Basic Stormwater Management Course

Participant Guide

Training provided by the Virginia Department of Environmental Quality
Office of Training Services

Version 2.0

Table of Contents

Course Goal

Provide participants with the knowledge and tools needed to successfully meet the regulatory requirements of the VSM Act and Regulations to ensure the general health, safety and welfare of the citizens of Virginia, as well as provide protection for state waters.

Participant expectations

- Use the training materials as you like. All the materials that you received were prepared for your use, and you may use the handouts for note taking during the training.
- Be honest with yourself about your strengths and areas that you need to develop. You are responsible for your own learning. Ask for what you need from your trainers and other group members.

Acronyms

BMP: Best management practice

CA: Composted amended soils

CBPA: Chesapeake Bay Preservation Area

CDA: Contributing drainage area

CFS: Cubic feet per second

CN: Curve number

CPv: Channel protection volume

CSN: Chesapeake Stormwater Network

CSO: Combined sewer overflow

CWA: Clean Water Act

CWP: Center for Watershed Protection

DEQ: Virginia Department of Environmental Quality

ED: Extended detention

EMC: Event mean concentration

EPA: United States Environmental Protection Agency

ESC: Erosion and sediment control

ESD: Environmental site design

g/cc: Grams (weight) per milliliter (volume)

GP or Construction GP: Construction General Permit

HSG: Hydrologic soil groups

HUC: Hydrologic unit code

I-D-F curves: Intensity-Duration-Frequency curves

LDA: Land-disturbing activity

LID: Low-impact development

MS4: Municipal Separate Storm Sewer System

NHRCS TR-55: Natural Resources Conservation Service Technical Release 55

NOAA: National Oceanic and Atmospheric Administration

NPDES: National Pollution Discharge Elimination System

NPS: Nonpoint source

P: Phosphorus

P2 Plan: Pollution prevention plan

Regulated LDA: Land-disturbing activity of one acre or more, 2,500 square feet in all areas of jurisdictions designated as subject to the Chesapeake Bay Preservation Act, part of a larger common plan of development or sale that is one acre or more, or a more stringent area as established in local ordinance, that must follow the provisions of the VSMP Regulations and obtain state permit coverage, where applicable, and VSMP authority permit coverage.

RR: Runoff reduction

RRM: Runoff Reduction Method

SAV: Submerged aquatic vegetation

SWM: Stormwater management

SWPPP: Stormwater pollution prevention plan

Tc or **TOC:** Time of concentration

TMDL: Total maximum daily load (a federal and state regulatory term which describes the maximum pollutant amount a body of water can receive while still meeting water quality standards)

TV: Treatment volume

VESCP: Virginia Erosion and Sediment Control Program

VRRM: Virginia Runoff Reduction Method

VSMA: Virginia Stormwater Management Act

VSMP: Virginia Stormwater Management Program

VPDES: Virginia Pollution Discharge Elimination System

Module 1: Course Overview

Module 1 Objectives

After completing this module, you will be able to:

- Identify the training and certification requirements for stormwater management and erosion and sediment control

Module 1 Content

1a. Introduction

1b. Training and Certification

1c. Roles and Responsibilities in a VSMP Authority

1a. Introduction

The Virginia Stormwater Management Act (VSMA) was amended in 2012 with the passage of House Bill 1065, also called the Integration Bill. Among the changes is the requirement that certain counties, cities, and towns adopt and administer a local Virginia Stormwater Management Program (VSMP) – effectively creating a statewide stormwater management program that operates at the local level.

A cornerstone of the VSMP for all localities is the requirement for state permit coverage for regulated land-disturbing activities either under the General Permit for Discharges of Stormwater from Construction Activities (Construction GP) or an applicable individual permit. Starting July 1, 2014, VSMP authorities will hold the primary role of reviewing and approving applications for coverage under the Construction GP. Final permit coverage will still be issued by the Department of Environmental Quality (DEQ). VSMP authorities will also hold the primary role of inspecting best management practices (BMPs) and enforcing compliance with the VSMP authority permit and local stormwater ordinances.

The movement of the VSMP from the state level to the local level allows localities to integrate their stormwater management requirements with the requirements of erosion

and sediment control, flood insurance (if applicable), flood plain management, and Chesapeake Bay Preservation Act (if applicable) into a unified stormwater program. This is intended to make the submission and approval of plans, issuance of permits, payment of fees, and coordination of inspection and enforcement activities more convenient and efficient for both the locality and the applicant.

The VSMA and Regulations also bring about a new shift to the runoff reduction paradigm, where designers will focus on reducing the post-development stormwater runoff volume from a site, as well as meeting more stringent nutrient load reduction requirements to improve water quality.

1b. Training and Certification (9VAC25-850)

The VSMA requires personnel working in a VSMP to obtain and maintain a certificate of competence in the area of stormwater management. DEQ is required by the VSMA to create an expanded training and certification program.

The Erosion and Sediment Control and Stormwater Management Certification Regulations (9VAC25-850) require individuals performing certain duties in a Virginia Erosion and Sediment Control Program (VESCP) and/or a VSMP to be certified.

The following graphic illustrates the prerequisite courses needed for each certification through the traditional training and certification curriculum.

Erosion and Sediment Control (ESC) Exam Eligibility Training
Table 1-1

Program Administrator	=	ESC 2-day Basic				
Inspector	=	ESC 2-day Basic	+	ESC 1-day Inspector		
Plan Reviewer	=	ESC 2-day Basic	+	ESC 2-day Plan Reviewer		
Combined Administrator	=	ESC 2-day Basic	+	ESC 1-day Inspector	+	ESC 2-day Plan Reviewer

Stormwater Water Management (SWM) Exam Eligibility Training
Table 1 - 2

Program Administrator	=	SWM 2-day Basic				
Inspector	=	SWM 2-day Basic	+	SWM 1-day Inspector		
Plan Reviewer	=	SWM 2-day Basic	+	SWM 2-day Plan Reviewer		
Combined Administrator	=	SWM 2-day Basic	+	SWM 1-day Inspector	+	SWM 2-day Plan Reviewer

On-The-Job Experience

The other path for obtaining a certificate of competence is through on-the-job work experience in one of the classifications list in Table 1-1 and 1-2. If an individual has accumulated a minimum of 800 hours of on-the-job experience (verified through the application) they may be eligible to take the exam without attending training courses.

Dual Certificate

Individuals who perform both VESCP and VSMP duties may obtain a Dual Certificate of Competence by surrendering both valid certificates to the Department and paying the required administrative fee. For instance, a person who holds a valid ESC Inspector Certificate and obtains a SWM Inspector Certificate may surrender both certificates and obtain a Dual Inspector Certificate.

The dual certificate will **expire three years from the latest date of either certificate** being surrendered.

Dual Certificates of Competence
Table 1-3

ESC Program Administrator	+	SWM Program Administrator	=	**Dual Program Administrator**
ESC Inspector	+	SWM Inspector	=	**Dual Inspector**
ESC Plan Reviewer	+	SWM Plan Reviewer	=	**Dual Plan Reviewer**
ESC Combined Administrator	+	SWM Combined Administrator	=	**Dual Combined Administrator**

Certain Licensed Professionals are automatically certified as ESC Plan Reviewers. However, they must be certified to conduct ESC inspections or perform as an ESC Program Administrator. In the area of SWM, those professionals are **not** automatically certified and must obtain a certificate of competence if they are performing the duties of a VSMP Program Administrator, Inspector or Plan Reviewer (see section 9VAC25-850-50 of the Regulations for further details on who meets these requirements). Re-certification for those individuals is different and will be discussed below.

Exam

The exams are open book. You will be notified about what materials you are allowed to bring as reference material to take the exam. Typically the DEQ Handbooks along with course participant guides are used. Materials must be in a bound (3-ring) binder. No loose papers or study materials are allowed.

You will be notified of your exam results and if successful, you will receive your certificate via mail. If you fail the exam, you will be eligible to take it again up to one year without submitting an additional request or application. Additional exams are **not free**. You must attain a minimum score of **70%** in order to pass the exam. For exams that contain multiple parts, you must attain a minimum score of **70% on each part**.

Certificates and re-certifying

All certificates of competence are valid for **three years**. In order to maintain your certificate of competence, you must re-certify every three years. There several ways in which to re-certify:

1. Re-take the exam before the expiration date on your current certificate;
2. Attend the DEQ training courses required for your individual certificate; or
3. Complete the required amount of contact or CEU hours

Once you have completed either items 2 or 3 above, you may apply for re-certification and pay the appropriate fee.

Important!

You must re-certify **before** the expiration of your certificate in order to keep it valid. **If your certificate expires, you cannot re-certify.** You must take another certification exam. Individual work experience may qualify you to take the exam however, you must re-apply to take the exam or you may be required to attend the training again and certify through that path depending on your individual situation. Licensed Professionals may re-certify by providing evidence that they still hold a valid license and pay the appropriate fee. All re-certification of classifications must pay the appropriate fee. You may re-certify during the

last 12 months of your valid certificate without losing time on the valid certificate. The three years will be added to the expiration of that valid certificate.

Provisionally Certified

Once you are enrolled in the DEQ training program, you are "provisionally" certified. You have 12 months to complete the training program and 12 months from completion of the training program to obtain a passing score on the certification examination. See 9VAC25-850-50 for details and applicability.

RLD

The other certificate issued by the Department is the Responsible Land Disturber (RLD). This certificate is intended for individuals who are responsible for carrying out the land-disturbing activity (LDA) in accordance with the approved ESC plan. The RLD may be the owner, applicant, permittee, designer, superintendent, project manager, contractor, or any other project or development team member. The RLD must be designated on the ESC plan or permit as a prerequisite for engaging in land disturbance.

For further questions regarding training and certification, please visit the FAQ link on the DEQ Training & Certification page: www.deq.virginia.gov/ConnectWithDEQ/TrainingCertification.aspx.

1c. Roles and Responsibilities in a VSMP Authority

A VSMP authority is comprised of a program administrator, plan reviewer, project inspector, and in some cases, a combined administrator.

Program administrator

- Ensures plan review, approval, inspections, and enforcement are being properly conducted
- Completes annual report
- Manages long-term maintenance agreements
- Coordinates enforcement proceedings
- Keeps records
- Collects fees
- Updates local ordinances as needed

Plan reviewer

- Responsible for review of stormwater management plans to ensure they adhere to the Regulations and local ordinance(s)

Project inspector

- Reviews pollution prevention plan
- Conducts regular inspections of active construction sites to ensure proper construction and function of BMPs and other stormwater structures
- Ensures SWPPP is updated and implemented as required
- Documents inspections
- Initiates enforcement action when needed
- Ensures compliance to correct deficiencies or violations

Combined administrator

- Responsible for performing the combined duties of a program administrator, plan reviewer, and project inspector

Module 2: Why stormwater management matters

Module 2 Objectives

After completing this module, you will be able to:

- Summarize the hydrologic cycle and explain the changes to it from human influences
- List and identify stormwater impacts of precipitation changes in Virginia and consequences to current stormwater management approaches
- Explain the value and application of rainwater harvesting as a method of stormwater management
- Examine the relationship between landuse, stormwater runoff, and water quality
- Describe the various impacts and risks from human-influenced stormwater runoff to natural streams and downstream areas.
- Discuss how managing stormwater benefits public and private property and water quality

Module 2 Content

2a. Introduction

2b. Stormwater Runoff

2c. The Hydrologic Cycle

2d. Distribution of the Earth's Water – the Water Budget

2e. The Urban Water Cycle

2f. Understanding Stream Evolution and Urban Stream Syndrome

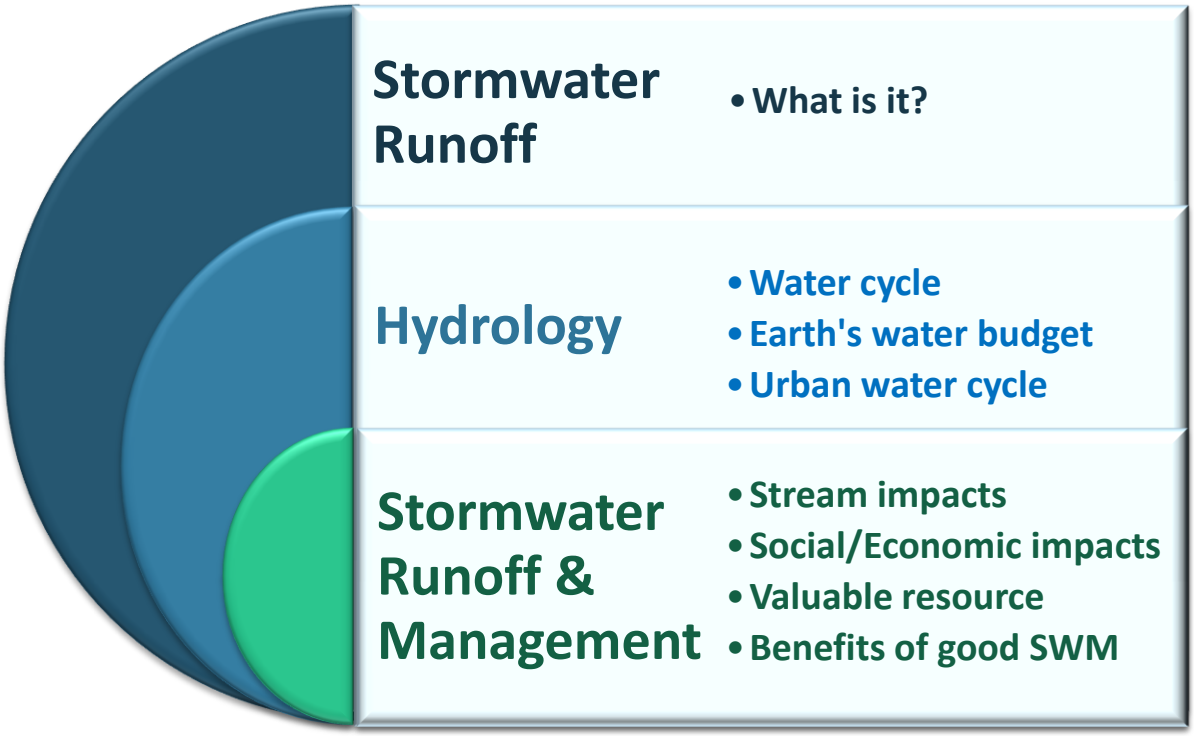
2g. Social and Economic Impacts of Stormwater on Virginia Communities

2h. Managing Stormwater and Rainwater Harvesting

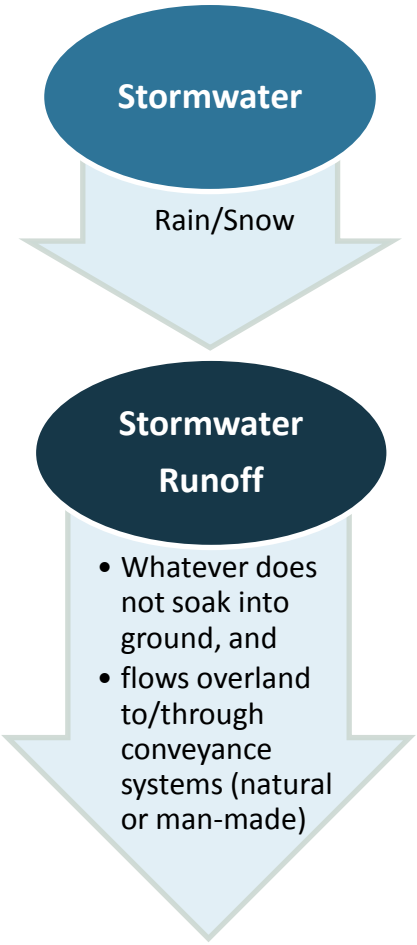
2i. The Economic Benefits of Effective Stormwater Management

2a. Introduction

The following module provides the scientific foundation for understanding the consequences of ineffective stormwater on Virginia's natural waterways. It helps to provide some of the rationale for the legal and regulatory changes in stormwater management. The module is divided into several sections. The first few sections define stormwater and stormwater runoff; relate stormwater to the global movement of water (the water or hydrologic cycle) and to the allocation of water on earth. The next sections explain the hydrologic changes that occur due to human influences, and the various impacts of ineffectively managed stormwater. The final sections introduce the benefits of Virginia's focus on effective stormwater management and promote stormwater as a valuable resource.



2b. Stormwater Runoff



Average annual rainfall across Virginia = 42 to 48 inches per year, isolated areas average less than 38 inches or more than 66 inches:

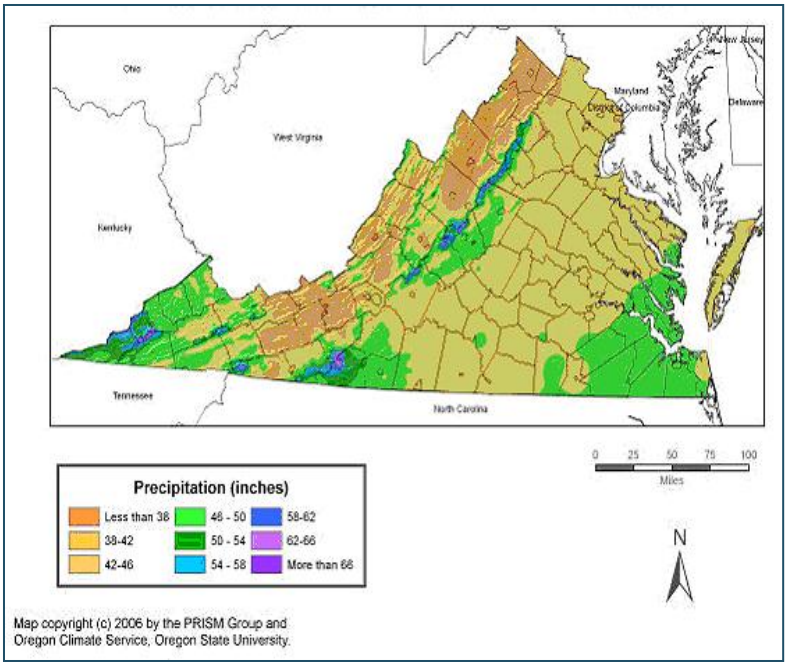


Figure 1. Average Virginia Annual Precipitation, 1970-2000.
(Source: Oregon Climate Service)

2c. The Hydrologic Cycle

The earth's water has been continuously moving and changing phases (between liquid, vapor, and ice) over millions of years. This process (earth's natural water recycling) is known as the hydrologic (or water) cycle (**Figure 2**).

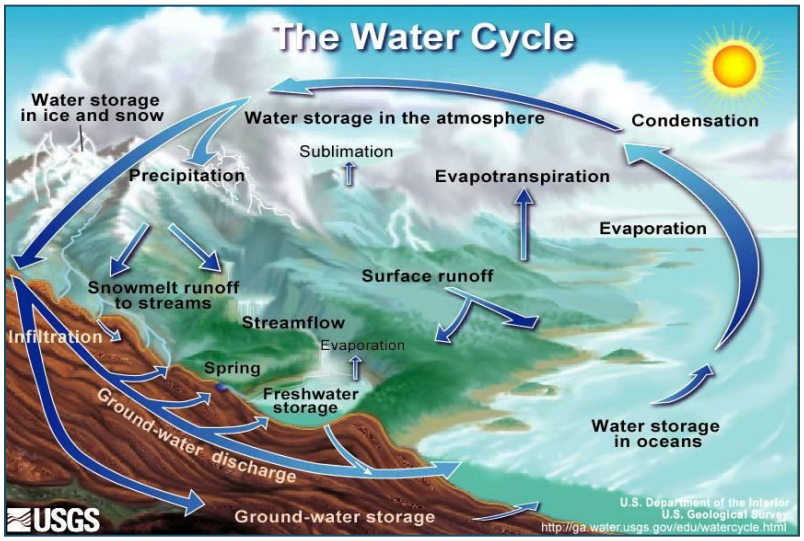


Figure 2. The Hydrologic Cycle
(Source: USGS web site)

Hydrologic cycle represented here is an over simplification of a very complex process and does not reflect human influences.

- Water is constantly being exchanged between the earth and the atmosphere (powered by the sun's energy)
- Water in oceans, lakes, rivers, other surface water, soils evaporate into the atmosphere
- Plants and animals also transpire water
- Water vapor rises with air currents up into the atmosphere and reaches cooler atmospheric layers
- Water condenses to form clouds, then water droplets which fall or precipitate to the earth's surface (rain, snow, sleet or hail)
- Water precipitating during local rain events mostly transported from elsewhere within clouds (as moisture) and seldom due to localized evaporation and transpiration
- Once precipitation reaches the ground, water:
  (1) evaporates;
  (2) is absorbed by the ground and/or taken up by plant roots; or
  (3) moves into (infiltrates) soil and through soil (percolates) to groundwater
  - Excess water then drains to streams, rivers, and other surface waters (***surface or stormwater runoff***).

Evapotranspiration ***equals*** *water evaporation* ***plus*** *water transpiration*

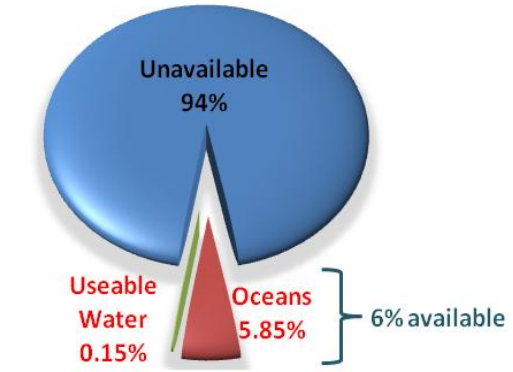
Key Points to Consider:

- Only a fraction of the earth's total water is available as fresh water
- This limited availability of fresh water is critical for human health and survival
- In Virginia, projected population increases and changes in precipitation patterns could make water availability much more concerning in the future

2d. Distribution of the Earth's Water – the Water Budget

Although water covers about three quarters of the earth's surface, most of it is *not* available for human use (**Figure 3** and **Figure 4**).

Figure 3. Overall Global Water Budget (top pie chart only)
(Source: Adapted from Day and Crafton, 1978)



94% of all water chemically bound in rocks and minerals (6% available) (**Figure 3**)

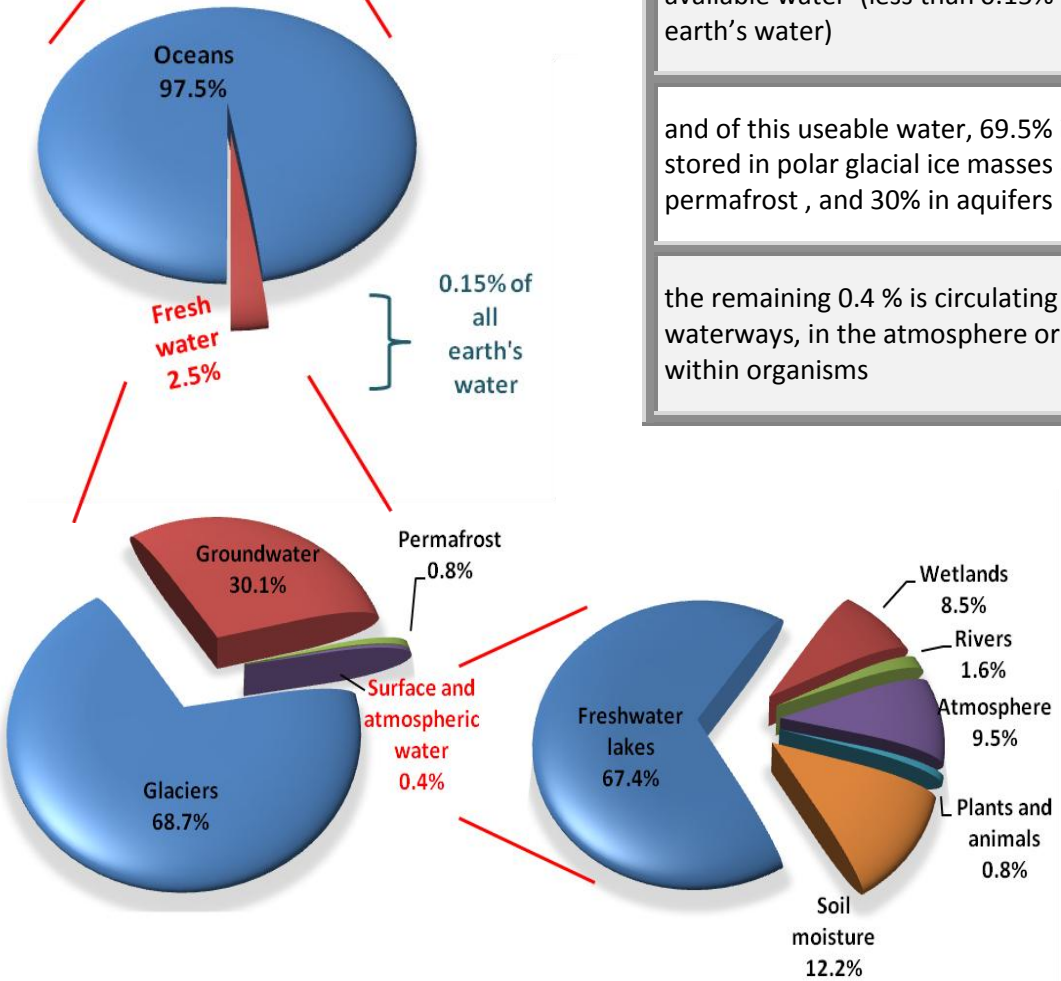
97% of the available water is in the oceans (**Figure 4**), but due to its salinity, is not a significant source for human consumption

for human basic needs: the remaining 2.5% of available water (less than 0.15% of all the earth's water)

and of this useable water, 69.5% is found stored in polar glacial ice masses and permafrost , and 30% in aquifers

the remaining 0.4 % is circulating in inland waterways, in the atmosphere or soil, or within organisms

Figure 4. Available Water Budget (Bottom 3 pie charts)
(Source: Adapted from Day and Crafton, 1978 and GreenFact.Org, 2011)



2e. The Urban Water Cycle

It is important to understand that all of the world's available water has been, for many years, subject to human influences (**Figure 5**).

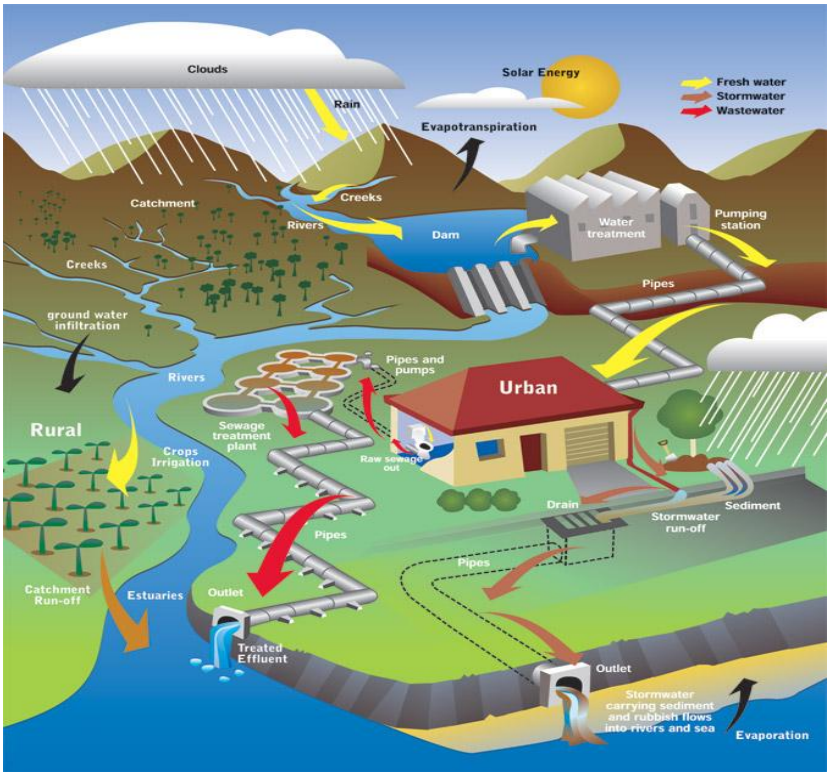
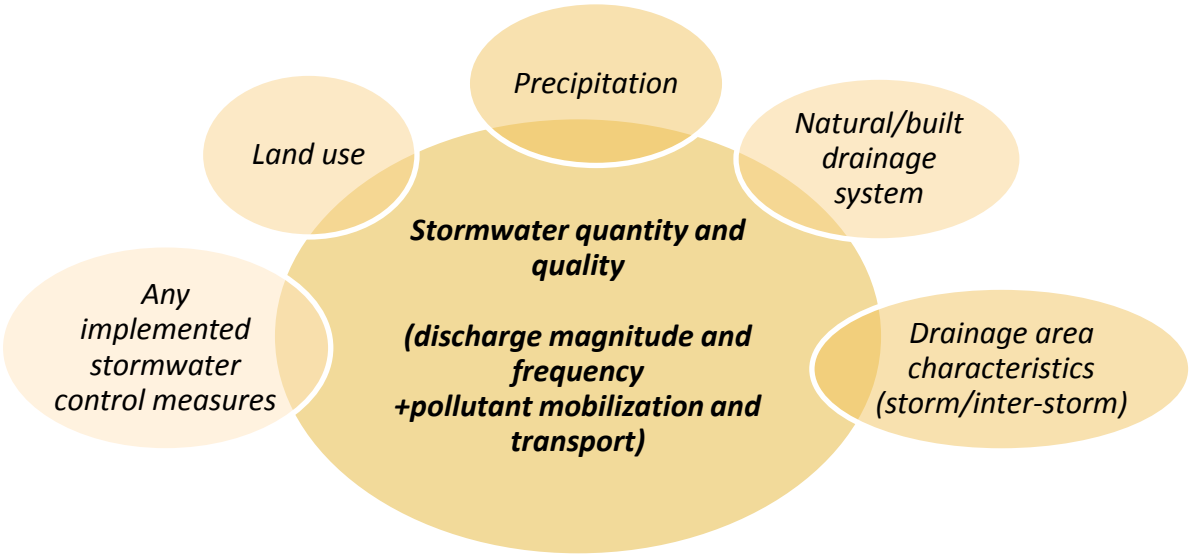


Figure 5. The Urban Water Cycle
(Source: Adapted from the SEQ Healthy Waterways partnership, http://www.healthywaterways.org)

- Smokestacks spew pollutants into the air which bind or attach to cloud water particles and subsequently drop to the earth as rain
- Pipes from industrial and sewage treatment plants and stormwater conveyance systems carry pollution into our streams and rivers
- Water that infiltrates into the soil can carry pollutants and percolate into groundwater tables that provide base flow for our streams, or even into deep aquifers that are often tapped for domestic water supply
- Natural water balance and flow is altered with increases in surface runoff, therefore less soil infiltration and less groundwater recharge

Since the water we see and use each day is such a small part of the total, we should consider it *all* to be a valuable resource and not view any of it, including stormwater, as disposable.

Focusing on stormwater runoff: the factors that influence stormwater discharge quantity and quality:



The following characteristics influence stormwater runoff quality and quantity:

- Soil characteristics, topography, vegetation, capacity of water storage areas
- Channel lengths (long meandering streams vs. short straight channels)
- Drainage density (total length of well defined channels that drain the watershed - developed areas tend to be more dense)
- Channel characteristics (roughness, slope)
- Stream flow characteristics
- Hydraulic structures, best management practices (BMPs)
- Weather patterns
    - Duration of dry periods
    - Rainfall duration, intensity, frequency

Any given storm is characterized by the storm's total rainfall depth, duration, and intensity

Changes in the hydrology cycle:

Land development leads to changes in the hydrology (the natural cycle of water) of a site or of a watershed (**Figure 6**).

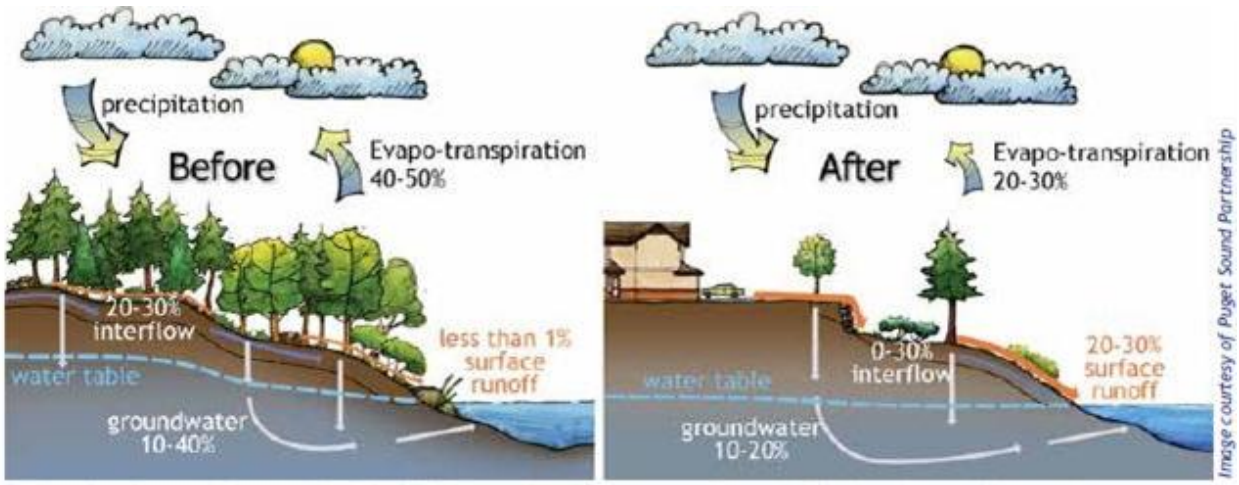


Figure 6. Changes in hydrology and land cover before (left) and after (right) development.
(Source: Puget Sound Partnership, 2013)

- Clearing removes the vegetation that intercepts, slows and returns rainfall to the air through evaporation and transpiration.
- A portion of the rainfall that once seeped into the ground now runs over the surface.
- Grading flattens hilly terrain and fills in natural depressions that would normally slow and provide temporary storage for rainfall.
- The topsoil (usually required to be replaced) and sponge-like layers of humus are scraped and removed, and the remaining subsoil is compacted.
- The addition of buildings, roadways, parking lots and other surfaces that are impervious to rainfall further reduces infiltration and increases runoff.

How does the change in impervious cover affect runoff?

Although the total amount of rainfall varies somewhat in different regions of the state, the basic changes to the hydrologic cycle holds true (**Figure 7** below).

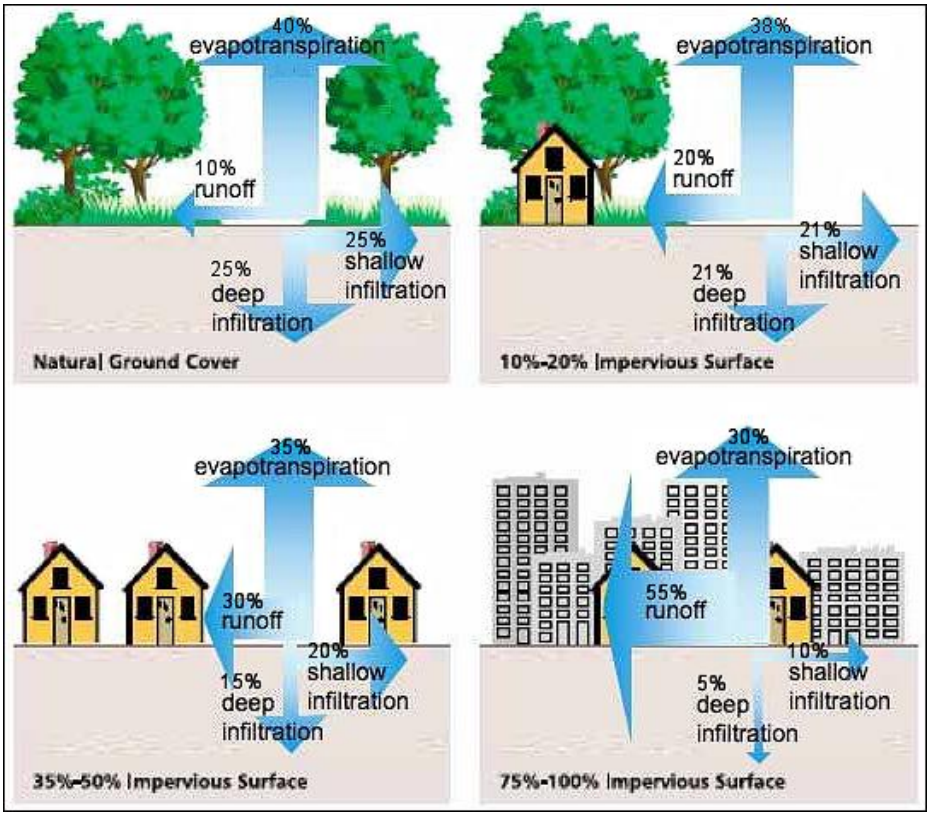


Figure 7. Relationship Between Impervious Cover and Surface Runoff.
(Source: Federal Interagency SWRG, 1998)

Impervious cover – ground surface that does not allow water absorption or infiltration but rather results in surface runoff

Impervious surfaces (roads, buildings, parking lots):

- Prevent rainfall from infiltrating into the soil and significantly increase surface runoff.
- Replace natural vegetation that alter natural drainage patterns
    - Evapotranspiration and infiltration decrease
    - Runoff increases in volume and flow rate

Altering one component of the water cycle affects all other elements of the cycle

Figure 8 is an example of the increased imperviousness (more roads, buildings, parking lots) that can take place as an area is developed over time:

Figure 8. Typical Changes in Land Surface (1958 – 1999) for a Commercial Area
(Source: ARC, 2001)

Hydrologic changes are further impacted with the widespread use of built drainage systems such as gutters, storm sewers (**Figure 9** and **Figure 10** below) and smooth-lined channels that are designed to quickly carry runoff to rivers and streams. This further reduces water infiltration into the soil and groundwater (and the amount of water that can recharge aquifers and feed streamflow during periods of dry weather).

