify type of easement.
- State grid north arrow.
- Show scale 1"=50' or 1"=100'.
- Plat size shall be determined by the Clerk of the Circuit Court.
- Date drawn and by whom, also checked by whom.
- Distances and bearings of easement and parcel or lot through which it passes.
- Width of easement with dimensions to each side of center line.
- Easements shall be tied down to an existing reference point, e.g. PI of the nearest existing intersection.
- Right of way width, name, and state route number of adjacent road.
- Curve data of easement or right of way alignment if not on a tangent.
- Where easements do not run along a property line, distances to property corners shall be given from the point where the easement may intersect a property line.
- If in a subdivision, show lot, block, section and name of subdivision.
- Property owners' names, deed book and page number showing where the owners' deeds were recorded.
- All adjacent landowners.
- If in a subdivision, tie-down with two access points will also be accomplished by state grid coordinate system.
- Off-site easements exiting proposed subdivisions may be tied down by its distances and bearings as long as the exit point, any angle turns, and the terminus of the off-site easement are tied to state grid coordinate system.

- Title "Plat showing 30' drainage easement across the property of ... " to include owners, legal description and/or tax map no., district, county and state.
- Include any related construction project name and/or number.
- Show any existing easements in relation to the proposed easement.
- The signed seal of the certified land surveyor or professional engineer for project related easements.

10.3.3. The Department of Public Utilities shall not approve the recordation of an easement unless it is approved as to form by the City Attorney and in a condition complying with City standards or adequate engineering and bonding have been provided to insure that construction will ultimately achieve City standards, i.e. plan approval received for intended use.

Chapter 11 – Construction Inspection and As-builts

Construction inspections and as-builts of stormwater facilities shall comply with *Virginia Stormwater Regulations 4 VAC 3-20-141, Administrative procedures: maintenance and inspections.* Stormwater construction activities are regulated under the Virginia Stormwater Management Program (VSMP) Permit Regulations (4 VAC 50-60).
Construction and maintenance of erosion control measures shall be as specified in the current issue of the *Virginia Erosion and Sediment Control Handbook.* The owner/ developer is responsible for obtaining and complying with all applicable permits.

11.1 General Policies

11.1.1. The designated project manager for City-funded Capital Improvement Projects shall have control over the construction on-site after the pre-construction meeting is held.

11.1.2. Responsibility for the operation and maintenance of stormwater management facilities, unless assumed by a governmental agency, shall remain with the property owner and shall pass to any successor or owner. If portions of the land are to be sold, legally binding arrangements shall be made to pass the basic responsibility to successors in title. These arrangements shall designate for each project the property owner, governmental agency, or other legally established entity to be permanently responsible for maintenance.

11.1.3. In the case of developments where lots are to be sold, permanent arrangements satisfactory to the locality shall be made to ensure continued performance of this chapter.

11.1.4. A schedule of maintenance inspections shall be specified in the BMP Maintenance Schedule, Stormwater Pollution and Prevention Plan, SWPPP or the Stormwater Management Plan, SMP to be included in the construction documents required for permitting. In cases where maintenance or repair is neglected, or the stormwater management facility becomes a danger to public health or safety, the City has the authority to perform the work and to recover the costs from the owner.

11.1.5. Where stormwater facilities are not located within the right of way, the City of Richmond requires right-of-entry agreements or easements from the applicant for purposes of inspection and maintenance.

11.1.6. Periodic inspections are required for all stormwater management facilities. The maintenance schedule shall:

1. Provide for inspection of stormwater management facilities on an annual basis; or
2. Require that the applicant establish an alternative inspection program which ensures that stormwater management facilities are functioning as intended. Any alternative inspection program shall be:
   a. Established in writing;
   b. Based on a system of priorities that, at a minimum, considers the purpose of the facility, the contributing drainage area, and downstream conditions; and
   c. Documented by inspection records.

11.1.7. During construction of the stormwater management facilities, City of Richmond Officials shall make site visit inspections on a regular basis.

11.1.8. Inspection reports shall be maintained as part of a land development project file.

11.2 Project Inspection Requirements

11.2.1. Inspections of storm drainage systems and stormwater management facilities shall be performed by the permittee and City Inspector to ensure that construction conforms to the approved plans and specifications. The frequency of inspections shall be outlined in the construction documents for each component of the system. Changes to the approved design will require a resubmittal to the City of Richmond.

11.2.2. A final inspection will be conducted once construction is complete, and as-built documentation shall be submitted to the City of Richmond to show that the constructed project meets the requirements of the approved Stormwater Management Plan.

11.2.3. After approval of as-built documents, the responsibility for the operation and maintenance of the storm drainage systems and stormwater management facilities is transferred from the permittee to the property owner or responsible party.

11.2.4. Where a project is constructed in phases, a final inspection shall be conducted of each completed phase as designated by the approved Stormwater Management Plan. The final inspection shall consist only of the phase being identified as complete.

11.2.5. After construction is complete, the property owner or responsible party is required to conduct periodic inspections and maintenance of the stormwater management facilities in accordance with the requirements of Appendix F.

11.2.6. Property owner inspections and maintenance activities must be documented and maintained.

11.2.7. The City of Richmond Department of Public Utilities will conduct periodic post-construction compliance inspections of stormwater management facilities.

11.3 Notification and Reporting

11.3.1 Notification to the City of Richmond

The permittee shall notify the City of Richmond 48 hours in advance of the start of construction and of the construction of critical components of a stormwater management facility. The following are examples of, but not limited to, critical components:

- Before the start of construction;
- Before installing a stormwater pond embankment;
- Before installing pond outlet structures;
- Before setting any concrete BMP structures, this does not include precast drop inlets or manholes;
- Before installing energy dissipation structures and any outlet structure into a jurisdictional stream (perennial or intermittent flow);
- Before installing any detention, infiltration or bioretention BMP; or
- Any other key BMP component as determined by the City of Richmond

11.3.2 Permittee Inspections

Upon completion of construction, the permittee must certify that the completed project is in accordance with the approved plans and specifications and must provide documentation of regular inspections sufficient to adequately support compliance. All permittee inspections shall be documented and written reports prepared that contain the following information:

- The date and location of the permittee inspection;
- Whether construction is in compliance with the approved Stormwater Management Plan;
- Variations from the approved construction specifications;

- Corrective actions that have been taken to correct previous violations;
- Any violations that exist or corrective actions that have been completed; and
- The name and signature of the person who performed the inspection.

11.3.3 City of Richmond Inspections

The City of Richmond Department of Public Utilities shall conduct periodic inspections during construction. During the City inspection, the permittee will provide copies of all permittee inspections which have been conducted since the last City inspection. If the City finds any violations, the permittee shall be notified in writing of the nature of the violation and of the required corrective actions.

A copy of a Stormwater Management Construction Inspection Checklist, for use by the permittee is included in Appendix F.

11.4 Final Inspection, As-Built Documentation and Certification

Prior to final acceptance of the project the permittee is required to submit to the City of Richmond Department of Public Utilities as-built documentation, confirming that the storm drainage systems and stormwater management facilities and practices that have been constructed conform to the approved Stormwater Management Plan. In addition, once the as-built documentation has been submitted, a final inspection will be conducted by the City of Richmond to confirm that the as-built documentation conforms to the actual construction.

As-built documentation shall include the following:

- As-built survey conducted following construction, certified by a registered land surveyor or professional engineer. The survey shall include enough information to verify that storage capacities in ponds and other stormwater management structures are no less than the storage volume required by the approved Stormwater Management Plan. For retention and detention structures, a stage-storage summary table with design values and as-built values shall be included. The survey shall verify inverts and sizes of pipes, culverts, and outlet structures. Maximum tolerance shall be +/- 0.1 feet for structures and +/- 0.5 feet for finished grades.

- The permittee's inspection log records with copies of all inspection test results documenting compliance with the approved Stormwater Management Plan.

• Redline revision of approved Stormwater Management Plan. Place a check mark where design values agree with actual constructed values. For changed values enter the constructed value in red.

• Certification statement, signed by the permittee and a Professional Engineer or Professional Land Surveyor, registered in the Commonwealth of Virginia, indicating conformance with the approved Stormwater Management Plan.

If it is determined from the as-built documentation that the storm drainage systems and the stormwater management facilities have not been constructed in accordance with the approved Stormwater Management Plan, then corrective action will be taken to comply with the approved Plan or the permittee shall provide studies and information required by the City of Richmond Department of Public Utilities to demonstrate that the constructed systems will function equivalent to the approved Stormwater Management Plan. This includes meeting all flow, velocity, and regulatory requirements and that the approved elevation-storage requirement is maintained.

Once the as-built documentation has been accepted by the City of Richmond Department of Public Utilities, the permittee shall schedule a final inspection of the project site prior to final acceptance of the project by the City and the return of performance bonds or securities. The permittee shall provide 48 hour notice of a final inspection to the City of Richmond.

After final inspection, the contractor is responsible for maintenance of the site until site is stabilized. See Chapter 50 of City ordinance for erosion and sediment control.

11.5 Post-Construction Inspections and Maintenance

The property owner or responsible party is responsible for the proper operation, inspection, maintenance, and repair of stormwater management facilities, after the completion of construction, in accordance with the applicable maintenance agreement. All inspection, maintenance, and repair activities shall be documented. Refer to Appendix F for additional information concerning maintenance and repair of stormwater management facilities.

The responsible party shall inspect and maintain stormwater management facilities at the frequencies listed in the Maintenance Agreement, or if they are not listed in the Maintenance Agreement, in accordance with Maintenance Schedule or as specified in the Stormwater Management Plan.

In addition to the inspections performed by the responsible party, each stormwater management facility will be inspected periodically by the City of Richmond Department

of Public Utilities. In the event that the stormwater management facility has not been maintained and/or becomes a danger to public safety, public health, or the environment, the City of Richmond Department of Public Utilities shall notify the property owner, or responsible party, by registered or certified mail and issue a Notice of Violation. The Notice shall specify the measures needed to correct the situation and shall specify the time within which such measures must be completed. If the responsible party fails or refuses to meet the requirements of the maintenance agreement, the City of Richmond Department of Public Utilities, after reasonable notice, may apply a civil or criminal penalty and may correct a violation of the design standards or maintenance needs by performing all necessary work to place the facility in proper working condition, and recover the costs from the responsible party or property owner.

11.6 Records

Parties responsible for the operation and maintenance of a stormwater management facility shall make records of the installation and of all inspections, maintenance and repairs, and shall retain the records accordingly: three (3) years minimum for the City and five (5) years minimum for developers. These records shall be made available to the City of Richmond Department of Public Utilities upon request. See Appendix E for a blank Stormwater Management Facilities Inspection Report Form and a blank Stormwater Management Facilities Maintenance/Repair Report Form.

Chapter 12 – Permitting

The overall permitting process for a project has 3 phases - preliminary phase, permit application phase and construction phase. In the preliminary phase, the owner/developer can meet with City staff to determine the project's feasibility and requirements. The determined requirements can take the project through various applications such as rezoning, special use permit or community unit plan. Once the project complies with zoning and master plan requirements, then one or more of the following applications can apply:

1. Plan of Development (POD)
2. By Right Development
3. Subdivision
4. Urban Design Committee

The applications can be found on the City's website under the Department of Planning and Development Review.

Once the project gets approval in the preliminary phase, then permits such as a building permit, land disturbance permit, and work in street permit need to be obtained before construction can begin. Once the construction phase begins then the various City departments will inspect to ensure code compliance. A certificate of completion or occupancy will be issued upon satisfactory completion of the project.

Chapter 13 – Glossary

AASHTO - American Association of State and Highway Transportation Officials

Adequate channel - means a channel that will convey the designated frequency storm event without overtopping its banks or causing erosive damage to the bed, banks and overbank sections of the same.

Anti-seep collar - A device constructed around a pipe or other conduit and placed into a dam, levee, or dike for the purpose of reducing seepage losses and piping failures along the conduit it surrounds.

Applicant - means any person submitting a stormwater management plan for approval.

Aquatic bench - A 10- to 15-foot wide bench around the inside perimeter of a permanent pool that ranges in depth from zero to 12 inches. Vegetated with emergent plants, the bench augments pollutant removal, provides habitats, protects the shoreline from the effects of water level fluctuations, and enhances safety.

As-built (drawing) - Drawing or certification of conditions as they were actually constructed.

Baffle - Guides, grids, grating or similar devices placed in a pond to deflect or regulate flow and create a longer flow path from the inlet to the outlet structure.

Barrel - Closed conduit used to convey water under or through an embankment, part of the principal spillway.

Best Management Practice (BMP) - Structural or nonstructural practice which is designed to minimize the impacts of changes in land use on surface and groundwater systems. Structural BMP refers to basins or facilities engineered for the purpose of reducing the pollutant load in stormwater runoff, such as Bioretention, constructed stormwater wetlands, etc. Nonstructural BMP refers to land use or development practices which are determined to be effective in minimizing the impact on receiving stream systems, such as preservation of open space and stream buffers, disconnection of impervious surfaces, etc.

Bioretention basin - Water quality BMP engineered to filter the water quality volume through an engineered planting bed, consisting of a vegetated surface layer (vegetation, mulch, and ground cover), planting soil, and sand bed (optional), and into the in-situ material. Also called rain gardens.

Bioretention filter - A bioretention basin with the addition of a sand layer and collector pipe system beneath the planting bed.

Channel - A natural or manmade waterway.

Check dam - Small dam constructed in a channel for the purpose of decreasing the flow velocity, minimize channel scour, and promote deposition of sediment. Check dams are a component of grassed swale BMPs.

Combined sewer system - A sewer system that carries both sanitary wastes and stormwater. Usually found in older areas of large cities, combined sewers are no longer permitted to be used.

Constructed stormwater wetlands - Areas intentionally designed and created to emulate the water quality improvement function of wetlands for the primary purpose of removing pollutants from stormwater.

Culvert – Any structure not classified as a bridge which provides an opening under any roadway, driveway or embankment.

Curve number (CN) - A numerical representation of a given area's hydrologic soil group, plant cover, impervious cover, interception and surface storage derived in accordance with Natural Resource Conservation Service methods. This number is used to convert rainfall depth into runoff volume. Sometimes referred to as Runoff Curve Number.

Design Storm – A selected rainfall hyetograph of specified amount, intensity, duration and frequency that is used as a basis for design; that a stormwater management system must be designed to accommodate, convey or hold stormwater to assure no significant detriment to public infrastructure, public health and safety and natural resources.

Detention - The temporary impoundment or holding of stormwater runoff such as to reduce its peak flow to prevent flooding, reduce erosion, and decrease the amount of sediment-bound pollution. Dry detention basins are designed for this purpose.

Detention Basin - A stormwater management facility which temporarily impounds runoff and discharges it through a hydraulic outlet structure to a downstream conveyance system. While a certain amount of outflow may also occur via infiltration through the surrounding soil, such amounts are negligible when compared to the outlet structure discharge rates and, therefore, are not considered in the facility's design. Since an extended detention basin impounds runoff only temporarily, it is normally dry during non-rainfall periods.

Discharge - Flow of water across the land surface or within the confines of a natural or manmade channel, or stream.

Disturbed area - An area in which the natural vegetative soil cover or existing surface treatment has been removed or altered and, therefore, is susceptible to erosion.

Drainage area - An area of land where water drains to single point, the outlet. In this manual, drainage area refers to small land areas such as industrial sites, residential developments, and commercial developments, while watersheds refer to larger land areas.

Drainage basin - An area of land that contributes stormwater runoff to a designated point. Also called a drainage area or, on a larger scale, a watershed.

Dry detention - Storing or holding stormwater and releasing it over a set period of time, at least 24 hours, to reduce high peak flows in the receiving water and to remove pollutants.

Duration - The length of time over which precipitation occurs.

Easement - An acquired right, or interest, in a specific portion of land owned by another that entitles the holder of the easement to use the land for a certain stated purpose

> *Access Easement – An easement that provides a safe route only, to the drainage facility, it is not for construction of any improvements.*
>
> *Temporary Construction easement - Areas of specified width, contiguous and adjacent to a permanent easement, which allow for use by the contractor of this area for the period of time the permanent facilities are being constructed within the limits of the permanent easement.*
>
> *Permanent Drainage Easement - A permanent easement provides the holder access to a parcel of land in perpetuity to perform specified construction and maintenance activities. This is usually a strip of land set aside for use for public storm drainage purposes. The easement is created to protect the use of the property from encroachments such as a home addition, grading for a pool, planting of trees or other activities that would diminish the functionality of the drainage feature or ability to maintain it.*

Emergency Spillway - A channel, usually an open channel constructed adjacent to an embankment, which conveys flows in excess of the design capacity of the principal spillway.

Erosion - The wearing away of the land surface by running water, wind, ice or other geological agents.

Accelerated erosion - erosion in excess of what is presumed or estimated to be naturally occurring levels and which is a direct result of human activities.

Gully erosion - erosion process whereby water accumulates in narrow channels and removes the soil to depths ranging from a few inches to 1 or 2 feet to as much as 75 to 100 feet.

Rill erosion - erosion process in which numerous small channels only several inches deep are formed.

Sheet erosion - spattering of small soil particles caused by the impact of raindrops on wet soils. The loosened and spattered particles may subsequently be removed by surface runoff.

Extended detention basin - A stormwater management facility which temporarily impounds runoff and discharges it through a hydraulic outlet structure over a specified period of time to a downstream conveyance system for the purpose of water quality enhancement or stream channel erosion control. While a certain amount of outflow may also occur via infiltration through the surrounding soil, such amounts are negligible when compared to the outlet structure discharge rates and, therefore, are not considered in the facility's design. Since an extended detention basin impounds runoff only temporarily, it is normally dry during nonrainfall periods.

Extended detention basin-enhanced - An extended detention basin modified to increase pollutant removal by providing a shallow marsh in the lower stage of the basin.

Filter Strip - An area of vegetation, usually adjacent to a developed area, constructed to remove sediment, organic matter, and other pollutants from runoff in the form of sheet flow.

Flooding - When the volume or rate flow exceeds the capacity of the natural or manmade conveyance system and overflows onto adjacent lands, causing or threatening damage.

Floodplain - For a given flood event, that area of land adjoining a continuous water course which has been covered temporarily by water.

Freeboard - Vertical distance between the surface elevation of the design high water and the top of a dam, levee, or diversion ridge.

Frequency (design storm frequency) - The recurrence interval of storm events having the same duration and volume. The frequency of a specified design storm can be expressed either in terms of exceedence probability or return period.

> *Exceedence probability* - The probability that an event having a specified volume and duration will be exceeded in one time period, usually assumed to be one year. If a storm has a one percent chance of occurring in any given year, than it has an exceedence probability of 0.01.
> *Return period* - The average length of time between events having the same volume and duration. If a storm has a one percent chance of occurring in any given year, than it has a return period of 100 years.

Froude Number (F) – A calculated number of classifying water flow as critical (F = 1), supercritical (F > 1) or subcritical (F < 1).

Grade - The slope of a specific surface of interest such as a road, channel bed or bank, top of embankment, bottom of excavation, or natural ground. Grade is commonly measured in percent (unit of measurement per one hundred units) or a ratio of horizontal to vertical distance.

Head - The height of water above any plane or object of reference; also used to express the energy, either kinetic or potential, measured in feet, possessed by each unit weight of a liquid.

Hydraulics - The physical science and technology of the static and dynamic behavior of fluids.

Hydrograph - A plot showing the rate of discharge, depth or velocity of flow versus time for a given point on a stream or drainage system.

Hydrologic Soil Group (HSG) - SCS classification system of soils based on the permeability and infiltration rates of the soils. '*A*' type soils are primarily sandy in nature with a high permeability while '*D*' type soils are primarily clayey in nature with a low permeability.

Hydrology - Science dealing with the distribution and movement of water on the Earth's surface.

Hyetograph - A graph of the time distribution of rainfall over a watershed.

Impervious cover - A surface composed of any material that significantly impedes or prevents natural infiltration of water into soil. Impervious surfaces include, but are not

limited to, roofs, buildings, streets, parking areas, and any concrete, asphalt, or compacted gravel surface.

Improvements – Any activity that results in the increased capacity, efficiency in operation or maintenance of part or whole of a drainage system.

Infiltration -The movement of water from the land surface into the soil. As a stormwater management method, infiltration means directing runoff water onto the soil surface or into storage areas where it can enter the soil.

Intensity - The depth of rainfall divided by duration.

Invert - The lowest flow line elevation in any component of a conveyance system, including storm sewers, channels, weirs, etc.

Land development - A manmade change to, or construction on, the land surface that changes its runoff characteristics. Certain types of land development are exempted from stormwater management requirements as provided in the Stormwater Management Act, § 10.1-603.8 B of the Code of Virginia.

Landscaping - The placement of vegetation in and around stormwater management BMP's.

Land use -How the land is used, such as forest, agricultural, rural, residential, commercial and industrial use, as a result of development or lack of development. Land use affects the types and amounts of pollutants generated in the area.

Locality - A county, city, or town.

Low Impact Development (LID) - Hydrologically functional site design with pollution prevention measures to reduce impacts and compensate for development impacts on hydrology and water quality.

Manning's formula - Equation used to predict the velocity of water flow in an open channel or pipeline.

Modified Rational Method - A variation of the rational method used to calculate the critical storage volume whereby the storm duration can vary and does not necessarily equal the time of concentration.

Nonpoint source pollution - Contaminants such as sediment, nitrogen and phosphorous,

hydrocarbons, heavy metals, and toxins whose sources cannot be pinpointed but rather are washed from the land surface in a diffuse manner by stormwater runoff. Refers to pollution that arises from diffuse or dispersed sources, such as the runoff from farmland, forestland, or an urban area rather than from a single, readily identifiable source.

Outfall - Place where effluent is discharged into receiving waters.

Outlet - The single point in a watershed to which all water flows or drains.

Overtopping Storm - The smallest hypothetical recurrence interval storm which will cause a water surface elevation that exceeds the height of the road, designed embankment, or other watershed boundary.

Peak discharge - The maximum rate of flow at associated with a given rainfall event or channel.