Figure 9. Impervious Cover Increases Stormwater Runoff and Pollutants. (Source: ARC, 2001)

Figure 10. Constructed Storm Drainage System Components. (Source: Chesapeake Bay Stormwater Training Partnership)

How does the change in stormwater runoff influence stream hydrology?

Where land development has occurred, the increase in volume and velocity of stormwater runoff to receiving waters results in significant changes to stream flow characteristics:

- Increased peak discharges for a developed watershed can be two to five times higher than those for an undisturbed watershed.
- As runoff velocities increase, it takes less time for water to run off the land and reach a stream or other water body (time of concentration).
- Streams in developed areas can be more volatile because of their response to these altered runoff characteristics.

Time of concentration is the time needed for water to flow from the most remote point in a watershed to the watershed outlet **or** time required for 100% contribution from all points in a watershed during any uniform storm having sufficient duration

- This characterization translates into the sharp peak and increased size of the post-development hydrograph as seen in **Figure 11** below, which depicts typical pre-development and post-development streamflow hydrographs for a developed watershed.

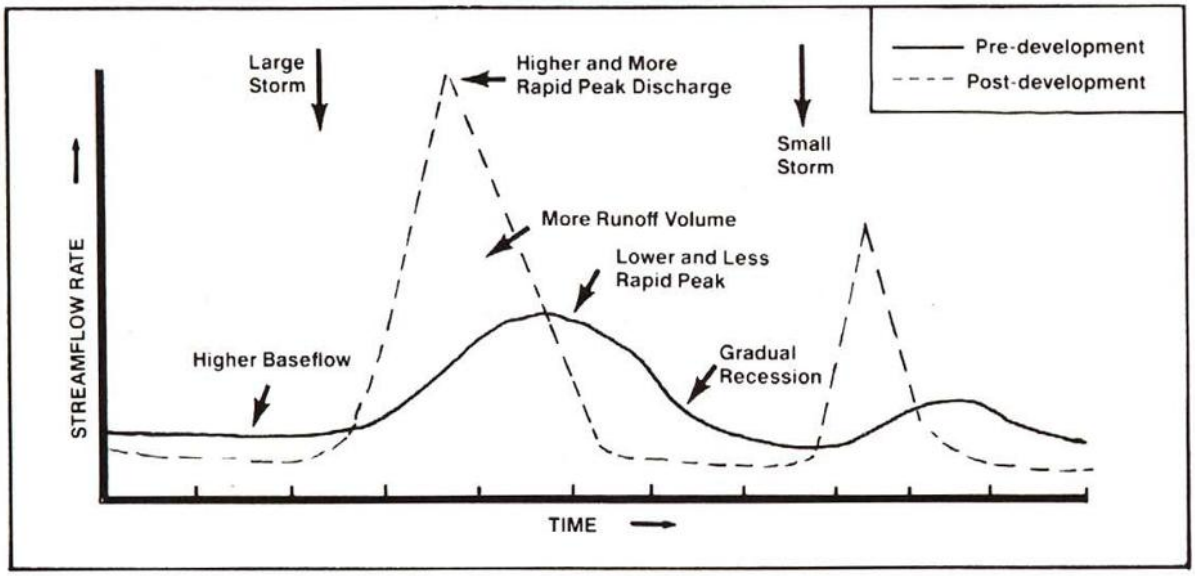


Figure 11. Pre- and Post-Development Stormwater Runoff Hydrographs

Stream flow alterations across the U.S:

A comprehensive nationwide study by the United States Geological Survey found that water flowing in streams and rivers has been significantly altered in nearly ***90 percent*** of waters that were assessed (**Figure 12** below). Flow alterations are considered to be the primary contributor to degraded river ecosystems and loss of native species. The USGS considers this assessment to provide the most geographically extensive analysis to date of stream flow alteration.

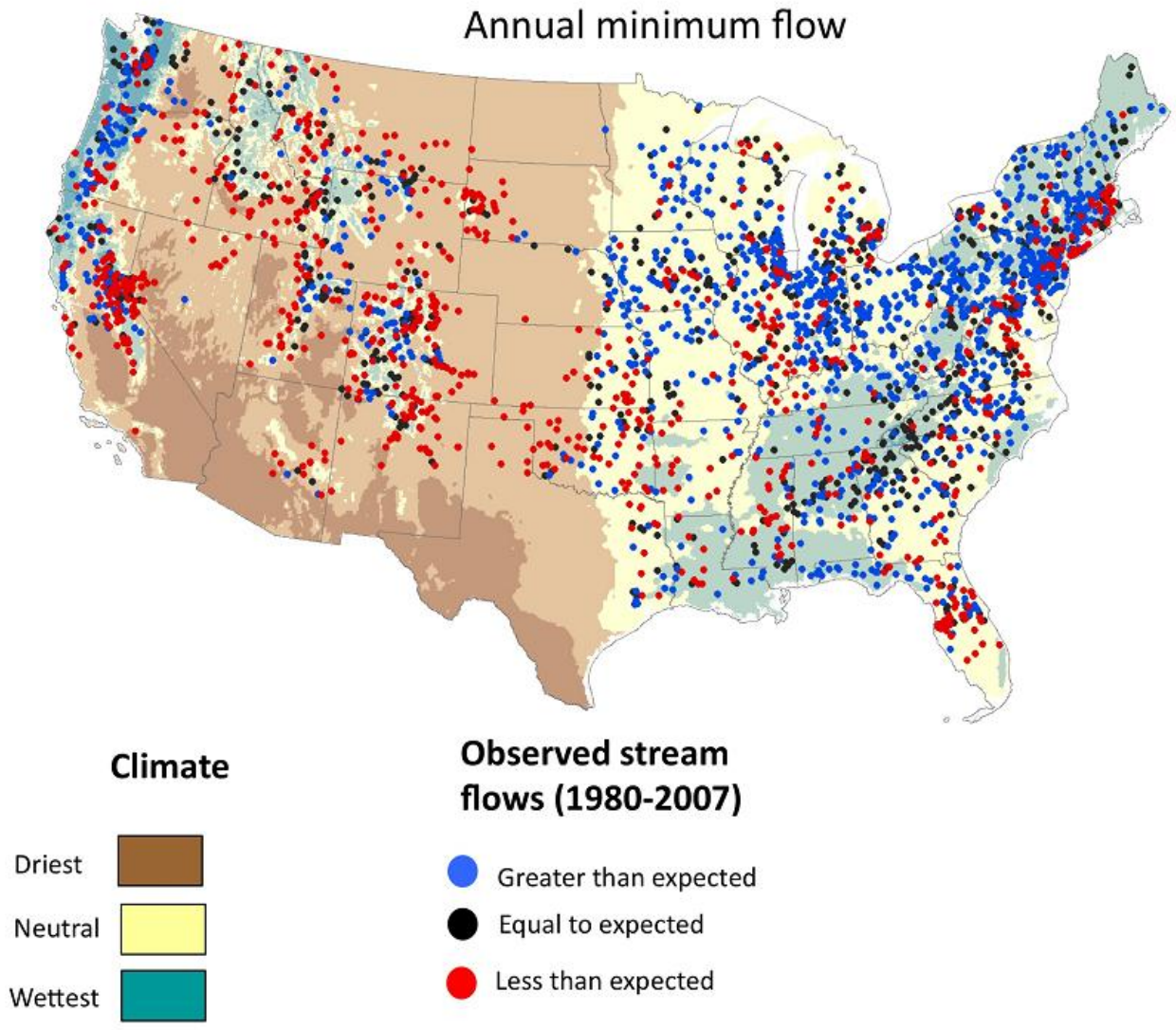


Figure 12. USGS Study Sites and Severity of Streamflow Alteration
(Source: Carlisle et al., 2010; http://water.usgs.gov/nawqa/home_maps/stream_flow.html)

What climate changes are we observing?

- Temperatures are increasing (air, ocean, land - melting glaciers and ice caps, rising sea levels)
- Global precipitation regimes are shifting systematically toward an increase in more intense rainfall events. There is a clear increase in heavy rainfall in the U.S. over the past few decades.
- Virginia has seen a ***25 percent increase*** in the frequency of extreme precipitation events since 1948. This is the greatest such increase among all states in the South Atlantic region (Maryland to Florida).
- The ***intensity and duration of drought periods*** is also increasing in Virginia (e.g., Lake Chesdin in the summer of 2007 and 2010). The consequences of this include soil moisture depletion, decrease of annual groundwater recharge, and increase of runoff from hardened dry soil surfaces.

An increase in the number of downpours does not necessarily mean more water will be available

What are the simple facts?

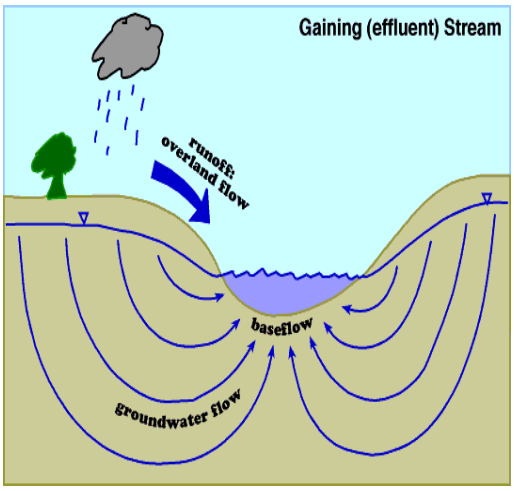
- The greater water-carrying capacity of a warmer atmosphere (even in a localized region) means that more water would accumulate there between rainfall events. When it does rain, there is a greater likelihood of a heavy downpour.
- The consequence of more frequent and intense storms may include flooding, erosion, pollution of waterways with excess runoff, wind damage, crop damage, and other environmental and economic damage. **Table 2-1** summarizes the potential effects of climate change on precipitation and stormwater runoff.

Warmer air can hold more water

Deciphering the complex components of our changing atmosphere is no simple task; natural variability in weather patterns, geographical disparities, and climate model limitations are some of the many challenges.

What are the long term implications?

- More surface runoff means less infiltration of water into the soil. This translates during the year into decreased stream base flow, since less water is stored in the shallow groundwater zone that feeds the baseflow (**Figure 13**). Less infiltration also means less groundwater recharge.



A gaining stream is a perennial stream that discharges water from the water table. Streams have two sources of water: ***stormwater*** *from overland flow after rain events, and* ***baseflow****, supplied by groundwater.*

(Source: New York Columbia University, Earth and Environmental Sciences; http://www.columbia.edu/~vjd1/streams_basic.htm)

Figure 13. Gaining (effluent) stream

- The combination of extreme events and droughts means that water level fluctuations become more common as storage areas (ponds, wetlands, floodplains) rapidly transition from dry, exposed conditions to flooded or high-water conditions that typically follow large storm events.
- More flooding is possible with less water infiltrating into the ground and more runoff.

- More frequent bankfull and flooding events are impacts resulting from increased run off volumes and increased peak flows.

  - ***Overbank*** or ***out-of-bank floods*** (flows that exceed the capacity of the stream channel and spill over onto adjacent floodplains) can damage downstream drainage areas.

  - The increase in stormwater volume is the direct result of more extensive impervious surface areas, combined with substantial tracts of natural landscape being converted to lawns on highly compacted soil.

  - Increased runoff volumes and peak flows increase the frequency and duration of smaller bankfull and near bankfull events (**Figure 14** and **Figure 15**), which are the primary channel forming events.

Figure 14. More Frequent Bankfull and Near Bankfull Flows
(Source: ARC, 2001)

Figure 15. Out-of-Bank Flooding Endangers Human Life and Property
(Source: ARC, 2001)

In many watersheds throughout the state, flooding problems have increased over time due to the changes in land use and ineffective stormwater management.

- During the 20th century, floods have caused more property damage and loss of life in the U.S. than any other type of natural disaster.

Coastal flooding will likely be more extensive due to the combination of rising sea level (related to climate change) and increases in tropical storms.

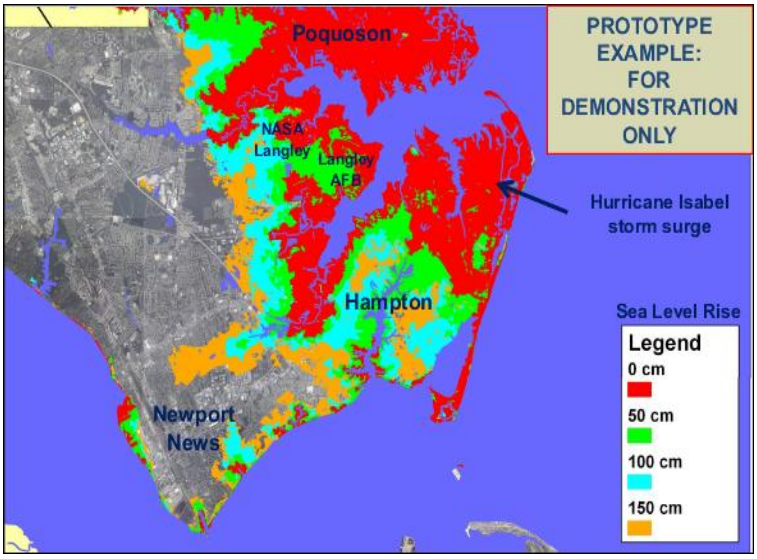


Figure 16. Hurricane Flood Prediction Model with Reference to Potential Level Rise
(Source: Virginia Institute of Marine Science and Noblis, Inc.)

Figure 16 shows the predicted extent of flooding in the Hampton-Poquoson area over the next 100 years resulting from a storm of the intensity of Hurricane Isabel if sea level were to remain at its current elevation (red), rise by 20 inches (green), 40 inches (blue) or 60 inches (orange).

Table 2-1
Summary of Climate changes* Leading to Stormwater Impacts

Changing Feature	Primary Impact	Secondary Impact
Precipitation	↑ mixed winter precipitation ↑ ice +/or rain-on-snow events	↑ winter runoff, ↑ ice ↑ road salt usage
	↓ summer rain	Drier surface-water bodies for longer periods ↑ water-level fluctuations wetland and floodplain disconnection
	Longer, more severe droughts over larger areas	Soil moisture depletion ↑ accumulated surface pollution ↓ available water supply
	↑ extreme precipitation events	Flooding erosion rapid water-level changes
Warmer winters	↓ snow accumulation more and earlier winter runoff earlier snowmelt	↓ water supply saved in snowpack (especially in the west) ↑ winter road salt application drier streams, wetlands, and floodplains earlier in the year ↓ groundwater recharge
	Shorter lake ice coverage	earlier lake turnover in spring, later in fall ↑ algal growth ↑ evaporation during winter longer lake water stratification period
Warmer summers	↑ temperature of runoff	depletion of cold-water fishery
	↑ humidity	greater severity of storms and extreme events like tornadoes
	More suitable vector environment	↑ in number and type of nuisance and health-related vectors (like mosquitoes in stormwater ponds)
	↓ water available in wetlands, lakes, reservoirs and streams	volume loss due to evapotranspiration-transpiration increases ↓ groundwater recharge ↓ stream base flow
	Gradual warming of the oceans	↑ tropical storm frequency and severity sea level rise
	Lower water levels	some perennial streams become intermittent hydrologic disconnect with riparian zone

*Variations will occur in different parts of North America

Additional considerations:

- Existing Best Management Practice (BMP) designs (based on old standards) may prove to be undersized in the future.

For example: Intensity-duration-frequency (I-D-F) curves, used for design storm data, will need updating given the changing magnitudes of various design storms.

- Many of the design standards currently in use are based on historical data. Revisions may be needed due to the changing patterns of storm events (increases in intensity and frequency of extreme events).

- Given future uncertainty, new BMPs may need to be designed conservatively to allow for additional storage that will be necessary for regions where increasing precipitation trends are predicted.

Even revised design standards may not be sufficient.

- Implementation of a monitoring program to check existing BMP inflows against original design inflows may be prudent to aid in judging whether retrofit of existing facilities or additional stormwater infrastructure is needed.

At the state and local level:

- Risks to public safety should be prioritized:
    - People living in floodplain areas and within potential dam break inundation zones should be educated risks (current and future), and steps they can take to prepare for potential floods.
    - Governments should consider strengthening land-use and building codes in these areas.
    - New development in flood-prone areas should be discouraged.
    - Natural systems (natural hydrologic flow patterns, natural retention areas, riparian zones) that help buffer against floods should be protected.
- Taking advantage of the natural water storage capacity of the floodplain provides benefits in terms of providing solutions that can overall function more efficiently and at lower costs to communities, localities, and the public.

- Some localities have started to account for climate change in their floodplain management programs.

One barrier to doing this is that floodplain maps and other planning tools are largely based on *historical* climate conditions.

With more accurate regional climate projections now available; it is prudent to update these maps and planning efforts.

Additional Resources:

http://www.epa.gov/climatechange/science/future.html#Precipitation

http://www.vims.edu/research/units/programs/icccr/_docs/coastal_sea_level.pdf

http://www.vims.edu/bayinfo/storm_central/index.php

http://water.usgs.gov/nawqa/home_maps/stream_flow.html

Knowledge Check

1. Rainfall in Virginia averages between _____ and _____ per year?

2. Which of the following represent human influences on the natural water cycle (circle all that apply):

   A. Groundwater withdrawal.

   B. Rainfall capture in cisterns for dry period usage.

   C. Diverting stormwater runoff from steep slopes.

   D. Evaporation of water from ocean surfaces to the atmosphere.

   E. None of the above.

3. The frequency of extreme precipitation events in Virginia since 1948 has increased by what percent?

2f. Understanding Stream Evolution and Urban Stream Syndrome

From land development and urban sprawl to Urban Stream Syndrome (putting the pieces together):

While the Chesapeake Bay watershed population increases by about 1 million per decade, impervious cover also continues to increase (increased more than 30% between 1990 and 2007) (Source: USEPA, 2010)

Urban Stream Syndrome is the consistently observed degraded ecological condition of streams draining urban areas.

Characterized by:

- Increased flash flooding
- Elevated nutrient and pollutant levels
- Altered stream morphology
- Sedimentation from eroded stream banks
- Loss of biological diversity

Figure 17. A natural (left) and urban stream (right) ecosystem
(Source: USGS, 2013)

Streams and rivers naturally evolve over time. Changes to natural waterways are accelerated and deviate from natural conditions due to land and water uses in our modern watersheds.

How does it happen and what are the consequences?

I. Changes to the land surface (topography, *impervious cover*, vegetation)

II. Stream channel and flood plain impacts

III. Habitat and Ecological Impacts

IV. Water quality impacts

V. Impacts on other receiving environments

I. CHANGES IN TOPOGRAPHY AND LAND COVER

Land cover changes due to development and subsequent impacts on the hydrologic regime of a site or watershed are discussed next:

Loss or change of vegetation

Soil compaction

Reduced groundwater recharge and stream base flow

Increased imperviousness of land surface

I. CHANGES IN TOPOGRAPHY AND LAND COVER

Loss or Change of Vegetation

As illustrated in **Figure 6** (above) and **Figure 18** (below), vegetation in natural areas such as Virginia woodlands and meadows contributes to the natural management of stormwater:

- **Rainfall and runoff is intercepted and slowed down *(reduces erosive capacity, decreases overland flow, opportunities for infiltration)***
    - Root systems of plants provide pathways for downward movement of water into soil
    - Water that moves down through soil (percolates) moves vertically or laterally
        - Vertical flow reaches the ground water table or aquifer
        - Lateral flow often emerges as springs or seeps (provides base flow for streams)

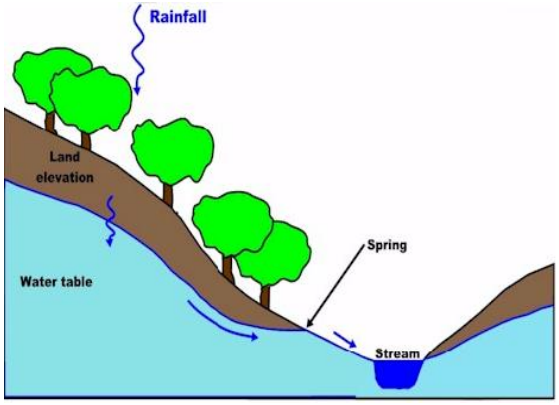


Figure 18. Relationship of infiltration to groundwater storage and stream base flow
(Source: PA DEP, 2006)

- **Very little rainfall leaves as runoff:**
    - Compared to developed sites, considerably more rain must fall before runoff will occur from wooded sites
    - Trees can effectively transpire most of the precipitation that falls in summer rain showers
    - During winter (as compared to summer):
        - More precipitation infiltrates and moves through the root zone, and the groundwater level rises (temperatures are lower and vegetation is dormant)
        - Less evapotranspiration
- **More than half of the annual amount of rainfall returns to the atmosphere through evapotranspiration:**
    - Surface vegetation, especially trees transpire water to the atmosphere (with seasonal variations and differences due to different types of vegetative cover)
    - Water is also stored in puddles, ponds and lakes on the earth's surface, where some of it will evaporate

Removing natural vegetation reduces evapotranspiration, reduces infiltration and increases the amount of stormwater runoff

I. CHANGES IN TOPOGRAPHY AND LAND COVER

Loss or Change of Vegetation

What about residential lawnscapes?

The largest crop grown in the Chesapeake Bay watershed is ***turf grass*** – more than 3.8 million acres covering a staggering 9.5% of the watershed's total land area (**Figure 19** and **Figure 20**).

75% of all turf grass in the watershed is home lawns (3.8 million acres)

Turf produces more runoff than natural open space and forestland

Turf management involves application of large amounts of fertilizer and pesticides (delivered by urban runoff to the bulk pollutant load that must be treated to protect our waterways

Amount of turf cover in the watershed has tripled in the last 30 years

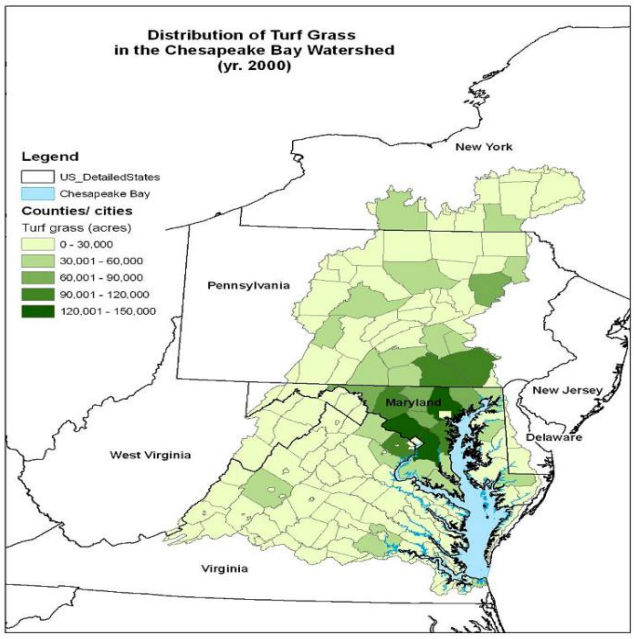


Figure 19. Distribution of Counties with High Turf Cover in the Chesapeake Bay Watershed.
(Source: Schueler, 2009a)

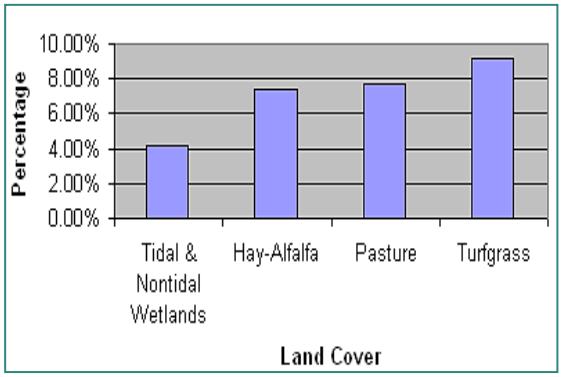


Figure 20. Comparative Land Coverages in the Chesapeake Bay Watershed (as a percent of total land area).
(Source: Schueler, 2009a)

I. CHANGES IN TOPOGRAPHY AND LAND COVER

Loss or Change of Vegetation

Consider the following facts:

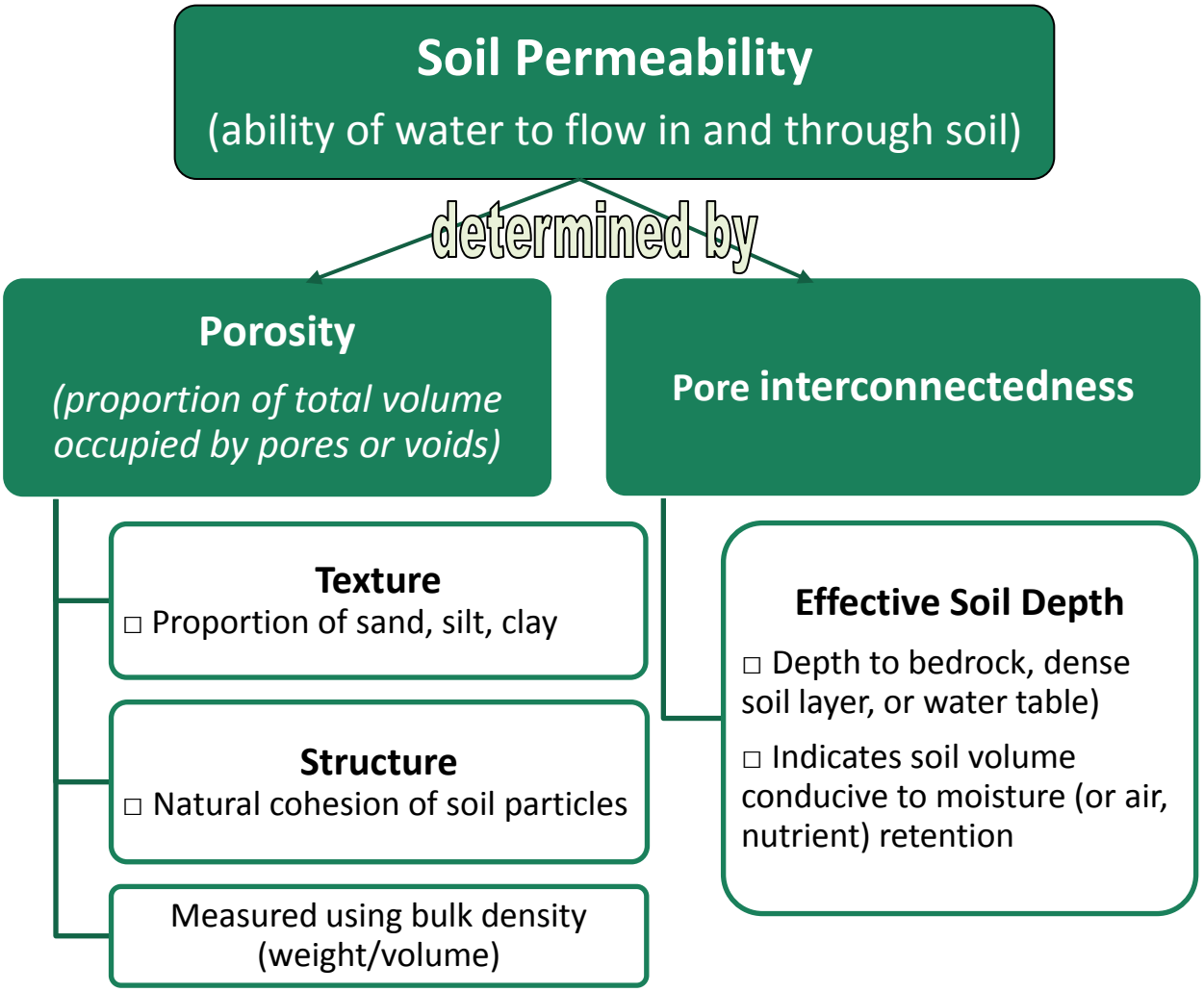
Summer lawn irrigation is calculated to use nearly 7,875 cubic feet per second (cfs) of water during the summer months. To put this amount of water consumption in perspective, it is roughly five times the *combined* summer flow of the Choptank, James, Monocacy, Pataspsco, Pamunkey, Patuxent and Rappahannock rivers in an average year

Our compacted lawns are roughly calculated to produce an extra storm runoff flow of 1,244 cfs *each day* to the Chesapeake Bay

I. CHANGES IN TOPOGRAPHY AND LAND COVER

Soil Compaction

Soil basics:



I. CHANGES IN TOPOGRAPHY AND LAND COVER

Soil Compaction

Putting it together:

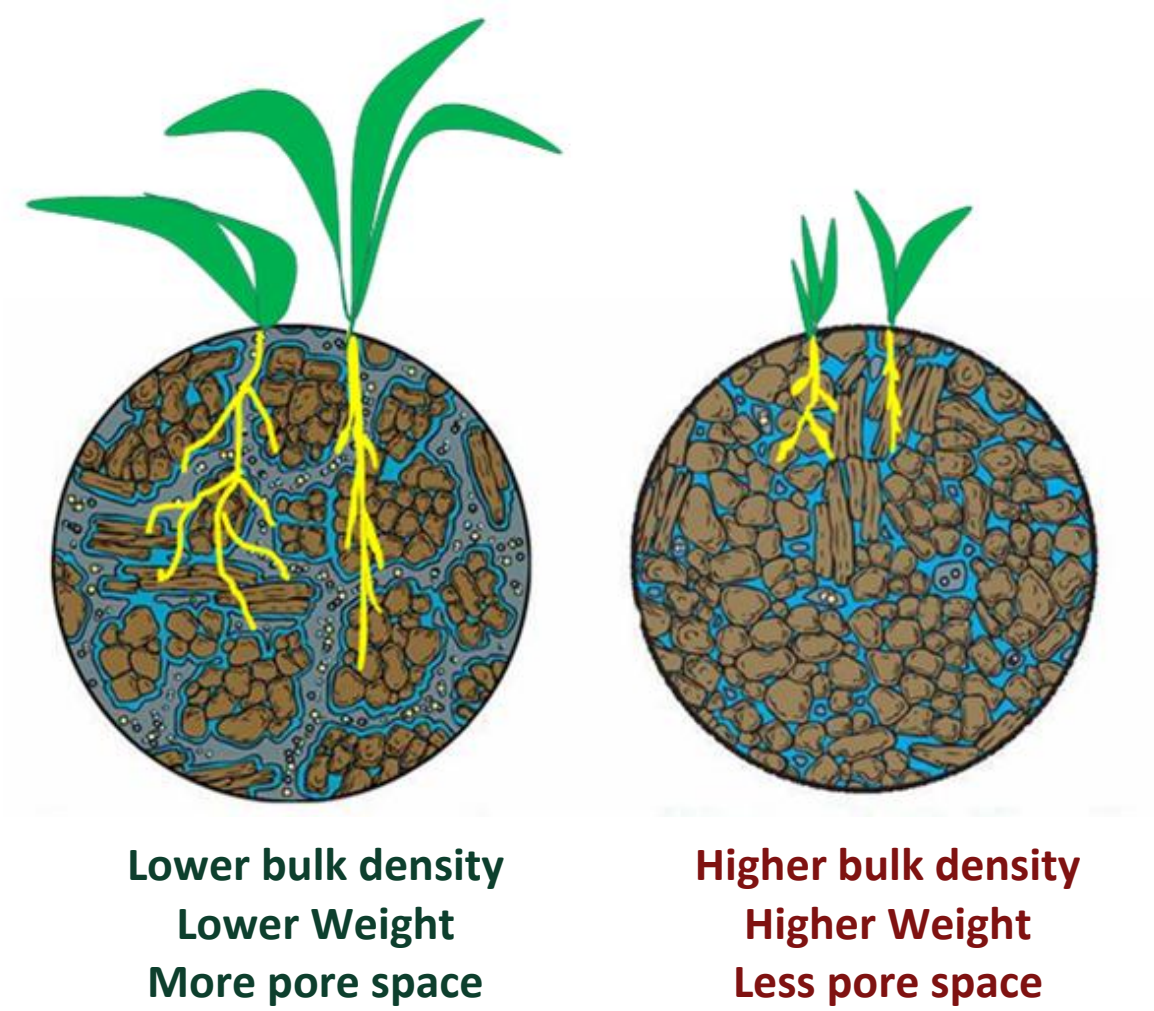


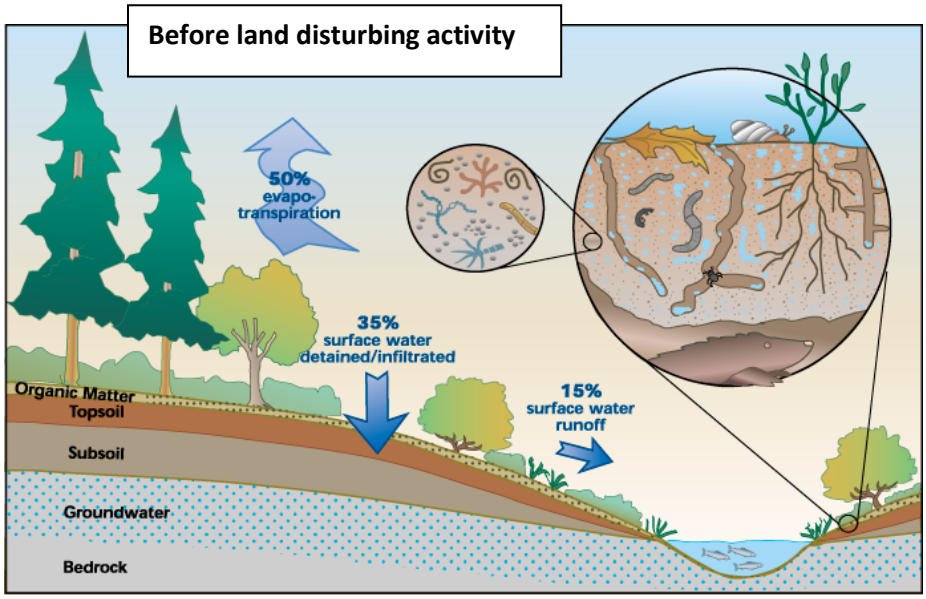
Figure 21. Adapted from international Society of Arboriculture, Bugwood.org

I. CHANGES IN TOPOGRAPHY AND LAND COVER

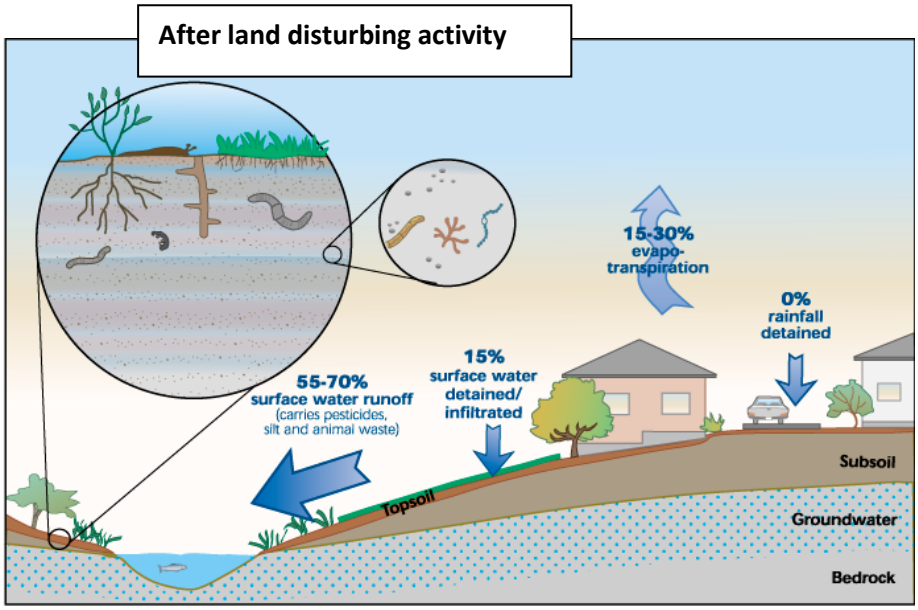
Soil Compaction

During land disturbing activities, soil is compacted and loses permeability; ***surface runoff increases***.

Figure 22. Soil Compaction in Urban Soils. (Source: http://chesapeakestormwater.net/wp-content/uploads/downloads/2012/01/SoilsforSalmonLIDrev9-16-04.pdf)



Thick topsoil, organic matter
Soil structure and texture intact
Good soil porosity (enhanced by biological channels – plant roots, soil organisms)
Soils permeable = very little surface runoff



Soil structure lost (compacted)
Thin topsoil (if any)
Organic matter often lost
Soil porosity and permeability decreases
More surface runoff

I. CHANGES IN TOPOGRAPHY AND LAND COVER

Soil Compaction

You should know:

Construction equipment can cause such profound soil compaction (topsoil and subsoil) that the soil's bulk density can approach that of concrete and as a result, come functionally impervious (**Figure 23**, **Figure 24** and **Table 2-2** below).

Figure 23. Construction soil compaction
(Source: Virginia Tech archived photos, http://clic.cses.vt.edu)

Figure 24. Compacted Soil
(Source: Center for Watershed Protection)

Table 2-2
Common Bulk Density Measurements

Land Surface/Use	Bulk Density
Undisturbed Lands Forest & Woodlands	1.03 g/cc
Residential Neighborhoods	1.69 to 1.97 g/cc
Golf Courses - Parks Athletic Fields	1.69 to 1.97 g/cc
Concrete	2.2 g/cc

I. CHANGES IN TOPOGRAPHY AND LAND COVER

Soil Compaction

Consider also:

Soils with the highest permeability (**Figure 25**, **Table 2-3**) are often considered most suitable for construction ***(and it is this characteristic that is typically reduced or eliminated by the construction process)***.