Phosphorus - An element found in fertilizers and sediment runoff which can contribute to the eutrophication of water bodies. It is the keystone pollutant in determining pollutant removal efficiencies for various BMP's as defined by the Virginia Stormwater Management Regulations.

Pipe (Storm sewer pipe) – A system of pipes (separate from sanitary sewers except in combined storm sewers) that carries water runoff from buildings and land surfaces and conveys them to designated outfall structures or receiving water bodies.

Post-development - Refers to conditions that reasonably may be expected or anticipated to exist after completion of the land development activity on a specific site or tract of land.

Pre-development - Refers to the conditions that exist at the time that plans for the land development of a tract of land are approved by the plan approval authority. Where phased development or plan approval occurs (preliminary grading, roads and utilities, etc.), the existing conditions at the time prior to the first item being approved or permitted establishes the pre-development conditions.

Rainfall - This manual groups all forms of precipitation under this term.

Rational method - Means of computing peak storm drainage flow rates based on average percent imperviousness of the site, mean rainfall intensity, and drainage area.

Receiving waters - The body or bodies of water (streams, rivers. lakes or estuaries) into which stormwater runoff flows.

Recharge - Replenishment of groundwater reservoirs by infiltration and transmission of water through permeable soils.

Redevelopment - Any construction, alteration, or improvement on existing development.

Retention - Holding stormwater for an extended period of time to allow for pollutant removal through settling and biological uptake.

Retention basin - A stormwater management facility which includes a permanent impoundment, or normal pool of water, for the purpose of enhancing water quality and, therefore, is normally wet, even during nonrainfall periods. Storm runoff inflows may be temporarily stored above this permanent impoundment for the purpose of reducing flooding, or stream channel erosion.

Riprap - Broken rock, cobbles or boulders placed on earth surfaces such as the face of a dam or the bank of a stream for the protection against erosive forces such as flow velocity and waves.

Riser - A vertical structure which extends from the bottom of an impoundment facility and houses the control devices (weirs/orifices) to achieve the desired rates of discharge for specific designs.

Roughness coefficient - A factor in velocity and discharge formulas representing the effect of channel roughness on energy losses in flowing water. Manning's '*n*' is a commonly used roughness coefficient.

Routing - A method of measuring the inflow and outflow from an impoundment structure while considering the change in storage volume over time.

Runoff - The rainwater that runs off the land surface into adjacent bodies of water.

Runoff coefficient - The fraction of total rainfall that appears as runoff. Represented as *C* in the rational method formula.

Sand filter - A contained bed of sand which acts to filter the first flush of runoff. The runoff is then collected beneath the sand bed and conveyed to an adequate discharge point or infiltrated into the in-situ soils.

Sediment - Material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by water or wind. Sediment piles up in

reservoirs, rivers and harbors, destroying wildlife habitat and clouding water so that sunlight cannot reach aquatic plants.

Site - The parcel of land being developed, or a designated planning area in which a land development project is located.

Storm Sewer - A system of pipes, separate from sanitary sewers, that only carries runoff from buildings and land surfaces.

Stormwater - The water that runs off the land as a result of precipitation. Both its quality and its quantity are important to environmental considerations.

Stormwater management facility - A device that controls stormwater runoff and changes the characteristics of that runoff including, but not limited to, the quantity and quality, the period of release or the velocity of flow.

Stormwater management plan - A document containing material for describing how existing runoff characteristics will be affected by a land development project and methods for complying with the requirements of the local program or this chapter.

Surcharge - Flow condition occurring in closed conduits when the hydraulic grade line is above the crown of the sewer. This condition usually results localized flooding or stormwater flowing out the top of inlet structures and manholes.

Surface water-Water that is on the surface of the land, in puddles, streams, rivers and lakes.

Technical Release No. 55 (TR-55) - Urban Hydrology for Small Watersheds. SCS watershed hydrology computation model that is used to calculate runoff volumes and provide a simplified routing for storm events through stream valleys and/or ponds.

Time of concentration - The time required for water to flow from the hydrologic most distant point (in time of flow) of the drainage area to the point of analysis (outlet). This time will vary, generally depending on the slope and character of the surfaces.

Travel time - The time required for water to flow from the outlet of a drainage sub-basin to the outlet of the entire drainage basin being analyzed. Travel time is normally concentrated flow through an open or closed channel.

Ultimate condition - Full watershed build-out based on existing zoning.

Urban runoff - Stormwater from city streets and adjacent domestic or commercial properties that carries nonpoint source pollutants of various kinds into the sewer systems and receiving waters.

VDOT - The Virginia Department of Transportation.

VESCH - The Virginia Erosion and Sediment Control Handbook, latest edition.

Water surface profile - Longitudinal profile assumed by the surface of a stream flowing in an open channel; hydraulic grade line.

Water table - Upper surface of the free groundwater in a zone of saturation.

Watershed - A defined land area drained by a river, stream, or drainage way, or system of connecting rivers, streams, or drainage ways such that all surface water within the area flows through a single outlet.

Weir - A wall or plate placed in an open channel to regulate or measure the flow of water.

Chapter 14- References

- VDOT Drainage Manual, Current Edition
- Virginia Stormwater Management Handbook, First Edition 1999
- Virginia Erosion and Sediment Control Regulations, 1990
- Virginia Erosion and Sediment Control Handbook, Third Edition 1992
- Chesapeake Bay Preservation Act, 1988
- City of Richmond Roadway Geometric Design Manual
- City of Richmond Right of Way and Construction Manual
- City of Richmond Code of Ordinances, Amended to October 2007 and in particular Chapter 50; Flood Plain Management, Erosion and Sediment Control and Chesapeake Bay Preservation Areas.
- Virginia Stormwater Management Regulations, 2001
- Virginia Stormwater Management Enforcement Manual, 2006
- http://www.richmondgov.com/planninganddevelopmentreview

Appendix A:

Department of Public Utilities
730 East Broad Street-6th
Richmond, Virginia 23219
804 646-6440/ (fax) 804 646-2870

CHECKLIST FOR STORM DRAIN SYSTEM

GENERAL

- All plans shall be signed and sealed by a professional Engineer.
- All plans shall have a complete title block.
- All letters shall be neat and legible and of the same size for each sub-text.
- Label all existing and proposed work.
- All drawings shall be prepared at an appropriate scale.
- All plans shall show a north arrow.
- All existing drawings shall show the limits of proposed clearing/construction.

HYDROLOGY

Provide a drainage area map for all existing and proposed site conditions.

1. **Existing site condition:**

_ Existing drainage area should include all sub-drainage areas. It should show size of drainage area, time of concentration, flow path, composite break down of the runoff coefficient, and arrow indicating direction of flow within each sub-drainage area.

_ Clearly define each sub-drainage area and its drainage divide lines. It should reflect the contours, roofs, crown of roads, islands, etc.

_ Show the type of soil on plan.

_ Show existing contours at 2-feet intervals.

_ Show all offsite drainage area.

_ Show all flood plain limits, wetland, Chesapeake limits, etc.

_ Show and label all existing slope 20 percent or more on plan.

_ Show and label all sub-drainage areas.

_ Show and label all existing drainage structures on plan. Existing storm drain pipes should show the length of the pipe, the size of the pipe, and the type of the pipe. Show the profile where applicable.

_ All existing drainage computations must be shown on plans.

2. **Proposed site condition:**

_ Show and label all proposed sub-drainage areas. List size of drainage area, time of concentration, flow path, composite break down of the runoff coefficient, and arrows indicating direction of flow.
_ Clearly define each sub-drainage area and its drainage divide lines. It should reflect the contours, roofs, crown of roads, islands, etc.
_ Show proposed contours at 2-feet intervals.
_ Show all offsite drainage area.
_ Show all flood plain limits, wetland, Chesapeake limits, etc.
_ Show and label all proposed drainage structures on plan. Show clearly how it ties into existing storm drain system. All proposed storm drain pipes should show the length of pipe, size of pipe and class of pipe on plan.
_ All proposed drainage computations must be shown on plan.

HYDRAULICS

1. **Culverts, storm drain and open channels designed to minimum 10-year criteria**

_ 10-year flow less than pipe capacity.
_ 10-year HW/D < 1 for private entrance culverts within right-of-way.
_ All calculations submitted on standard VDOT forms or other acceptable documentation.
_ All RC pipes shall be Class III at a minimum within the Right Of Way.
_ Dimensioned channel section with 10-year lining depth, side slopes, bottom width specified/shown in plan/profile.
_ Open channel slopes < 0.75% shall be paved.
_ Open channel/Storm sewer minimum slope 0.2%.
_ Manhole steps required in structures 4-feet and greater in depth.
_ Private driveway culvert crossing should be a minimum 20-feet length.
_ Driveway culvert (RCP) should be sized based on 10-year design storm minimum.

2. **Open Channel**

_ Rip-rap channels not acceptable in front or adjacent to single family homes unless further than 100-feet from homes or otherwise approved.
_ Rip-rap channels can be used to rear of lots if no closer than 75-feet to homes.
_ Where paved channels are steeper than 15%, anchor lugs are required every 10-feet, 'c-c'.

- _ 9-inch freeboard (vertical wall) is required along outside radius of paved ditches.
- _ Maximum permissible flow velocity of 3.5 fps for grass ditches.
- _ Open channel depth less than 3', otherwise flow path shall be piped.
- _ Rip-rap lining a minimum of 24-inch thickness with geotextile fabric underlayment.
- _ Provide cross-section details for open channel section. Show and label the location of the section on plan. Show the section's depth of flow, velocity, discharge and channel lining 'n' value, etc.

3. Storm drain Profile

Each storm drain profile should be shown with the minimum information:

- _ Show the percent of grade and length.
- _ Show size and type of material.
- _ Show existing ground and proposed grade surface elevations along the centerline of the system.
- _ Show and label all existing and proposed storm drain structures to include rim elevations, inverts in and out, etc.
- _ All existing and proposed utilities that cross the proposed storm drain profile. Show its clearance. Minimum clearance is required.
- _ Show the hydraulic grade line on storm drain profile. All hydraulic grade lines must be supported with computations shown on plan.
- _ Provide a minimum cover of 3.5-feet for all storm drain structures.
- _ Provide a scale of 1: 5 vertical and 1: 10 horizontal.
- _ Show and analyze the outfall of the storm drain profile. Submit storm drain computations to support all drainage outfalls.
- _ Submit computations to support the MS-19 requirements.
- _ All storm drain computations must be shown on plans.
- _ Provide storm drain load protection where necessary such as cradle and encasement. Provide pipe loading table on plan.
- _ Provide protective fill for all storm drains with less than two feet of cover.
- _ Show all storm drain crossing with the appropriate clearances.

SUBDIVISION

- For the MS-19 requirements, an analysis of the outfall of the proposed development shall be done so that the natural channel is extended to the receiving stream.

- If the drainage analysis fails to meet MS-19, stormwater management shall be required at the road construction plan stage of submission for a central facility.
- Any lots submitted for a building permit that is a part of a subdivision development shall not be considered as separate projects, rather the subdivision development as a whole, shall be considered as a single project. Therefore, the central stormwater management facility and the overall site grading plan shall govern.
- An overall site grading plan shall be required for the showing of the foot print of each lot, the finished floor elevations, lot size, setbacks, bearings and distances of the boundaries, septic systems, and easements along with the erosion and sediment control measures in place.
- For land disturbing activity for single family dwellings on lots of 7,500 square feet or more, and not disturbing more than 2,500 square feet in a Chesapeake Bay area, an agreement-in-lieu of plan and surety bond may be substituted for an erosion and sediment control plan at the discretion of the plan approving authority.
- Stormwater management shall be required at the road construction plan stage of submission for a central facility. If stormwater management is not provided at the road construction plan stage of approval, then a note shall be added to the road construction plan that stormwater management shall be required at the site plan stage of submission.

STORMWATER MANAGEMENT PLANS

1. **Plan (1" = 30')**

- Property Lines, Property Owners
- Applicable Record Plats
- Easements (Structure, Pond, Outfall, Access)
- Existing Right-of-way
- Proposed Right-of-way
- Existing and Proposed Topography
- Existing Conditions and Proposed Improvements
- Test Boring and Bench Mark Locations

_ Swales, Channels, Low-Flow Channels, Drains
_ Outfall, Outfall Protection
_ Soil Erosion and Sediment Control Plans
_ Delineation of Disturbed Areas
_ Vegetative Stabilization
_ Delineation of 100-year Water Surface Elevation
_ Access Road
  - o Approved Plan and Profile of Public Row from which access will be obtained
  - o Proposed Plan and Profile of Access Road

_ Access Ramp
_ References to Standard Specifications or Detail Design
_ Coordinate ticks (250' intervals and bracket work)

2. **Profile (1" = 5' Vertical and 1" = 10' Horizontal)**

_ Storm drainage system entering device
_ Low flow channel in basins (Pilot channel)
_ Profiles of all devices
  - o Existing ground
  - o Proposed Grade
  - o Pipes and Other Utilities
  - o Proposed Construction

3. **Device Information**

_ Infiltration Device
  - o Soil Investigation Data
    - Soil borings locations
    - Soil classification
    - Strata profile
    - Water table elevation
    - Elevations of strata
  - o Plan View
    - Location and easements
    - Dimensions #1, #2, etc.
    - Label system
      - Type of system
      - Public/private____/____
  - o Water Surface Elevation of 10- and 100- year design storms Profile
    - Existing ground
    - Proposed grades
    - Existing/proposed storm drainage and utilities

- Phreatic line
- Core trench
- Anti-seep collar
- Depth of 2-, 10- and 100-year design storms

o Details and notes
- Construction specifications
- Inspection notes and schedule
- Maintenance notes
- Special structure details drawn to scale
- Profiles and sections for embankment structures as required by VDOT Manual

– **Attenuation Devices**

o Plan
- Location and Easements
- Dimensions
- Label devices
- Show existing and new topography features
- Existing and proposed grading
- Design flow inundation areas

o Profile
- Proposed system
- System dimensioned
- Label devices
- Show existing and proposed ground lines
- Show existing and proposed storm drainage and utilities.

o Details and Notes
- Construction and material specifications
- Inspection schedule
- Maintenance schedule
- All special items detailed

– **Detention and Retention Devices**

o Plan View
- Proposed device shown and labeled
  - Existing and proposed contours
  - Access from public road
  - Maintenance access
  - Pipes and structures labeled
  - Easements
- Location
- Device labeled as to public/private
- Topographic features existing and proposed profile

o Profile View

- Existing and proposed ground lines
- Existing and proposed storm drainage and utilities.
- Water Surface Elevations, Normal Pool, Emergency Spillway, 100-yr elevation
- All information (sections and profiles) required by State standards.

o Details and Notes
- Materials and construction specifications
- Inspection requirements and schedule
- Maintenance schedules and requirements
- All special items (items detailed to scale)

_ **Miscellaneous Items**

o Fence to be shown
- Gate (width and swing)
- Height of fence
- Location of fence
- Fence material and specifications

o Access
- Site access
  - Easements
  - Aprons
  - Pavement materials
  - Dimensions and location
- Maintenance access
  - Grades 15% max.
  - Materials
  - Width and dimensions
  - Typical Section
  - Side slopes 2:1 max.

o Details
- All permanent material to be equal to standard inlets and structures quality and materials.
- Scale drawing and plan, profiles, and sections as required
- Material specification on plan
- Construction specification on plan

DESIGN REPORT

1. **To be presented in bound 8 ½" x 11" booklet**
2. **Drainage ` existing and proposed conditions folded and tucked in (no fold outs)**

_ Color coded as required

_ 1" = 200' scale
_ Land use
_ Soils
_ Drainage flows
_ Streets named
_ Proposed and existing conditions

3. **Narrative**
   - o Explanation of method used
   - o Findings of existing conditions
   - o Proposed development
   - o Best management investigation
     - Alternatives considered
     - Why chosen or abandoned
   - o Water quality benefits of design
   - o Peak management benefits of design

4. **Signature and Seal of Professional Engineer**

_ Name
_ Seal and Number
_ Address (including zip code)
_ Telephone Number (including area code)

5. **Design Data**

_ Formulas and source of information
_ Input determination for all computer programs
_ TR-55 for storm sewer pipes for areas greater than 200 acres and hydrologic models for areas greater than 20 acres.
_ Rational Method for storm sewer pipes for areas up to 200 acres and hydrologic models for areas up to 20 acres
_ HEC-2 or HEC-RAS computer runs
_ Details, nomographs, formulas determination
- Existing peaks – 2- and 10-year storms
- Proposed peaks – 2- and 10-year storms
- Performance curve of device (elevation vs. discharge)
- Hydrograph plot for proposed conditions 2- and 10-year storms
- Water quality computations

_ Conclusions and summary of results
_ Design factors considered in design
- Best management device
- Clearances - vertical and horizontal
- Benefits of design water quality and peak management

_ Outfall Study

- Existing condition statement
  - Recommendations
  - Hydraulic analysis
- Proposed condition statement
  - Proposed flows
  - Proposed devices
  - Erosion prediction and measures taken to prevent erosion
  - MS-19 requirements

FLOOD PLAIN

Determination of 100-year Flood Plain

- Ultimate condition (as zoned) 100-year storm
  - No credit for upstream management
  - No credit for upstream constrictions
  - Assume developed channel condition
- Determine existing natural channel grade in development
  - Profile along natural line boundary to boundary
  - Average grade line
- Inundation area for 100-year storm event
  - Hydraulic sections
  - HEC-II run or step method determination
  - HEC-RAS backwater analysis
- Inundation area
- Dedicated under subdivision
- Not graded under building permit
- Exemptions and waivers
- FEMA forms

GENERAL INFORMATION

1. Includes Tables, Charts

City of Richmond Storm Data
(These values shall be used in all submitted calculations)

24 hour rainfall depths, inches from VDOT Hydraulic Design Advisory 05-04.2 revised 2/1/08						
1 year	2 year	5 year	10 year	25 year	50 year	100 year
2.76	3.34	4.28	5.08	6.27	7.29	8.42

B, D, & E factors for determining rainfall intensity in the Rational and Modified Rational Methods from VDOT Hydraulic Design Advisory 05-03 dated 6/21/05							
	1 year*	2 year	5 year	10 year	25 year	50 year	100 year
B	46.61	57.69	54.99	47.91	41.66	36.88	33.15
D	11.06	11.50	10.75	9.25	7.75	6.50	5.25
E	0.84	0.85	0.78	0.72	0.65	0.60	0.56

* Factors derived by the City of Richmond from data in NOAA Atlas 14 for Richmond WSO Airport (44-7201)

$$I_f = \frac{B}{(T_c + D)^E}$$

Where: If = rainfall intensity for a given recurrence interval "f", inches/hour
Tc = watershed time of concentration, minutes

2. The types of stormwater management facilities are adapted from Virginia Stormwater Management Facilities Handbook (VSMH).

3. The types of stormwater quality facilities, Best Management Practices (BMP) are adapted from VSMH.

RECOMMENDATION

Department of Public Utilities Review Engineers I have reviewed the reference plans, specifications, and computations and found them:

_____ Acceptable

_____ Not Acceptable- revise as noted for resubmittal

_____ See attached letter of explanation

Appendix B:

Department of Public Utilities
730 East Broad Street-6th
Richmond, Virginia 23219
804 646-6440/ (fax) 804 646-2870

Erosion & Sediment Control Checklist for Plan Submission

Project Name & address: _____ Permit #:_____

Reviewed by: _____ Date: _____

Cover Sheet submittal requirements:

___ In title block, show legal subdivision and common name with lots/blocks, parcels or other legal references: grading only or street only as applicable. Include Standard rough grading notes if applicable. Include address (or range of addresses) of parcel(s) to be developed.

___ Owner/Permit application name, address, phone number, and contact person.

___ Vicinity map with site outlined 1"= 2,000'.

___ Engineer's, Architect's, Land Surveyor's, or Landscape Architect's stamp signed and dated on all plan sheets.

___ List all related required permits.

___ All drawings must be to scale (1" = 50' maximum)

___ Provide a north arrow on every plan sheet

___ Show all topography at (2' intervals maximum)

___ Show property lines and owner. Legal description for adjacent properties.

___ Provide detail schematic for plans that cover two or more sheets.

E & S and Drainage Plan Sheet:

___ Show existing vegetation with any tree protection and undisturbed areas on plan.

___ Provide adequate access, staging, and stockpiling areas with appropriate E & S measures on the plans.

___ Show all 100-year flood plain limits. (No land disturbance or structures permitted in the floodplain limits without prior City Approval.)

___ Provide E & S narrative per VAESCH to include the following:

Project Description- describe scope of work of land disturbing and area (acres) to be disturbed.
Existing Site Conditions- topography, vegetation, drainage, improvements, etc.
Adjacent Site- neighboring areas, streams, lakes, or road
Off-Site areas- balanced or borrowed site, off site grading?
Soils- brief description, names, mapping units, erodibility, depth, texture, and permeability
Critical areas- describe critical areas with potential erosion problems.
Erosion & Sediment Control measures- Describe methods and measures used.
Permanent stabilization- describe how the site will be stabilized.
Stormwater run-off considerations- Will site cause increase in peak run off rates?
Calculations- all channels, basins, diversions, pre- and post-development run-off, etc.

___ Show existing and proposed contours.

___ Provide a soils map.

___ Show limits of disturbance outlined and labeled. All E & S measures must be within the limits of disturbance.

___ Show and label all E & S control measures on plan sheet.

___ Show all existing and proposed easements (utilities, streets) and all improvements (buildings, ancillary structures, etc.) on plan sheet.

___ Show limits of wetlands and any Chesapeake Bay RMA and/or RPA buffer zones.

___ Show existing and proposed drainage patterns in acres with sub-areas, flow arrows, and c- factors.

___ Notate any off-site drainage areas (in acres) entering site.

___ All E & S measures within 20' of a building's foundations must be evaluated.

___ List key of E & S measures with quantities.

___ Sediment traps (Disturbed area with contributing drainage area of < 3 acres): Provide proper in-flow point protection, proper outlet location (maximizing flow length from in-flow points.) Provide existing drainage area, developed drainage area, storage capacity, and all supporting calculations per VAESCH, Third Ed. 1992.