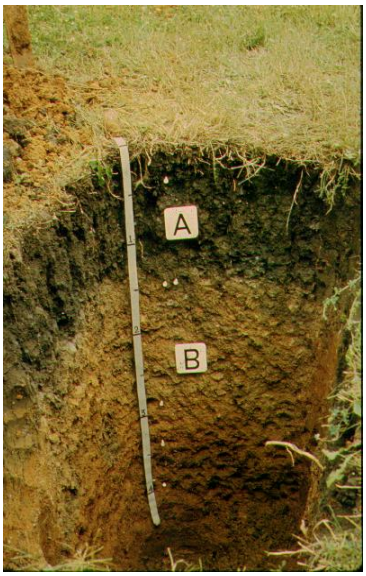


Figure 25. Soil horizons (Various soil properties are used to group soils into hydrologic soil groups, based on their ability to infiltrate and percolate water).

Table 2-3
USDA-NRCS Estimates of Annual Groundwater Recharge Rates, Based on Soil Type

Hydrologic Soil Group (HSG)	Recharge Rate
Hydrologic Soil Group A	18 inches/year
Hydrologic Soil Group B	12 inches/year
Hydrologic Soil Group C	6 inches/year
Hydrologic Soil Group D	3 inches/year

NOTE: Average annual rainfall varies from approximately 42 - 48 inches across Virginia

All of these factors have some effect on how water will move through the soil. It is important to understand these factors when designing an appropriate stormwater system at a particular location. These factors are especially critical when considering BMPs that rely on infiltration to remove runoff volume or pollutants.

I. CHANGES IN TOPOGRAPHY AND LAND COVER

Reduced Groundwater Recharge and Reduced Stream Base Flow

Eventually the groundwater table intersects the land surface and forms springs, and can provide baseflow to headwaters and wetlands (see **Figure 13** and **Figure 18** above).

- Perennial streams receive continuous baseflow from this groundwater discharge, during both wet and dry periods. Much of the time, all of the natural flow in a stream is from groundwater discharge.
- Groundwater discharge can be seen as the "life" of streams, supporting all water-dependent uses and aquatic habitat (**Figure 26**).
- During periods of wet weather, the water table may rise to near the ground surface in the vicinity of the stream.
- As a result, this area saturates quickly during rain events; surface runoff begins to flow to streams from the saturated areas surrounding streams.
- More stormwater runoff means less groundwater recharge (the hydrologic balance is altered)

Figure 26. Headwater stream
(Source: Chesapeake Bay Stormwater Training Partnership)

- Stream base flow is deprived of constant groundwater discharge, and the flow may diminish or even cease.
- Wetlands and headwaters reflect changes in groundwater levels most profoundly, and the reduced flow can stress or even eliminate the aquatic community.
- During a drought, reduced stream base flow may also significantly affect the water quality in a stream *(reduced dissolved oxygen → aquatic community stressed (fish, macroinvertebrates) + chemical reactions can release pollutants previously bound up in bottom sediments)*.

As the most hydrologically and biologically sensitive elements of the drainage network, headwaters and first order streams warrant special consideration and protection in stormwater management planning

I. CHANGES IN TOPOGRAPHY AND LAND COVER

Increased Imperviousness of the Land Surface

Impervious cover has emerged as a measurable, integrating concept used to describe the overall health or, conversely, degradation of a watershed.

- When impervious cover in a watershed reaches between 10 and 25 percent (**Figure 27**), ecological stress becomes apparent.
- Beyond 25 percent impervious cover, stream stability is reduced, habitat is lost, water quality is degraded, and biological diversity is diminished.

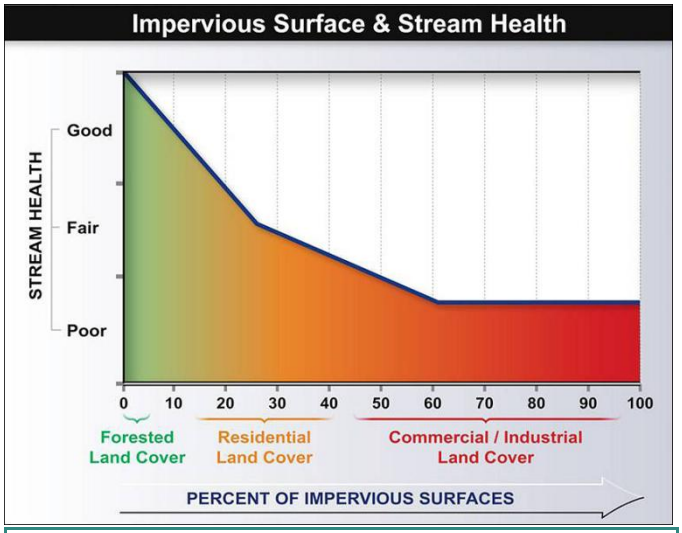


Figure 27. The Impervious Cover Model: How Imperviousness Impacts Stream Health. (Source: Chesapeake Bay Stormwater Training Partnership)

When considering specific land use imperviousness **(Table 2-4)**:

Table 2-4
Typical Site Impervious Coverage of Land Uses in the Northeast U.S.

Land Use	% Impervious Cover
Commercial and Business District	65-100
Industrial	70-80
High Density Residential	45-60
Medium Density Residential	35-45
Low Density Residential	20-40
Open (Natural Areas)	0-10

Source: MADEP, 1997; Kauffman and Brant, 2000; Arnold and Gibbons, 1996; Natural Resource Conservation Service, 1975

- Typical single-family home residential neighborhoods ranges from 15 to 60 percent.
- *Note: Table values reflect impervious within specific land uses, not overall watershed imperviousness.*
- In watersheds with significant residential, commercial, and industrial development, ***overall watershed imperviousness often exceeds ecological stress thresholds.***

II. STREAM CHANNEL AND FLOODPLAIN IMPACTS

The impacts of altered stormwater runoff characteristics *(greater volumes more often and at higher flow rates)* on stream channels and floodplains include the following:

- *Altered stream flow*
- *Channel* erosion, widening and downcutting
- *Increased frequency of bank-full and over-bank*
- *Floodplain expansion*

II. STREAM CHANNEL AND FLOODPLAIN IMPACTS

Altered Stream Flow

Annual and seasonal cycles of water flows – particularly the low and high flows – shape ecological processes in rivers and streams.

- Adequate minimum flow maintain suitable water conditions and habitat for fish and other aquatic life.
- High flows replenish floodplains and flush out accumulated stream sediment that can degrade habitat.
- Flows are altered by a variety of land- and water-management activities, including reservoirs, diversions, subsurface tile drains, groundwater withdrawals, wastewater inputs, and impervious surfaces, such as parking lots, sidewalks and roads.
- 42% of the U.S's wadeable stream segments were rated by the USEPA in 2006 as is in poor biological condition.

In wet climates, like that in Virginia, watershed management is typically focused on flood control, which can result in lower maximum flows and higher minimum flows.

Altered flow affects stream biota as much or more than pollution does.

Stream biota refers to the stream's combined flora and fauna

II. STREAM CHANNEL AND FLOODPLAIN IMPACTS

Channel Erosion, Widening, and Downcutting

There is undoubtedly a link between altered stream channels and land development:

- The natural shape, form and stability of stream channels are influenced by increases in runoff volume from each storm *(more frequent bank-full or nearly bank-full conditions)*.
- Downstream channels enlarge through widening and stream bank erosion in order to accommodate and convey increased runoff volumes and higher stream flows.
- Increased stormwater runoff volume can turn small meandering streams into highly eroded and deeply incised stream channels (**Figure 28**).
- Increased stormwater runoff undercuts and scours the lower parts of the streambank and causes steeper banks to slump and collapse during larger storms. Higher flow velocities further increase streambank erosion rates.

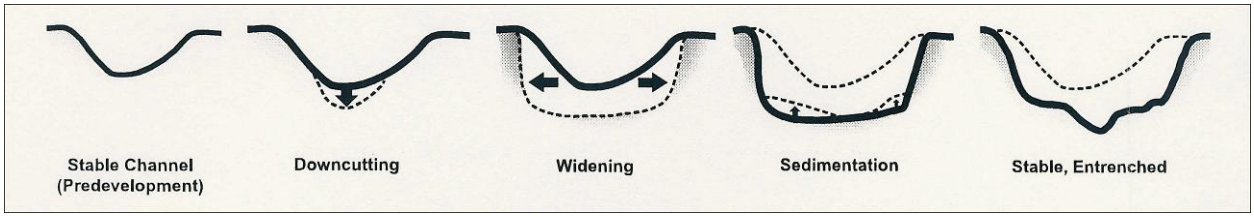


Figure 28. Typical Changes to a Stream's Physical Character Due to Watershed Development

- The majority of this stream channel devastation is intensified during the frequently occurring small-to-moderate rainfall events, rather than major flooding events.

II. STREAM CHANNEL AND FLOODPLAIN IMPACTS

Channel Erosion, Widening, and Downcutting

Rainfall events, or *storms*, are typified by their total rainfall, time span, and average and peak intensity. Storms are ranked in terms of the statistical frequency of their return interval (**Figure 29**). For example, a storm that has a 50% chance of occurring in any given year is termed a "2-year" storm (i.e., it is statistically likely to occur once every two years).

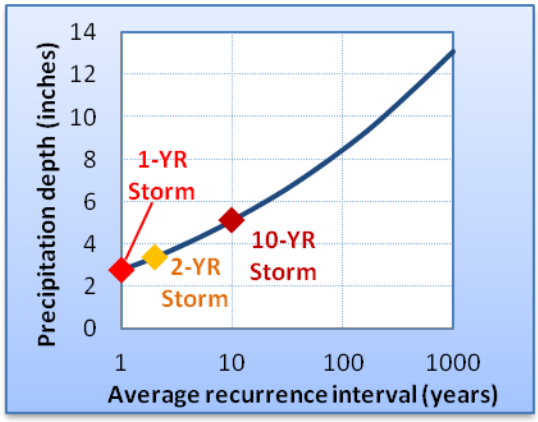


Figure 29. 24-Hr Storm Precipitation Frequencies for Richmond, VA

(Source: Data for this graph obtained using NOAA's National Weather Service, Precipitation Frequency Data Server, http://hdsc.nws.noaa.gov/hdsc/pfds/index.html)

- Traditionally, the 2-year storm was believed to represent the typical bankfull flow of a stream channel, because earlier research had indicated that most natural stream channels in the Commonwealth have just enough capacity to carry the 2-year flow without spilling out of the stream's banks.

- In Virginia, a 2-year storm produces from 2.5 to 5.2 inches of rain in a 24-hour period. The majority of the state experiences from 3.2 to 3.6 inches of rain from a two-year 24-hour storm. *This rainfall depth is called the 2-year design storm.*

- Stream channels in urban areas may be formed by flows as little as the 0.9-year storm, whereas channels in rural areas are typically formed by the 1.5-year to 1.7-year storm (i.e., a storm that is statistically likely to occur once every 18 to 21 months).

- In Virginia, a 1-year storm produces from approximately 1.9 to 3.2 inches of rain in a 24-hour period. However, the majority of the state experiences from 2.6 to 3.0 inches of rain from a 1-year 24-hour storm. *This rainfall depth is called the 1-year design storm.*

For regulatory purposes, most states including Virginia, have begun to establish the *1-year 24-hour storm* event as the average channel-forming storm.

II. STREAM CHANNEL AND FLOODPLAIN IMPACTS

Channel Erosion, Widening, and Downcutting

- In Virginia, a 10-year storm (10% chance of occurring in any given year) produces from approximately 3.5 to 8 inches of rain in a 24-hour period. However, the majority of the state experiences from 4.8 to 5.5 inches of rain from a 10-year 24-hour storm.
- Considering the implications of changing precipitation patterns, as discussed above, it is paramount to update applicable I-D-F curves in order to better assure stormwater management facilities will be able to accommodate more intense precipitation.

Under traditional engineering practice, most channels and storm drains in Virginia are designed with enough capacity to safely pass the peak discharge from a *10-year design storm*.

Additional Resources:

For a network of precipitation gauge data, visit the National Climatic Data Center online at http://www.ncdc.noaa.gov/oa/ncdc.html or the Cooperative Weather Observer Program at http://www.nws.noaa.gov/om/coop/. Additionally, the National Weather Service offers a service that estimates the return period for a range of depth-duration events. It can be found at http://www.nws.noaa.gov/om/coop/.

II. STREAM CHANNEL AND FLOODPLAIN IMPACTS

Channel Erosion, Widening, and Downcutting

The shape of a stream channel (i.e., its width, depth, slope, and how it moves through the landscape) is influenced by the amount of flow the stream channel is *expected* to carry (**Figure 30**).

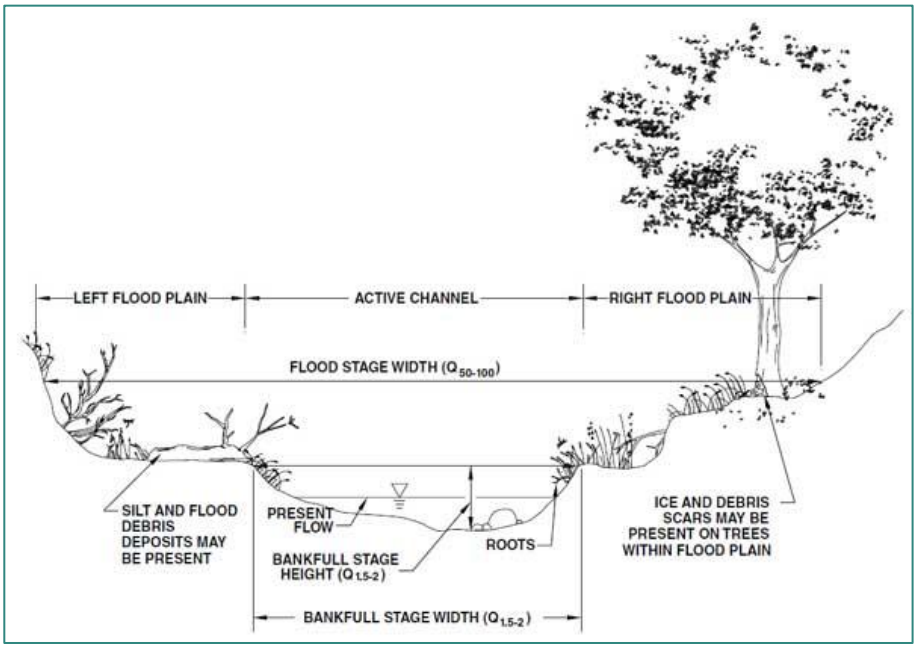


Figure 30. Schematic showing water level stages.
(Source: US Dept. of Agriculture, US Forest Service, http://www.fs.fed.us/eng/pubs/htmlpubs/htm10232808/page03.htm)

- The stream channel's physical shape and character (morphology) is determined by the energy of typical stream flows ranging from "low flow" to "bankfull".
- During bankfull flows, the speed (velocity) of the water flow is typically at its maximum.
- If these high-velocity flows last long enough or occur often enough, they can generate enough energy to scour soil from streambanks and transport sediment and rocks from the stream bottom.
- During larger flood events, the flow overtops the stream banks and flows into the floodplain.

II. STREAM CHANNEL AND FLOODPLAIN IMPACTS

Channel Erosion, Widening, and Downcutting

- As the flow spreads out, velocity is reduced, resulting in much less impact on the shape of the stream channel itself.

- In a developing watershed, bankfull flows occur more often. *(Remember: Increases in stormwater runoff volume and flow rate during small storm events change the shape of the stream channel as it transforms to accommodate greater flows.)*

- ***Greater flows occurring more often and for longer periods of time will erode the stream banks and/or cut down the channel bottom, configuring the stream channel geometry for these larger flows.***

- A stream can become many times wider than its original size due to post-development runoff (**Figure 31. Stream Channel Widening**).

Figure 31. Stream Channel Widening
(Source: Center for Watershed Protection)

- As streambanks are gradually undercut and slump into the channel, trees that had protected the banks are exposed at the roots, making them more likely to be uprooted during major storms, further weakening bank structure.

II. STREAM CHANNEL AND FLOODPLAIN IMPACTS

Channel Erosion, Widening, and Downcutting

Another way that streams accommodate higher flows is by downcutting the streambed (**Figure 32**). This causes instability in the stream profile, or elevation along a stream's flow path, which increases velocity and triggers further channel erosion both upstream and downstream.

- Shoreline and bank erosion diminish property values. In fact, many urban governments find themselves engineering degraded stream channels, straightening them and lining them with concrete, in order to prevent further erosion and speed the stormwater through their jurisdiction.

Stormwater regulations have attempted to assure that runoff from development sites should not exceed the capacity of the receiving stream channel.

Figure 32. Stream Channel Downcutting
(Source: ARC, 2001)

- This transfers the damage into another part of the stream wherever the concrete channel ends, and the higher-volume, higher-velocity flows are released.

- Traditionally, stormwater managers have used detention basins to capture (detain) excess stormwater runoff and slowly release it over a period of days into the receiving stream channel. However, the release rate of flow from the basin typically mimics the bankfull flow.

II. STREAM CHANNEL AND FLOODPLAIN IMPACTS

Channel Erosion, Widening, and Downcutting

- In Virginia, previously the 2-year 24-hour design storm, *(originally considered to be the bankfull storm)* was used to regulate post development runoff to natural streams.
- Damage and negative impacts to streams and channels have still been observed.
- The problem is that, unlike a normal "flashy" rainstorm, after which runoff flow recedes rather quickly, the outflow from a detention basin often exposes the channel to a longer *duration* of erosive flows than it would have otherwise received. Thus, in order to prevent flooding, the stream bed and banks stay wet and subject to high-velocity flows for a longer period of time, which makes them more susceptible to erosion. Channel deterioration is often most pronounced downstream of detention basins or where similar stormwater management practices are placed as a result of land development.
- These physical changes, in turn, degrade stream habitat and produce substantial increases in sediment loads resulting from accelerated channel erosion. The typical stream bed structure of pools, riffles and meanders disappears. Sediments are deposited in the stream as sandbars and other features, covering the channel bed, or substrate.

II. STREAM CHANNEL AND FLOODPLAIN IMPACTS

Floodplain Expansion

Floodplains (the land area bordering streams that would be flooded during a 100-year storm, see **Figure 30** above) are very important habitat areas, encompassing riparian forests, wetlands, and wildlife corridors.

- Floodplains are natural storage areas that help to attenuate downstream flooding.
- In most of Virginia, a 100-year storm results in approximately 8 to 9 inches of rainfall in a 24-hour period. Floods of this scale can be very destructive and can pose a threat to human life.

Remember, the 100-year storm has a 1% chance of occurring in any given year.

All local jurisdictions in Virginia restrict or even prohibit new development within the 100-year floodplain, to prevent flood hazards and conserve habitats. *(Prior development in floodplains remain subject to periodic flooding)*

- Development sharply increases the peak discharge rate associated with the 100-year design storm.
- The elevation of a stream's 100-year flood crest and floodplain have become higher and the boundaries of floodplains have expanded laterally (see **Figure 33** below).
- This problem is compounded by building and filling in floodplain areas, which cause flood heights to rise even further. In some instances, property and structures that had not previously been subject to flooding become at risk.
- Additionally, such a shift in a floodplain's hydrology can degrade wetlands and forest habitats.

II. STREAM CHANNEL AND FLOODPLAIN IMPACTS

Floodplain Expansion

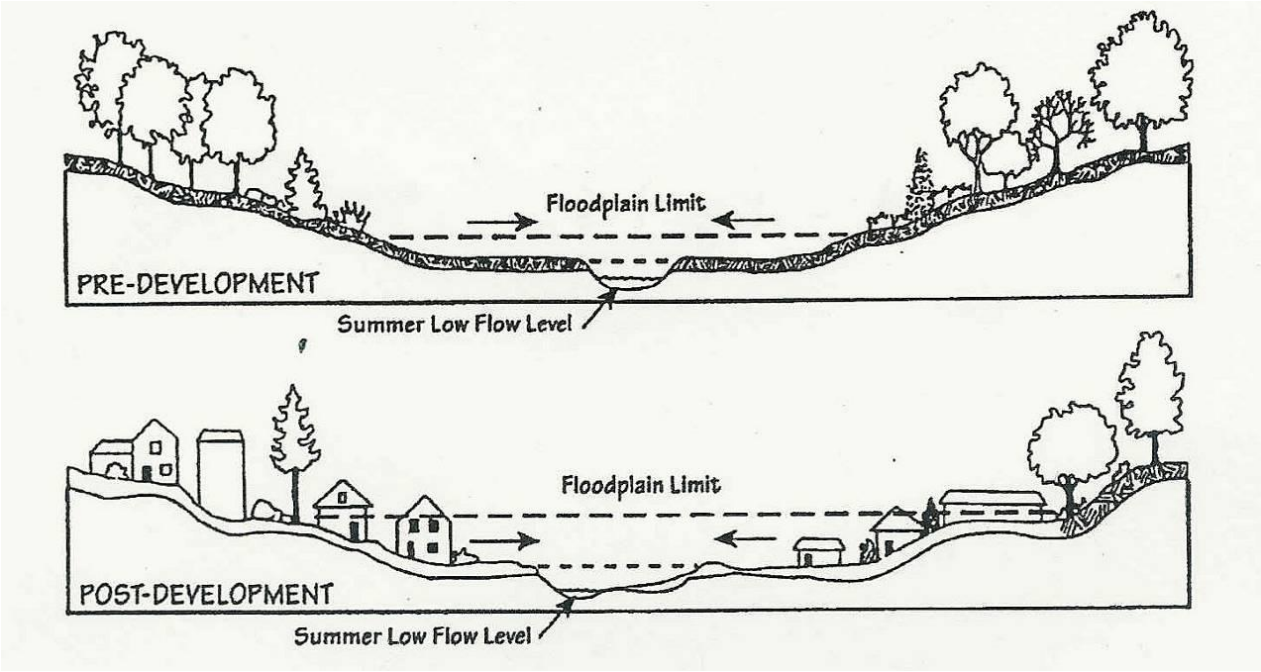


Figure 33. Response of Stream Geometry to Land Development

III. HABITAT AND ECOLOGICAL IMPACTS

As the shape of the stream channel changes to accommodate more runoff, aquatic habitat is often lost or altered, and aquatic species decline. Destruction of freshwater wetlands, riparian buffers, and springs often occurs as a result of land development.

Degradation of Habitat Structure

- Effects occur at many levels in the aquatic community.
- Higher and faster flows due to development can scour channels and wash away entire biological communities.
- Sediment from runoff and eroding stream banks deposit along stream bottoms, burying the substrate material of stream beds (the habitat for many benthic organisms)
- The amount and types of microorganisms that live along the stream bottom decline.

Loss of Pool-Riffle Structure

- Meandering streams draining undeveloped watersheds often contain pools of deeper, more slowly flowing water that alternate with "riffles" or shoals of shallower, faster flowing water.
- These pools and riffles provide valuable habitat for fish and aquatic insects.
- Increased flows and sediment loads from urban watersheds lead to elimination of these pools and riffles and replacement with wider, more uniform streambeds that provide less varied aquatic habitat.
- Much larger channels have lower and shallower flows. The result is a decline in diversity and abundance of fish and aquatic insects and changes in which species tolerate the new conditions.

Reduced Baseflows

As noted earlier, reduced baseflows – due to increased impervious cover in a watershed and the loss of rainfall infiltration into the soil and water table – adversely affect in-stream habitats, especially during periods of drought.

III. HABITAT AND ECOLOGICAL IMPACTS

Increased Stream Temperature

- Runoff from warm impervious areas, storage in impoundments, loss of shading as riparian trees and shrubs topple or are removed, and shallower channels can all cause an increase in the water temperature in urban streams.
- Increased temperatures can reduce dissolved oxygen levels and disrupt the food chain.
- Certain aquatic species can only survive within a narrow temperature range.
- Thermal problems are especially critical for many Piedmont streams which straddle the borderline between cold water and warm water stream conditions.

Shift in Aquatic Food Sources

A shift takes place from external food sources (leaf matter) for the aquatic species to internal stream production (algal organic matter). This also results in diminished biomass.

Decline in Abundance, Richness and Biodiversity of the Stream Community (aquatic insects, fish, amphibians, etc.)

- Just as weeds can invade and overwhelm preferable vegetation when conditions provide the opportunity, less desirable species begin to replace desirable species in degraded streams when there is a reduction in various habitats and habitat quality.
- Both the number and the variety (diversity) of organisms (wetland plants, fish, macroinvertebrates, etc.) are reduced.
- Sensitive fish species and other life forms disappear and are replaced by those organisms that are better adapted to the poorer conditions.
- For example, in streams with severely diminished flow, native trout, a popular sport fish that requires cold, fast-flowing streams with gravel bottoms, are replaced by less desirable non-native species, such as carp.
- The diversity and composition of the benthic, or streambed, community have frequently been used to evaluate the quality of urban streams.

III. HABITAT AND ECOLOGICAL IMPACTS

Water Quality Impacts on Aquatic Species

Fish and other aquatic organisms are impacted not only by the habitat changes brought on by increased stormwater runoff quantity, but are often also adversely affected by water quality changes due to development and resultant land use activities in a watershed (**Figure 34** and **Figure 35**). These impacts are discussed more specifically in the next section of this module.

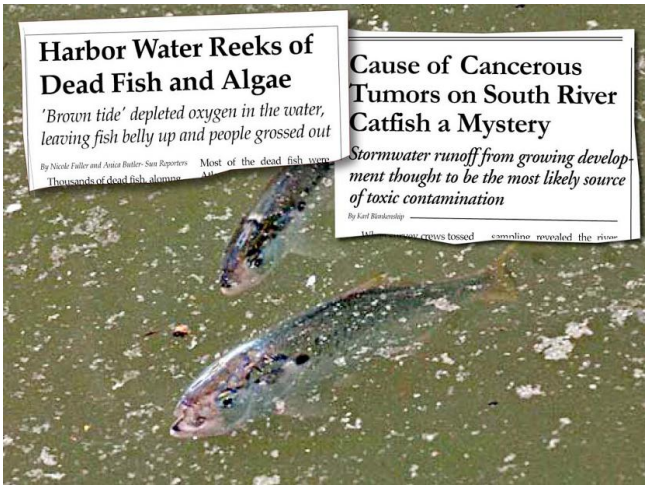


Figure 34. Fish Kills.
Source: Chesapeake Bay NEMO Program

IV. WATER QUALITY IMPACTS

Point and nonpoint source water pollution from pipes, streets, rooftops, and parking lots swell downstream waterways every time it rains. Since the natural vegetation and soils that could absorb it have been paved over, stormwater becomes a high-speed, high-volume conduit for pollution into streams, rivers, lakes and coastal waters (**Figure 35** below).

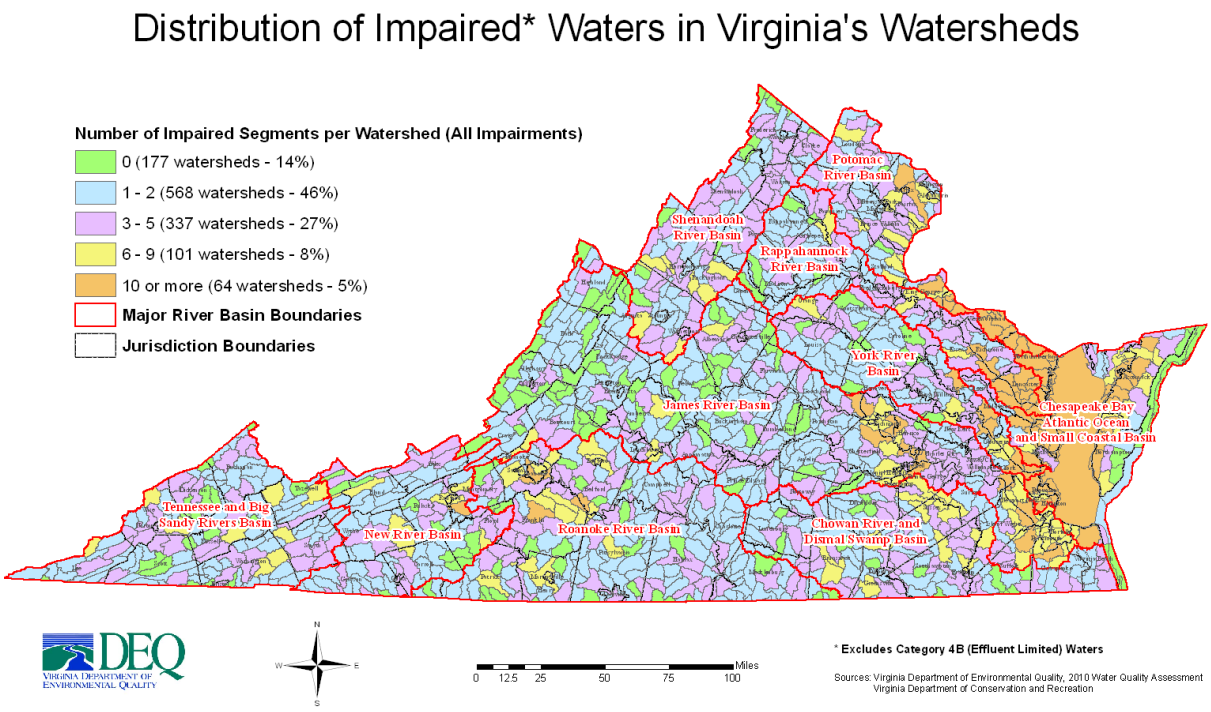


Figure 35. Impaired Waters in Virginia
(Source: Virginia DEQ, 2010)

- Urban stormwater runoff can be considered both a point source and a nonpoint source of pollution. Stormwater runoff that flows into a conveyance system and is discharged through a pipe, ditch, channel, or other structure is considered a *point source* because it discharges from a discrete location (point on a map).

- Stormwater runoff that flows across the land surface and is not concentrated in a defined channel or pipe is considered *nonpoint source (NPS)* pollution, which is the primary cause of polluted stormwater runoff and water quality impairment.

- NPS pollution comes from many diffuse or scattered sources, many of which are the result of human activities within a watershed.

IV. WATER QUALITY IMPACTS

- Development concentrates and increases the amount of these nonpoint source pollutants.
- As stormwater runoff moves across the land surface, it picks up and carries away both natural and human-made pollutants, depositing them into Virginia's streams, rivers, lakes, wetlands, coastal waters and marshes, and underground aquifers.
- Both point and nonpoint sources of urban stormwater runoff have been shown to be significant causes of water quality impairment to rivers and streams. Urban runoff is also reported as a contributor to excessive nutrient enrichment in numerous lakes and ponds throughout the state, as well as a continued threat to estuarine waters and the Chesapeake Bay.
- The USEPA has ranked stormwater runoff as the second most prevalent source of water quality impairment in the nation's estuaries (agriculture is currently ranked as number one).

IV. WATER QUALITY IMPACTS

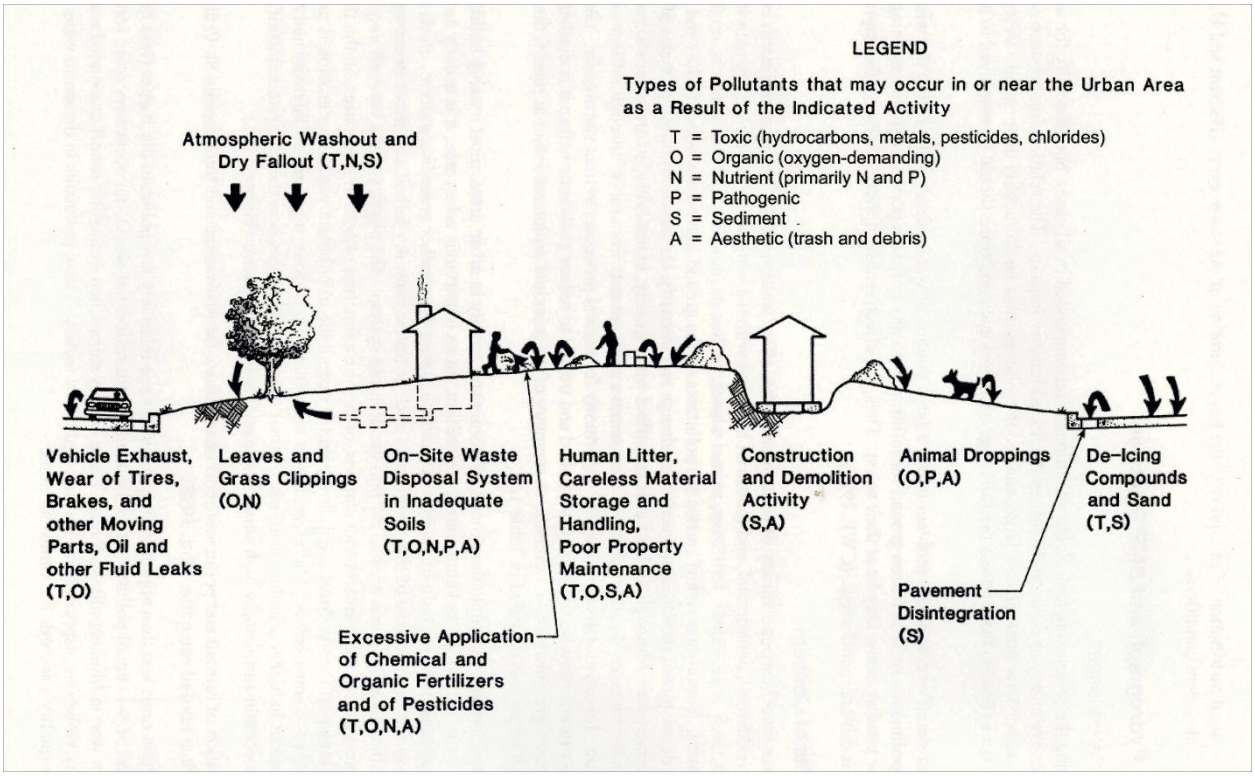


Figure 36. Availability of Potential Pollutants on the Land Surface
(Source: Walesh, 1989)

What are some of the sources?

- Combined sewer overflows (CSOs). Cities with older sewer infrastructure (Richmond, Lynchburg) have sewer pipes that are also open to stormwater flow. Some storms cause excessive flows to the wastewater treatment plants which exceed holding and treatment capacity. The result is the discharge of untreated human, commercial, and industrial wastewaters into our waterways.
- Most Virginia cities have separate stormwater sewer systems through which stormwater discharges directly into waterways. These storm flows often cause streambank erosion and carry pollutants directly into waterways.
- Stormwater can also carry sewage leaching from failing septic drainfields to waterways.

IV. WATER QUALITY IMPACTS

- Erosion from construction sites and other disturbed areas (**Figure 37** below) can potentially contribute large amounts of sediment to streams.
- Increased impervious surfaces that replace natural land cover become a surface depository for pollutants from human activities. During storm events, these pollutants are washed off and transported to streams.
- There are a number of other causes of NPS pollution in urban areas that are not specifically related to wet weather events, including leaking sewer pipes, sanitary sewage spills, fluid leaks from vehicles, residue from tire wear, and illicit discharge of commercial/industrial wastewater and wash waters to storm drains.

Figure 37. Construction Site Erosion
Source: Chesapeake Bay Stormwater Training Partnership

IV. WATER QUALITY IMPACTS

How does development contribute to pollutant load?

- Structural stormwater collection and conveyance systems allow stormwater pollutants to quickly wash off and concentrate during rainfall or snowmelt events and discharge to downstream receiving waters. By contrast, in undeveloped areas, natural processes such as infiltration, interception, depression storage, filtration by vegetation, and evaporation can reduce the quantity of stormwater runoff and remove pollutants. Impervious areas decrease the natural stormwater purification functions of watersheds and increase the potential for water quality impacts in receiving waters.

- Many areas assumed to be pervious, such as lawns and landscaped areas, also add significantly to the pollutant load, especially where these pervious areas drain to impervious surfaces and storm sewers.

- As noted above, compacted soils at many land development sites result in vegetated surfaces that are, in many instances, nearly impervious and produce far more runoff than the natural (pre-development) soil did. These new lawn surfaces are often loaded with fertilizers that result in polluted runoff that degrades receiving streams, ponds, and lakes.

- Urban land uses and activities can also degrade groundwater quality if stormwater with high pollutant loads is directed into the soil without adequate treatment.

- Certain land uses and activities, referred to as stormwater "hotspots" (e.g., commercial parking lots, vehicle service and maintenance facilities, fuel stations, etc.), are known to produce higher loads of pollutants such as trace metals, petroleum hydrocarbons and toxic chemicals (**Figure 38**).

Figure 38. Fueling Stations Can Be Stormwater Hotspots
Source: Chesapeake Bay Stormwater Training Partnership

IV. WATER QUALITY IMPACTS

- Soluble pollutants from hotspot sites can migrate into groundwater and potentially contaminate wells in groundwater supply areas (aquifers). The potential for groundwater pollution from stormwater is even greater in regions of karst geologic formations, where seams and channels dissolved in the limestone base material can quickly transport pollutants into perched groundwater and deeper aquifers.
- The actual transport process of stormwater pollution is more complex than just the "first flush" would indicate (first flush typically considered the first 1/2-inch of runoff from impervious surfaces during the first half-hour of a storm).
- Capturing the first flush pollutant load was the focus of earlier quality control criteria In Virginia's stormwater management regulations.
- In areas with high impervious cover, the first flush can make up as little as **20%** of the annual runoff pollution load.
- Rainfall volumes of 1-inch or more must be treated to capture the majority of the load.
- Capturing the first flush only does not necessarily ensure effective treatment of the majority of pollution in runoff.

Due to the magnitude of the problem, it is important to understand the nature and sources of urban stormwater pollution.

IV. WATER QUALITY IMPACTS

What are some of the pollutants of concern?

Solids, suspended solids, particulates:

- Solids suspended in the water column make the water cloudy or turbid and impact submerged aquatic vegetation (SAV), fish habitat, overwhelm suspension feeding shellfish, and settled solids can suffocate bottom-dwelling (benthic) organisms.
- Sediment deposition in water bodies can reduce the capacities of reservoirs, lakes, and streams.

Figure 39. A Sediment Plume Entering a River
Source: ARC (2001)

- Oils, grease, gasoline and antifreeze are also carried by sediments into water bodies.
- Particulates (soil, sediment) can carry pollutants such as nutrients, metals, pathogens, and hydrocarbons (oils, grease).
- Organic substances such as grass clippings, leaves, animal waste, street litter commonly found in stormwater are oxygen demanding when they end up in streams and can lead to depleted dissolved oxygen levels, impairments, and even fish kills.

IV. WATER QUALITY IMPACTS

Excess Nutrients

- Nutrients are a major source of degradation in many of Virginia's water bodies.
- Urban runoff has been defined as a key and controllable source of nutrients by the USEPA Chesapeake Bay Program.
- Urban stormwater runoff typically contains elevated concentrations of nitrogen and phosphorus compounds that are most commonly derived from lawn fertilizer, detergents, animal waste, atmospheric deposition, organic matter, sewer overflows and leaks, and improperly installed or failing septic systems.
- Elevated nutrient concentrations in stormwater runoff can stimulate excessive growth of vegetation or algae in streams, lakes, reservoirs, and estuaries (**Figure 40** below), a process known as accelerated eutrophication.
- This abundance of plant growth (algae) are decomposed by organisms that simultaneously use up of a waterbody's dissolved oxygen during this part of the process and lead to inhabitable conditions for most existing aquatic organisms.
- Phosphorus is typically the growth limiting nutrient in freshwater systems, while nitrogen is growth limiting in marine systems.
- Without added phosphorus from human activities, phosphorus is normally contained in a closed loop from plants, to animals that eat them, to decomposers like fungi, into the soil and back to the plants again. Very little, if any, is released to waterways compared to the kind of phosphorus discharges that currently occur from developed areas.

IV. WATER QUALITY IMPACTS

Figure 40. Algae Bloom in the James River
Source: Richmond Times-Dispatch

Pathogens

- Pathogens such as bacteria, viruses, and other microbes that can cause disease in humans, in urban runoff routinely exceed public health standards for water contact recreation and shellfish harvesting.
- Sources of pathogens in stormwater runoff include animal waste from pets, wildlife, and waterfowl; combined sewer overflows; failing septic systems; and illegal sanitary sewer cross-connections.
- High levels of indicator bacteria in stormwater have commonly led to the closure of beaches and shellfish beds along coastal areas of Virginia.

Trace Metals

- Metals such as copper, lead, zinc, mercury, aluminum, chromium, nickel and cadmium are commonly found in urban stormwater runoff from industrial and commercial sites, including marinas, urban surfaces such as rooftops and painted areas, etc.

IV. WATER QUALITY IMPACTS

- Antifreeze from automobiles is a source of phosphates, chromium, copper, nickel, and cadmium.
- Building roofs, gutters, downspouts can be sources of copper and zinc stormwater runoff.

Other pollutants/water quality impairments:

- Pesticides/Synthetic Organic Chemicals
- Chlorides/Deicing Constituents
- Trash and Debris
- Thermal Impacts
- Freshwater Impacts into brackish/tidal areas

Table 2-5 below lists the main pollutants found in urban stormwater runoff, typical pollutant sources, related impacts to receiving waters, and factors that promote pollutant removal. The Table also identifies the pollutants that commonly occur in dissolved or soluble form, which has important implications for the selection and design of stormwater treatment practices.

Concentrations of pollutants in stormwater runoff vary considerably between sites and storm events.

IV. WATER QUALITY IMPACTS

Consider the following facts:

The annual biomass generated by lawn clippings is equivalent to 272 million bushels of corn (over 6.8 million tons - fill over 17,400 standard corn silos).

An estimated $600 million annually is spent on lawn fertilizer and pesticides across the Bay watershed

The best estimate of nitrogen fertilizer applied to lawns in the Bay watershed is nearly 215 million pounds per year – enough to grow nearly 2 million acres of corn

About 19 million pounds of pesticide active ingredients are used each year (mostly herbicides to kill weeds). These pesticides are reaching local streams and rivers. According to USGS monitoring data, one or more pesticides were detected in 99% of urban streams, and one out of every five samples exceeded water quality standards, endangering aquatic life

IV. WATER QUALITY IMPACTS

Table 2-5
Summary of Urban Stormwater Pollutants

Stormwater Pollutant	Potential Sources	Receiving Water Impacts	Removal Promoted by[1]
Excess Nutrients Nitrate, Nitrite, Ammonia, Organic Nitrogen, Phosphate, Total Phosphorus	Animal waste, fertilizers, failing septic systems, landfills, atmospheric deposition, erosion and sedimentation, illicit sanitary connections	Algal growth, nuisance plants, ammonia and nitrate toxicity, reduced clarity, oxygen deficit (hypoxia), pollutant recycling from sediments, decrease in submerged aquatic vegetation (SAV), eutrophication, loss of recreation and aesthetic value	***Phosphorus:*** Filtering/settling sediment, high soil exchangeable aluminum and/or iron content, vegetation and aquatic plants, alum in pond ***Nitrogen:*** Aeration, alternating aerobic and anaerobic conditions, maintaining near neutral pH (7)
Sediments Suspended, dissolved, sorbed pollutants, turbidity	Construction sites, stream bank erosion, washoff from impervious surfaces	Increased turbidity, lower dissolved oxygen, deposition of sediments, aquatic habitat alteration, sediment and benthic toxicity, contaminant transport, filling of lakes and reservoirs, loss of recreation and aesthetic value	Low turbulence, increased residence time
Pathogens Total and Fecal Coliforms, Fecal Streptococci, Viruses, E. Coli, Enterocci	Animal waste, failing septic systems, illicit sanitary connections	Human health risk via drinking water supplies, contaminated swimming beaches, and contaminated shellfish consumption	High light (ultraviolet radiation), increased residence time, media/soil filtration, disinfection
Organic Materials Vegetation, sewage, other oxygen	leaves, grass clippings, brush, failing septic systems	Dissolved oxygen depletion, odors, fish kills, algal growth, reduced clarity	Aerobic conditions, high light (ultraviolet radiation), high soil organic content,

IV. WATER QUALITY IMPACTS

Table 2-5
Summary of Urban Stormwater Pollutants

Stormwater Pollutant	Potential Sources	Receiving Water Impacts	Removal Promoted by[1]
demanding materials (BOD/COD)			maintaining near neutral pH
Hydrocarbons Oil and grease	Industrial processes, commercial processes, automobile wear, emissions, and fluid leaks, improper oil disposal	Toxicity of water column and sediments, bioaccumulation in food chain organisms	Low turbulence, increased residence time, physical separation or capture technique, volatilization
Metals Copper, lead, zinc, mercury, cadmium, chromium, nickel, aluminum (soluble)	Industrial processes, normal wear of automobile brake linings and tires, automobile emissions and fluid leaks, metal roofs and pipes	Toxicity of water column and sediments, bioaccumulation in food chain organisms	High soil organic content, high soil cation exchange capacity, maintaining near neutral pH (7), controlling sludge applications
Synthetic Organic Chemicals Pesticides, VOCs, SVOCs, PCBs, PAHs (soluble)	Residential, commercial, and industrial application of herbicides, insecticides, fungicides, rodenticides, industrial processes, commercial processes	Toxicity of water column and sediments, bioaccumulation in food chain organisms	Aerobic conditions, high light (ultraviolet radiation), high soil organic content, low levels of toxicants, near neutral pH (7), high temp. and air movement for volatilization of VOCs
Deicing Constituents Sodium chloride, calcium chloride, potassium chloride, ethylene glycol,	Road salting and uncovered salt storage, snowmelt runoff from snow piles in parking lots and along roads during the spring	Toxicity of water column and sediments, contamination of drinking water, harmful to salt-intolerant plants;	Aerobic conditions, high light (ultraviolet radiation), high soil organic content, low levels of toxicants, near neutral pH (7)

IV. WATER QUALITY IMPACTS

Table 2-5

Summary of Urban Stormwater Pollutants

Stormwater Pollutant	Potential Sources	Receiving Water Impacts	Removal Promoted by[1]
other pollutants (soluble)	snowmelt season or during winter rain and snow events	concentrated loadings of other pollutants as a result of snowmelt	
Trash and Debris	Litter washed through the storm drain networks	Degradation of aesthetics, threat to wildlife, potential clogging of storm drainage	Low turbulence, physical straining/capture
Thermal Impacts	Runoff with elevated temperatures from contact with impervious surfaces (asphalt)	Dissolved oxygen depletion, adverse impacts to aquatic organisms that require cold and cool water conditions	Use of wetland plants and trees for shading, increased pool depths
Freshwater Impacts to Saltwater	Stormwater discharges to tidal wetlands and estuarine environments	Dilution of the high marsh salinity and encouragement of the invasion of brackish or upland wetland species, such as Phragmites	Stormwater retention and volume reductions

[1] Factors that promote removal of most stormwater pollutants include: (1) Increasing hydraulic residence time;
(2) Low turbulence; (3) Fine, dense, herbaceous plants; and (4) Medium-fine textured soil

Source: Adapted from Connecticutt DEP, 1995, Metropolitan Council, 2001; Watershed Management Institute, Inc., 1997

V. IMPACTS ON OTHER RECEIVING ENVIRONMENTS

Ecological impacts of urbanization and stormwater runoff are not just focused on streams:

Development alters the physical, geochemical, and biological characteristics of aquatic systems creating impacts that destroy natural environments and public beneficial uses.

Wetlands

- Pollutant sink (nutrients, metals, sediments are not quickly flushed out)
- Accelerated eutrophication
- Sediment deposition and turbidity impact biota
- Loss of habitat and particular biota
- Scour and erosion lead to permanent loss of wetlands

Lakes and Ponds

- Pollutant sink (nutrients, metals, sediments are not quickly flushed out)
- Accelerated eutrophication
- Sediment deposition and turbidity impact biota
- Aesthetic impairment (trash, debris)

Estuaries

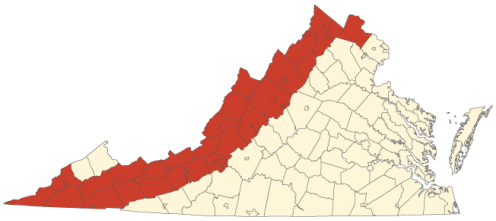
- Pulses of runoff and reduced base flow
- Pollutant sink due to trapping nature of tidal flows
- Variations in salinity change create intolerable conditions for many estuarine species
- Sediment deposition and turbidity impact biota
- Accelerated eutrophication

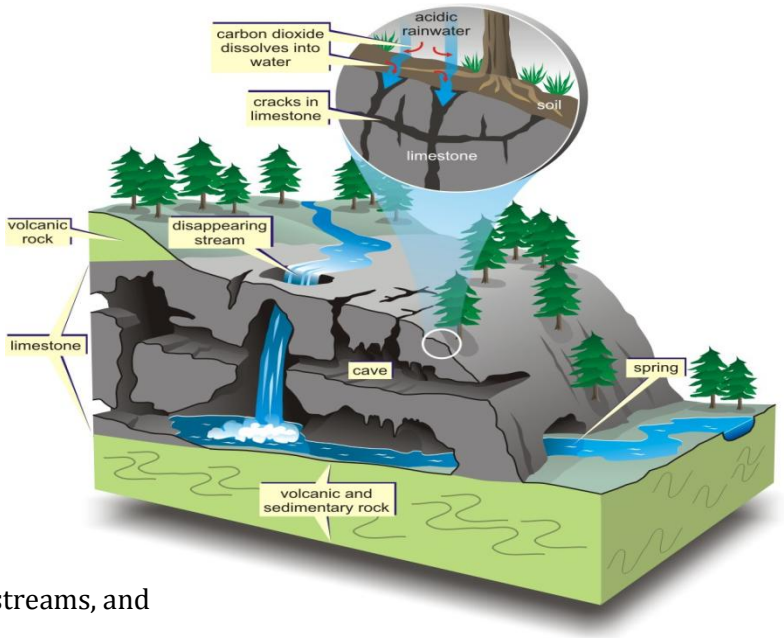
Karst Systems

- Erosion and underground sediment deposition
- Decreased recharge of aquifers
- Transport of pollutants directly to groundwater
- More sinkholes

V. IMPACTS ON OTHER RECEIVING ENVIRONMENTS

Karst areas:





The valleys of western Virginia are underlain largely by soluble bedrock (limestone and dolomite), which slowly dissolved over the millennia to form karst areas with unique hydrologic systems (fissures, sinkholes, underground streams, and caverns). These areas supply drinking water and support base flow of local streams.

The effects of poor stormwater management are exacerbated in this setting:

- Karst terrain soils are not very permeable
- Rainwater is diverted underground through fractured bedrock or other karst features to aquifers and springs without the usual natural attenuation (natural ground filtration) process that accompanies groundwater flow (leads to increased contamination of groundwater and base stream water)
- After development, increased surface runoff is typically routed overland to surface streams or discharged to karst features which lack sufficient capacity
- Increased stormwater ponding or infiltration form sinkholes (surface sediments collapse due to the intrusion of stormwater runoff)
- More runoff deprives the karst system of recharge (groundwater table and base stream flows diminished)

Additional Resources:

http://chesapeakestormwater.net/training-library/design-adaptations/stormwater-in-karst-topography/

Knowledge Check

4. Traditionally, Virginia has used what design storm for discharges into a natural channel or stream?

   A. 2 Year / 24 hour

   B. 2 Year / 12 hour

   C. 10 Year / 24 hour

   D. 10 year / 12 hour

5. True or False? When stormwater runoff is allowed to drain away instead of being used to recharge the groundwater it alters the hydrologic balance of a watershed.

   A. True

   B. False

6. Nationwide, significant flow alterations have occurred in what proportion of assessed waters?

   A. 50%

   B. 60%

   C. 75%

   D. 90%

7. Ecological stress becomes apparent when impervious cover in a watershed reaches between:

   A. 40-50%

   B. 30-40%

   C. 20-30 acres

   D. 10-25%

8. Increased peak discharges for a developed watershed can be how many times higher than an undisturbed watershed?

2g. Social and Economic Impacts of Unmanaged Stormwater

The effects of unmanged stormwater runoff due to land development are not only environmental, but also have very real social and economic impacts on Virginia's communities. These include the following, some of which have been mentioned above:

- ***Endangerment of human life from floodwaters***.
    - The hydrologic changes in a watershed (leading to increased runoff peak flows and volumes) can potentially overwhelm under-designed stormwater drainage facilities, structural controls and downstream conveyances, putting human life and property at risk.
    - Floodwaters can cause driving hazards by overtopping roadways and washing out bridges, as well as carrying sediment and debris onto streets and highways.
- ***Property and structural damage due to flooding*.**
    - Upstream development extends floodplains and risk to property damage previously located outside the 100-year floodplain.
    - Increased occurrences and severity of flooding create more risk.
    - Increased property and infrastructure damage can also result from stream channel widening, undersized runoff storage and conveyance facilities, and development in the floodplain.
- ***Loss of Reservoir Capacity.***
    - Sediment deposition in lakes and reservoirs gradually displaces storage capacity and water supply volume.
- ***Impairment of Drinking Water Supplies (Surface and Groundwater).***
    - Water quality degradation from polluted stormwater runoff can contaminate both surface and groundwater drinking water supplies and potentially reduce the availability of this resource.

- ***Increased Cost of Treating Drinking Water.***
    - Even if a drinking water supply remains viable, heavy concentrations of contaminants such as sediment and bacteria can increase the costs of water treatment to a community and water customers.
- ***Increased Cost of Remediating Pollution and Other Damages.***
    - Degraded water bodies and exceedences of state water quality standards necessitate expensive remediation projects.
    - Example: Hundreds of millions of dollars have been spent over the past 25 years for the Chesapeake Bay Program, which still has a long way to go to achieve a truly restored Bay.
- ***Loss of Recreational Opportunities on Streams, Lakes, Rivers and Ocean Beaches*.**
    - Turbidity from sediment, odors, floating trash, toxic pollutants and microbial contamination from stormwater runoff all reduce the viability of water bodies for recreational activities such as swimming, boating and fishing.
    - Aesthetic loss along these waterways reduces public enjoyment (eg. non-contact recreation such as picnicking, jogging, biking, camping and hunting).
- ***Declining Property Values of Waterfront Homes and Businesses.***
    - As water quality and/or aesthetic values of water bodies decrease, so does desirability of working, living, travelling or owning property nearby.
    - For example, shoreline and bank erosion diminish property values.
- ***Loss of Sport and Commercial Fisheries.***
    - Polluted water bodies in Virginia have lead to numerous fish consumption health advisories, can lead to fish losses directly and through degradation of fish habitat.
    - Commercial fisheries, a significant part of Virginia's economy, can quickly decline when water quality declines.

  - In 1989 the USEPA estimated that stormwater runoff costs the commercial fish and shellfish industries approximately $17 million to $31 million per year.

  - High levels of nutrients associated with stormwater runoff have been linked to fish kills caused by toxic algal blooms (one species in particular). It is estimated that the Chesapeake Bay seafood industry lost $43 million in 1997, and the recreational fishing industry $4.3 million, due to this one species.

- ***Closure of Shellfish Harvesting Areas.***

  - Bacterial contamination due to urban stormwater runoff has made many of Virginia's estuaries *unsafe* for shellfish consumption.

- ***Increased Litigation.***

  - Increased legal action can result against local governments that have not adequately addressed stormwater runoff drainage and water quality problems or against developers or private citizens who do not comply with stormwater management requirements.

Knowledge Check

9. Beneficial uses for the Chesapeake Bay include:

   A. Swimming and sport fishing

   B. Human consumption of fish or shellfish

   C. A depository for excess nutrients

   D. A. and B.

   E. All of the above

2h. Managing Stormwater and Rainwater Harvesting

What are the problems with stormwater runoff?

High Stormwater Volume and Velocity

- More impervious surfaces lead to less ground infiltration, more higher energy runoff
- Increased stream volumes and flow rates, flooding, more erosion

Pollutants in Stormwater Runoff

- Pollutants transported untreated to our waterways (nutrients, sediments, toxics, litter, debris, bacteria and pathogens, higher water temps)

Ecological Impacts

- Altered or lost habitats (aquatic, riparian)
- Reduced species richness and diversity
- Shift in ecological balance (aquatic food sources, opportunistic species)

Loss of Beneficial Uses

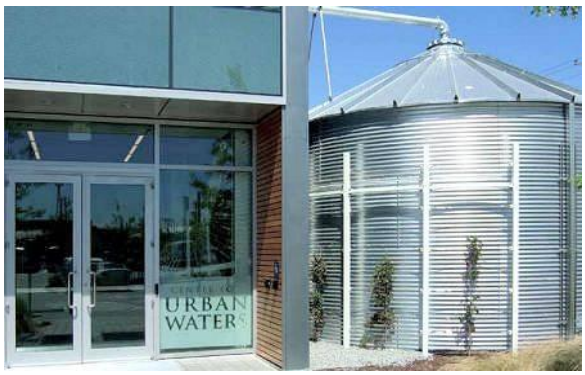
- Reduction in desirable fish species
- Shellfish contamination
- Contamination of drinking water sources
- Contamination of swimming beaches
- Loss of recreation and aesthetic value of state waters

What do we do?

How has our approach changed over time?

Stormwater as a valuable resource:

As changing precipitation patterns and human influences alter the hydrologic cycle, it is more important than ever to make smart and conscientious use of water supplies. Recycling or reusing stormwater ***(rainwater harvesting)*** presents a tremendous opportunity to do just that.



Stormwater harvesting is encouraged in the Virginia Stormwater Management Program Regulations (9VAC25-870-74) [Module 4]

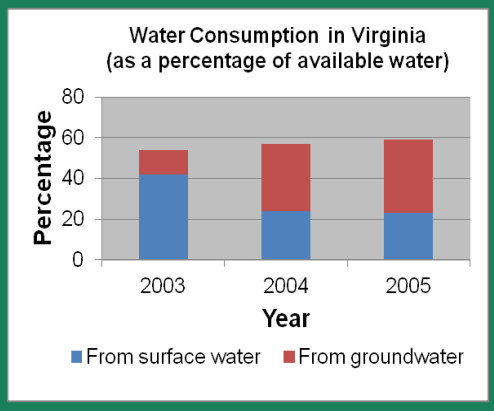
&

Is included as one of Virginia's non-proprietary BMPs [Module 6]

Why is this important?

Water Demand → **Water Supply**

- Virginia's water consumption continually increasing while population growing (**Figure 41**)



- Overall global water consumption outpacing population growth

- Water treatment plants struggling to keep up with current demands
- More runoff = Less groundwater
- Decreased stream base flow (and clean water supply)

Figure 41. Virginia water consumption

Why rainwater harvesting?

rainwater harvesting is a sustainable approach with the added benefit of providing an alternative water source

- Excellent alternative non-potable water source
  - affordable
  - cost-effective
  - simple
  - reliable
  - sustainable
- Reduction in water consumption (and associated costs) – costs will continue to rise with decreasing supply and increasing demand
- Less stormwater runoff needing treatment prior to off-site discharge
- Use can reduce damaging delivery of site runoff to surface waters (erosion potential and nonpoint pollution source)
- Rainwater typically softer than tap water – less detergent needed for laundry and other types of washing
- Can be treated (e.g. reverse osmosis, etc.) for potable uses

Where can it be used?

- Large commercial and industrial buildings (*diverted from flat roofs to onsite storage tanks or pond*; used for toilet flushing, laundry, cleaning, fire suppression, cooling towers, industrial processes, landscape supplementary irrigation)
- Homes (*rain barrels, cisterns*; used for toilet flushing, laundry, fill swimming pools, vehicle and home power-washing, watering lawns-borders-gardens)

Proactive efforts to both protect property and the environment and conserve water are beneficial now and in the future

What next?

- Stormwater runoff reduction via Low Impact Development (LID) practices are being required for new developments in Virginia and other states (state and local authorities)
- Virginia building codes and health regulations are currently being reviewed to enable more extensive use of rainwater harvesting options

How do we do it?

- Take proactive approaches (before, during, and after land development)
- Move beyond less effective traditional stormwater management approaches
- Control flooding and erosion
- Prevent hazardous materials from polluting environment
- Construct stormwater systems/utilize effective BMPs to remove contaminants and detain/slow down stormwater runoff
- Protect natural waterways
- Focus on maintaining the natural land conditions
- Educate communities about how they can improve water quality and what the benefits are of doing so

Creating beneficial uses for stormwater ultimately:

- *Serves to minimize impacts from urban and developed runoff rates and volumes*
- *Decreases reliance and demand on progressively stressed groundwater and surface water sources*
- *Provides time needed for these stressed sources to replenish and allow for future sustainable use*

Example: Orlando, FL current runoff volumes exceed resident annual water demand by over 50%

(see 2013 Virginia Stormwater Management Handbook, Chapter 4, Section 4.4.

Additional Resources:

The Cabell Brand Center in Salem, Virginia, has produced the *Virginia Rainwater Harvesting Manual 2007*, which details the benefits of rainwater harvesting, both economical and environmental.

http://www.cabellbrandcenter.org/Downloads/RWH_Manual2009.pdf

Virginia developed a new Rainwater Harvesting best management practice design specification (discussed more in **Chapter 8** of the 2013 Virginia Stormwater Management Handbook) and provides a spreadsheet tool for sizing and designing rain storage cisterns, which can be found at the following web URL:

http://www.vwrrc.vt.edu/swc/NonProprietaryBMPs.html .

2i. The Economic Benefits of Effective Stormwater Management

The economic value of the Chesapeake Bay is estimated to be nearly **$1 trillion** to the economies of Virginia and Maryland through commercial fishing, marine trade, water recreation and tourism, port activities, and land values.

There are two types of economic benefits of implementing sound stormwater management regulations and programs:

(1) Income generated by economic activities that rely on water and related natural resources; and

(2) A reduction in or avoidance of costs which may result from environmental degradation and consumption of natural resources. These benefits are listed in **Table 2-6** below.

Table 2-6

Economic Benefits of Sound Stormwater Management

Watershed Protection Tool	Economic Benefit
Open Space Protection – forest conservation, wetland protection, preservation of parkland and open space	• Income from recreation and tourism • Increased property values • Reduction of energy costs, health care costs, flood control and stormwater quality and quantity treatment costs
Aquatic Buffers – Resource Protection Areas, stream buffers	• Enhanced aquatic habitat • Income from fishing • Increased property values • Reduction of flood control and stormwater quality and quantity treatment costs • Reduction of stream channel erosion and related degradation • Reduction of stream restoration costs
Environmental Site Design – cluster development, reduction of impervious cover, natural stormwater conveyances	• Increased property values • Reduction of construction, maintenance, and infrastructure costs • Reduction of flood control and stormwater quality and quantity treatment costs
Erosion and Sediment Control – channel protection, limiting clearing and grading, construction site erosion and sediment control	• Reduction of dredging costs • Improved income from marine and port activities • Reduction of drinking water treatment costs • Increased property values • Reduction of construction costs • Reduction of stream restoration costs
Stormwater Management Practices – stormwater management regulations, floodplain protection, etc.	• Increased property values • Reduction of flood damage costs • Reduction of flood control costs • Reduction of stream channel erosion and related degradation • Reduction of stream restoration costs • Improved water quality in our streams and rivers • Protected or improved aquatic habitat • Enhanced recreational opportunities • Lower water supply and laundry supply costs

Source: Adapted from DCR and CWP-2001

Knowledge Check

10. Rainwater harvesting presents an option that could alleviate pressures on water supplies in Virginia. What are some of these pressures?

11. How does increasing surface runoff change groundwater recharge rates?

Module 3: Federal and state laws that address stormwater management

Module 3 Objectives

After completing this module, you will be able to:

- Discuss the purpose of the Clean Water Act and its formation of the Environmental Protection Agency and the National Pollutant Discharge Elimination System (NPDES) Permit Program
- Discuss the general purpose of the Virginia Pollutant Discharge Elimination System (VPDES) and the Virginia Stormwater Management Program (VSMP)
- Discuss key sections of the Stormwater Management Act (VSMA) as it pertains to a local VSMP authority

Module 3 Content

3a. Brief history of federal and State Stormwater Legislation

3b. Virginia Stormwater Management Act – Highlights

3c. Virginia Stormwater Management Act - Overview

3a. Brief History of Stormwater Legislation

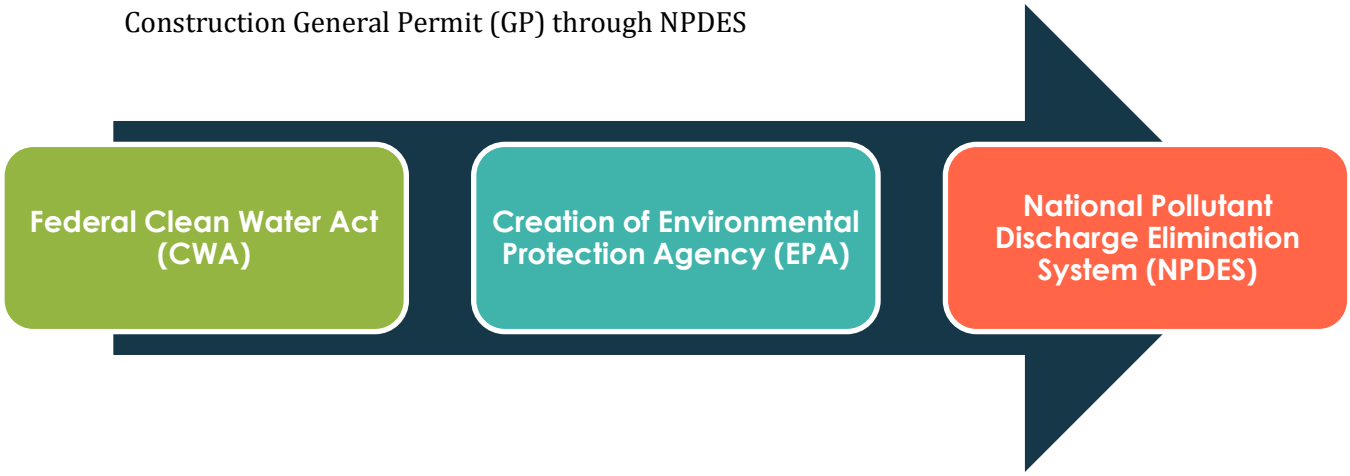
The Federal Water Pollution Control Act (1948)

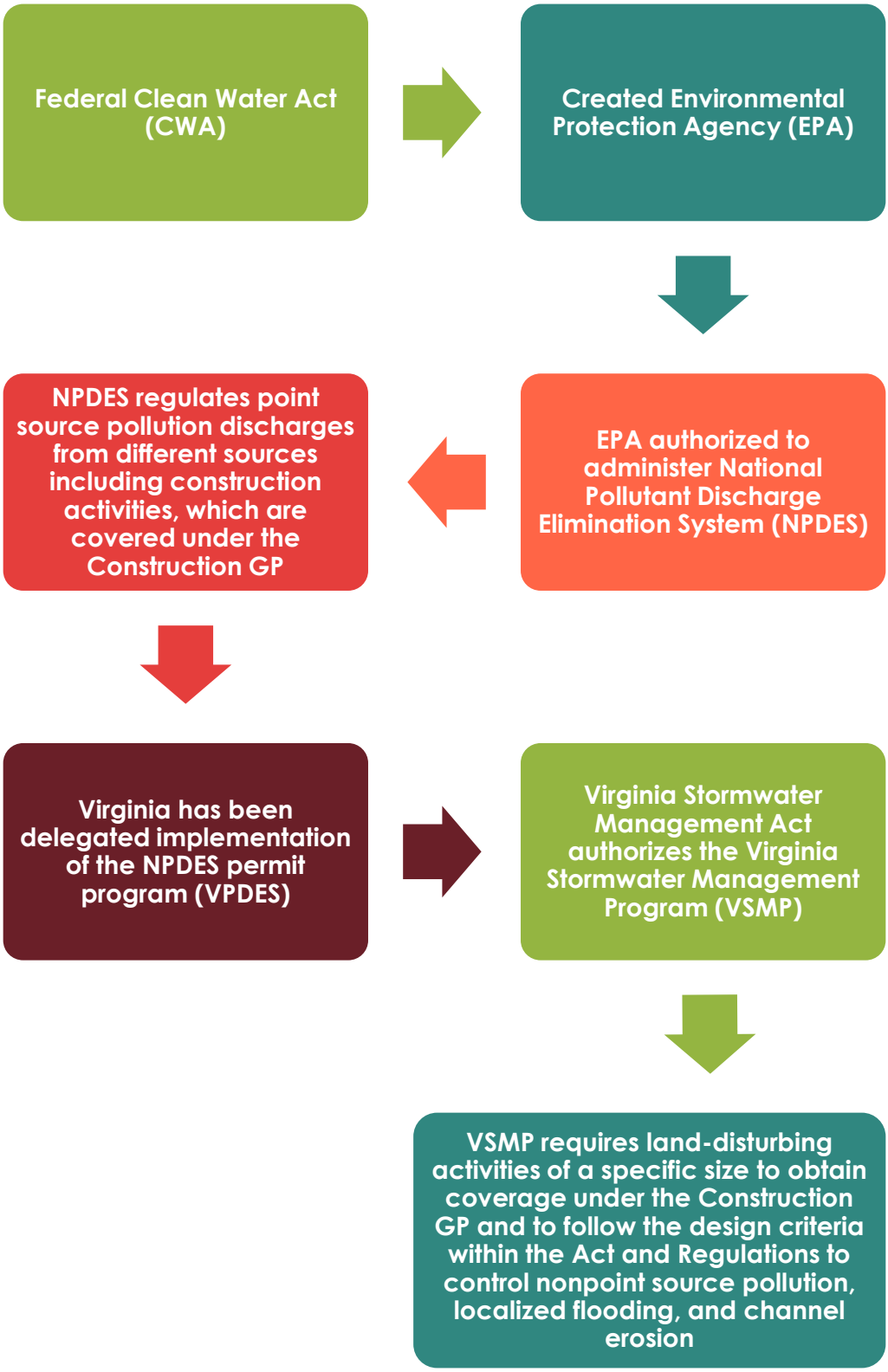
The Federal Water Pollution Control Act of 1948 was the first major US law to address water pollution. The Act was one of the earliest references to clean water as a resource and the importance of protecting water quality through the managed reduction of pollutants flowing into waterways. This Act also set the precedent for a federal authority to regulate water quality.

The Clean Water Act (1972)

Congress passed major amendments to the Federal Water Pollution Control Act in 1972, creating what we now know as the Clean Water Act (CWA). The amendments made a number of changes to strengthen the existing law including:

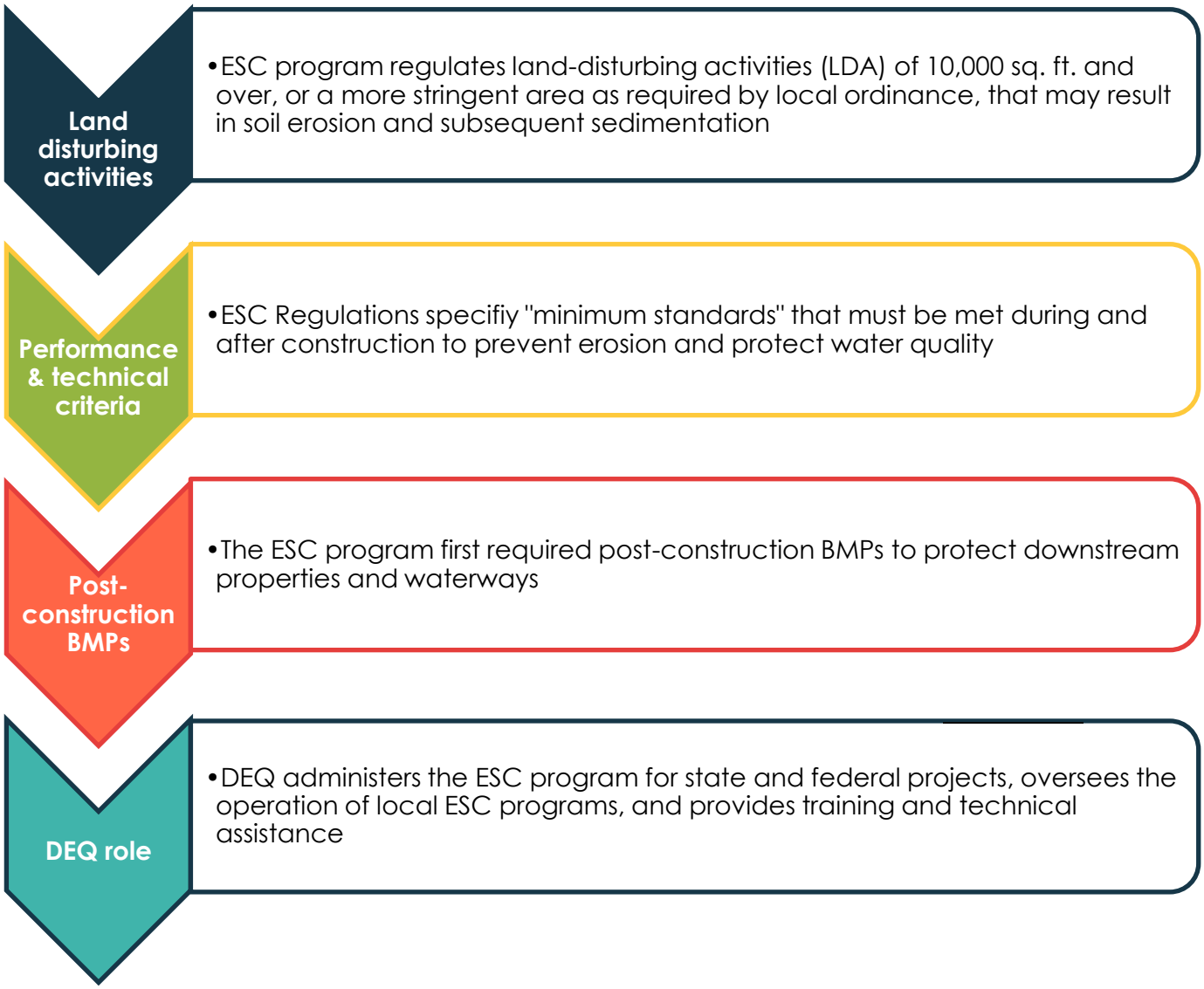
- Consolidated the control of water pollution policy under the administrator of the newly created US Environmental Protection Agency (EPA)
- Established the National Pollutant Discharge Elimination System (NPDES) Permit Program, which in Virginia is administered by the Virginia Pollutant Discharge Elimination System (VPDES), to control water pollution by regulating point sources that discharge pollutants
- Stormwater discharges from land disturbing activities are permitted under the Construction General Permit (GP) through NPDES




Federal Clean Water Act (CWA)
Created Environmental Protection Agency (EPA)
EPA authorized to administer National Pollutant Discharge Elimination System (NPDES)
NPDES regulates point source pollution discharges from different sources including construction activities, which are covered under the Construction GP
Virginia has been delegated implementation of the NPDES permit program (VPDES)
Virginia Stormwater Management Act authorizes the Virginia Stormwater Management Program (VSMP)
VSMP requires land-disturbing activities of a specific size to obtain coverage under the Construction GP and to follow the design criteria within the Act and Regulations to control nonpoint source pollution, localized flooding, and channel erosion

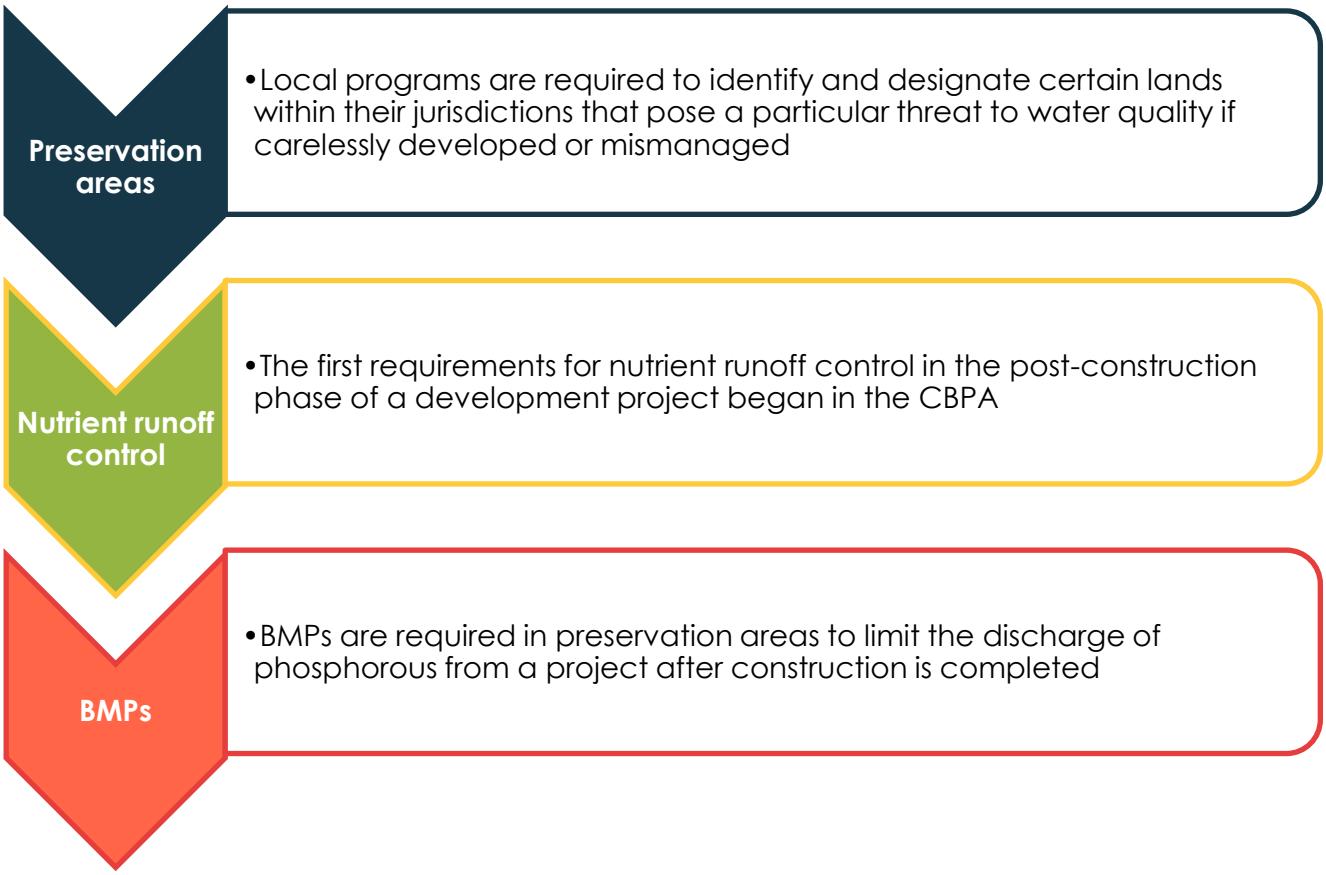
Virginia Erosion and Sediment Control Law

The Virginia Erosion and Sediment Control (ESC) Law was first passed in 1973. Not solely an environmental protection law, the original law was passed "to prevent the unreasonable degradation of properties, stream channels, waters, and other natural resources."