___ Sediment basins (Disturbed area with contributing drainage area of ≥ 3 acres): Provide proper flow input protection, proper outlet location (maximizing flow length from inflow points), and baffles as needed. Provide basin data as follows: Basin type, existing drainage areas, proposed drainage area, storage required, storage provided, weir crest elevation, storage depth, bottom dimensions, cleanout elevation, channel depth of flow, maximum side slopes (specify cut or fill), bottom elevation, embankment elevation, riser dimensions, barrel dimensions. Pipe outlet traps require separate dewatering device. Provide all supporting calculations per VAESCH.

___ Temporary storm drain diversions: show profile, give invert elevations of temporary pipe into trap on plan view, and details. Add to Construction Sequence, schedule.

Detail Plan Sheet:

___ List construction sequence/ schedule specific to project and all phases.

___ Provide E & S measure during demolition of the site. This should be stated in the sequence of construction under the first phase.

___ Provide general notes 1-9 per VAESCH pg. V-15

___ Provide standard E & S notes.

___ Provide all applicable 19 Minimum standards per VAESCH.

___ Provide details for all erosion & sediment control measures proposed per the VAESCH.

___ Provide E & S maintenance and seeding schedule.

Supporting Documentation:

___ Provide copy of the wetland permit and approved delineation.

___ Provide copy of the VSMP permit.

___ Provide copy of perennial stream determination letter.

___ Off-site grading requires written documentation of permission from adjoining owner, otherwise include on current permit, or separate land disturbing plan.

___ Work done within a City of Richmond Park will require the Director of Parks and Recreation approval.

Additional Review comments:

Appendix C:

Department of Public Utilities
730 East Broad Street-6th
Richmond, Virginia 23219
804 646-6440/ (fax) 804 646-2870

CHECKLIST FOR CHESAPEAKE BAY

Chesapeake Bay Site Plan - Requirements and Submission Checklist

Address of Project:_____

Application/Permit Number:_____

IMPORTANT: This checklist is to be completed by the plan preparer and submitted with the permit application package; in time, submittals will be rejected without it. All items must be fully addressed and indicated so by checking the box for that item or entering a comment as to why it has not been addressed (upon review, the plan reviewer may still require the item to be addressed). The comments "N/A" or "not applicable" are not acceptable responses.

Note that plan sheets may be combined as long as all required information is legible.

A. Submission

☐ Provide 4 copies of all plan sheets

☐ All plan sheets must be certified by the appropriate professional

B. Basic information required to appear on each sheet:

☐ Name of project, developer, preparer of plan (Name, address, phone, fax, and email.)

☐ Engineer/Architect's stamp (seal).

☐ North arrow

☐ Scale (suitable scale for base/plan information)

☐ Plan date/revision dates

☐ Property lines with dimensions and bearings taken from deed or survey

☐ Limits of Chesapeake Bay Preservation Areas

☐ Area of site

☐ Vicinity map (to show location of site in relation to nearby landmarks)

C. Existing physical site characteristics ***(sheet #1)***

☐ Existing topography, depending on the scale of the base sheet, contour intervals should be no greater than 5-feet; intervals of 2-feet or 1-foot are desirable.

☐ Location of Mean High Water Line (MHWL) of the shores on which the site is located as determined by the best available information acceptable to the Program Administrator. If such line is not within the confines of the property, a locator map at a scale of 1"=200' shall be required to show its proximity to the site.

☐ Location of tributary streams, as shown on the most recent USGS 7 1/2 minute quadrangle sheets (note revision date).

☐ Limits of 100-year floodplain, taken from the latest edition of the Flood Insurance Rate Maps of the City (available from the Division of Permits and Engineering Services) or other available sources and site specific studies.

☐ Location and boundaries of tidal and non-tidal wetlands, as delineated on the National Wetland Inventory (NWI) Maps prepared by the U.S. Department of the Interior available from the Program Administrator. In cases of either direct or indirect impact on NWI identified wetlands, the Program Administrator may require a delineation of wetlands to be performed by a technical professional acceptable to the Administrator in the field by type, following the classification system found in the *Classification of Wetlands and Deep Water Habitats of the United States*, U.S. Department of the Interior, Fish and Wildlife Service.

☐ Limits of the boundary line for the established buffers for the RPA and/or RMA.

☐ Location of all significant plant material, including all trees on-site six inches or greater in diameter at breast height; groupings of trees or significant vegetation may be outlined.

☐ Physical features, including streets, alleys (including all improved and unimproved rights-of-way), parking areas and existing site improvements to remain, such as structures and their use, parking areas, driveways and all areas of impervious cover.

☐ Existing utilities, including storm sewer, curb and gutter, sewer (including existing septic drainfields), water, electrical, gas, and easements or other improved or unimproved rights-of-way for utilities.

☐ Land uses immediately adjacent to the site.

D. Proposed improvements ***(sheet #2)***

☐ Areas of proposed impervious surface, including:
☐ Streets, alleys, easements or other rights-of-way, including proposed improvements to existing rights-of-way
☐ New sidewalks, curbs and gutters, driveways and access, loading and other paved areas, including location and materials to be used.
☐ Proposed structures, including building footprint, dimensions, and use.
☐ The location of any sewage disposal system or reserve drainfields.

E. Preliminary grading plan and/or cross-section drawings (if necessary to evaluate site drainage and conservation of natural features).

F. Limits of the proposed area of disturbance based on all anticipated improvements, including buildings, driveways, parking spaces, utilities, etc.

G. Proposed location and basic layout of planned structural Best Management Practice (BMP) facilities.

H. Additional supporting information including calculations shown in a table format on plan sheet #2

☐ Total gross square footage area
☐ Total land area covered by buildings
☐ Amount of open space on-site
☐ Amount of paved or graveled area (impervious surface) on the site (acreage and percent of site coverage)
☐ Number of parking spaces
☐ Number of residential units of each type
☐ Pre and Post-development runoff rate from 2 and 10 design year storms
☐ Pollutant load calculations (See App. 5D of VA. Stormwater Management Handbook, Vol. 2)
☐ BMP design calculations (See VA Stormwater Management Handbook

I. Erosion and Sediment Control Plan ***(sheet #3)***

Requirements in accordance with Chapters 3, through 6 of the *Virginia Erosion and Sediment Control Handbook*:

- ☐ Erosion and Sediment Control Checklist with required E & S plans as per the Virginia Erosion & Sediment Control Handbook, 1992 Third Ed.
- ☐ Detailed narrative and notes on all E & S measures used including but not limited to any stream crossings or wetland disturbance.
- ☐ Assessment of existing shoreline conditions and a determination of required erosion control measures.
- ☐ Directional arrows of drainage flow to the planned sediment control measures (if applicable).
- ☐ Existing and proposed grades.
- ☐ Existing natural and/or developed features on-site or directly adjacent to the site.
- ☐ Pre- and post-development drainage (including off-site) for all permanent and temporary sediment control measures for the 10-year storm.
- ☐ 100-year floodplain under proposed channel conditions.
- ☐ Means proposed to preserve any existing vegetation during construction and retention as part of completed project in accordance with guidelines established in the following section (see Performance Criteria, page 18).
- ☐ Phasing and sequencing of development, and provisions for handling surface water throughout the stages of development.

J. Landscape Plan ***(sheet #4)***

- ☐ Major landscaping features, including existing vegetation, to be retained.
- ☐ Clear delineation of all trees proposed for removal.
- ☐ Description of plant species to be disturbed or removed.
- ☐ Treatment of the RPA buffer, indicating proposed landscaping and vegetation to be retained by type and quantity.
- ☐ Replanting schedule for trees and other significant vegetation removed for construction, including list of trees and plants to be used.
- ☐ Demonstration that the design will preserve to the greatest extent possible any significant trees and vegetation on-site and provide maximum erosion control and overland flow benefits.
- ☐ Demonstration that indigenous plants (See Plant List, Appendix E) are to be used to the greatest extent possible.

K. Narrative

☐ Accompanying sheets 1 through 4 shall be a narrative that describes the following:
☐ A description of the impact the development will have on existing vegetation
☐ A description, including location and design, of all measures to be taken to meet the performance criteria outlined in the ordinance

L. Water Quality Impact Assessment (WQIA) (sheet #5)

☐ Required for all development proposed in an RPA or any other area warranted as determined by the Program Administrator. The WQIA consists of the following elements in addition to information contained on previous sheets:

☐ **Hydrological element**
☐ Describe existing topography, soils, hydrology and geology of the site and immediately adjacent lands.
☐ Describe impacts of the proposed development on topography, soils, hydrology and geology on-site and adjacent lands.

In addition to the information shown on the CBSP, the WQIA plan sheet must show:

1. Disturbance/destruction of wetlands and justification for such action;
2. Disruption/reduction in supply of water to wetlands, streams, lakes, rivers or other water bodies;
3. Disruption to existing hydrology, including wetland and stream circulation patterns;
4. Source, location and description of proposed fill material;
5. Location of dredge material and location of dumping area for such material;
6. Location of, and impacts on, shellfish beds, submerged aquatic vegetation, and fish spawning areas;

☐ Provide evidence of required permits in addition to wetlands permits from all applicable agencies necessary to develop the project.
☐ Describe proposed mitigation measures for the potential hydrological impacts. Potential mitigation measures include:

1. Proposed erosion and sediment control concepts which may include minimizing the extent of the cleared area, perimeter controls, reduction of runoff velocities, measures to stabilize disturbed areas, schedule and personnel for site inspection;
2. Proposed stormwater management system;
3. Creation of wetlands to replace those lost;
4. Minimizing cut and fill.

☐ **Landscape Element**
☐ The standard requirements of the Landscape Plan (sheet #4), satisfy this section. At the discretion of the Program Administrator, the applicant may be required to provide additional information, particularly in support of significant mitigation requirements for a project that disturbs more than 50,000 square feet of area.

☐ **Wastewater Element**
☐ Include calculations and locations of anticipated changes which affect existing septic drainfield or wastewater irrigation areas;
☐ Provide justification for sewer line locations in environmentally sensitive areas and describe construction techniques and standards;
☐ Discuss any proposed on-site collection and treatment systems, their treatment levels and impacts on receiving water courses.
☐ Describe the potential impacts of any proposed wastewater systems, including the proposed mitigative measures for these impacts.