Chesapeake Bay Preservation Act

Chesapeake Bay Preservation Act (CBPA) was passed in 1988 with the expressed purpose of protecting "the public interest in the Chesapeake Bay, its tributaries, and other state waters." To accomplish this purpose the CBPA requires that certain regions of the state, where improperly managed land use could have a detrimental effect on the waters of the Chesapeake Bay, establish programs administered by local governments that protect water quality.



3b. Virginia Stormwater Management Act (VSMA)- highlights

History

The Virginia Stormwater Management Act (VSMA) was first passed in 1989, and is the basis for all requirements pertaining to stormwater management in Virginia. When the VSMA was first passed, all state agencies were required to meet its requirements and local governments were given the option, but not required to adopt a local program.

The VSMA and Virginia Stormwater Management Program Regulations have been amended and expanded over the past 24 years..

The stated intent of the VSMA is to "ensure the general health, safety and welfare of the citizens of the Commonwealth as well as protect the quality and quantity of state waters from the potential harm of unmanaged stormwater."

Today

The biggest changes to the VSMA occurred in 2012 as a result of the passage of House Bill 1065, also called the Integration Bill. Among the changes made by the Integration Bill, is the requirement that certain counties, cities and towns in the state adopt and administer a local Virginia Stormwater Management Program (VSMP), effectively creating a statewide stormwater management program that can operate at the local government level.

The Integration Bill also brings about a new shift to the runoff reduction paradigm, where designers will focus on reducing the post-development stormwater runoff volume from a site, as well as meeting more stringent nutrient load reduction requirements.

Under the VSMA, land-disturbing activity of one acre or more, 2,500 square feet in all areas of jurisdictions designated as subject to the Chesapeake Bay Preservation Act, part of a larger common plan of development or sale that is one acre or more, or a more stringent area as established in local ordinance, must follow the provisions of the VSMA and obtain state permit coverage, where applicable, and VSMP authority permit coverage.

Highlights from the Virginia Stormwater Management Act (VSMA)

Board role	• State Water Control Board (Board) permits, regulates, and controls stormwater runoff
VSMP authority	• Counties, cities, and towns with regulated MS4s must adopt a VSMP by ordinance
Consistency	• Local VSMPs must be consistent with the Act, Regulations, and the Construction GP
Integration	• Local VSMPs bring together MS4, erosion and sediment control, flood insurance, flood plain management, and other related programs
Approval and review	• Board approves VSMPs and Department of Environmental Quality (Department) reviews programs every 5-years
LDA	• VSMP applies to LDAs of ≥ 1 acre, ≥ 2,500 sq. ft. in a Chesapeake Bay Preservation Area, part of a larger common plan of development or sale that is one acre or more, or a more stringent area as required by local ordinance
Inspection	• VSMP authorities must periodically inspect the installation of BMPs and require long-term maintenance agreements for BMPs
Violations	• Violations of the Act, Regulations, or local ordinance are subject to civil penalties of up to $32,500 at the discretion of the court

3c. The Virginia Stormwater Management Act (VSMA) - Overview

Now that we are able to understand where laws to control stormwater and pollution originated, we can focus on the VSMA. This discussion is not an all-inclusive study of the VSMA, but it will discuss key sections as they pertain to local VSMP implementation. Participants should obtain a full copy of the VSMA. An official listing is available at: lis.virginia.gov/cgi-bin/legp604.exe?000+cod+62.1-44.15C24.

Definitions (§62.1-44.15:24)

The VSMA contains the definitions of certain terms to explain their legal meanings and how they are to be applied to stormwater management.

"Virginia Stormwater Management Program" or "VSMP"

A program approved by the Soil and Water Conservation Board after September 13, 2011, and until June 30, 2013, or the State Water Control Board (Board) on and after June 30, 2013, that has been established by a VSMP authority to manage the quality and quantity of runoff resulting from land-disturbing activities and shall include such items as local ordinances, rules, permit requirements, annual standards and specifications, policies and guidelines, technical materials, and requirements for plan review, inspection, enforcement, where authorized in this article, and evaluation consistent with the requirements of this article and associated regulations.

"Virginia Stormwater Management Program authority" or "VSMP authority"

An authority approved by the Board after September 13, 2011, to operate a Virginia Stormwater Management Program or, until such approval is given, the Department. An authority may include a locality; state entity, including the Department; federal entity; or, for linear projects subject to annual standards and specifications in accordance with subsection B of § 62.1-44.15:31, electric, natural gas, and telephone utility companies, interstate and intrastate natural gas pipeline companies, railroad companies, or authorities created pursuant to § 15.2-5102.

Further powers and duties of the State Water Control Board

(§62.1-44.15:25)

The Board is required to:

- Permit, regulate, and control stormwater runoff

The Board may:

- Issue, deny, revoke, terminate, or amend state stormwater individual or general permits
- Adopt regulations
- Approve and periodically review VSMPs and management programs developed in conjunction with a state MS4 permit
- Enforce the VSMA
- Act to ensure the general health, safety, and welfare of citizens as well as protect the quality and quantity of state waters from the potential harm of unmanaged stormwater
- Issue, deny, amend, revoke, terminate, and enforce state permits for the control of stormwater discharges from MS4s and land-disturbing activities (LDA)
- Take administrative and legal actions to ensure compliance
- Amend or revoke any state permit for good cause
- Investigate, inspect or provide recommendations or instructions to ensure compliance
- Adopt certain rules or cancel any rule it has adopted
- Issue special orders
- Take enforcement action for any past violation of provisions of the VSMA or Regulations
- With the consent of the violator, issue an order for the payment of civil charges in lieu of a civil penalty

State permit means an approval to conduct a land-disturbing activity issued by the Board in the form of a state stormwater individual permit or coverage issued under a state general permit or an approval issued by the Board for stormwater discharges from an MS4. Under these permits, the Commonwealth imposes and enforces requirements pursuant to the federal Clean Water Act and regulations and this article and its attendant regulations. (§62.1-44.15:24)

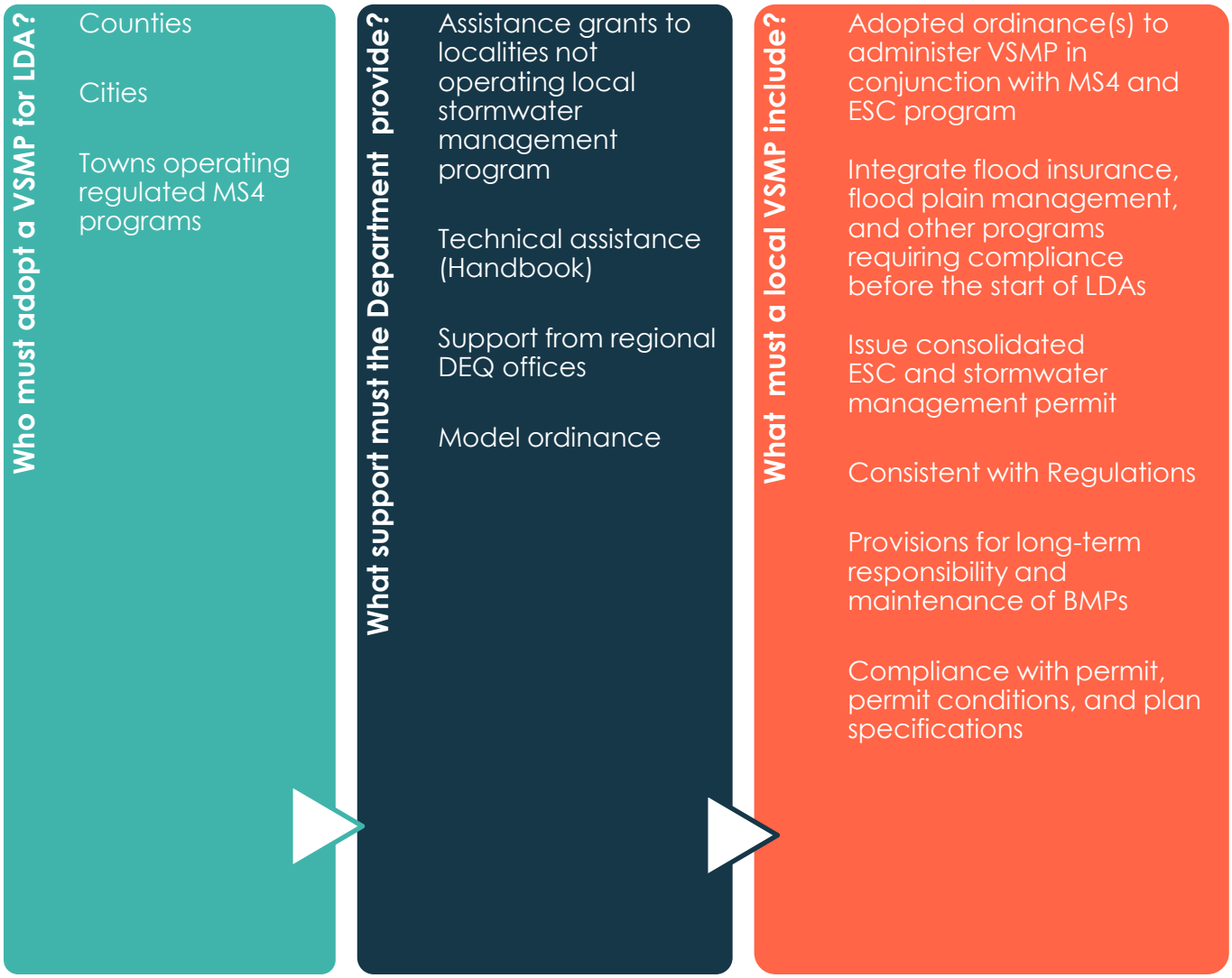
LDA or **land-disturbing activity** means a manmade change to the land surface that potentially changes its runoff characteristics including clearing, grading, or excavation. (9VAC25-870-10)

State permits (§62.1-44.15:26)

The maximum state permit term is five years.

Establishment of Virginia Stormwater Management Programs

(§62.1-44.15:27)



Development of regulations (§62.1-44.15:28)

The Board is authorized to adopt regulations that specify minimum technical criteria and administrative procedures for VSMPs. The Board may consolidate components of the ESC program, Chesapeake Bay Preservation Area Designation and Management program with the VSMP Regulations

The Regulations shall…
Establish standards and procedures for administering a VSMP
Establish minimum standards to control nonpoint source pollution and localized flooding, and incorporate Minimum Standard 19 from the Erosion and Sediment Control Regulations (relates to the prevention of stream channel erosion)
Require long-tem maintenance of stormwater management control devices and other techniques specified to manage the quality and quantity of runoff
Require VSMPs to follow administrative procedures including stormwater management plan review and approval, and inspection of approved projects
Establish permit fee schedule
Establish statewide standards for stormwater management from LDAs of one acre or greater and also apply those same standards to Chesapeake Bay Preservation Act LDAs
Maintain post-development runoff rate of flow and characteristics that replicate, as nearly as practicable, the existing pre-development runoff characteristics and site hydrology; or improve upon the pre-development site conditions if stream channel erosion or localized flooding exists Except where more stringent requirements are necessary to address TMDLs or protect exceptional state waters, stormwater management practices must be designed to: 1. Detain the water quality volume and release it over 48 hours 2. Detain and release over a 24-hour period the expected rainfall resulting from the one year, 24-hour storm 3. Reduce the allowable peak flow rate resulting from the 1.5-year, 2-year, and 10-year, 24-hour storms to a level that is less than or equal to the peak flow rate from the site assuming it was in a good forested condition by using the energy balance equation If the practice meets these conditions, it is exempt from any flow rate capacity and velocity requirements for natural or man-made channels
Encourage low-impact development design, stormwater reuse, regional and watershed approaches, and nonstructural means for controlling stormwater
Establish statewide permit fee schedule for MS4s
Provide for the evaluation and potential inclusion of emerging or innovative stormwater control technologies

Education and training programs (§62.1-44.15:30)

The Board is required to issue certificates of competence for subject areas of the VSMP including program administration, plan review, and project inspection. To carry out this requirement, the Department must develop training programs and may charge reasonable fees to cover its costs.

Additional certification information can be found in the Erosion and Sediment Control and Stormwater Management Certification Regulations (9VAC25-850).

Annual standards and specifications for state agencies, federal entities, and other specified entities (§62.1-44.15:31)

Annual Standards and Specifications
Table 3-1

What	Who must submit	Who may submit	Coverage under the state general permit
Single set of standards and specifications approved by the Department that describes how LDA must be conducted Must be consistent with VSMA, Regulations, Construction GP, and Erosion and Sediment Control Law and Regulations	State entities Linear projects Electric Natural gas Telephone Railroad	Federal entities	Must be obtained before the start of LDA

Must Include	
Technical criteria laid out in VSMA and Regulations	ESC and stormwater management program administration, plan design, review and approval, and construction inspection and enforcement
Provisions for the long-term responsibility and maintenance of stormwater management control devices and other techniques to manage the quality and quantity of stormwater runoff	Provisions for personnel and contractors obtain certifications or qualifications for ESC and stormwater management comparable to those required for local government
Implementation of project tracking and notification system to the Department of all LDAs	Requirements for documenting onsite changes as they occur

Inspections	
The Department must perform random site inspections or inspections in response to a complaint	Department may take enforcement action
Administrative Charge	
The Department must assess an administrative charge to cover the costs of services rendered	

Duties of the Department (§62.1-44.15:32)

- Provide technical assistance, training, research, and coordination in stormwater management technology to VSMP authorities
- Review stormwater management plans for any project with real or potential inter-jurisdictional impacts at the request of one or more of the involved localities to determine plan consistency
- Implement the VSMA

Authorization for more stringent ordinances (§62.1-44.15:33)

Ordinances

Localities are authorized to adopt more stringent ordinances provided they are based upon factual findings of local or regional comprehensive watershed management studies or findings and are determined by the locality to be necessary to:

- Prevent further degradation to water resources
- Address TMDL requirements
- Protect exceptional state waters
- Address specific existing water pollution including nutrient and sediment loadings, stream channel erosion, depleted groundwater resources, or excessive localized flooding within the watershed

Before adopting more stringent ordinances, a public hearing is held after due notice is given.

Flooding means a volume of water that is too great to be confined within the banks or walls of the stream, water body, or conveyance system and that overflows onto adjacent lands, thereby causing or threatening damage.

A **watershed** means a defined land area drained by a river or stream, karst system, or system of connecting rivers or streams such that all surface water within the area flows through a single outlet. In karst areas, the karst feature to which water drains may be considered the single outlet for the watershed. (§62.1-44.15:24)

Localities must submit a **letter report** to the Department within **30 days** after adoption of more stringent ordinances. The letter report must include a summary of why the ordinance is necessary.

An affected landowner or their agent has **90 days** after the adoption of ordinances to request a review of the ordinances by the Department. The request is submitted to the Department and a copy of the letter is sent to the locality. The locality must then submit the ordinances and supporting materials to the Department for determination of whether the requirements of the VSMA have been met. The Department must issue a written decision with rationale within **90 days** of submission. The determination or failure to make a determination may be appealed to the Board.

Best management practices (BMPs)

A locality VSMP authority may prohibit the use of a Board approved BMP or require more stringent conditions for a specific land-disturbing project based on a review of the stormwater management plan and project site conditions. Prohibitions must be based on site-specific concerns and can be appealed to the Department.

A locality VSMP authority may also prohibit the use of a Board approved BMP or require more stringent conditions across its jurisdiction or in a specific geographical area. Within **90 days** of adoption, an affected landowner or their agent may submit a request asking the Department to review the locality's determination.

Regulated activities; submission and approval of a permit application; security for performance; exemptions (§62.1-44.15:34)

Submission and approval of a permit application

A person shall not conduct an LDA activity until they have submitted a Construction GP application to the VSMP authority. More details about the plan review process are included in Module 4.

- VSMP authority has **60 days** from determination of administrative completeness to review plan
- Written rationale for denial must be provided
- VSMP authority has **45 days** to review resubmitted applications

Security for performance

Prior to plan approval, a VSMP authority may require an applicant, excluding state or federal entities, to submit a reasonable performance bond and must refund the bond within **60 days** of project completion or permit termination.

Chesapeake Bay Preservation Act LDAs

Chesapeake Bay Preservation Act LDAs are equal to or greater than 2,500 square feet and less than one acre. After **July 1, 2014**, the LDAs do not require coverage under the Construction GP. However, the LDAs are still required to meet the criteria in Part II of the Regulations.

Chesapeake Bay Preservation Act LDAs	
Now	**Starting July 1, 2014**
• Required to obtain coverage under the Construction GP	• **Not** required to obtain coverage under the Construction GP • Must hold VSMP authority permit and follow Part II criteria of VSMP Regulations

Exemptions

The following activities are exempt from the VSMA**:**

- Permitted surface or deep mining or oil and gas operations
- Clearing of lands specifically for agricultural purposes, harvesting of forest crops, livestock feedlot operations, and agricultural engineering operations
- Single-family residences separately built and disturbing less than one acre and that are not part of a larger common plan of development or sale, including additions or modifications to existing single-family detached residential structures

Single family residences that disturb less than 1-acre of land and are not part of a common plan of development or sale – regardless of location – are not required to obtain coverage under the Construction GP.

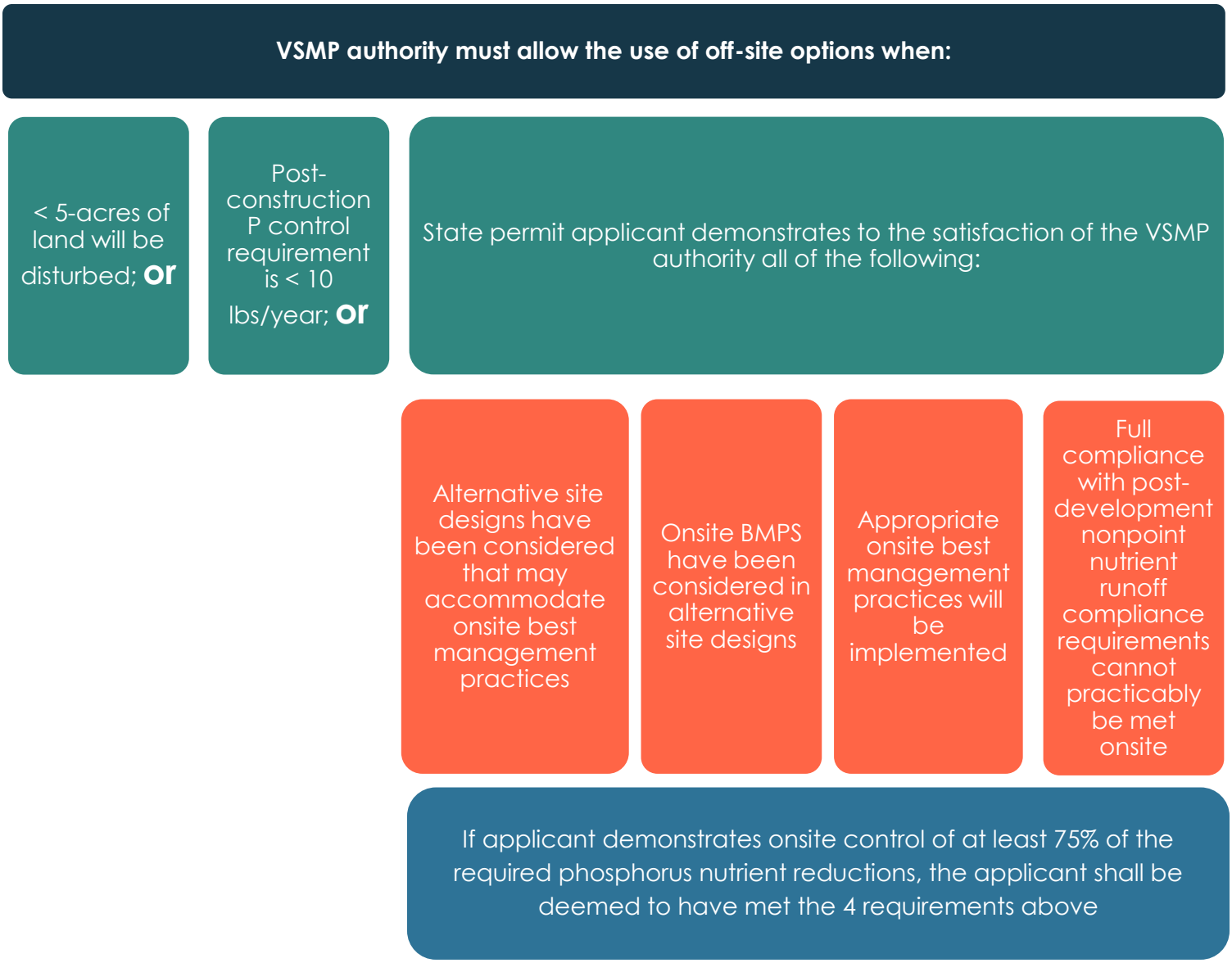
- LDAs that disturb less than one acre of land area **except:**
    - Chesapeake Bay Preservation Act LDAs
    - Activities that are part of a larger common plan of development or sale that is one acre or greater of disturbance
        - A VSMP authority may reduce this exception to a smaller area of disturbed land or qualify the conditions of this exception, but it cannot require the project to have coverage under the Construction GP

Common plan of development or sale: A contiguous area where separate and distinct construction activities may be taking place at different times on different schedules (ex. subdivision). (9VAC25-870-10)

- Discharges to a sanitary sewer or a combined sewer system
- Activities under a state or federal reclamation program to return an abandoned property to an agricultural or open land use
- Routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original construction of the project
- Conducting LDAs in response to a public emergency to avoid imminent endangerment to human health or the environment

Nutrient credit use and additional off-site options for construction activities (§62.1-44.15:35)

A VSMP authority is authorized to allow compliance with the water quality criteria through the use of nutrient credits in the same tributary. Nutrient credits cannot be used to address water quantity control requirements, nor can they be used in violation of local water quality based limitations.



Monitoring, reports, investigations, inspections, and stop work orders (§62.1-44.15:37)

This section defines the procedures for enforcement of the approved plan, outlining both the responsibilities and the authorities assigned to the VSMP authority.

Inspections, monitoring, and reports

- The authority must provide for **periodic** inspections of the installation of stormwater management measures and may require monitoring and reports from the person responsible for carrying out the permit conditions

Notice to comply

- If it is determined by the VSMP authority or Department that there is a failure to comply with the permit conditions, notice shall be served upon the permittee or person responsible for carrying out the permit conditions by registered or certified mail or at the development
- The notice must specify the measures needed to comply with the permit conditions and specify the time within which such measures shall be completed
- Upon failure to comply within the time specified, a stop work order may be issued, or the permit may be revoked by the VSMP authority, or the state permit may be revoked by the Board. The Board or the VSMP may also take enforcement action

Stop work order

If a permittee fails to comply with a notice within the time specified, the VSMP authority or the Department may issue an order requiring the owner, permittee, person responsible for carrying out an approved plan, or person conducting the LDAs without an approved plan or required permit to cease all LDA until the violation of the permit has ceased, or an approved plan and required permits are obtained, and specified corrective measures have been completed.

Such orders shall be issued:

- In accordance with local procedures if issued by a locality VSMP authority
- After a hearing held in accordance with the requirements of the Administrative Process Act if issued by the Department

Such orders shall become effective upon service on the person by mailing.

If the VSMP authority or the Department finds that any such violation is grossly affecting or presents an **imminent** and **substantial danger** of causing harmful erosion of lands or sediment deposition in the watershed of the Commonwealth or otherwise substantially impacting water quality, it may issue, without advance notice or hearing, an emergency order directing the LDA to cease immediately. The Department or the VSMP authority must provide an opportunity for a hearing and give reasonable notice as to the time and place. The hearing will affirm, modify, amend, or cancel such emergency order.

Department to review VSMPs (§62.1-44.15:38)

The Department shall develop and implement a review and evaluation schedule so that the effectiveness of each VSMP authority is evaluated no less than every five years.

The review shall include an assessment of the extent to which the program has reduced nonpoint source pollution and mitigated the detrimental effects of localized flooding. The review will be coordinated with other program reviews.

Right of entry (§ 62.1-44.15:39)

The Department, VSMP authority, or MS4 authority may, at reasonable times and under reasonable circumstances, enter establishments or properties for the purpose of obtaining information, conducting surveys or investigations necessary to enforce the VSMA.

In accordance with a performance bond with surety, cash escrow, letter of credit, any combination thereof, or such other legal arrangement, a VSMP authority may also enter any establishment or upon any property for the purpose of initiating or maintaining appropriate actions that are required by the permit conditions when a permittee, after proper notice, has failed to take acceptable action within the time specified.

Penalties, injunctions, and other legal actions (§ 62.1-44.15:48)

Civil actions

Any person who violates any part of the VSMA, Regulations, local ordinances, or standards and specifications, or who fails, neglects, or refuses to comply with any order of a VSMP authority, the Department, the Board, or a court, shall be subject to a civil penalty not to exceed $32,500 for each violation within the discretion of the court. Each day of a violation constitutes a separate offense.

The Board, Department, or VSMP authority may issue a summons for collection of the civil penalty and the action may be prosecuted in the appropriate court. Actions on behalf of the Board or the Department are brought by the Virginia Attorney General's Office.

Any civil penalty assessed by a court as a result of a summons issued by a locality VSMP authority shall be paid into the locality's treasury and is to be used for the purpose of

minimizing, preventing, managing, or mitigating pollution of the waters of the locality and abating environmental pollution.

Any civil penalty assessed by the court as a result of a summons issued by the Board or Department, or when the locality or its agent is the violator, shall be paid into the Virginia Stormwater Management Fund.

The Board, Department, or VSMP authority may also apply to the court for an injunction for a violation or threatened violation of the VSMA or local ordinance.

Consent orders

The Board, Department, or VSMP authority may issue a consent order to any person who has violated or failed, neglected, or refused to obey the VSMA, an ordinance, a permit condition, a regulation of the Board, or an order of the Board, Department, or VSMP authority. A consent order may include civil charges up to $32,500 for each violation instead of a civil penalty.

Criminal actions

Violators who act willfully, negligently, or knowingly may also be subject to the criminal penalties under the VSMA that are listed in Table 3-2 on the next page. Criminal actions are prosecuted by the Commonwealth's Attorney in the locality where the criminal act occurred.

Criminal Actions
Table 3-2

Misdemeanor

Behavior	Punishment for individuals	Punishment for non individuals
Willfully or negligently violates any of the following: VSMA Regulations or order of the Board Local VSMP authority ordinance or order Department order Permit Order of a court	Jail for up to 12 months and/or a fine between $2,500 and $32,500 Each day of violation of each requirement constitutes a separate offense	Fine ≥ $10,000 Each day of violation of each requirement constitutes a separate offense

Felony

Behavior	Punishment for individuals	Punishment for non individuals
Knowingly violates any of the following: VSMA Regulations or order of the Board Local VSMP authority ordinance or order Department order Permit Order of a court	Imprisonment for 1-3 years, or in the discretion of the jury or the court, confinement in jail for up to 12 months and a fine between $5,000 and $50,000 for each violation Each day of violation of each requirement constitutes a separate offense	Fine ≥ $10,000 Each day of violation of each requirement constitutes a separate offense
Knowingly makes any false statement in any form required by VSMA		
Knowingly causes any required monitoring device or method to be inaccurate		
Knowingly violates a provision of VSMA and knows at the time that they are placing another person in imminent danger of death or serious bodily harm	Imprisonment for 2-15 years and/or a fine up to $250,000 Maximum fine and imprisonment doubled for subsequent convictions of same person	Fine up to the greater of $1 million or 3x the economic benefit realized by the defendant as a result of the offense Maximum fine and imprisonment doubled for subsequent convictions of same non individual

Knowledge Check

1. A _____ is a good example of a "Common Plan of Development"

2. With respect to stormwater runoff, the Code of Virginia requires the Board to:
    a. Permit
    b. Regulate
    c. Control
    d. All of the above

3. Which of the following statements is false with respect to technical criteria and administrative procedures for VSMPs?
    a. Establish a permit fee schedule
    b. Provide for the evaluation of innovative technologies
    c. Discourage the use of LID design
    d. Establish provisions for the long term maintenance of SWM control devices

4. True or False. Localities may adopt more stringent ordinances if they are necessary to address TMDL requirements or depleted ground water resources.
    a. True
    b. False

5. The VSMP authority must act on any permit application within what time frame?
    a. 30 days after it has determined the final application is complete
    b. Before the first snowfall
    c. 45 days before the bond is posted
    d. 60 days after it has determined the final application is complete

6. Absent an imminent threat, documentation of a problem is done throughout an onsite inspection and enforcement consists of the following steps?
    a. Don't ask, don't tell
    b. Stop, drop, and roll
    c. Report, notice, stop work order

7. The Department may invoke civil penalties not to exceed
    a. $25,00/day
    b. $32,500/violation
    c. $100,000/annually

8. True or false. Professional engineers licensed in VA do not need to complete a Board administered training program to qualify for the initial certificate of competency?
    a. True
    b. False

Virginia Stormwater Management Act Index

Table 3-3

§ 62.1-44.15:24	Definitions
§ 62.1-44.15:25	Further powers and duties of the State Water Control Board
§ 62.1-44.15:26	State permits
§ 62.1-44.15:27	Establishment of Virginia Stormwater Management Programs
§ 62.1-44.15:28	Development of regulations
§ 62.1-44.15:29.	Virginia Stormwater Management Fund established
§ 62.1-44.15:30	Education and training programs
§ 62.1-44.15:31	Annual standards and specifications for state agencies, federal entities, and other specified entities
§ 62.1-44.15:32	Duties of the Department
§ 62.1-44.15:33	Authorization for more stringent ordinances
§ 62.1-44.15:34	Regulated activities; submission and approval of a permit application; security for performance; exemptions
§ 62.1-44.15:35	Nutrient credit use and additional offsite options for construction activities
§ 62.1-44.15:36	Recovery of administrative costs
§ 62.1-44.15:37	Monitoring, reports, investigations, inspections, and stop work orders
§ 62.1-44.15:38	Department to review VSMPs
§ 62.1-44.15:39	Right of entry
§ 62.1-44.15:40	Information to be furnished
§ 62.1-44.15:41	Private rights; liability
§ 62.1-44.15:42	Enforcement by injunction, etc.
§ 62.1-44.15:43	Testing validity of regulations; judicial review
§ 62.1-44.15:44	Right to hearing
§ 62.1-44.15:45	Hearings
§ 62.1-44.15:46	Appeals
§ 62.1-44.15:47	Appeal to Court of Appeals
§ 62.1-44.15:48	Penalties, injunctions, and other legal actions
§ 62.1-44.15:49	Enforcement authority of MS4 localities
§ 62.1-44.15:50	Cooperation with federal and state agencies

Module 4: Virginia Stormwater Management Program Regulations - Overview

Module 4 Objectives

After completing this module, you will be able to:

- Navigate the Virginia Stormwater Management Program (VSMP) Permit Regulations, and know how to locate the information in the Regulations that pertains to your role in the VSMP
- Apply the Regulations to the administration of a local government VSMP
- Describe the stormwater management plan review process

Module 4 Content

Virginia Stormwater Management Program (VSMP) Regulations - Overview

Virginia Stormwater Management Program (VSMP) Regulations - Overview

The following module is an introduction to the Virginia Stormwater Management Program (VSMP) Regulations.

Virginia Stormwater Management Program (VSMP) Regulations

The following parts focus on the authority and details needed to operate and work within a VSMP

Table 4-1

Part I	Definitions, Purpose, and Applicability
Part II	Administrative and Technical Criteria for Land-Disturbing Activities
Part II A	General Administrative Criteria for Regulated Land-Disturbing Activities
Part II B	Technical Criteria for Regulated Land-Disturbing Activities
Part II C	Technical Criteria for Regulated Land-Disturbing Activities: Grandfathered Projects and Projects Subject to the Provisions of 9VAC25-870-48
Part III	General Provisions Applicable to VSMPs and VSMP Authorities
Part III A	Programs Operated by a VSMP Authority
Part III B	Department of Environmental Quality Procedures for Review of VSMPs
Part III C	Virginia Water Control Board Authorization Procedures for Virginia Stormwater Management Programs
Part IV	Technical Criteria and State Permit Application Requirements for State Projects
Part V	Reporting
Part VI	General Program Requirements Related to MS4s and Land-Disturbing Activities
Part XI	Enforcement of State Permits
Part XIII	Fees

Note: "Shall" means what must be done, and "may" means what can be done.

Part I

Definitions (9VAC25-870-10)

A list of definitions is provided in the Regulations to clarify the meaning of the terms that are used throughout.

Purposes (9VAC25-870-20)

The Regulations provide a framework for the administration, implementation, and enforcement of the Virginia Stormwater Management Act (VSMA) and to outline the procedures and requirements to be followed in connection with state permits issued by the Board pursuant to the Clean Water Act (CWA) and the VSMA and permits issued by a VSMP authority.

Applicability (9VAC25-870-30)

The Regulations apply to:

- Every VSMP authority that administers a VSMP
- The Department in its oversight of VSMPs or in its administration of the VSMP
- Every municipal separate storm sewer system (MS4) program
- Every state agency project regulated and every federal entity project covered under the VSMA and Regulations
- Every land-disturbing activity (LDA) regulated under the VSMA (§ 62.1-44.15:34)
    - ≥ 1 acre
    - ≥ 2,500 square feet in Chesapeake Bay Preservation Areas
    - A more stringent area as included in a locality's ordinance

A **VSMP authority** is approved by the Board to operate a VSMP. An authority may include a locality, state entity, federal entity; or for linear projects, electric, natural gas, and telephone utility companies, railroad companies, etc.

Land-disturbing activity (LDA) means a manmade change to the land surface that potentially changes its runoff characteristics including clearing, grading, or excavation. (9VAC25-870-10)

Part II – Administrative and Technical Criteria for Land-Disturbing Activities

Part II of the Regulations lays out the general requirements for administering a VSMP, content of plans, and the specific technical criteria for water quality and quantity.

Authority (9VAC25-870-40)

The VSMA requires the Board to adopt regulations that specify the standards and procedures for VSMPs, establish statewide standards for stormwater management for LDAs, and protect property, quality and quantity of state waters, the physical integrity of stream channels, and other natural resources.

Implementation date (9VAC25-870-45)

Starting **July 1, 2014**, Construction GPs must include the technical criteria listed in Part II A and Part II B. Until then, the required technical criteria is listed in Part II C.

A **Construction GP** or **General VPDES Permit for Discharges of Stormwater from Construction Activities** authorizes stormwater discharges associated with large and small construction activities through a point source to state waters or through a municipal or non municipal separate storm sewer system to state waters. (9VAC25-880-10)

General objectives (9VAC25-870-46)

The objectives of the Regulations include supporting state designated uses and water quality standards, and using control measures that minimize impacts on receiving state waters as described in Module 2.