M. Additional documentation that must be provided
☐ A copy of any stream perennial flow determination
☐ A copy of any US Army Corps of Engineer wetland delineation approval
☐ A copy of all required Federal permits
☐ A copy of all State permits

Signature of preparer:_____
Date of signature:_____
Preparer's professional seal:

Appendix D: TR55 WORKSHEET

Runoff curve number and runoff

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Figure 2-3	CN [1/] Figure 2-4	Area ☐ acres ☐ mi² ☐ %	Product of CN x area
	Totals ➡					

[1/] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = _____ = _____ ; Use CN ➡ ☐

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr			
Rainfal, P (24-hour)	in			
Runoff, Q	in			

(Use P and CN with table 2-1, figure 2-', or equations 2-3 and 2-4)

Time of Concentration (T_c) or Travel time (T_t)

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)

	Segment ID	
1. Surface description (table 3-1)		
2. Manning's roughness coefficient, n (table 3-1)		
3. Flow length, L (total L † 300 ft) ..... ft		
4. Two-year 24-hour rainfall, P_2 ..... in		
5. Land slope, s ..... ft/ft		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t ..... hr		+ =

Shallow concentrated flow

	Segment ID	
7. Surface description (paved or unpaved)		
8. Flow length, L ..... ft		
9. Watercourse slope, s ..... ft/ft		
10. Average velocity, V (figure 3-1) ..... ft/s		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t ..... hr		+ =

Channel flow

	Segment ID	
12. Cross sectional flow area, a ..... ft^2		
13. Wetted perimeter, p_w ..... ft		
14. Hydraulic radius, $r = \frac{a}{P_w}$ Compute r ..... ft		
15 Channel slope, s ..... ft/ft		
16. Manning's roughness coefficient, n		
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V .....ft/s		
18. Flow length, L ..... ft		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t ..... hr		+ =
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... Hr		

Appendix E: MANNING'S N VALUES

Recommended n Values to be used with Manning's Equation

Surface	Min.	Design	Max.
Asphalt Lining		0.015	
Brick in cement mortar; brick sewers	0.012	0.015	0.017
Concrete-lined channel	0.012	0.015	0.018
Cement-rubble surface	0.017		0.030
Neat cement surfaces	0.010	0.012	0.013
Plastic-lined channels	0.012		0.014
Shotcrete	0.016		0.017
Asbestos Cement Pipe		0.009	
Concrete Pipe	0.012	0.015	0.016
Vitrified Clay Pipe	0.010	0.013	0.017
Common-clay drainage tile	0.011	0.012	0.017
Semi-circular metal flumes, smooth	0.011		0.015
Semi-circular metal flumes, corrugated	0.023	0.025	0.030
Channels and Ditches			
Earth, Straight and uniform	0.017	0.023	0.025
Rock cuts, smooth and uniform	0.025	0.030	0.035
Jagged and irregular	0.035	0.040	
Dredged earth channels	0.025	0.028	0.033
Earth bottom, rubble sides	0.028	0.030	0.035
Natural Streams			
1. Clean, straight bank, full stage no rifts or deep pools	0.025		0.033
2. Same as 1, but some weeds and stones	0.030		0.040
3. Winding, some pools and shoals, clean	0.033		0.045
4. Same as 3, lower stages, more ineffective slope and sections	0.040		0.055
5. Same as 3, same weeds and stone	0.035		0.050
6. Same as 4, stony sections	0.045		0.060
7. Sluggish river reaches, rather weedy or with very deep pools	0.050		0.080
8. Very weedy reaches	0.075		0.150

Appendix F: INSPECTION FORMS

Stormwater Management Construction Inspection Checklist
Stormwater Management Facilities Inspection Report Form
Stormwater Management Facilities Maintenance/Repair Report Form

Stormwater Management Construction
Inspection Checklist

Inspector Name: _____ Inspection Date: _____
Permittee's Name: _____ Permit Number: _____
Site Address or Location: _____
Watershed: _____ Tax Map or Parcel ID No: _____
Reason for Inspection:
☐ Routine Inspection ☐ Intensive Rainfall
☐ Complaint ☐ Other _____
Disturbed Area (at time of inspection): _____
Does the Site Require:
☐ Erosion and Sediment Control Plan ☐ Stormwater Pollution Prevention Plan
☐ SPCC Plan (oil storage) ☐ Other _____
If required, are these plans or permits available on-site? _____

Erosion and Sediment Control

Item	Used	Acceptable Condition	Observations and Actions Required	Completion Date
Silt Fence	Y ☐ N ☐	Y ☐ N ☐		
Straw Bales	Y ☐ N ☐	Y ☐ N ☐		
Inlet Protection	Y ☐ N ☐	Y ☐ N ☐		
Stabilized Construction Entrance	Y ☐ N ☐	Y ☐ N ☐		
Sediment Trap/Basin	Y ☐ N ☐	Y ☐ N ☐		
Check Dams	Y ☐ N ☐	Y ☐ N ☐		
Seeding (Temporary or Final)	Y ☐ N ☐	Y ☐ N ☐		
Other:	Y ☐ N ☐	Y ☐ N ☐		

Stormwater Management BMP
Inspection Checklist

Inspector Name: _____ Inspection Date: _____
Site Address or Location: _____
Watershed: _____ Tax Map or Parcel ID No: _____
Type of Stormwater BMP or Structure
☐ Culvert ☐ Pond (Permanent Pool)
☐ Inlet and Storm Drain ☐ Pond (Dry Pool)
☐ Open Channel (Vegetated/Geotextile) ☐ Bioretention Basin
☐ Open Channel (Concrete) ☐ Oil/Water Separator
☐ Other (Describe) _____

Item Inspected	Observations and Remarks	Yes	No	Reqd.	Not Req.
Open Channel and BMP Embankments		☐	☐	☐	☐
Does the structure show signs of settling, cracking, bulging, or other structural deterioration?		☐	☐	☐	☐
Do embankments, spillways, side slopes, or inlet/outlet structures show signs of erosion?		☐	☐	☐	☐
Is there evidence of animal burrows?		☐	☐	☐	☐
Is there woody vegetation growth that may interfere with the flow or operation of the facility?		☐	☐	☐	☐
Do vegetated areas need mowing or is there a build up of clipping that could clog the facility?		☐	☐	☐	☐
Are there bare areas which need seeding or sodding?		☐	☐	☐	☐
Is there standing water in inappropriate areas?		☐	☐	☐	☐
Is there an accumulation of sediment, debris, or trash?		☐	☐	☐	☐
Is there evidence of improper use of buffer areas, or construction or fill at channels or embankments which restrict flow or interfere with the proper operation?		☐	☐	☐	☐
Is there evidence of oil or other pollutant spills?		☐	☐	☐	☐
Is there standing water in inappropriate areas?		☐	☐	☐	☐
Is there an accumulation of sediment, debris, or trash?		☐	☐	☐	☐
Is there evidence of improper use of buffer areas, or construction or fill at channels or embankments which restrict flow or interfere with the proper operation?		☐	☐	☐	☐
Is there evidence of oil or other pollutant spills?		☐	☐	☐	☐

Item Inspected	Observations and Remarks	Yes	No	Reqd.	Not Req.
Culverts and Storm Drains					
Is the culvert or storm drain filled more than 25% with debris, sediment, or trash?		☐	☐	☐	☐
Is there evidence of structural failure of the culvert pipe?		☐	☐	☐	☐
Is there evidence of erosion at the inlet and outlet of the culvert or at the storm drain inlet?		☐	☐	☐	☐
Are there signs of settling, cracking, or misalignment of culverts, storm drain pipe, or concrete inlets?		☐	☐	☐	☐
Stormwater Ponds (see also Embankments)					
Is the emergency spillway clear of obstructions, debris, and vegetation?		☐	☐	☐	☐
Is the outlet structure and pipe clean of debris and sediment, free of damage, and in working order?		☐	☐	☐	☐
Is there an accumulation of debris, litter or trash?		☐	☐	☐	☐
(For dry detention ponds) Is there standing water in the pond?		☐	☐	☐	☐
(For wet ponds) Is their excessive algae growth or other vegetation?		☐	☐	☐	☐
Is there evidence of oil or other pollutants in the pond?		☐	☐	☐	☐
Is there erosion at the discharge point?		☐	☐	☐	☐
Do any safety devices, fences, gates, or locks need repair?		☐	☐	☐	☐
Other BMPs (Infiltration, Sand Filters, and Manufactured Structures)					
Is there sediment, debris, litter, oil, or trash that needs to be cleared for aesthetic or functional reasons?		☐	☐	☐	☐
Is there standing water where there should not be standing water?		☐	☐	☐	☐
Is there structural damage to concrete structures?		☐	☐	☐	☐
Are there signs of erosion at entrance or exit?		☐	☐	☐	☐
Are valves, sluice gates, and other mechanical devices operational?		☐	☐	☐	☐

STORMWATER MANAGEMENT BMP FACILITIES INSPECTION REPORT FORM

Inspection Requirements: See the Stormwater Management BMP Facilities Maintenance Schedule for landowner's responsibilities for frequency of inspection and other requirements. This information is a part of the Maintenance Agreement that is recorded in the land records with the deed.

Inspection Purpose: To assure safe and proper functioning of the stormwater management BMP facilities and associated structures, by providing regular observations of their conditions and operation.

Retention of Records: All inspection/maintenance/repair documentation shall be retained by the landowner for a minimum of five (5) years.

Submission of Records: At the end of each year, by December 31st, mail all BMP inspection and maintenance documentation to:
City of Richmond
Department of Public Utilities
900 East Broad St. Room 603
Richmond, VA 23219
Attention: BMP Inspection and Maintenance Records

NAME OF BUSINESS OR LANDOWNER:
ADDRESS:
INSPECTION DATE:
PERFORMED BY:

Facility Management Checklist
The following items should be checked for each BMP:

1. Facility construction meets the requirements of the City of Richmond Stormwater Management Design Manual, where applicable, and is adequate for the intended function.

2. The facility has been maintained properly according to the requirements of the Recorded Maintenance Agreement, BMP Maintenance Schedule, and the City of Richmond Stormwater Management Design Manual.

3. The facility is functioning adequately.

4. There have been no changes to the site conditions or area that would require modification and/or replacement of the existing facilities.

5. Access to the facility is adequate and maintained.

CITY OF RICHMOND
Department of Public Utilities

STORMWATER MANAGEMENT BMP FACILITIES INSPECTION REPORT FORM
REFER TO THE RECORDED MAINTENANCE AGREEMENT BMP MAINTENANCE SCHEDULE FOR EACH BMP TYPE – COMPLETE SEPARATE FORM FOR EACH STORMWATER MANAGEMENT BMP FACILITY

BMP Type:

BMP Location:

Authorization
Does the facility comply adequately with all pertinent regulations and requirements?
Yes ☐ No ☐

Requirements to Meet Compliance

Additional Observations/Comments

STORMWATER MANAGEMENT BMP FACILITIES MAINTENANCE/REPAIR REPORT FORM

Maintenance Requirements: Refer to the site's Stormwater Management BMP Facilities Maintenance Schedule for landowner's responsibilities for frequency of maintenance and other requirements. This Maintenance Schedule is a guideline of minimum maintenance requirements. Additional maintenance shall be performed as necessary for the proper functioning of Stormwater Management BMP facilities. This information is a part of the Maintenance Agreement that is recorded in the land records with the deed

Maintenance Purpose: To enable the proper long-term functioning of the stormwater management BMP facilities to protect the Valley's water quality and prevent downstream flooding.

Retention of Records: All inspection/maintenance/repair documentation shall be retained for a minimum of five (5) years.

Submission of Records: At the end of each year, by December 31st, mail all BMP inspection and maintenance documentation to:

Department of Public Utilities
730 East Broad Street-6th
Richmond, Virginia 23219
804 646-6440/ (fax) 804 646-2870
Attention: BMP Inspection and Maintenance Records

NAME OF BUSINESS OR LANDOWNER:
ADDRESS:
MAINTENANCE/REPAIR DATE:
PERFORMED BY:
GENERAL COMMENTS:

STORMWATER MANAGEMENT BMP FACILITIES MAINTENANCE/REPAIR REPORT FORM

REFER TO THE RECORDED MAINTENANCE AGREEMENT BMP MAINTENANCE SCHEDULE FOR EACH BMP TYPE – COMPLETE SEPARATE FORM FOR EACH STORMWATER MANAGEMENT BMP FACILITY

BMP Type:

BMP Location:

Routine Maintenance Performed
Yes ☐ No ☐

Repairs Performed:

Remarks (Are additional maintenance/repairs needed? Yes ☐ No ☐):

Best Management Practices (BMPs)

Best Management Practice	Constructed as Approved?	Discrepancies and Corrections	Completion Date
	Y ☐ N ☐		
	Y ☐ N ☐		
	Y ☐ N ☐		
	Y ☐ N ☐		
	Y ☐ N ☐		
	Y ☐ N ☐		

Stormwater Collection and Transport
(Culverts, Storm Drains, and Inlets)

Item	Constructed as Approved?	Discrepancies and Corrections	Completion Date
	Y ☐ N ☐		
	Y ☐ N ☐		
	Y ☐ N ☐		
	Y ☐ N ☐		
	Y ☐ N ☐		
	Y ☐ N ☐		
	Y ☐ N ☐		
	Y ☐ N ☐		
Discharge Outfall from Development		Adequate channel: Y ☐ N ☐	

Signature of Inspector _____

Appendix G: EASEMENT TEMPLATES

TEMPLATE #1 – RIGHT OF ENTRY
TEMPLATE #2 – TEMPORARY CONSTRUCTION EASEMENT
TEMPLATE #3 – PERMANENT EASEMENT
TEMPLATE #4 – BMP EASEMENT AND MAINTENANCE AGREEMENT

TEMPLATE #1

This Document Prepared By:
Richmond City Attorney's Office
900 East Broad Street, Room 300
Richmond, Virginia 23219
Tax Parcel No._____

RIGHT OF ENTRY AGREEMENT

This RIGHT OF ENTRY AGREEMENT is made this _____ day of _____, 20__, between _____ ("Owner") and THE CITY OF RICHMOND, a municipal corporation of the Commonwealth of Virginia ("The City") (together, "the parties").

RECITAL

WHEREAS, The City has requested the right to enter upon property owned by Owner and described as _____ (Address) ("Property") to _____; and

WHEREAS, Owner is willing to grant such a right of entry on the terms and subject to the conditions set forth herein.

AGREEMENT

NOW, THEREFORE, in consideration of the mutual covenants herein and for $1.00 cash in hand paid, receipt of which is hereby acknowledged, the parties agree as follows:

1. **Right of Entry.** Owner hereby grants The City, its representatives, agents, and employees, the right to enter upon the Property for a period of _____ (____) days, beginning on _____ and ending _____, subject to the terms set forth herein. Owner grants The City the right, without limitation, to ingress and egress the Property, without prior notice, during normal business hours. Additionally, Owner grants The City the right to perform work on the _____ while on the Property.

2. **Term of Right of Entry.** The Right of Entry granted hereby shall automatically terminate at 5:00 p.m. on _____ or upon completion of the work, which occurs first. Upon such termination, The City and its agents, representatives and employees shall immediately cease all activity and vacate the Property.

WITNESS the following signatures:

THE CITY: CITY OF RICHMOND, a municipal corporation of the Commonwealth of Virginia

By:

_____

Title: Director, Department of Public Utilities

_____

By: _____

OWNER

APPROVED AS TO FORM:

_____

Assistant City Attorney

TEMPLATE #2

This Document Prepared By:
Richmond City Attorney's Office
900 East Broad Street, Room 300
Richmond, Virginia 23219
Tax Parcel No._____

TEMPORARY CONSTRUCTION EASEMENT AGREEMENT

THIS AGREEMENT, made this _____ day of _____, 20___ between _____ herein referred as "Grantor", and the **CITY OF RICHMOND,** a municipal corporation of the Commonwealth of Virginia, herein referred to as "Grantee";

WITNESSETH:

WHEREAS, the Grantor is the owner of certain land wherein a temporary construction easement ("Easement") is necessary for _____ as set forth in Ordinance No. _____, adopted _____, 20___, by the Council of the City of Richmond, and the Grantor is willing to grant to the Grantee the said temporary easement for a term not to exceed 36 months from the date of execution of this deed by the Grantor. The Easement granted herein shall automatically terminate at the end of 36 months, and the Grantee will no longer have any rights associated with this Easement.

NOW, THEREFORE, for the above-specified purposes, and in consideration of the sum of **ONE DOLLAR ($1.00)** and other good and valuable consideration, receipt of which is hereby acknowledged, the Grantor does hereby give, grant dedicate and convey to the Grantee, the Easement in and across certain land owned by the Grantor, as follows:

SEE EXHIBITS "A" ATTACHED HERETO AND INCORPORATED HEREIN BY THIS REFERENCE.

The Grantee hereby covenants and agrees with the Grantor that the Grantee will restore or replace the land and the surface thereof within the boundaries of the Easement to its original condition as far as practicable upon completion of the purposes of this Easement.

WITNESS the following signature and seal.

_____

COMMONWEALTH OF VIRGINA
CITY/COUNTY OF _____, to-wit:

Subscribed and sworn to before me this _____ day of _____, 20__ by _____.

_____
Notary Public

My commission expires: _____

TEMPLATE #3
This Document Prepared By:
Richmond City Attorney's Office
900 East Broad Street, Room 300
Richmond, Virginia 23219
Tax Parcel No._____

DEED OF EASEMENT

THIS DEED OF EASEMENT, made this _____ day of _____, 20__, by and between _____, herein referred to as "Grantor", and the **CITY OF RICHMOND**, a municipal corporation of the Commonwealth of Virginia, herein referred to as "Grantee",

EXEMPTION FROM TAXES

This conveyance is exempt from Virginia's Grantor Tax pursuant to Section 58.1-811 (C)(5) of the Code of Virginia (1950) as amended.

WITNESSETH:

WHEREAS, Grantor is the owner of certain land wherein a permanent drainage easement is necessary for purposes of drainage improvements at _____, Richmond, Virginia, and the Grantor is willing to grant to Grantee the said easement.

NOW, THEREFORE, for purposes of the aforementioned drainage improvement project, and in consideration of the sum of **TEN ($10.00) DOLLARS** and other good and valuable consideration, to be delivered with copies of the said deed, the Grantor does hereby give, grant, dedicate, and convey to the Grantee, with General Warranty of Title, a permanent easement in and across certain land owned by the Grantor, as follows:

SEE EXHIBIT "A" ATTACHED AND INCORPORATED HEREIN BY REFERENCE

Being a portion of the same real estate conveyed to the Grantor by deed recorded in the Clerk's Office of the Circuit Court of the City of Richmond, in Deed Book 796, page 186.

The Grantee hereby covenants and agrees with the Grantor that the Grantee will restore or replace the land and the surfaces thereof within the boundaries of the easement to its original condition as far as practicable upon completion of the construction, reconstruction, maintenance or repair of the facilities within the boundaries of said permanent easement.

WITNESS the following signatures and seals.
By: _____

_____

COMMONWEALTH OF VIRGINIA
CITY/COUNTY OF _____, to wit
The foregoing instrument was acknowledged before me, the undersigned notary public by _____ on this ____ day of _____, 20___.

_____
Notary Public

Notary Registration Number: _____
My commission expires: _____

COMMONWEALTH OF VIRGINIA
CITY/COUNTY OF _____, to wit
The foregoing instrument was acknowledged before me, the undersigned notary public by _____ on this ____ day of _____, 20___.

_____
Notary Public

Notary Registration Number: _____
My commission expires: _____

The foregoing Deed of Easement from _____ is hereby accepted the _____ day of _____, 20__, pursuant to authority granted by Section 26-42 of the 2005 Richmond City Code.

CITY OF RICHMOND
By_____
Director Public Utilities

Prepared and approved as to form:

_____

Assistant City Attorney

GRANTEE ADDRESS:
City of Richmond
Real Estate Services
900 East Broad Street, Room 1105
Richmond, Virginia 23219

TEMPLATE #4
This Document Prepared By:
Richmond City Attorney's Office
900 East Broad Street, Room 300
Richmond, Virginia 23219
Tax Parcel No._____

BMP EASEMENT AND MAINTENANCE AGREEMENT

THIS EASEMENT AND MAINTENANCE AGREEMENT is made as of the _____ day of _____, 20 _____ by _____
(the "Owner")
and the CITY OF RICHMOND, VIRGINIA (the "City").

RECITALS

WHEREAS, _____is the Owner of that _____acre parcel of land located at _____in Richmond, Virginia, and described as _____ in the deed recorded at the Richmond Circuit Court Clerks Office in Deed Book _at Page, _____and/or as instrument # _____ (the "Property") and

WHEREAS, a Site Plan/Subdivision Plat prepared by
_____
_,dated _____ and entitled
_____
has been approved or submitted for approval by the City (the "Plan") and

WHEREAS, said Site Plan/Subdivision Plat provides for a stormwater management facility and other drainage measures and improvements within the confines of the property (the "Facilities") the description of work as follows
_____
_____
_____
_____
_____ and

WHEREAS, the City requires that the Facilities as shown on the Plan prepared by
_____ _____, dated _____ and
designated _____ _____ be
constructed and adequately maintained by the Owner;

NOW THEREFORE, in consideration of the obligations mutually undertaken herein and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the parties agree as follows:

AGREEMENT

1. This Agreement shall be binding on the parties, their administrators, executors, successors, heirs, assigns and agents.

2. Indefinitely and at all times, the Facilities as shown on the Plan shall be maintained in good working order acceptable to the City.

3. The inspection and maintenance of the Facilities shall be performed following the guidance provided in the latest edition of the "Virginia Stormwater Management Handbook" or at the Virginia Stormwater BMP Clearinghouse web site.

4. The Owner hereby grants, bargains and conveys to the City an easement over the Property to take whatever steps it deems necessary to maintain the Facilities. This easement may only be exercised by the City in the event that the Owner fails to correct defects or does not commence action necessary to correct any defects to the good working order of the Facilities within fourteen (14) days after written notice of such defects to Owner.

5. In the event Owner fails to correct any defects or commence the correction of such defects to the good working order of the Facilities within fourteen (14) days after written notice of such defects to Owner, the City may enter upon the Property and take whatever steps it deems necessary to maintain said Facilities. It is expressly understood and agreed that the City is under no obligation to maintain or repair the Facilities and in no event shall this Agreement be construed to impose any such obligation on the City.

6. In the event of an emergency involving the Facilities, as determined by the Director of Public Utilities, the City, at its option, may enter immediately upon the property and take whatever steps it deems necessary to meet the emergency. Alternatively, the City may notify the owner by phone at _____, to take whatever action is necessary within a specified period of time. Should the Owner fail to respond, or should the owner inform the City that it intends not to respond within the specified period of time, the City may, at its option, enter immediately upon the land and take whatever steps it deems necessary to meet the emergency.

7. The City shall not pay any compensation at any time for its use of the Property in any way necessary for the inspection and maintenance of the facility, including access to the facility.