Applicability of other laws and regulations – Time limits on applicability of approved design criteria (9VAC25-870-47)

Updated with 12/17/13 Board approved amendments

The Regulations do not limit the applicability of other state or federal laws and regulations, including the CWA, VSMA, Virginia Erosion and Sediment Control Law, and the Chesapeake Bay Preservation Act (CBPA). The Regulations do not limit the rights of state and federal agencies or local governments to impose more stringent technical criteria or other requirements as allowed by law.

9VAC25-870-47B

Permits issued before July 1, 2014

Land-disturbing activities that obtain an initial state permit or commence land disturbance prior to July 1, 2014, shall be conducted in accordance with the Part II C technical criteria. Such projects shall remain subject to the Part II C technical criteria for **two additional** state permit cycles (permit cycle is five years). After such time, portions of the project not under construction shall become subject to any new technical criteria adopted by the Board.

Permits issued on July 1, 2014 and after

Land-disturbing activities that obtain an initial state permit on or after July 1, 2014 shall be conducted in accordance with the Part II B technical criteria, except as provided for in section 48. Land-disturbing activities conducted in accordance with the Part II B technical criteria shall remain subject to the Part II B technical criteria for **two additional** state permit cycles (permit cycle is five years). After such time, portions of the project not under construction shall become subject to any new technical criteria adopted by the board.

★ Nothing in this section precludes an operator from constructing to a more stringent standard at their own discretion.

Grandfathering (9VAC25-870-48)

Updated with 12/17/13 Board approved amendments

Any land-disturbing activity shall be considered grandfathered by the VSMP authority and shall be subject to the Part II C technical provided:

1. A proffered or conditional zoning plan, zoning with a plan of development, preliminary or final subdivision plat, preliminary or final site plan, or any document determined by the locality to be equivalent thereto (i) was approved by the locality prior to July 1, 2012, (ii) provided a layout as defined in 9VAC25-870-10, (iii) will comply with the Part II C technical criteria, and (iv) has not been subsequently modified or amended in a manner resulting in an increase in the amount of phosphorus leaving each point of discharge, and such that there is no increase in the volume or rate of runoff;
2. A state permit has not been issued prior to July 1, 2014; and
3. Land disturbance did not commence prior to July 1, 2014

Locality, state, and federal projects shall be considered grandfathered by the VSMP authority and shall be subject to the Part II C technical criteria provided:

1. There has been an obligation of locality, state, or federal funding, in whole or in part, prior to July 1, 2012, or the Department has approved a stormwater management plan prior to July 1, 2012;
2. A state permit has not been issued prior to July 1, 2014; and
3. Land disturbance did not commence prior to July 1, 2014

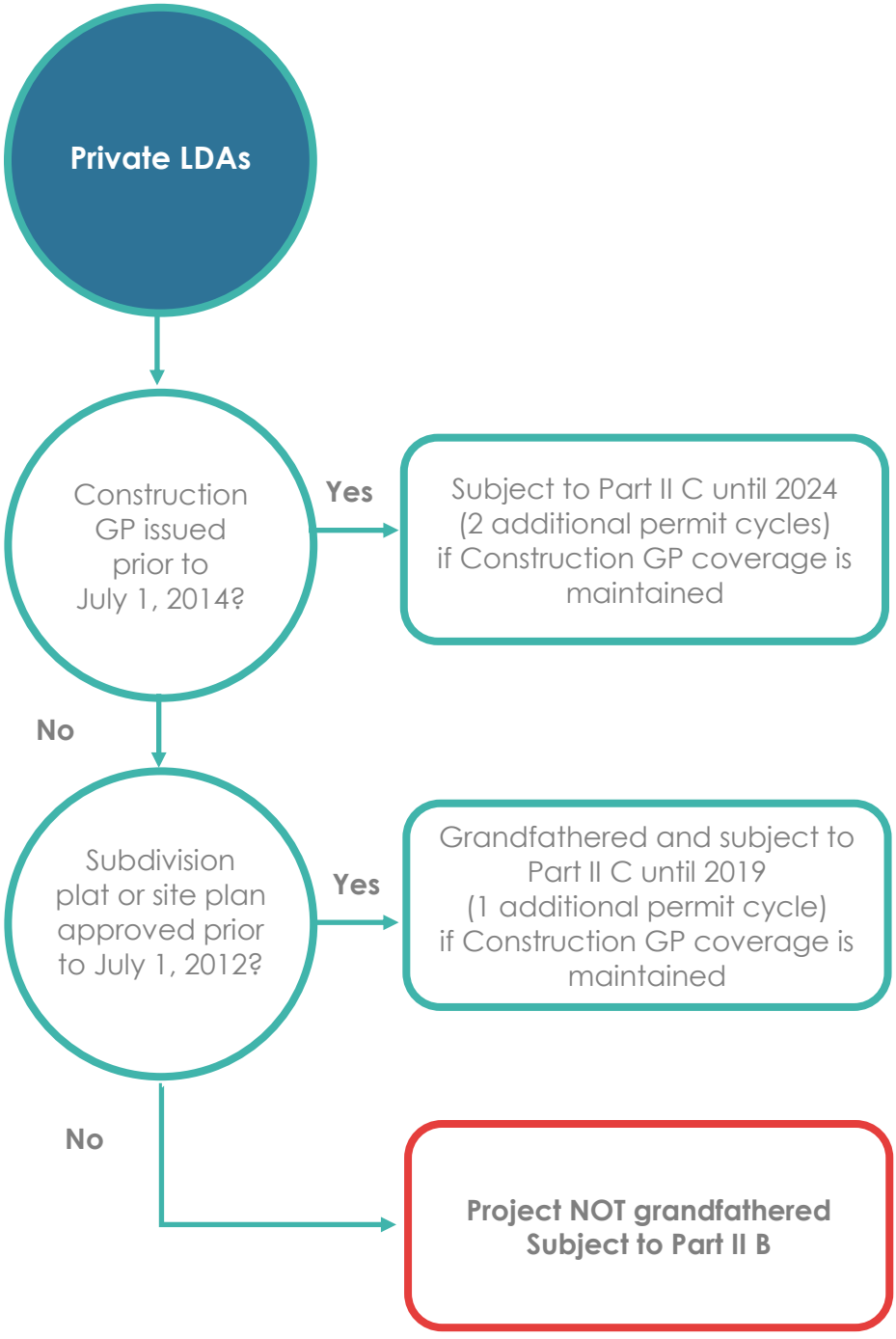
Land disturbing activities grandfathered under the provisions listed above, shall remain subject to the Part II C technical criteria for **one additional state permit cycle**. After such time, portions of the project not under construction shall become subject to any new technical criteria adopted by the Board.

In cases where governmental bonding or public debt financing has been issued for a project prior to July 1, 2012, such project shall be subject to the technical criteria of Part II C.

★Nothing in this section precludes an operator from constructing to a more stringent standard at their own discretion.

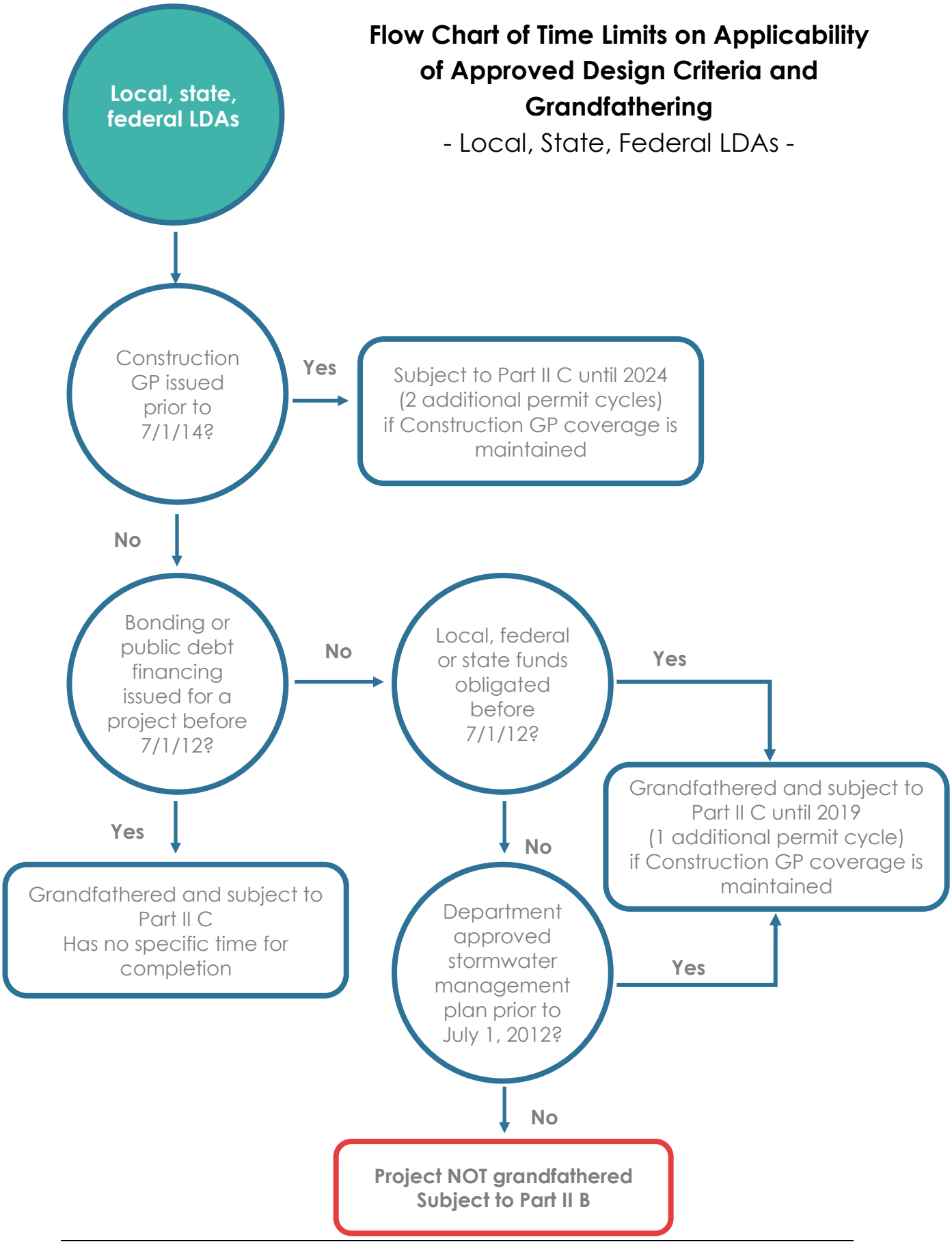
Flow Chart of Time Limits on Applicability of Approved Design Criteria and Grandfathering

- Private LDAs -



Flow Chart of Time Limits on Applicability of Approved Design Criteria and Grandfathering

- Local, State, Federal LDAs -



Chesapeake Bay Preservation Act land-disturbing activity

(9VAC25-870-51)

Chesapeake Bay Preservation Act LDAs do not require completion of a registration statement or coverage under the Construction GP.

However, prior to the start of LDA, the Part II A administrative criteria and Part II B technical criteria must be met.

A **Chesapeake Bay Preservation Act land-disturbing activity** applies to LDAs that result in a land disturbance **greater than or equal to 2,500 sq. ft. and less than one-acre** in all areas of jurisdictions designated as subject to the Chesapeake Bay Preservation Area Designation and Management Regulations.
(9VAC25-870-10)

Part II Knowledge Check

1. Are local governments able to impose more stringent technical criteria or other requirements than are included in the Regulations?

2. A two-acre LDA received a Construction GP on March 14, 2013. What technical criteria must be met and for how long?

3. What are the exceptions to the question above?

4. What date must grandfathered projects be completed by?

5. If a portion of the grandfathered project is not complete by the above date, what happens?

Part II A – General Administrative Criteria for Regulated Land-Disturbing Activities

Applicability (9VAC25-870-53)

Part II A applies to all regulated LDAs. This part explains the **components of a Construction GP application**. The stormwater management plan review process is detailed later in 9VAC25-870-108.

Stormwater pollution prevention plan (SWPPP) requirements (9VAC25-870-54)

The SWPPP is the cornerstone of the Construction GP and the VSMP. The plan includes prevention measures for both during and after construction. All SWPPPs must contain the following:

1. Approved erosion and sediment control plan
2. Approved stormwater management plan
3. Pollution prevention plan (P2 Plan)
4. Plan specifying any additional control measures to meet the requirements of a TMDL (if applicable)

The SWPPP must address the following nine requirements:

1. Control stormwater volume and velocity within the site to minimize soil erosion
2. Control stormwater discharges, including peak flow rates and total stormwater volume, to minimize erosion at outlets and to minimize downstream channel and stream bank erosion
3. Minimize the amount of soil exposed during construction activity
4. Minimize the disturbance of steep slopes
5. Minimize sediment discharges from the site through the design, installation and maintenance of controls that address factors such as:
    - Amount, frequency, intensity, and duration of precipitation

- Nature of resulting stormwater runoff
- Soil characteristics, including the range of particle sizes

6. Provide and maintain natural buffers around surface waters, direct stormwater to vegetated areas to increase sediment removal and maximize stormwater infiltration, unless infeasible
7. Minimize soil compaction and, unless infeasible, preserve topsoil
8. Immediately initiate stabilization of disturbed areas where LDA ceases longer than 14 days; and in arid, semiarid, and drought areas, employ alternative stabilization measures as specified by the VSMP authority
9. Utilize outlet structures that discharge water from the surface of impoundments

Amendments - The SWPPP must be amended whenever there is a change in design, construction, operation, or maintenance that has a significant effect on the discharge of pollutants to state waters and that has not been previously addressed in the SWPPP.

Location - The SWPPP must be maintained at a certain location onsite. If onsite location is unavailable, notice of the SWPPP's location must be posted near the main entrance at the construction site.

Stormwater management plans (9VAC25-870-55)

Updated with 12/17/13 Board approved amendments

The stormwater management plan is part of the SWPPP and must be approved by the VSMP authority prior to land disturbance. The plan outlines how stormwater leaving a site after construction will meet the necessary water quality and quantity technical criteria. The plan review process is outlined in (9VAC25-870-108).

The plan must:

1. Apply the appropriate technical criteria to the entire LDA. **Individual lots in new residential, commercial, or industrial developments shall not be considered separate LDAs.**
2. Consider all sources of surface runoff and all sources of subsurface and groundwater flows converted to surface runoff.

The plan must include the following elements:

1. Information on the type of and location of stormwater discharges, information on the features to which stormwater is being discharged including:
    - Surface waters or karst features if present
    - Pre-development and post-development drainage areas
2. Contact information including:
    - Name, address, telephone number, and email address of the owner
    - Tax reference number and parcel number of the property or properties affected
3. Narrative including:
    - Description of current site conditions and final site conditions
    - Or if allowed by the VSMP authority, the information provided and documented during the review process that addresses the current and final site conditions
4. General description of the proposed stormwater management facilities and the mechanism through which the facilities will be operated and maintained after construction is complete
5. Information on the proposed stormwater management facilities, including:
    - Type of facilities
    - Location, including geographic coordinates
    - Acres treated
    - Surface waters or karst features into which the facility will discharge
6. Hydrologic and hydraulic computations, including runoff characteristics
7. Documentation and calculations verifying compliance with the water quality and quantity requirements of these Regulations
8. Map(s) of the site that depict the topography of the site and includes:
    - All contributing drainage areas
    - Existing streams, ponds, culverts, ditches, wetlands, other water bodies, and floodplains

- Soil types, karst features if present, forest cover, and other vegetative areas
- Current land use including existing structures, roads, and location of known utilities and easements
- Sufficient information on adjoining parcels to assess the impacts of stormwater from site on these parcels
- Limits of clearing and grading, and the proposed drainage patterns on the site
- Proposed buildings, roads, parking areas, utilities, and stormwater management facilities
- Proposed land use with tabulation of the percentage of surface area to be adapted to various uses, including but not limited to planned locations of utilities, roads, and easements

9. Letter of availability from the off-site provider if using off-site compliance options
10. Fee and fee form if required

Record drawings for the plan must be appropriately sealed and signed by a professional registered in Virginia.

At the completion of the project, a construction record drawing ("as-built") for permanent stormwater management facilities must be provided bearing the seal and signature of a Virginia registered professional, certifying that the stormwater management facilities have been constructed in accordance with the approved plan.

Stormwater management facility means a control measure 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. (9VAC25-870-10)	**A best management practice (BMP)** means schedules of activities, prohibitions of practices, maintenance procedures, and other best management practices, including both structural and nonstructural practices, maintenance procedures, and other management practices to prevent or reduce the pollution of surface waters and groundwater systems. (9VAC25-870-10)

Pollution prevention plans (P2 plan) (9VAC25-870-56)

The P2 plan is also part of the SWPPP. It describes the pollution prevention measures that will take place during construction.

The P2 plan must detail the design, installation, implementation, and maintenance of effective pollution prevention measures to minimize the discharge of pollutants during construction.

At a minimum, such measures must be designed, installed, implemented, and maintained to:

1. Minimize discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters
    - Wash waters must be treated in a sediment basin or alternative control that provides equivalent or better treatment prior to discharge
2. Minimize exposure of the following to precipitation and stormwater:
    - Building materials
    - Building products
    - Construction wastes
    - Trash
    - Landscape materials
    - Fertilizers
    - Pesticides
    - Herbicides
    - Detergents
    - Sanitary waste
    - Other materials on the site
3. Minimize discharge of pollutants from spills and leaks, and implement chemical spill and leak prevention and response procedures

P2 plan must include effective best management practices to prohibit the following discharges:

1. Wastewater from washout of concrete, unless managed by an appropriate control
2. Wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds, and other construction materials
3. Fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance
4. Soaps or solvents used in vehicle and equipment washing

Discharges from dewatering activities, including discharges from dewatering of trenches and excavations, are prohibited unless managed by appropriate controls.

Requesting an exception (9VAC25-870-57)

- A written request for an exception for the technical criteria in Part II B or Part II C, including the reason for making the request, may be made to the VSMP authority. The request for an exception will be reviewed pursuant to 9VAC25-870-122.

The VSMP authority **cannot** grant exceptions for:

- Economic hardship alone
- Obtaining a state permit

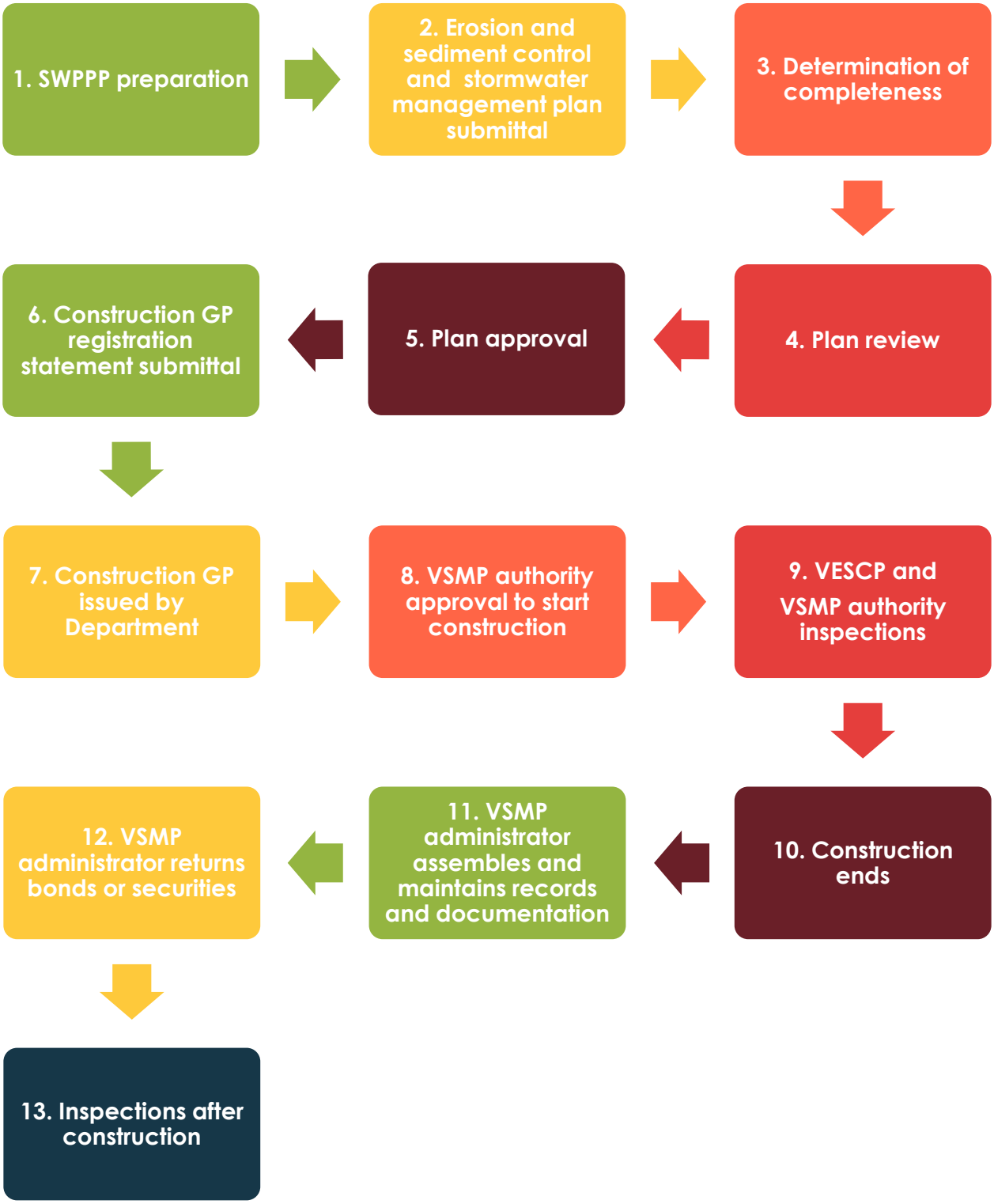
Long Term Maintenance (9VAC25-870-58)

An agreement in accordance with 9VAC25-870-112 for the long-term maintenance of a permanent stormwater management facility must be prepared and submitted to the VSMP authority for review and approval **before** the stormwater management plan can be approved.

Applying for state permit coverage (9VAC25-870-59)

The operator must submit a complete, accurate registration statement on the official Department form to the VSMP authority in order to apply for state permit coverage. The registration statement must be signed by the operator in accordance with 9VAC25-870-370.

VSMP Process



Part II A Knowledge Check

1. What are the four components of a SWPPP?

2. Who approves the erosion and sediment control plan?

3. Which two plans have to be approved before the Department can issue a Construction GP?

4. Which plan within the SWPPP describes the pollution prevention measures that will take place during construction activities to protect waterways?

Part II B – Technical Criteria for Regulated Land-Disturbing Activities

This part of the Regulations addresses Virginia's new approach to stormwater management by improving water quality through runoff reduction (i.e. reduce and treat stormwater runoff) and by establishing water quantity standards (i.e. storage and release of stormwater runoff) for channel and flood protection.

The water quality and quantity objectives of this part are integrated into the Virginia Runoff Reduction Method (RRM) compliance calculation spreadsheet. By meeting the requirements of the RRM, a BMP's treatment for water quality is improved and runoff volume is reduced.

The BMP Clearinghouse at **vwrrc.vt.edu/swc** contains the design standards and specifications for the approved stormwater best management practices (BMPs) that can be used to control post-development stormwater quality and quantity.

Applicability (9VAC25-870-62)

Part II B establishes the minimum technical criteria that must be used by a state agency or a VSMP authority to protect water quality and quantity.

Water quality design criteria requirements (9VAC25-870-63)

In order to protect the quality of state waters and to control the discharge of stormwater pollutants from regulated activities, the minimum design criteria and statewide standards in Table 3-2 below for stormwater management must be applied to the site.

Part II B Water Quality Design Criteria Requirements (9VAC25-870-63)

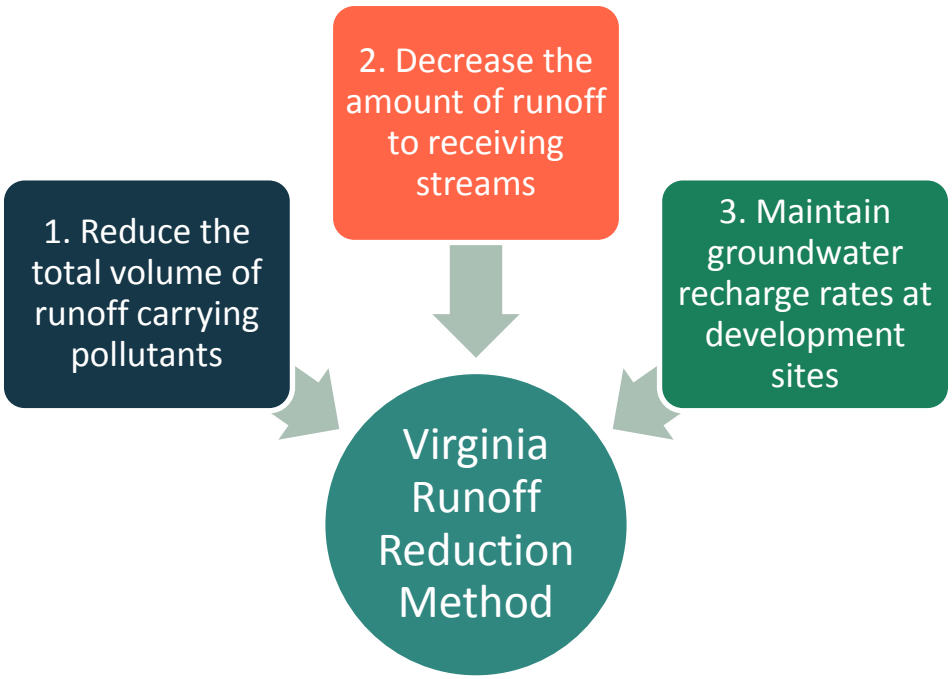
Table 3-2

Development Scenario	Phosphorus (P) Load
New development	Cannot exceed **0.41** lbs./acre/yr.
Development on prior developed land	
LDA **does not** increase impervious cover from pre-development conditions	
LDA ≥ 1 acre	Must be reduced at least **20%** below pre-development P load
LDA < 1 acre	Must be reduced at least **10%** below pre-development P load
LDA **does** increases impervious cover over pre-development conditions	
LDA ≥ 1 acre	Increased impervious area cannot exceed **0.41** lbs./acre/yr. and on remainder of site must be reduced **20%** below pre-development P load
LDA < 1 acre	Increased impervious area cannot exceed **0.41** lbs./acre/yr. and on remainder of site must be reduced **10%** below pre-development P load
Linear development	Must be reduced **20%** below the pre-development P load

★The total P load must not be required to be reduced below the new development standard unless a more stringent standard has been established by a locality.

Water quality compliance (9VAC25-870-65)

Compliance with the water quality design criteria of 9VAC25-870-63 shall be determined by using the Virginia Runoff Reduction Method or an equivalent methodology approved by the board.



The 15 BMPs listed below are approved for use as necessary to effectively reduce the P load and runoff volume in accordance with the Virginia Runoff Reduction Method.

1. Vegetated roof
2. Rooftop disconnection
3. Rainwater harvesting
4. Soil amendments
5. Permeable pavement
6. Grass channel
7. Bioretention
8. Infiltration
9. Dry swale
10. Wet swale
11. Sheet flow to filter/open space
12. Extended detention pond
13. Filtering practice
14. Constructed wetland
15. Wet pond

Other approved BMPs found on the Virginia Stormwater BMP Clearinghouse website may be utilized. Design specifications and the pollutant removal efficiencies for all approved BMPs are found on the Virginia Stormwater BMP Clearinghouse website.

BMPs other than those listed on page 20 or on the Clearinghouse shall be reviewed and approved by the Director in accordance with procedures established by the Department.

A VSMP authority **may** limit the use of specific BMPs.

The VSMP authority shall have the discretion to allow the water quality design criteria to be applied to each drainage area of the site. However, where a site drains to more than one hydrologic unit code (HUC), the pollutant load reduction requirements shall be applied independently within each HUC unless reductions are achieved in accordance with a comprehensive stormwater management plan in accordance with 9VAC25-870-92.

Offsite alternatives where allowed in accordance with 9VAC25-870-69 may be utilized to meet the design criteria listed in Table 3-2 (9VAC25-870-63).

Channel means a natural or manmade waterway. (9VAC25-870-10)

Flooding means a volume of water that is too great to be confined within the banks or walls of the stream, water body, or conveyance system and that overflows onto adjacent lands, thereby causing or threatening damage. (9VAC25-870-10)

Concentrated flow is runoff that accumulates or converges into well-defined channels.

Sheet flow is an overland flow or down slope movement of water taking the form of a thin, continuous film over the land. Sheet flow picks up and transports loose soil particles, eroding the site.

Water quantity (9VAC25-870-66)

This section explains what post-development minimum water quantity standards must be met in site design and included in the stormwater management plan.

The water quantity standards cover channel and flood protection for both concentrated and sheet flow. This section also explains how to determine if a project will meet those minimum standards.

Compliance with these minimum standards satisfies the requirements of Minimum Standard 19 of the Erosion and Sediment Control Regulations.

A locality's VSMP authority may establish more stringent standards especially where more stringent requirements are

necessary to address total maximum daily load requirements or to protect exceptional state waters.

Channel protection

The purpose of channel protection criteria is to prevent habitat degradation and erosion in natural streams caused by an increased frequency of bankfull and sub-bankfull stormwater flows. The channel protection criteria seek to minimize downstream channel enlargement and opening that is a common consequence of development.

Concentrated stormwater flow from a development must be released into a stormwater conveyance system and must meet the quantity criteria from a discharge point to the point where the limits of analysis (explained below) is applied for these three conditions following the LDA:

1. Discharge to a **manmade** stormwater conveyance system
    - Conveyance system must convey the post-development peak flow rate from the two-year 24-hour storm event without causing erosion of the system
    - Detention of stormwater or downstream improvements may be incorporated into the approved LDA to meet this criterion at the discretion of the VSMP authority
2. Discharge to a **restored** stormwater conveyance system that has been restored using natural design concepts
    - The development shall be consistent, in combination with other stormwater runoff, with the design parameters of the restored stormwater conveyance system that is functioning in accordance with the design objectives; or

3 types of stormwater conveyance systems
(9VAC25-870-10)

Manmade stormwater conveyance system means a pipe, ditch, vegetated swale, or other stormwater conveyance system constructed by man except for restored stormwater conveyance systems.

Restored stormwater conveyance system means a stormwater conveyance system that has been designed and constructed using natural channel design concepts. Restored stormwater conveyance systems include the main channel and the flood-prone area adjacent to the main channel.

Natural stormwater conveyance system means the main channel of a natural stream and the flood-prone area adjacent to the main channel.

- The requirements below for natural stormwater conveyance systems shall be met

3. Discharge to a **natural** stormwater conveyance system
    - The maximum peak flow rate from the one-year 24-hour storm following the LDA shall be calculated using the energy balance equation:

$$\mathbf{Q}_{Developed} \leq \mathbf{I.F.} \times (\mathbf{Q}_{Pre\text{-}developed} \times \mathbf{RV}_{Pre\text{-}Developed}) \; / \; \mathbf{RV}_{Developed}$$

$Q_{Developed}$	Allowable peak flow rate of runoff from the developed site
$RV_{Developed}$	Volume of runoff from the site in the developed condition
$Q_{Pre\text{-}Developed}$	Peak flow rate of runoff from the site in the pre-developed condition
$RV_{Pre\text{-}Developed}$	Volume of runoff from the site in pre-developed condition
Q_{Forest}	Peak flow rate of runoff from the site in a forested condition
RV_{Forest}	Volume of runoff from the site in a forested condition
I.F.	Improvement factor

★ Under no condition can the post-development peak flow rates be greater than pre-development peak flow rates

★ Under no condition can the post-development peak flow rates be required to be less than the peak flow rate of the site in a forested condition after adjusting for runoff volume

A VSMP authority may use another methodology that has been demonstrated to achieve equivalent results and has been approved by the Board

Limit of analysis - Unless the methodology for natural stormwater conveyance systems is utilized, stormwater conveyance systems must be analyzed for compliance with the channel protection criteria to a point where either:

- **Based on land area**, the site's contributing drainage area is less than or equal to 1% of the total watershed area; or
- **Based on peak flow rate**, the site's peak flow rate from the one-year 24-hour storm is less than or equal to 1% of the existing peak flow rate from the one-year 24-hour storm prior to the implementation of any stormwater quantity control measures

Flood protection

The goal of flood protection is to prevent flood damage to the conveyance system and drainage infrastructure and reduce minor flooding caused by over-bank floods. Over-bank floods are defined as floods which exceed the bankfull capacity of the channel and spill over onto the floodplain, where they can damage property and structures. The key management objective is to protect downstream structures, culverts, and bridges from increased over-bank flooding.

To meet the minimum standards for flood protection, post-development concentrated stormwater flow must be released into a stormwater conveyance system and must meet the following point of discharge criteria for stormwater conveyance systems that either **do** or **do not** experience localized flooding during the 10-year 24-hour storm event:

1. **Do not** experience localized flooding during the 10-year 24-hour storm event:
    - Post-development peak flow rate from the 10-year 24-hour storm event must be confined within the stormwater conveyance system
        - Detention of stormwater or downstream improvements may be incorporated into the approved LDA at the discretion of the VSMP authority
2. **Do** experience localized flooding during the 10-year 24-hour storm event, either:
    - Post-development peak flow rate from the 10-year 24-hour storm event must be confined within the stormwater conveyance system
        - Detention of stormwater or downstream improvements may be incorporated into the approved LDA to meet this criterion at the discretion of the VSMP authority

    Or

    - Post-development peak flow rate released for the 10-year 24-hour storm event must be less than the pre-development peak flow rate from the 10-year 24-hour storm event

- Downstream stormwater conveyance systems do not require any additional analysis to show compliance with flood protection criteria if this option is utilized

Limits of analysis – Unless the post-development peak flow rate for the 10-year 24-hour storm event is less than the pre-development peak flow rate for the 10-year 24 hour storm event, stormwater conveyance systems shall be analyzed for compliance with flood protection criteria to a point where either:

1. The site's contributing drainage area is ≤ 1.0% of the total watershed area draining to a point of analysis in the downstream stormwater conveyance system
2. Based on peak flow rate, the site's peak flow rate from the 10-year 24-hour storm event is ≤ 1.0% of the existing peak flow rate from the 10-year 24-hour storm event prior to the implementation of any stormwater quantity control measures
3. The stormwater conveyance system enters a mapped floodplain or other flood-prone area, adopted by ordinance, of any locality

Sheet flow - Increased volumes of sheet flow resulting from pervious or disconnected impervious areas, or from physical spreading of concentrated flow through level spreaders, must be identified and evaluated for potential impacts on down-gradient properties or resources.

Increased volumes of sheet flow that will cause or contribute to erosion, sedimentation, or flooding of down gradient properties or resources shall be diverted to a stormwater management facility or a stormwater conveyance system that conveys the runoff without causing down-gradient erosion, sedimentation, or flooding. If all runoff from the site is sheet flow and the conditions of this section are met, then no further water quantity controls are required.

Computing pre-development runoff - All pervious lands on the site shall be assumed to be in good hydrologic condition in accordance with the U.S. Department of Agriculture's NRCS standards, regardless of conditions existing at the time of computation. Pre-development runoff calculations utilizing other hydrologic conditions may be utilized provided that it is demonstrated to and approved by the VSMP authority that actual site conditions warrant such considerations.

Pre-development and post-development runoff characteristics and site hydrology - Must be verified by site inspections, topographic surveys, available soil mapping or studies, and calculations consistent with good engineering practices. Guidance provided in the Virginia Stormwater Management Handbook and by the Virginia Stormwater BMP Clearinghouse shall be considered appropriate practices.

Offsite compliance options (9VAC25-870-69)

If an operator cannot meet the water quality design criteria (9VAC25-870-63) onsite, a VSMP authority may allow the operator to meet them offsite.

Offsite options include:

- Controls utilized in accordance with a comprehensive stormwater management plan (9VAC25-870-92) for the local watershed within which a project is located
- A locality pollutant loading pro rata share program (§ 15.2-2243) or similar local funding mechanism
- Nonpoint nutrient offset program (§62.1-44.15:35)
- Other offsite options approved by an applicable state agency or state board
- An operator's additional properties that are within the same hydrologic unit code (HUC) or upstream HUC that the LDA directly discharges to or within the same watershed as determined by the VSMP authority

Offsite options **can** be used under any of the following conditions:

- Less than five acres of land will be disturbed
- Post-development construction P load is less than 10 pounds per year
- At least 75% of the required P reductions are achieved onsite

If at least 75% of the required P nutrient reductions cannot be met onsite, and the operator can demonstrate to the satisfaction of the VSMP authority all of the following, then the required P reductions may be achieved, in whole or in part, offsite:

- Alternative site designs have been considered that may accommodate onsite BMPs

- Onsite BMPs have been considered in alternative site designs to the maximum extent practicable
- Appropriate onsite BMPs will be implemented
- Full compliance with post-development nonpoint nutrient runoff compliance requirements cannot practicably be met onsite

Offsite options are **not** allowed if:

- The selected offsite option does not achieve the necessary P reductions prior to the start of LDA
    - Phased projects - Operator may acquire or achieve offsite P reductions prior to the commencement of each phase of LDA in an amount sufficient for each phase
- Local water quality-based limitations at the point of discharge based on an impaired waters plan or an MS4 program plan

Design storms and hydrologic methods (9VAC25-870-72)

This section specifies the hydrologic methods that may be used to analyze site conditions for the selection and design of BMPs so that the BMPs are in compliance with water quality and quantity design criteria in Part II B. The analysis must be included in the stormwater management plan.