8. In the event the City, pursuant to this Agreement performs work or expends any funds necessary for the maintenance of the Facilities, including labor, equipment, supplies and materials, the Owner shall reimburse the City, within ten (10) days after the City gives the Owner written notice of such expenditures.

9. The Owner, its executors, administrator, assigns and any other successors in interest, shall indemnify and hold harmless the City and its agents and employees for any and all damages, accidents, casualties, occurrences or claims which might arise or be asserted against the City arising out of or resulting from the construction, presence, existence or maintenance of the Facilities by the Owner or the City.

10. In the event a claim is asserted against the City, its agents or employees, the City shall promptly notify the Owner and the Owner shall defend at its own expense any suit based on such claim. If any judgment or claim against the City, its agents or employees shall be allowed, the Owner shall pay all costs and expenses immediately.

11. This Agreement shall be recorded in the Richmond Circuit Court Clerks office, shall constitute a covenant running with the land, and shall be binding upon its administrators, executors, assigns, heirs and any other successors in interest.

12. All notices herein shall be in writing and shall be hand delivered to the parties or sent by registered or certified mail, return receipt requested, postage paid, addressed to the parties as follows:

To the City:	Director of Public Utilities 730 East Broad Street 6th floor Richmond, VA 23219-1850
With copy to:	City Attorney 730 East Broad Street 6th floor Richmond, VA 23219-1850
To Owner:	_____ _____ _____
With copy to:	_____ _____ _____

Such notice shall be deemed to have been given upon hand delivery or upon deposit in the mail as aforesaid. Any change of persons or addresses shall be provided in the aforesaid manner.

WITNESS the following signatures and seals.
By: _____

_____
Name Title

COMMONWEALTH OF VIRGINIA
CITY/COUNTY OF _____, to wit
The foregoing instrument was acknowledged before me, the undersigned notary public by _____ on this ____ day of _____, 20____.

_____
Notary Public

My commission expires:_____

The foregoing deed of easement from _____ is hereby accepted the _____ day of _____, 20____, pursuant to authority granted by Section 26-42 of the 2005 Richmond City Code.

CITY OF RICHMOND

By_____

Director Public Utilities

Prepared and approved as to form:

_____
Assistant City Attorney

GRANTEE ADDRESS:
Department of Public Utilities
730 East Broad Street, 6th floor
Richmond, Virginia 23219-1850

Appendix H: TRAP DETAILS

H-2 Trap Inlet Detail
H-3 Trap Manhole Detail

DETAIL

H-2

STANDARD DETAIL

RICHMOND, VA

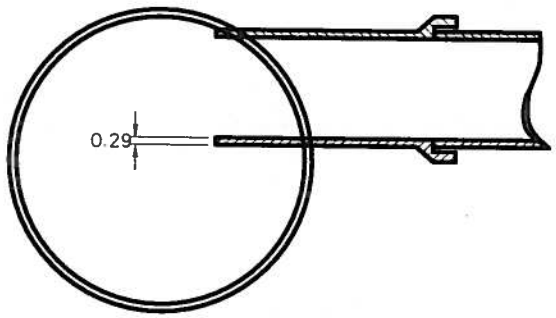
TRAP INLET DETAIL

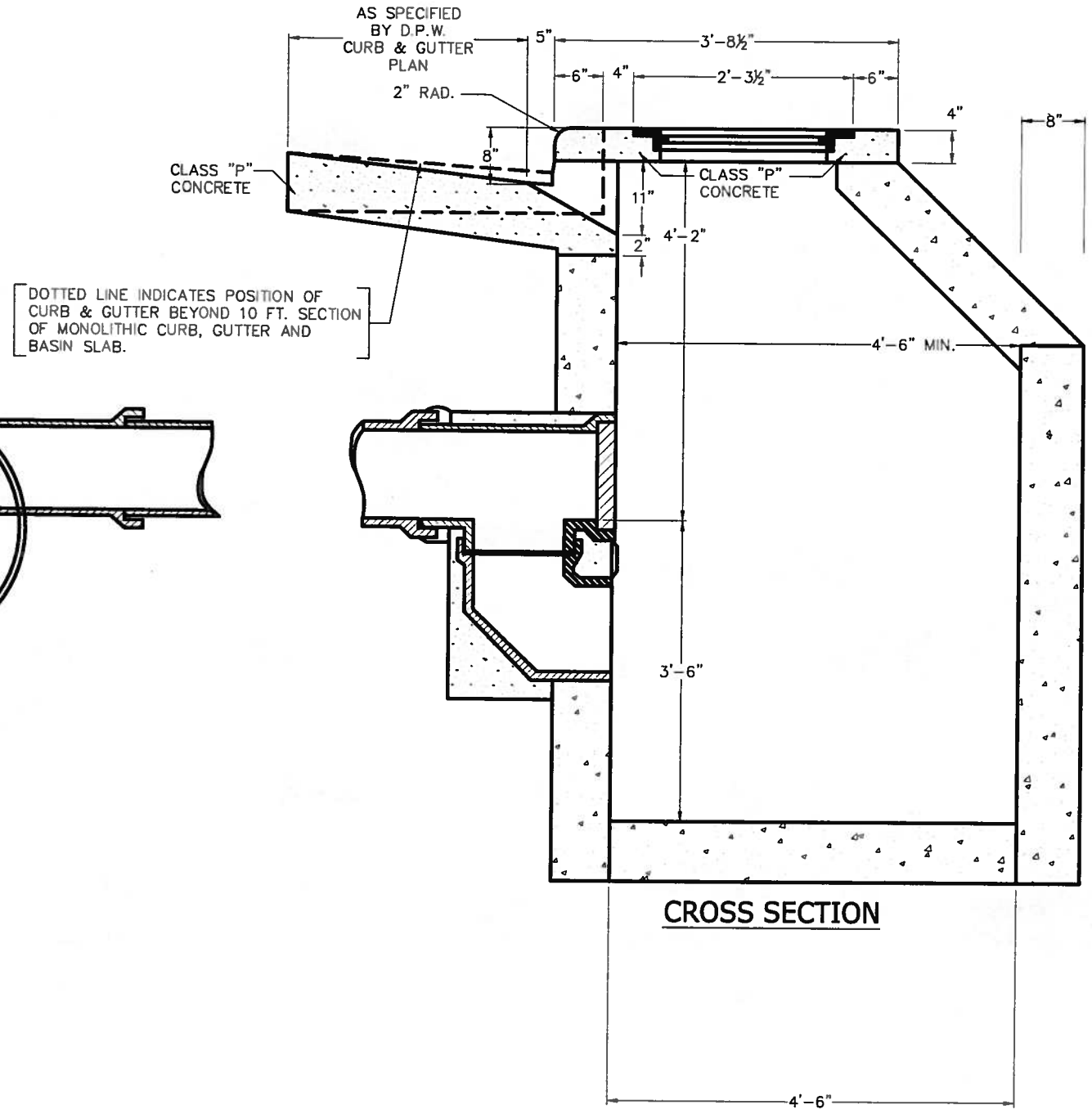
N.T.S

02/09

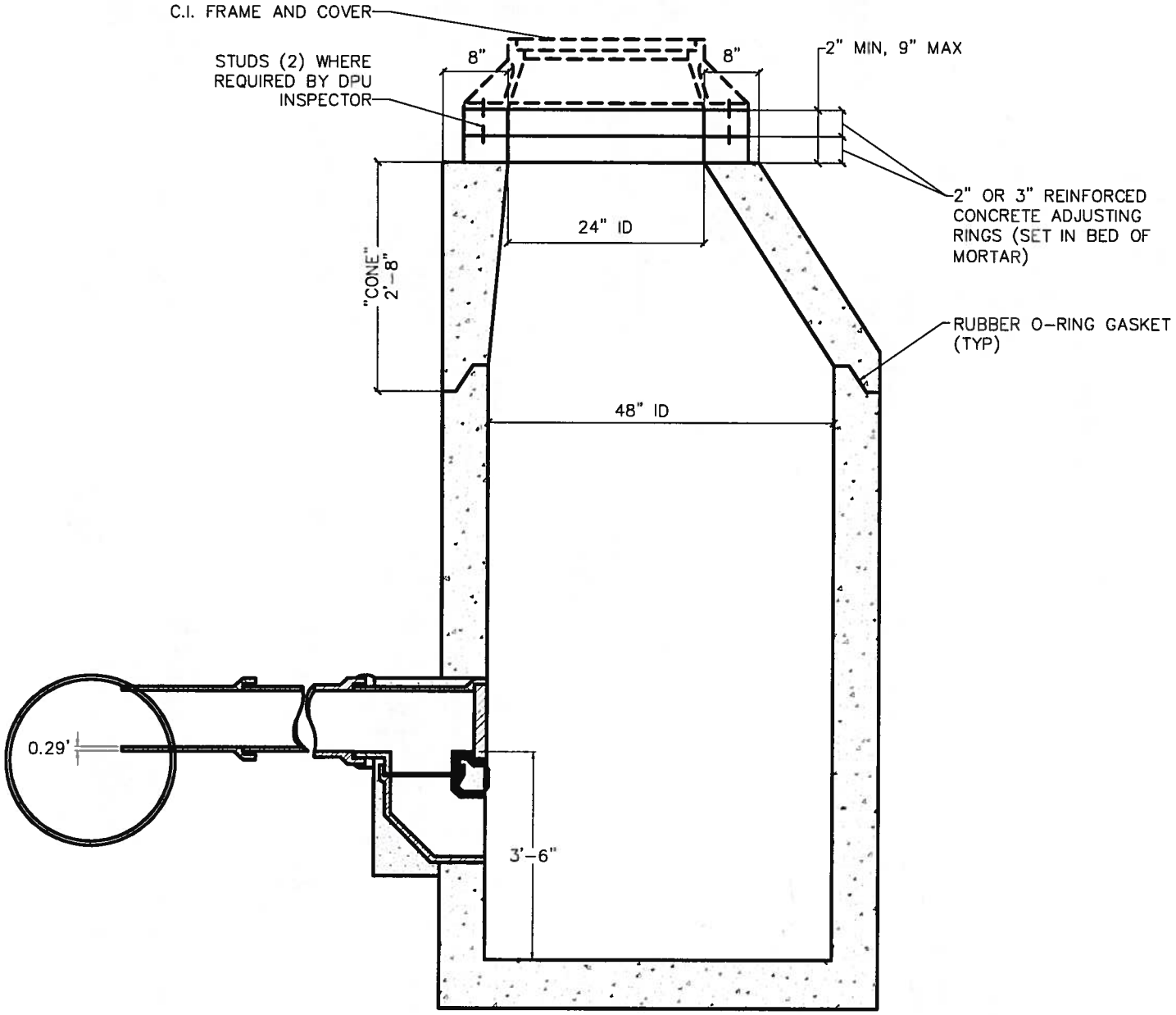
DATE

REVISION DESCRIPTION





CROSS SECTION



RICHMOND VIRGINIA

JOB NO.	STANDARD DETAIL			
DETAIL	RICHMOND, VA		N.T.S.	02/09
SHEET NO. H-3	TRAP MANHOLE DETAIL			

DATE	REVISION DESCRIPTION