Prescribed design storms are the one-year, two-year, and 10-year 24-hour storms using the site-specific rainfall precipitation frequency data recommended by the U.S. National Oceanic and Atmospheric Administration Atlas 14 (found in Chapter 11 of the 2013 Virginia Stormwater

Hydrology is the science of the characteristics, distribution, and movement of water on and below the earth's surface and in the atmosphere.

Hydrologic methods are used in these Regulations to estimate flow peaks, volumes, and time distribution of stormwater runoff. The analysis of these parameters is fundamental for the design of BMPs.

There are a number of **factors** that affect the nature of stormwater runoff from the site including:

- Rainfall amount and storm distribution
- Drainage area site, shape, and orientation
- Ground cover and soil type
- Slopes of terrain and stream channel(s)
- Relative wetness or dryness of a watershed
- Watershed development potential
- Watershed development potential

Management Handbook).

Unless otherwise specified, the hydrologic analyses must be based on the existing watershed characteristics and the ultimate development conditions.

The analysis in Part II B shall be done using the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) synthetic 24-hour rainfall distribution and models, including, but not limited to:

- TR-55 and TR-20 (computer models)
- Hydrologic and hydraulic methods developed by the U.S. Army Corps of Engineers
- Other standard hydrologic and hydraulic methods

The VSMP authority may allow for the use of the Rational Method for evaluating peak discharges for drainage areas of 200 acres or less, and may allow the use of the Modified Rational Method for evaluating volumetric flows to stormwater conveyances for drainage areas of 200 acres or less.

Stormwater harvesting (9VAC25-870-74)

Stormwater harvesting is encouraged for the purposes of landscape irrigation systems, fire protection systems, toilet flushing, and other water handling systems (non potable) to the extent such systems are consistent with federal, state, and local regulations.

Linear development projects (9VAC25-870-76)

Linear development projects shall control post-development stormwater runoff in accordance with a site-specific stormwater management plan or a comprehensive watershed stormwater management plan (9VAC25-870-92).

Linear development projects are land-disturbing activities that are linear in nature.
Example: construction of electric and telephone utility lines, natural gas lines, highway construction projects, water and sewer lines, etc. (9VAC25-870-10)

Stormwater management impoundment structures or facilities (9VAC25-870-85)

Stormwater management wet ponds and extended detention ponds that are not covered by the Impounding Structure Regulations shall, at a minimum, be engineered for structural integrity for the 100-year storm event.

Karst areas

A study of the geology and hydrology of the area must first been conducted to determine the presence or absence of karst features that may be impacted by stormwater runoff and BMP placement.

- Discharges to a karst feature must still meet the water quality (9VAC25-870-63)and quantity (9VAC25-870-66) design criteria
- Permanent stormwater management impoundment structures or facilities shall only be constructed after completion of a geotechnical investigation that identifies any necessary modifications to the BMP to ensure its structural integrity and maintain its water quality and quantity efficiencies
- The person responsible for the LDA is encouraged to screen for known existence of heritage resources in the karst features
- Any Class V Underground Injection Control Well registration statements for stormwater discharges to improved sinkholes shall be included in the SWPPP

Comprehensive stormwater management plans (9VAC25-870-92)

A locality's VSMP authority may develop comprehensive stormwater management plans (regional stormwater management plans) to be approved by the Department. The plans must meet the water quality objectives, quantity objectives, or both of these Regulations.

Appendix 3-A of the 2013 Stormwater Management Handbook discusses the potential elements of a comprehensive local stormwater management program and how to synchronize independent but related local requirements into a more cohesive and efficient program delivery system.

Plan components:

- Ensure offsite reductions equal to or greater than those that would be required on each contributing site are achieved within the same hydrologic unit code (HUC) or within another locally designated watershed
- Implementation of a combination of channel improvement, stormwater detention, or other measures that are satisfactory to the locality's VSMP authority may be provided to prevent downstream erosion and flooding (water quantity)

If the land use assumptions upon which the plan was based change or if any other amendments are deemed necessary by the locality's VSMP authority, the authority shall provide plan amendments to the Department for review and approval.

During the plan's implementation, the locality's VSMP authority shall document nutrient reductions accredited to the BMPs specified in the plan.

State and federal agencies may develop comprehensive stormwater management plans, and may participate in locality-developed comprehensive stormwater management plans where practicable and permitted by the locality's VSMP authority.

Part II B Knowledge Check

1. What nutrient is measured to control the quality of stormwater discharge from a site after construction?

2. Why is it important to control the quantity of stormwater leaving a site after construction?

3. What are the three conditions that offsite options can be used under to meet required P reductions?

Part II C - Technical Criteria for Regulated Land-Disturbing Activities: Grandfathered Projects and Projects Subject to the Provision of 9VAC25-870-47 B

Definitions (9VAC25-870-93)

This section supplements the definitions provided at the start of the VSMA and the Regulations. Most of these definitions pertain to BMPs specified in the 1999 Virginia Stormwater Management Handbook.

Applicability (9VAC25-870-94)

Part II C applies to grandfathered (9VAC25-870-47 B) LDAs.

General (9VAC25-870-95)

This section specifies the technical and performance criteria applied to grandfathered LDAs.

Water quality (9VAC25-870-96)

Grandfathered projects can achieve compliance by applying either the performance-based criteria or the technology-based criteria to the site or a planning area.

Performance based criteria

Regulated LDAs are divided into four land development situations (Table 4-3). The calculated post-development pollutant runoff load is compared to the calculated pre-development load based upon the average land cover condition or the existing site condition.

A BMP shall be located, designed, and maintained to achieve the target pollutant removal efficiencies specified in Table 4-4 to effectively reduce the pollutant load to the required level based upon the four applicable land development situations in Table 4-3.

Part II c Water Quality Performance-Based Criteria (9VAC25-870-96)

Table 4-3

% Existing impervious cover	% Proposed impervious cover	Pollutant discharge requirement after disturbance
1. ≤ Average land cover condition	< Average land cover condition	No reduction required
2. ≤ Average land cover condition	> Average land cover condition	Cannot exceed existing average land cover condition pollutant discharge
3. > Average land cover condition		Cannot exceed: - Pollutant discharge based on existing conditions less 10%; or - Pollutant discharge based on average land cover condition **Whichever is greater**
4. Served by an existing stormwater management BMP		- Cannot exceed existing discharge based on existing % impervious cover while served by the existing BMP - Existing BMP must show that it was designed and constructed in accordance with proper design standards and specifications, and be in functioning condition

Average land cover condition means a measure of the average amount of impervious surfaces within a watershed, assumed to be 16% or a calculated watershed-specific value for the average land cover conditions as approved by the Chesapeake Bay Local Assistance Board prior to September 13, 2011 (9VAC25-870-93)

Technology based criteria

Post-development stormwater runoff from impervious cover shall be treated by an appropriate BMP as required by the post-development condition percent impervious cover as specified in Table 4-4 on the next page.

Part II C BMP Target Pollutant Removal Efficiencies (9VAC25-870-96)

Table 4-4

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

*Innovative or alternate BMPs not included in this table may be allowed at the discretion of the local program administrator or the department. Innovative or alternate BMPs not included in this table that target appropriate nonpoint source pollution other than phosphorous may be allowed at the discretion of the local program administrator or the department.

Stream channel erosion (9VAC25-870-97)

This section describes the requirements that must be met to protect downstream properties and receiving channels from changes to hydrologic characteristics resulting from LDAs.

The VSMP authority shall require compliance with Minimum Standard 19 of the Virginia Erosion and Sediment Control Regulations to protect properties and receiving waterways downstream of any LDA from erosion and damage due to changes in runoff rate of flow and hydrologic characteristics.

The locality's VSMP authority may determine some watersheds or receiving stream systems require enhanced criteria in order to address the increased frequency of bankfull flow

conditions (top of bank) brought on by LDA or where more stringent requirements are necessary to address TMDL requirements or to protect exceptional waters

Therefore, instead of the reduction of the two-year post-development peak rate of runoff as required by Minimum standard 19, the land development project being considered shall provide 24-hour extended detention of the runoff generated by the one-year, 24-hour duration storm.

A locality's VSMP authority may, by ordinance, or the Board by regulation, adopt more stringent channel analysis criteria or design standards to ensure that the natural level of channel erosion, to the maximum extent practicable, will not increase due to the LDA. These criteria may include, but are not limited to, the following:

- Criteria and procedures for channel analysis and classification
- Procedures for channel data collection
- Criteria and procedures for the determination of the magnitude and frequency of natural sediment transport loads
- Criteria for the selection of proposed natural or manmade channel linings

Flooding (9VAC24-870-98)

The 10-year post-development peak rate of runoff from the development site shall not exceed the 10-year pre-developed peak; or localities may, by ordinance, adopt alternate design criteria based upon geographic, land use, topographic, geologic factors, or other downstream conveyance factors.

Linear development projects shall not be required to control post-development stormwater runoff for flooding, except in accordance with a watershed or regional stormwater management plan.

Regional (watershed-wide) stormwater management plans

(9VAC25-870-99)

Water quality requirements and where allowed, water quantity requirements, may be achieved by utilizing offsite compliance options (9VAC25-870-69) and through the use of comprehensive stormwater management plans (9VAC25-870-92).

Part II C Knowledge Check

The following questions all pertain to grandfathered projects

1. What is the assumed percentage of impervious surface in a watershed?

2. If the percentage of proposed impervious cover for a project is less than the average land cover condition and the existing percentage of impervious cover on the site is less than or equal to the average land cover condition, what is the pollutant discharge requirement?

3. When utilizing technology based criteria, is the appropriate BMP selected based on the pre-development condition or the post-development condition?

4. If utilizing a comprehensive stormwater management plan, what is the requirement for offsite reductions?

Part III – General Provisions Applicable to VSMPs and VSMP Authorities

Applicability (9VAC25-870-100)

Part III establishes:

- Board's procedures for the authorization of a VSMP
- Board's procedures for the administration of a VSMP by a locality's VSMP authority or by other VSMP authorities
- Board and Department oversight of a VSMP

Authority (9VAC25-870-102)

The Board is required to establish standards and procedures for the authorization of an entity to administer a VSMP.

VSMP authority requirements for Chesapeake Bay Preservation Act land-disturbing activities (9VAC25-870-103)

A VSMP authority must regulate runoff associated with Chesapeake Bay Preservation Act LDAs (greater than or equal to 2,500 sq. ft. and less than one-acre). After June 30, 2014, these LDAs do not require completion of a registration statement or require coverage under the Construction GP. However, the activity is subject to the technical criteria and program and administrative requirements set out in 9VAC25-870-51.

A VSMP authority permit, where applicable, shall be issued permitting the LDA.

The VSMP authority shall regulate such land disturbing activity in compliance with the:

- Program requirements in 9VAC25-870-104
- Plan review requirements in 9VAC25-870-108
- Long-term stormwater management facility requirements in 9VAC25-870-112
- Inspection requirements in 9VAC25-870-114

- Enforcement components in 9VAC25-870-116
- Hearing requirements in 9VAC25-870-118
- Exception conditions in 9VAC25-870-122
- Reporting and recordkeeping requirements in 9VAC25-870-126

A locality's VSMP authority shall adopt an ordinance, and other VSMP authorities shall provide program documentation, that incorporates the components of this section. In accordance with subdivision 5 of § 62.1-44.15:28 A, a locality's VSMP authority may collect a permit issuance fee from the applicant of $290 and an annual maintenance fee of $50 for such LDA.

Part III A – Programs Operated by a VSMP Authority

Criteria for programs operated by a VSMP authority (9VAC25-870-104)

- All VSMP authorities shall require compliance with the administrative and technical criteria for LDAs laid out in Part II (9VAC25-870-40 et seq.)
- When a locality's VSMP authority has adopted requirements more stringent than those imposed by these Regulations or implemented a comprehensive stormwater management plan (9VAC25-870-92), the Department shall consider such requirements in its review of state projects within that locality in accordance with Part IV (9VAC25-870-160 et seq.)
- Localities cannot regulate or require prior approval by a locality for a state or federal project unless authorized by separate statute
- A VSMP authority may require, excluding state and federal entities, the submission of a reasonable performance bond or other financial surety and provide for the release of such sureties in accordance with the criteria set forth in § 62.1-44.15:34

Additional requirements for VSMP authorities (9VAC25-870-106)

A locality's VSMP authority must adopt ordinances, and other VSMP authorities must provide program documentation, that ensure compliance with the state permit conditions

of 9VAC25-870-460 L and are at least as stringent as the provisions of the Construction GP (9VAC25-880).

Stormwater management plan review

(9VAC25-870-108)

Review of completeness

The VSMP authority (program administrator) has **15 days** to determine the completeness of a stormwater management plan in accordance with 9VAC25-870-55 and notify the applicant of its determination. If the application is not complete, the VSMP authority must notify the applicant in writing or electronically of the reason(s).

If a plan is complete and the applicant has been notified within 15 days of submission, the VSMP authority (plan reviewer) has **60 days from the time of notification** to review the plan.

If a determination of completeness is not made and communicated to the applicant within the 15 calendar days, the plan is determined complete as of the date of submission, and the VSMP authority (plan reviewer) has **60 days from the date of submission** to review the plan.

The VSMP authority (plan reviewer) has **45 days from the date of resubmission** to review a plan that was previously disapproved.

Plan review

During the review period, the VSMP authority (plan reviewer) must notify the operator or the designated agent in writing of the decision to approve or disapprove the plan. The reason(s) for not approving a plan must be provided in writing.

If a plan meets all the requirements of these Regulations and of the VSMP authority but no action is taken within the time specified above, then the plan is approved.

Modifications

The VSMP authority has **60 days** to respond in writing for plans that have been modified after approval with either an approval or disapproval.

Based on an inspection, the VSMP authority may require amendments to the approved stormwater management plan to address any deficiencies within a time frame set by the VSMP authority.

See diagram on next page for a comparison of the VESC and VSMP plan review process.

Comparison of VSMP and VESCP Plan Review Process

Long-term maintenance of permanent stormwater management facilities (9VAC25-870-112)

VSMP authority must require the provision of long-term responsibility for and maintenance of stormwater management facilities and other techniques specified to manage the quality and quantity of runoff. The requirements must be set forth in an instrument recorded in the local land records prior to state permit termination or earlier as required by the VSMP authority and shall at a minimum:

- Be submitted for review and approval prior to the approval of the stormwater management plan
- Be stated to run with the land
- Provide for all necessary access to the property for purposes of maintenance and regulatory inspections
- Provide for inspections and maintenance and the submission of inspection and maintenance reports to the VSMP authority
- Be enforceable by all appropriate governmental parties

At the discretion of the VSMP authority, such recorded instruments need not be required for stormwater management facilities designed to treat stormwater runoff primarily from an individual residential lot, provided it is demonstrated to the satisfaction of the VSMP authority that future maintenance of such facilities will be addressed through an enforceable mechanism at the discretion of the VSMP authority.

Inspections (9VAC25-870-114)

The VSMP authority must periodically inspect the LDA during construction for:

- Compliance with the approved erosion and sediment control plan
- Compliance with the approved stormwater management plan

According to the VSMA, VSMP authorities shall provide for **periodic inspections** for the installation of stormwater management measures. (§62.1-44.15:37)

- Development, updating, and implementation of a P2 plan
- Development and implementation of any additional control measures necessary to address a TMDL

Post-construction inspection program - The VSMP authority must establish an inspection program that ensures that stormwater management facilities are maintained after completion of the LDA. Inspection program shall:

- Be approved by the Board
- Ensure that each facility is inspected by the VSMP authority, or its designee, not to include the owner, except as provided below, at least once every five years
- Be documented by records

The VSMP authority may utilize the inspection reports of the owner of a stormwater management facility as part of its established inspection program if the inspection is conducted by a person who is licensed as a professional engineer, architect, landscape architect, or land surveyor; or a person who works under the direction and oversight of the licensed professional; or a person who holds an appropriate certificate of competence from the board.

If a recorded instrument is not required (9VAC25-870-112), a VSMP authority shall develop a strategy for addressing maintenance of stormwater management facilities constructed on an individual residential lot. Such a strategy may include periodic inspections, homeowner outreach and education, or other methods targeted at promoting the long-term maintenance of such facilities. Such facilities shall not be subject to the requirement for an inspection to be conducted by the VSMP authority.

Enforcement (9VAC25-870-116)

A locality's VSMP authority must adopt ordinances that outline the steps to be taken regarding enforcement actions under the VSMA and VSMP Regulations.

Informal and formal administrative enforcement procedures

- A locality's VSMP authority shall incorporate components of the following informal and formal administrative enforcement procedures into local ordinance: Verbal warnings and inspection reports
- Notice of corrective action
- Consent orders including civil charges in accordance with § 62.1-44.15:48 D 2
- Notices to comply in accordance with § 62.1-44.15:37

Civil and criminal judicial enforcement procedures

A locality's VSMP authority must incorporate enforcement authority and schedule of civil penalties for enforcement actions into local ordinance. The maximum penalty the court may issue is $32,500 per violation per day. Criminal misdemeanor and felony charges are also an option.

Violations for which a penalty may be imposed include, but are not limited to:

1. No state permit registration
2. No SWPPP
3. Incomplete SWPPP
4. SWPPP not available for review
5. No approved erosion and sediment control plan
6. Failure to install stormwater management BMPs or ESCs
7. Stormwater BMPs or erosion and sediment controls improperly installed or maintained
8. Operational deficiencies
9. Failure to conduct required inspections
10. Incomplete, improper, or missed inspections

Any civil penalty assessed by a court as a result of a summons issued by a locality VSMP authority shall be paid into the locality's treasury and is to be used for the purpose of

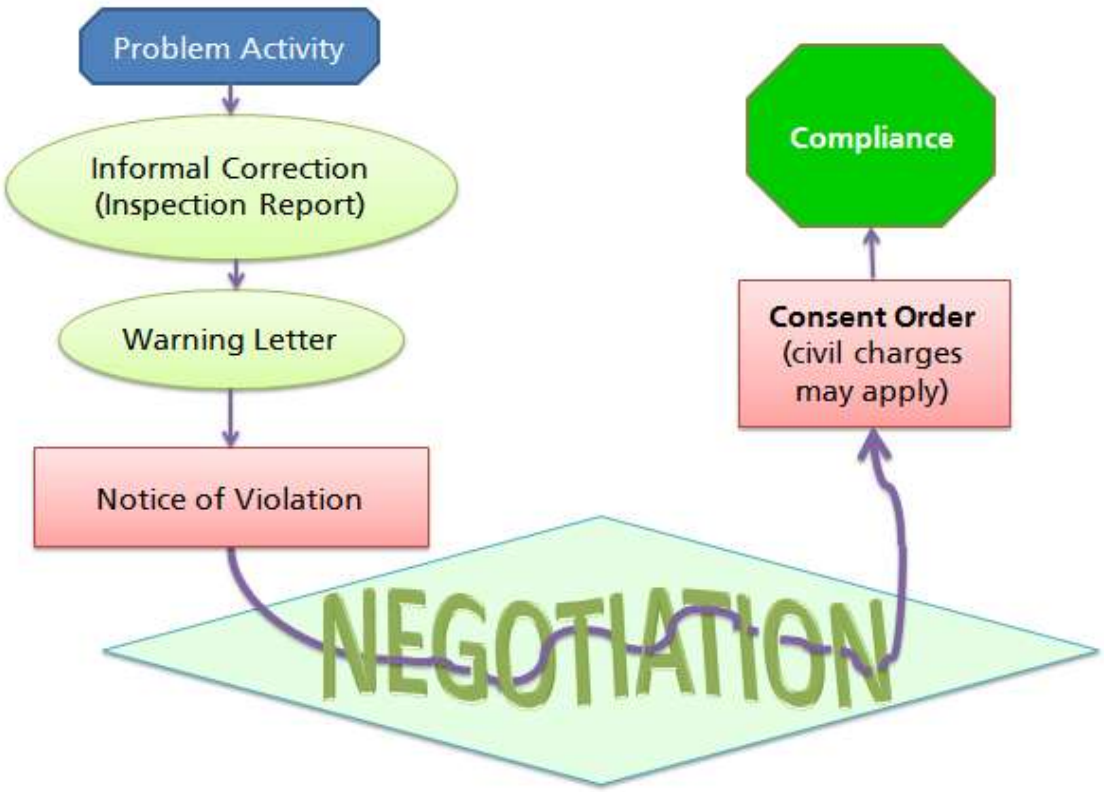
minimizing, preventing, managing, or mitigating pollution of the waters of the locality and reducing environmental pollution in such manner as the court may direct.

Permit revocation

The Board may revoke or amend state permits for good cause or when the violation meets specific statutory conditions related to environmental harm or culpability, or for failure to comply with a notice to comply.

DEQ enforcement model

The following flow chart is a simplified version of the standard DEQ enforcement model. The chart serves as an example of how compliance/enforcement actions would flow for a typical regulated activity. Different shapes used in the chart provide a visual roadmap for the different levels of compliance and enforcement activity that can be used to progressively handle problem activities or violations. **This chart is to be used solely as an example for the VSMP authority**. Each locality's VSMP authority must establish enforcement procedures.



DEQ enforcement model

Inspection reports {IR} and warning letters {WL}, issued by compliance staff, can be thought of as routine components of the compliance process. Warning letters provide opportunity for response and corrections within specified time periods. Failure to make appropriate and timely corrections in response to a warning letter can lead to further enforcement actions and assessment of civil charges or penalties.

Notices of violations {NOV} are the tools used once alleged violations are considered ongoing, persistent, severe, or of such significance that further enforcement action is deemed appropriate (e.g. continued non-compliance following notifications via inspection reports or warning letters). A notice of violation marks the transition from compliance to enforcement. If alleged violations are confirmed, a notice of violation may be resolved through a consent order .

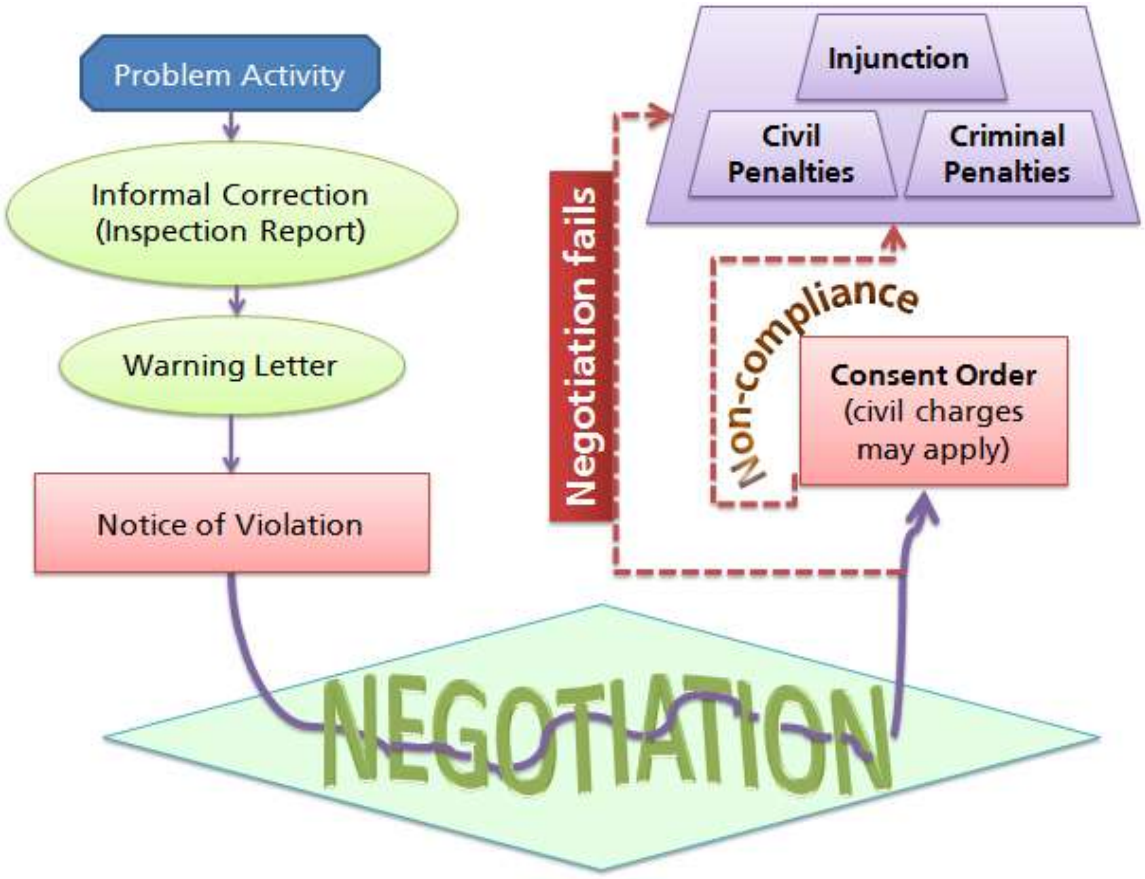
A consent order {CO} is issued with the consent of the responsible party, often after negotiation, and requires the responsible party to perform specific actions to return a site to compliance according to a compliance schedule and/or to pay civil charges.

Warning letters and notice of violations are both considered written notifications of ***alleged*** violations.

Level 3 Judicial Enforcement

Injunctions, civil penalties, and/or criminal penalties are remedies that can be obtained through judicial enforcement actions, which are used when other administrative enforcement tools as described in Level 1 and Level 2 are not adequate for achieving appropriate compliance in a timely manner (see flowchart below). Injunctions compel compliance through the courts by "any person violating or failing, neglecting, or refusing to obey any rule, regulation, ordinance, approved standard and specification, order or permit condition issued by the Board, Department, or VSMP authority as authorized to do such, or any provision of [the Stormwater Management Act]". See Va. Code §§ 62.1-44.15:25, 62.1-44.15:42, 62.1-44.15:48(D), 62.1-44.15:25; 9VAC25-870-660(A)(4). The court may also impose civil penalties up to $32,500 per day for each violation (Va. Code § 62.1-44.15:48(A)).

DEQ Enforcement Model



In addition to the procedures shown above, the Virginia Stormwater Management Act also authorizes VSMP authorities to issue notices to comply if they determine that there has been a failure to comply with permit conditions. Failure to comply with a notice to comply may be addressed with a stop work order issued in accordance with local procedures, revocation of local permits, judicial action, or a consent order.

Additional Resources:

For an overview of DEQ's enforcement procedures, see Chapter 2 of the DEQ Civil Enforcement Manual available at:
http://www.deq.virginia.gov/Programs/Enforcement/LawsRegulationsGuidance.aspx

Additionally, a DEQ model construction stormwater warning letter, notice of violation and consent order (documents 2-2E, 2-4F, and 2-15L) are available at:
http://www.deq.virginia.gov/Portals/0/DEQ/Enforcement/Manual/Chapter2/attachments/Chapter2A-Attachments(2013-12-2).pdf

These documents may be useful models for local VSMP authorities, but note that localities will need to amend them for consistency with local ordinances and to specify local enforcement authorities rather than DEQ/State Water Control Board enforcement authorities.

Additional enforcement guidance will be posted to the DEQ website as it becomes available:
http://www.deq.virginia.gov/Programs/Enforcement/LawsRegulationsGuidance.aspx

Hearings (9VAC25-870-118)

The VSMP authority shall ensure that any permit applicant, permittee, or person subject to state permit requirements under the VSMA aggrieved by any action of the VSMP authority taken without a formal hearing, or by inaction of the VSMP authority, shall have the right to a hearing pursuant to § 62.1-44.15:44 and shall ensure that all hearings held under these Regulations are conducted in a manner consistent with § 62.1-44.26 or as otherwise provided by law. The provisions of the Administrative Process Act (§ 2.2-4000 et seq.) shall

not apply to decisions rendered by localities but appeals shall be conducted in accordance with local appeal procedures.

Exceptions (9VAC25-870-122)

A VSMP authority may grant exceptions to the technical requirements of Part II B or Part II C. An exception may be granted provided the following:

- The exception is the minimum necessary to afford relief
- Reasonable and appropriate conditions shall be imposed so that the intent of the VSMA and Regulations are preserved
- Granting the exception will not confer any special privileges that are denied in other similar circumstances
- Exception requests are not based upon conditions or circumstances that are self-imposed or self-created

Remember, economic hardship alone is not sufficient reason to grant an exception from the requirements of the Regulations. The VSMP authority cannot grant an exception to the requirement that the LDA obtain required state permits, nor approve the use of a BMP not found on the Virginia Stormwater BMP Clearinghouse, except where allowed under Part II C. Exceptions to requirements for P reductions shall not be allowed unless offsite options have been considered and found not available.

A record of all exceptions granted shall be maintained by the VSMP authority.

Reports and record keeping (9VAC 25-870-126)

On a fiscal year basis (July 1 to June 30), a VSMP authority shall report to the Department by October 1 of each year. The information provided shall include:

- Information on each permanent stormwater management facility completed during the fiscal year
    - Type of stormwater management facility
    - Geographic coordinates

- Acres treated
- Surface waters or karst features into which the facility will discharge

- Number and type of enforcement actions during the fiscal year
- Number of exceptions granted during the fiscal year

A VSMP authority shall keep records in accordance with the following:

- Project records, including approved stormwater management plans, shall be kept for **three** years after state permit termination or project completion
- Stormwater management facility inspection records shall be documented and retained for at least **five** years from the date of inspection
- Construction record drawings shall be maintained **in perpetuity** or until a stormwater management **facility is removed**
- All registration statements submitted in accordance with 9VAC25-870-59 shall be documented and retained for **at least three years** from the date of project completion or state permit termination

Part III A Knowledge Check

1. What part of the Regulations explains the administrative and technical criteria must VSMP authorities require LDAs to comply with?

2. A locality's VSMP authority must adopt ordinances and other VSMP authorities must provide program documentation that ensures compliance with what?

3. How long does the VSMP authority have to determine the completeness of a stormwater management plan?

4. If a plan is determined complete, and notification has been given within 15 days of submission, how long does the authority have to review the plan?

Part III B – Department of Environmental Quality Procedures for Review of VSMPs

Authority and applicability (9VAC25-870-142)

This part specifies the criteria that the Department will utilize in reviewing a VSMP authority's administration of a VSMP.

Virginia stormwater management program review (9VAC25-870-144)

The Department shall coordinate the once per five year review with its other program reviews for the same entity. The review shall consist of the following:

- Consultation with the VSMP administrator or designee
- Review of the local ordinance(s) and other applicable documents
- Review of a subset of the plans approved by the VSMP authority for consistency of application including exceptions granted and calculations or other documentation that demonstrates that required nutrient reductions are achieved using appropriate onsite and off-site compliance options
- Review of the funding and staffing plan developed in accordance with 9VAC25-870-148
- Review of inspection of regulated activities
- Review of enforcement actions and an accounting of amounts recovered through enforcement actions where applicable

If deficiencies are found, the Department shall provide results and compliance recommendations to the Board in the form a corrective action plan and schedule within 120 days of the completion of a review.

Part III C – State Water Control Board Authorization Procedures for Virginia Stormwater Management Programs

Authority and applicability (9VAC25-870-146)

This part describes the specific elements required to be incorporated into a VSMP and the procedures the Board will follow to make its approval.

Virginia stormwater management program administrative requirements (9VAC25-870-148)

A VSMP shall provide for the following:

1. Identification of the authorities accepting complete registration statements and of the authorities completing plan review, plan approval, inspection, and enforcement
2. Submission and approval of ESC plans and stormwater management plans
3. Requirements to ensure compliance with the SWPPP (9VAC25-870-54), stormwater management plan (9VAC25-870-55), and pollution prevention plan (9VAC25-870-56)
4. Requirements for inspections and monitoring of construction activities by the operator for compliance with local ordinances
5. Requirements for long-term inspection and maintenance of stormwater management facilities
6. Collection, distribution to the state if required, and expenditure of fees
7. Enforcement procedures and civil penalties where applicable
8. Policies and procedures to obtain and release bonds, if applicable
9. Procedures for complying with the applicable reporting and recordkeeping requirements in 9VAC25-870-126

A locality's VSMP authority shall adopt and enforce an ordinance(s) that incorporate(s) the components set out in 1 through 5 and 7 above. Other VSMP authorities shall provide supporting documentation that incorporates the components set out in 1 through 5 above.

Part III B & IIIC Knowledge Check

1. How often does the Department review each Board approved VSMP?

2. If the Board determines that the deficiencies noted in the Department's review of a VSMP and its ordinances will cause the VSMP to be out of compliance of the VSMA and Regulations, what are the next steps for the VSMP authority?

Part IV – Technical Criteria and State Permit Application Requirements for State Projects

Technical criteria and requirements for state projects (9VAC25-870-160)

State permit applications prepared for state projects must comply with the technical criteria outlined in Part II and, to the maximum extent practicable, any locality's VSMP authority's technical requirements. It is the state agency's responsibility to demonstrate that the locality's VSMP authority's technical requirements are not practical for the project under consideration.

The Department may establish criteria for selecting either the site or a planning area on which to apply the water quality criteria. As a minimum the state permit application shall contain the following:

- The location and the design of the proposed stormwater management facilities
- Overall site plan with pre-developed and post-developed condition drainage area maps
- Comprehensive hydrologic and hydraulic computations of the pre-development and post-development runoff conditions for the required design storms, considered individually
- Calculations verifying compliance with the water quality requirements
- A description of the requirements for maintenance of the stormwater management facilities and a recommended schedule of inspection and maintenance
- The identification of a person or persons who will be responsible for maintenance
- All stormwater management plans and erosion and sediment control plans associated with a state permit application shall be appropriately sealed and signed by a professional in adherence to all minimum standards and requirements pertaining to the practice of that profession

Requirements for state stormwater management annual standards and specifications (9VAC25-870-170)

Standards and specifications may, and after June 30, 2014 shall, be submitted to the Department by a state agency on an annual basis. Such standards and specifications shall be consistent with the requirements of the VSMA and Regulations, including the Construction General Permit and the Erosion and Sediment Control Law and Regulations. Each project shall obtain coverage issued under the state permit prior to commencing LDAs.

State agency stormwater management standards and specifications describe how land disturbing activities shall be conducted and shall include, but are not limited to:

- Technical criteria to meet the requirements of the VSMA and Regulations
- Provisions for the preparation of stormwater management and ESC plans for each project
    - The individual plans, to the maximum extent practicable, shall comply with any locality's VSMP authority's technical requirements adopted pursuant to the VSMA
    - It shall be the responsibility of the state agency to demonstrate that the locality's VSMP authority's technical requirements are not practicable for the project under consideration
- Provisions for the long-term responsibility and maintenance of stormwater management control devices and other techniques specified to manage the quantity and quality of runoff, including an inspection and maintenance schedule, shall be developed and implemented
- Provisions for erosion and sediment control and stormwater management program administration, plan design, review and approval, and construction inspection and enforcement
- Provisions for ensuring that responsible personnel and contractors obtain certifications or qualifications for erosion and sediment control and stormwater management comparable to those required for VSMP authorities

- Implementation of a project tracking and notification system to the Department of all LDAs
- Requirements for documenting onsite changes as they occur

Copies of such stormwater management specifications and standards including, but not limited to, design manuals, technical guides and handbooks, shall be submitted to the Department.

Administrative procedures: stormwater management permit applications (9VAC25-870-180)

This section describes the requirements and procedures that the Department must follow when providing Construction GP coverage to projects submitted by state agencies who are not subject to local government VSMP authorities.

Within **30 days** after receipt of a complete state permit application (registration statement) submitted by a state agency, the Department shall issue or deny the state permit.

- The Department shall provide its decision in writing to the state agency that submitted the state permit application
- Denied state permit applications shall be revised and resubmitted to the Department

Approval of a state permit application (registration statement) for a state project shall be subject to these requirements:

- The state agency shall comply with all applicable requirements of the state permit and these Regulations, and shall certify that all land clearing, construction, land development, and drainage will be done according to the state permit
- The land development shall be conducted only within the area specified in the state permit
- No changes may be made to a plan for which a state permit has been issued without review and written approval by the Department
- The Department shall be notified **one week** prior to the pre-construction meeting and **one week** prior to the commencement of LDA

- The Department shall conduct **random** inspections of the project to ensure compliance with the state permit
- The Department shall require inspections and reports from the state agency responsible for compliance with the state permit and to determine if the measures required in the state permit provide effective stormwater management

Compliance with the state permit shall be subject to the following conditions:

- Where inspection by the responsible state agency reveals deficiencies in carrying out a permitted activity, the responsible state agency shall ensure compliance with the issued state permit, state permit conditions, and plan specifications
- Where inspections by Department personnel reveal deficiencies in carrying out the state permit, the responsible state agency shall be issued a notice to comply, with corrective actions specified and the deadline within which the work shall be performed
- Whenever the Commonwealth or any of its agencies fail to comply within the time provided in a notice to comply, the director may petition the secretary of a given secretariat or an agency head for a given state agency for compliance. Where the petition does not achieve timely compliance, the director shall bring the matter to the Governor for resolution
- Where compliance will require the appropriation of funds, the director shall cooperate with the appropriate agency head in seeking such an appropriation; where the director determines that an emergency exists, he shall petition the Governor for funds from the Civil Contingency Fund or other appropriate source
- The department may also seek compliance through other means specified in the VSMA and Regulations

Administrative procedures: maintenance and inspections

(9VAC25-870-200)

Responsibility for the operation and maintenance of stormwater management facilities shall remain with the state agency 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 state project the property owner, governmental agency, or other legally established entity to be permanently responsible for maintenance.

At a minimum, a stormwater management facility shall be inspected by the responsible state agency on an **annual basis** and **after any storm which causes the capacity of the facility's principal spillway to be exceeded**. During construction of the stormwater management facilities, the Department shall make inspections on a **random basis**.

The Department shall require inspections and reports from the state agency responsible for ensuring compliance with the state permit and to determine if the measures required in the state permit provide effective stormwater management. Inspection reports shall be maintained as part of the land disturbance project file.

Part IV Knowledge Check

1. What technical criteria do state projects have to comply with?

2. What is the purpose of state stormwater management annual standards?

3. At a minimum, how often should stormwater management facilities by inspected by the responsible state agency?

Part V – Reporting

Reporting on stormwater management (9VAC25-870-210)

State agencies shall report **annually** to the Department on the extent to which stormwater management programs have reduced nonpoint source pollution to the Commonwealth's waters and mitigated the effects of localized flooding.

The report shall provide the following:

- Number and types of stormwater management facilities installed in the reporting year
- Drainage area or watershed size served
- Receiving stream or hydrologic unit
- Summary of monitoring data
- Other data useful in determining the effectiveness of the programs and BMP technologies in current use

Module 5: Overview of a VSMP

Module 5 Objectives

After completing this module, you will be able to:

- Discuss the VSMP process from conception to completion of a land-disturbing activity
- Identify the elements a local ordinance must include

Module 5 Content

5a. VSMP Process

5b. Adopting Local Ordinances

5a. VSMP Process - The following flow chart outlines how the VSMP process can run from the conception to the end of a land-disturbing activity.

Step 1: SWPPP preparation

Before starting a land-disturbing activity (LDA), an operator must complete a stormwater pollution prevention plan (SWPPP) in accordance with 9VAC25-870-54. The SWPPP must include:

- Approved erosion and sediment control plan
- Approved stormwater management plan (9VAC25-870-55)
- Pollution prevention plan (9VAC25-870-56)
- Description of any additional control measures necessary to address a TMDL (9VAC25-870-54)
- Performance measures (9VAC25-870-54)

DEQ 2012 Impaired Waters GIS Application:
http://www.deq.virginia.gov/ConnectWithDEQ/VEGIS/2012WQMAssessmentGISApplications.aspx

Search for Approved TMDL Reports:
http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/TMDL/TMDLDevelopment/ApprovedTMDLReports.aspx

In addition to the SWPPP, the operator must prepare a long-term maintenance agreement for permanent stormwater management facilities in accordance with 9VAC25-60-112. (★Remember, the agreement must be recorded in the local land records before termination of the permit or earlier as required by the VSMP authority).

Step 2: Erosion and sediment control and stormwater management plan submittal

The operator must submit the erosion and sediment control plan to the VESCP authority for review and approval and the stormwater management plan to the VSMP authority for review and approval.

VESCP authority reviews and approves erosion and sediment control plans in accordance with the Erosion and Sediment Control Law (§ 10.1-560 et seq. of the Code of Virginia) and the Erosion and Sediment Control Regulations.

Step 3: Determination of completeness

The VSMP authority (program administrator) has **15 days** to determine the completeness of a stormwater management plan in accordance with 9VAC25-870-55 and to notify the applicant of its determination. If the application is not complete, the VSMP authority must notify the applicant in writing or electronically of the reason(s).

Step 4 & 5: Plan review and approval

If a plan is complete and the applicant has been notified within 15 days of submission, the VSMP authority (plan reviewer) has **60 days** from the time of notification to review the plan.

Before approving a stormwater management plan, the plan reviewer must approve any long-term maintenance agreements for permanent stormwater management facilities in accordance with 9VAC25-870-112.

Step 6: Construction GP registration statement submittal

The operator must submit a complete and accurate registration statement in accordance with 9VAC25-870-59 and pay any permit fees required.

By signing the registration statement, the operator certifies the SWPPP has been prepared.

Step 7: Construction GP issued by Department

Before permit coverage can be issued, the program administrator must confirm the following:

- ✓ Registration statement is accurate and complete
- ✓ Stormwater management plan has been approved by the VSMP authority
- ✓ Long-term maintenance agreement for permanent stormwater management facilities has been approved by the VSMP authority
- ✓ Erosion and sediment control plan has been approved by the VESCP authority
- ✓ All fees have been paid

Once the program administrator confirms the above, permit coverage is issued by the Department.

Step 8: VSMP authority approval to start construction

Step 9: VESCP and VSMP authority inspections (9VAC25-870-114)

During construction, the VSMP authority (inspector) must periodically inspect (§62.1-44.15:37) the land-disturbing activity for:

- Compliance with the approved erosion and sediment control plan
- Compliance with the approved stormwater management plan

VSMP authority confirms operator has updated, modified, and implement the pollution prevention plan, and ensure compliance and implementation of any additional control measures to meet a TMDL (if needed).

The inspectors and program administrator work together to carry out enforcement actions that may become necessary should the work not proceed in accordance with the approved plan (9VAC25-870-116).

Step 10: Construction ends

Before the operator can submit notice of termination to the VSMP authority, the Construction GP (9VAC25-880-60) requires them to ensure necessary permanent control measures included in the SWPPP for the site are in place and functioning effectively and that final stabilization has been achieved on all portions of the site for which the operator is responsible. When applicable, long-term responsibility and maintenance requirements for permanent control measures must be recorded in the local land records. For residential construction only, the operator must ensure temporary soil stabilization has been completed and the residence has been transferred to the homeowner. (See 9VAC25-880-60 for information about termination of permit coverage when another operator assumes control or when an alternative VPDES or state permit has been obtained.)

Step 11: Operator submits notice of termination to VSMP authority

Notice of termination should be submitted no later than 30 days after meeting the permit termination conditions.

Step 12: VSMP authority inspects site if necessary and confirms maintenance agreements have been recorded

Step 13: Construction GP terminated by DEQ

Step 14: VSMP administrator assembles and maintains records and documentation

Once construction is complete, the program administrator will assemble and maintain the required records and documentation including certified project record drawings ("as-built"), inspection and enforcement records, and registration statements (9VAC 25-870-126). On a fiscal basis (July 1 to June 30), administrators will report to DEQ by October 1 of each year information on any exceptions granted, enforcement actions, and specifics pertaining to the BMPs installed over the course of the year.

In the future, the program administrators may work with the owners or operators of the finished stormwater management facility to collect fees to offset the VSMP authority's costs to inspect and ensure long-term effectiveness of any permanent stormwater management measures.

Step 15: VSMP administrator returns bonds or securities

Within 60 days of completing the requirements of the permit conditions, the VSMP authority returns or terminates any bonds or securities provided by the operator at the onset of the project.

Step 16: Inspections after construction (9VAC25-870-114)

The VSMP authority (inspector) must inspect stormwater management facilities at least once every five years to ensure they are being adequately maintained as designed.

Knowledge Check

1. By signing the Construction General Permit registration statement, the operator is verifying what plan has been prepared?

2. A long-term maintenance agreement for permanent stormwater management facilities has to be approved before approving what plan?

3. What five things must the VSMP administrator verify before permit coverage can be issued by the department?

5b: Adopting local ordinances (9VAC25-870-148)

To become a VSMP authority, a locality needs to adopt a stormwater management ordinance. The ordinance provides the legal foundation for program implementation, compliance determinations, and enforcement of the local program requirements. The local ordinance must include the following elements:

- Identification of the authority accepting complete registration statements and of the authorities completing plan review, plan approval, inspection, and enforcement
- Submission and approval of erosion and sediment control plans in accordance with the Virginia Erosion and Sediment Control Law and attendant regulations and the submission and approval of stormwater management plans
- Requirements to ensure compliance with stormwater pollution prevention plan requirements (9VAC25-870-54), stormwater management plans (9VAC25-870-55), and pollution prevention plans (9VAC25-870-56)
- Requirements for inspections and monitoring of construction activities by the operator for compliance with local ordinances
- Requirements for long-term inspection and maintenance of stormwater management facilities
- Enforcement procedures and civil penalties where applicable

The VSMP authority may require a permittee to provide a bond or other financial surety in accordance with § 62.1-44.15:34 of the Act to ensure that corrective actions could be taken by the VSMP authority at the permittee's expense if, after proper notice and a specified time, the permittee does not take corrective actions to meet the conditions of the Construction GP. If the locality is going to require a financial surety it needs to be included in the ordinance, as well as a provision that the financial surety will be refunded within 60 days of the completion of the requirements of the Construction GP.

Module 6: Environmental site design and BMPs

Module 6 Objectives

After completing this module, you will be able to:

- Discuss the benefits of using Environmental Site Design
- Realize how the Runoff Reduction Method can be used to demonstrate the reduction of post-development runoff and pollutant removal
- Use the BMP Clearinghouse to find the design standards and specifications of all stormwater best management practices (BMPs) approved for use in Virginia to control the quality and/or quantity of stormwater runoff

Module 6 Content

6a. Environmental Site Design (ESD)

6b. Virginia Runoff Reduction Method

6c. BMP Clearinghouse

6a. Environmental Site Design (ESD)

Environmental Site Design (ESD) is grounded in the belief that environmental balance can be maintained as new communities are developed throughout our watersheds if basic principles are obeyed. ESD requires an understanding of our natural systems and making the commitment to work within the limits of these systems whenever and wherever possible.

Stormwater management through ESD

ESD views stormwater as a precious resource that must be used carefully, rather than a waste product in need of disposal. In the context of stormwater management, the goal of ESD should be to promote runoff control through the use of the natural drainage systems and to reduce the environmental impact of commonly used land development and drainage methods.

In addition to maintaining natural drainage, ESD should:

- Provide a natural open-space based drainage system using undeveloped flood plains and drainage swales
- Avoid channelization within the natural drainage system
- Maintain forest cover and other natural vegetation to the extent feasible

These practices will result in maintenance or enhancement of the normal water table level.

ESD employs small-scale stormwater management practices, non-structural techniques, and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources. This includes:

- Optimizing conservation of natural features (e.g., drainage patterns, soil, vegetation)
- Minimizing impervious surfaces (e.g., pavement, concrete channels, rooftops)
- Slowing down runoff to maintain discharge timing and to increase infiltration and evapotranspiration on the development site

- Using other non-structural practices or innovative technologies approved by DEQ

Benefits of ESD

The application of ESD principles can help developers and local governments recognize increased economic and environmental benefits through reduced infrastructure requirements, decreased need for clearing and grading of sites, and less expenditure to meet stormwater management requirements due to reduced runoff volumes and pollutant export from sites.

It is important to recognize that ESD practices are more appropriately applied to greenfield development, where there is ample space and soil conditions to apply the principles and practices. ESD principles may be difficult to apply at typical redevelopment sites, where space is limited and costly and "urban" (mixed, dense) soils exist.

8 principles of ESD

1. Achieve multiple objectives
2. Integrate stormwater management and design *early* in the site planning and design process
3. Prevent problems to avoid having to mitigate them
4. Conserve resources and minimize land cover changes
5. Design the development to fit the terrain
6. Apply decisions that have the effect of maintaining the natural site hydrology
7. Manage stormwater as close to the point of origin (generation) as possible to minimize collection and conveyance
8. Rely to the maximum on natural processes that occur within the soil and the plant community

Environmental Site Design Techniques and Practices

Table 6-1

Conserving natural features and resources	
Preserve undisturbed natural areas	Preserve or plant native trees
Preserve riparian buffers	Avoid floodplains
Avoid steep slopes	
Using low impact site design techniques	
Fit the design to the terrain	Locate development in less sensitive areas
Reduce the limits of clearing and grading	Use open space development
Consider creative development design	Reduce roadway lengths and widths
Reduce impervious footprints	Reduce the parking footprints
Reduce setbacks and frontages	Use fewer or alternative cul-de-sacs
Create parking lot stormwater "islands"	
Using natural features and runoff reduction to manage stormwater	
Use buffers and undisturbed filter areas	Use creative site grading, berming and terracing (terraforming)
Use natural drainageways and vegetated swales instead of storm sewers and curb and gutter	Drain runoff to pervious areas
Infiltrate site runoff or capture it for reuse	Restore or daylight streams at redevelopment projects

6b. Runoff Volume Reduction and the Virginia Runoff Reduction Method

The Regulations have brought about a shift to the runoff reduction paradigm by establishing post-development **treatment volume (Tv)** criteria, which represents the volume of runoff that must be reduced and/or treated and post-development on-site **runoff volume reduction** standards.

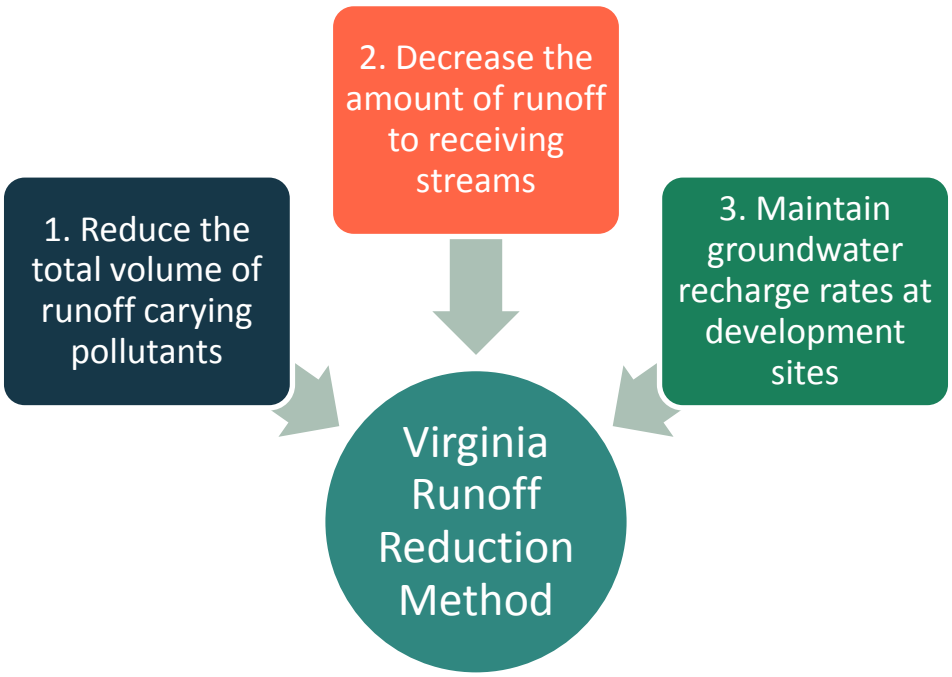
BMP Structures Designed to Achieve Part II C Technical Criteria (Old way)	**vs**	**BMP Structures Designed to Achieve Part II B Technical Criteria (New way)**
BMP designed to "treat" the first flush (1/2 inch) of runoff from impervious surface to remove pollutants (Doesn't take into account the intensity of rain)	**Event**	Treatment volume (Tv) 1-inch rainfall event statewide standard
Impervious surface	**Land Use(s)**	Forest/open space, turf, impervious
Average land cover condition	**New Design Criteria**	0.41 lbs./acre/yr of P
10% reduction of phosphorus	**Redevelopment Criteria**	< 1 acre = 10% P reduction > 1 acre = 20% P reduction
Simple Method, Blue Book, BMPs	**Compliance Methodology**	Runoff Reduction, BMP Clearinghouse
P = Phosphorus		

Benefits of treatment volume (Tv) for evaluating runoff reduction practices and sizing BMPs:

- Provides effective stormwater treatment for approximately 90% of the annual runoff volume from the site, and larger storms will be partially treated
- Storage is a direct function of impervious cover and disturbed soils, which provides designers incentives to minimize the area of both at a site
- Provides adequate storage to treat pollutants for a range of storm events
- Provides an objective measure to gauge the aggregate performance of environmental site design, runoff reduction and other innovative practices, and conventional BMPs together using a common currency (runoff volume)

- Calculating the TV explicitly acknowledges the difference between forest and turf cover and disturbed and undisturbed soils, creating incentives to conserve forests and reduce mass grading and provide a defensible basis for computing runoff reduction volumes for these actions

The water quality and quantity objectives of Part II B are integrated into the Virginia Runoff Reduction Method (RRM) compliance calculation spreadsheet. By meeting the requirements of the RRM, a BMP's treatment for water quality is improved and runoff volume is reduced.



The VRRM is accompanied by two compliance spreadsheets. The first is applicable to new development and is referred to as the **VRRM Compliance Spreadsheet.** The second is applicable to development on prior developed lands and is referred to simply as the **VRRM Redevelopment Compliance Spreadsheet**. The spreadsheets are designed to help designers and plan reviewers quickly evaluate the implementation of BMPs on a given site and verify compliance with the local and/or state stormwater requirements.

The spreadsheets do the following:

- Provide a summary of land cover for the entire site in its developed condition, the pollutant load (Total Phosphorus and Total Nitrogen), and the corresponding design Treatment Volume
- The Redevelopment spreadsheet provides a summary of the pre and post development (or pre and post redevelopment) land cover, pollutant load, and corresponding design Treatment Volume
- Allow the designer to quickly evaluate the effectiveness of different BMPs and BMP combinations in up to five different drainage areas.
- Provide a summary for each drainage area that includes the land cover, runoff volume and pollutant load generated in the drainage area, the BMPs selected, and the runoff volume and pollutant load reduced by the selected BMPs.
- Calculate the volume reduction credited towards compliance with quantity control requirements in each drainage area (i.e., channel and flood protection requirements).
- Provide an overall compliance summary report that itemizes BMP implementation in each drainage area as well as overall site compliance.

NOTE: The RRM compliance spreadsheets are not BMP design tools. When a BMP is selected in a spreadsheet, it is assumed that the designer will locate and design the BMP according to the design criteria provided in the Virginia BMP Design Specifications. Please refer to the Virginia BMP Clearinghouse website, found online at vwrrc.vt.edu/swc/PostConstructionBMPs.html, for the latest BMP design criteria.

In most cases, designers will need to analyze a lot of design options with the spreadsheet, and will end up with a system or sequence of multiple practices across the site. While the compliance spreadsheet helps determine whether a site is in compliance, designers must still meet design criteria for individual practices at the site.

6c. BMP Clearinghouse http://vwrrc.vt.edu/swc/

The Virginia Stormwater Management BMP Clearinghouse is a website that serves several key purposes:

- Disseminate the design standards and specifications of all stormwater best management practices (BMPs) approved for use in Virginia to control the quality and/or quantity of stormwater runoff. This information covers the following categories of stormwater BMPs:
  - Traditional practices (ex. detention or wet ponds)
  - Low impact development (LID) practices (ex. roof drain disconnection)
  - Environmental site design (ESD) practices (ex. cluster development)
  - Manufactured treatment devices (MTDs) (ex. hydrodynamic separators)
- Disseminate the results of Virginia's process to evaluate and certify the performance claims of manufactured/proprietary BMPs approved for use in Virginia
- Provide information and links to related websites for those who must comply with the Virginia Stormwater Management Law and Regulations

VSMP and BMPs

The new Regulations have brought a shift to the runoff reduction paradigm, where designers focus on reducing the post-development stormwater runoff volume from a site, as well as meeting more stringent nutrient load reduction requirements.

The BMP Clearinghouse is jointly administered by the Virginia Department of Environmental Quality (DEQ), and the Virginia Water Resources Research Center (VWRRC). DEQ and VWRRC have jointly established an oversight committee, called the Virginia Stormwater BMP Clearinghouse Committee. Committee members represent various stakeholder groups involved with stormwater management. The Committee provides advice and direction for the Clearinghouse project and is governed by a charter.

Post construction BMPs

Since the early 1980's, land developers, particularly in fast-growing regions of the United States, have been required by states and municipalities to manage the stormwater runoff from their development sites.

In the last decade, a new type of BMP has evolved that is aimed at reducing the volume of stormwater runoff leaving the development site and, therefore, mimicking the hydrologic patterns that existed at a site before it was developed. This is a way to minimize our "human footprint" or our interference with natural processes. These new kinds of practices have been labeled Low Impact Development (LID) BMPs and include green roofs, bioretention, rain gardens, rooftop disconnection, dry swales, and wet swales.

ESD and **LID –**BMPs that keeps the volume of stormwater runoff leaving a developed site the same as or better than the pre-development conditions.

LID practices can be linked with Environmental Site Design (ESD) techniques, which include conserving open space and natural areas, and reducing the amount of imperviousness and infrastructure on lots, residential streets, and parking areas. LID and ESD techniques can significantly reduce the amount of impervious cover and the overall development costs while providing greater protection of natural systems and processes.

Virginia stormwater design specifications for 15 non-proprietary BMPs

DEQ has developed an updated set of 15 non-proprietary BMP standards and specifications for use in complying with the Virginia Stormwater Management Act and Regulations, which put a premium on maximizing the degree of runoff volume reduction and nutrient removal achieved at a developed site. Each BMP has a different capability to reduce annual runoff volumes, as well as a different treatment efficiency to reduce the event mean concentration (EMC) of nutrients as they pass through the BMP.

Table 6-1 on the next page lists each BMP's runoff volume reduction rates (RR) and pollutant removal rates for total phosphorus (TP). The legend below accompanies the table.

Table 6-1 Legend

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

EMC = Event mean concentration

BMP Pollutant Removal Efficiencies (March 1, 2011)
vwrrc.vt.edu/swc
Table 6-1

Practice Number	Practice	Removal of TP by runoff reduction (RR as %) (Based upon 1 inch of rainfall)	Removal of TP by treatment – pollutant (EMC) reduction (PR as %)	Total mass load removal of TP (TR as %)
1	Rooftop disconnection	25 or 50 [1]	0	25 or 50 [1]
2	Sheet flow to vegetated filter or conserved open space 1	25 or 50 [1]	0	25 or 50 [1]
	Sheet flow to vegetated filter or conserved open space 2 [5]	50 to 75 [1]	0	50 to 75 [1]
3	Grass channel	10 to 20 [1]	15	23
4	Soil amendments	Used to decrease runoff coefficient for turf cover at the site. See the design specs for roof disconnection, sheet flow to vegetated filter or conserved open space, and grass channels		
5	Vegetated roof 1	45	0	45
	Vegetated roof 2	60	0	60
6	Rainwater harvesting	Up to 90 [3,5]	0	Up to 90 [3,5]
7	Permeable pavement 1	45	25	59
	Permeable pavement 2	75	25	81
8	Infiltration 1	50	25	63
	Infiltration 2	90	25	93
9	Bioretention 1	40	25	55
	Bioretention 2	80	50	90
	Urban Bioretention	40	25	55
10	Dry swale 1	40	20	52
	Dry swale 2	60	40	76
11	Wet swale 1	0	20	20
	Wet swale 2	0	40	40
12	Filtering practice 1	0	60	60
	Filtering practice 2	0	65	65
13	Constructed wetland 1	0	50	50
	Constructed wetland 2	0	75	75
14	Wet pond 1	0	50 (45) [4]	50 (45) [4]
	Wet pond 2	0	75 (65) [4]	75 (65) [4]
15	Extended detention pond 1	0	15	15
	Extended detention pond 2	15	15	31

Design Specification No. 1: Rooftop (and impervious area) disconnection

This strategy involves managing runoff close to its source by intercepting, infiltrating, filtering, treating, or reusing it as it moves from the impervious surface to the drainage system. Two kinds of disconnection are allowed:

1. Simple disconnection whereby rooftops and/or on-lot residential impervious surfaces are directed to pervious areas
2. Disconnection leading to an alternative runoff reduction practice(s) adjacent to the roof

Summary of Stormwater Functions Provided by Rooftop Disconnection
vwrrc.vt.edu/swc
Table 6-2

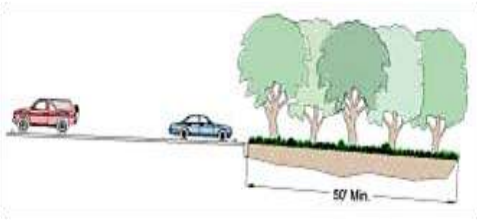
	HSG A and B	HSG C and D
Annual runoff volume reduction	50%	25%
Total phosphorus EMC reduction by BMP treatment process	0	0
Total phosphorus mass load removal	50%	25%
Total nitrogen EMC reduction by BMP treatment process	0	0
Total nitrogen mass load removal	50%	25%
Channel & flood protection	**Partial:** Designers can use the RRM spreadsheet to adjust curve number for each design storm for the contributing drainage area (CDA), based on annual runoff reduction achieved	

EMC = Event mean concentration
HSG = Hydrologic soils group
Note: Stormwater functions of disconnection can be boosted if an acceptable alternative runoff reduction practice is employed. Acceptable practices and their associated runoff reduction rates are listed below. Designers should consult the applicable specification number for design standards.

Alternative practice	Specification number	Runoff reduction rate
Soil compost-amended filter path	4	50%
Dry well or French drain #1 (Micro-infiltration #1)	8	50%
Dry well or French drain #2 (Micro-infiltration #2)	8	90%
Rain garden #1, front yard bioretention (Micro-bioretention #1)	9	40%
Rain garden #2, front yard bioretention (Micro-bioretention #2)	9	80%
Rainwater harvesting	6	Defined by user
Stormwater planter (Urban Bioretention)	9	40%

Design Specification No. 2: Sheet flow to a vegetated filter strip or conserved open space

Filter strips are vegetated areas that treat sheet flow delivered from adjacent impervious and managed turf areas by slowing runoff velocities and allowing sediment and attached pollutants to settle and/or be filtered by the vegetation. The two design variants are conserved open space and vegetated filter strips.



In both instances, stormwater must enter the filter strip or conserved open space as sheet flow. If the inflow is from a pipe or channel, an engineered level spreader must be designed in accordance with the DEQ criteria to convert the concentrated flow to sheet flow.

Summary of Stormwater Functions Provided by Conservation Areas and Filter Strips
vwrrc.vt.edu/swc
Table 6-3

	Conservation area		Vegetated filter strip	
	HSG A&B	HSG C&D	HSG A&B	HSG C&D
	Assume no CA[2] in conservation area		No CA [3]	With CA[2]
Annual runoff volume reduction	75%	50%	50%	50%
Total phosphorus EMC reduction[5] by BMP treatment process	0		0	
Total phosphorus mass load removal	75%	50%	50%	50%
Total nitrogen EMC reduction by BMP treatment process	0		0	
Total nitrogen mass load removal	75%	50%	50%	50%
Channel & flood protection	**Partial:** Designers can use the RRM spreadsheet to adjust curve number for each design storm for the contributing drainage area (CDA); and designers can account for a lengthened time-of-concentration flow path in computing peak discharge			

[1]CWP and CSN (2008); CWP (2007)
[2]CA = Compost amended soils (see design specification number 4)
[3]Compost amendments are generally not applicable for undisturbed A soils, although it may be advisable to incorporate them on mass-graded A or B soils and/or filter strips on B soils, in order to maintain runoff reduction rates.
[4]The plan approving authority may waive the requirements for compost amended soils for filter strips on B soils under certain conditions
[5]There is insufficient monitoring data to assign a nutrient removal rate for filter strips at this time

Design Specification No.3: Grass channels

Grass channels can provide a modest amount of runoff filtering and volume reduction within the stormwater conveyance system resulting in the delivery of less runoff and pollutants than a traditional system of curb and gutter, storm drain inlets, and pipes. The performance of grass channels will vary depending on the underlying soil permeability (Table 6-4).

Grass channels can also be used to treat runoff from the managed turf areas of turf-intensive land uses, such as sports fields and golf courses, and drainage areas with combined impervious and turf cover (e.g., roads and yards).

Summary of Stormwater Functions Provided by Grass Channels
vwrrc.vt.edu/swc
Table 6-4

	HSG Soils A and B		HSG Soils C and D	
	No CA[2]	**With CA**	**No CA**	**With CA**
Annual runoff volume reduction	20%	NA[3]	10%	30%
Total phosphorus EMC reduction[4] by BMP treatment process	15%		15%	
Total phosphorus mass load removal	32%		24% (no CA) to 41% (with CA)	
Total nitrogen EMC reduction[4] by BMP treatment process	20%		20%	
Total nitrogen mass load removal	36%		28% (no CA) to 44% (with CA)	
Channel & flood protection	**Partial:** Designers can use the RRM spreadsheet to adjust curve number for each design storm for the contributing drainage area (CDA), based on annual runoff reduction achieved. Also, the Tc for the grass swale flow path should reflect the slope and appropriate roughness for the intended vegetative cover.			

[1]CWP and CSN (2008); CWP (2007)
[2]CA = Compost amended soils (see design specification number 4)
[3]Compost amendments are generally not applicable for A and B soils, although it may be advisable to incorporate them on mass-graded and/or excavated soils to maintain runoff reduction rates. In these cases, the 30% runoff reduction rate may be claimed, regardless of the pre-construction HSG.
[4]Change in event mean concentration (EMC) through the practice. Actual nutrient mass load removed is the product of the pollutant removal rate and the runoff volume reduction rate (see Table 1 in the *Introduction to the New Virginia Stormwater Design Specifications*).

Design Specification No. 4: Soil compost amendments

Soil restoration is an Environmental Site Design (ESD) practice applied after construction to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can reduce the generation of runoff from compacted urban lawns and may also be used to enhance the runoff reduction performance of downspout disconnections, grass channels, and filter strips (Table 6-5).

Summary of Stormwater Functions Provided by Soil Compost Amendments
vwrrc.vt.edu/swc
Table 6-5

Annual runoff volume reduction (RR)	HSG Soils A and B		HSG Soils C and D	
	No CA[2]	With CA	No CA	With CA
Simple rooftop disconnection	50%	NA[3]	25%	50%
Filter strips	50%	NA[3]	NA[4]	50%
Grass channel	20%	NA[3]	10%	30%
Total phosphorus EMC reduction[4] by BMP treatment process	0		0	
Total phosphorus mass load removal	Same as for RR above		Same as for RR above	
Total nitrogen EMC reduction[4] by BMP treatment process	0		0	
Total nitrogen mass load removal	Same as for RR above		Same as for RR above	
Channel & flood protection	**Partial:** Designers can use the RRM spreadsheet to adjust the curve number for each design storm for the contributing drainage area, based on annual runoff volume reduction achieved.			

[1]CWP and CSN (2008); CWP (2007)
[2]CA = Compost amended soils (see design specification number 4)
[3]Compost amendments are generally not applicable for A and B soils, although it may be advisable to incorporate them on mass-graded B soils to maintain runoff reduction rates.
[4]Filter strops in HSG C and D should use composted amended soils to enhance runoff reduction capabilities. See Stormwater Design Specification No. 2: Sheetflow to Vegetated Filter Strip or Conserved Open Space.

Design Specification No. 5: Vegetated roofs

Vegetated roofs are alternative roof surfaces that typically consist of waterproofing and drainage materials and an engineered growing media that is designed to support plant growth. Vegetated roofs capture and temporarily store stormwater runoff in the growing media before it is conveyed into the storm drain system. A portion of the captured stormwater evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites.

There are two different types of vegetated roof systems. The first, *intensive* vegetated roofs have a deeper growing media layer that ranges from 6 inches to 4 feet thick, which is planted with a wider variety of plants, including trees. The second, *extensive* systems typically have much shallower growing media (2 to 6 inches), which is planted with carefully selected drought tolerant vegetation. Extensive vegetated roofs are much lighter and less expensive than intensive vegetated roofs and are recommended for use on most development and redevelopment sites.

Summary of Stormwater Functions Provided by Vegetated Roofs
vwrrc.vt.edu/swc
Table 6-6

	Level 1 Design	Level 2 Design
Annual runoff volume reduction (RR)	45%	60%
Total phosphorus EMC reduction[2] by BMP treatment process	0	0
Total phosphorus mass load removal	45%	60%
Total nitrogen EMC reduction[2] by BMP treatment process	0	0
Total nitrogen mass load removal	45%	60%
Channel & flood protection	Use the following curve numbers (CN) for design storm events: 1-year storm = 64; 2-year storm = 66; 10-year storm = 72; and the 100 year storm = 75	

[1]CWP and CSN (2008); CWP (2007)
[2]Moran et al (2004) and clark et al (2008) indicate no nutrient reduction or even negative nutrient reduction (due to leaching from the media) in early stages of vegetated roof development.
[3]See Miller (2008), NVRC (2007) and MDE (2008)

Design Specification No. 6: Rainwater harvesting

Rainwater harvesting systems intercept, divert, store, and release rainfall for future use. The term rainwater harvesting is used in this specification, but it is also known as a cistern or rainwater harvesting system. Rainwater that falls on a rooftop is collected and conveyed into an above- or below-ground storage tank where it can be used for non-potable water uses and on-site stormwater disposal/infiltration. Non-potable uses may include flushing of toilets and urinals inside buildings, landscape irrigation, exterior washing (e.g. car washes, building facades, sidewalks, street sweepers, fire trucks, etc.), and fire suppression (sprinkler) systems.

In many instances, rainwater harvesting can be combined with a secondary (down-gradient) runoff reduction practice to enhance runoff volume reduction rates and/or provide treatment of overflow from the rainwater harvesting system.

Summary of Stormwater Functions Provided by Rainwater Harvesting
vwrrc.vt.edu/swc
Table 6-7

	Performance
Annual runoff volume reduction (RR)	Variable up to 90%[2]
Total phosphorus EMC reduction[1] by BMP treatment process	0%
Total phosphorus mass load removal	Variable up to 90%[2]
Total nitrogen EMC reduction[1] by BMP treatment process	0%
Total nitrogen mass load removal	Variable up to 90%[2]
Channel protection	Partial: Reduced curve numbers and increased time of concentration
Flood mitigation	Partial: Reduced curve numbers and increased time of concentration

[1]Nutrient mass removal is equal to the runoff reduction rate. Zero additional removal rate is applied to the rainwater harvesting system only. Nutrient removal rates for secondary practices will be in accordance with the design criteria for those practices.
[2]Credit is variable and determined using the Cistern Design Spreadsheet. Credit up to 90% is possible if all water from storms with rainfall of 1 inch or less is used through demand, and the tank sized such that no overflow from this size event occurs. The total credit may not exceed 90%.

Design Specification No. 7: Permeable pavement

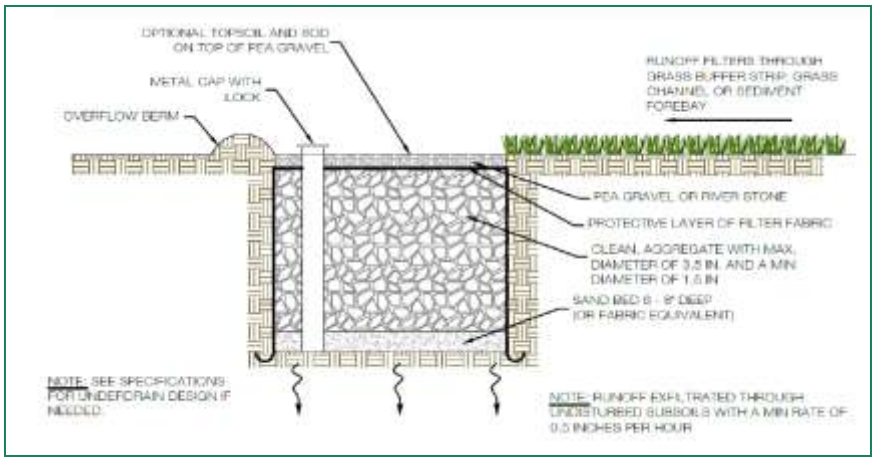
Permeable pavements are alternative paving surfaces that allow stormwater runoff to filter through voids in the pavement surface into an underlying stone reservoir, where it is temporarily stored and/or infiltrated. A variety of permeable pavement surfaces are available, including **pervious concrete**, **porous asphalt,** and permeable **interlocking concrete pavers**. While the specific design may vary, all permeable pavements have a similar structure, consisting of a surface pavement layer, an underlying stone aggregate reservoir layer and a filter layer or fabric installed on the bottom.

Summary of Stormwater Functions Provided by Permeable Pavement
vwrrc.vt.edu/swc
Table 6-8

	Level 1 Design	Level 2 Design
Annual runoff volume reduction (RR)	45%	75%
Total phosphorus EMC reduction[1] by BMP treatment process	25%	25%
Total phosphorus mass load removal	59%	81%
Total nitrogen EMC reduction[1]	25%	25%
Total nitrogen mass load removal	59%	81%
Channel protection	• Use the spreadsheet to calculate a curve number (CN) adjustment; or • Design extra storage (optional, as needed) in the stone underdrain layer to accommodate larger storm volumes, and use NRCS TR-55 Runoff Equations[2] to compute a CN adjustment	
Flood mitigation	Partial: May be able to design additional storage into the reservoir layer by adding perforated storage pipe or chambers	

[1]Change in event mean concentration (EMC) through the practice. Actual nutrient mass load removal is the product of the removal rate and the runoff reduction rate (see Table 1 in the *Introduction to the New Virginia Stormwater Design Specifications)*.
[2]NRCS TR-55 Runoff Equations 2-1 thru 2-5 and Figure 2-1 can be used to compute a curve number adjustment for larger storm events based on the retention storage provided by the practice(s).
Sources: CWP and CSN (2008) and CWP (2007)

Design Specification No. 8: Infiltration



Infiltration practices use temporary surface or underground storage to allow incoming stormwater runoff to go into underlying soils. Runoff first passes through multiple pretreatment mechanisms to trap sediment and organic matter before it reaches the practice. As the stormwater penetrates the underlying soil, chemical and physical adsorption processes remove pollutants. Infiltration practices have the greatest runoff reduction capability of any stormwater practice and are suitable for use in residential and other urban areas where *measured* soil permeability rates exceed 1/2 inch per hour. To prevent possible groundwater contamination, infiltration should not be utilized at sites designated as stormwater hotspots.

Summary of Stormwater Functions Provided by Infiltration

vwrrc.vt.edu/swc

Table 6-9

	Level 1 Design	Level 2 Design
Annual runoff volume reduction (RR)	50%	90%
Total phosphorus EMC reduction[1] by BMP treatment process	25%	25%
Total phosphorus mass load removal	63%	93%
Total nitrogen EMC reduction[1] by BMP treatment process	15%	15%
Total nitrogen mass load removal	57%	92%
Channel and flood protection	• Use the RRM spreadsheet to calculate a curve number (CN) adjustment; or • Design extra storage (optional, as needed) on the surface or in the subsurface storage volume to accommodate larger storm volumes, and use NRCS TR-55 Runoff Equations[2] to compute the CN Adjustment	

[1]Change in event mean concentration (EMC) through the practice. Actual nutrient mass load removal is the product of the removal rate and the runoff reduction rate (see Table 1 in the *Introduction to the New Virginia Stormwater Design Specifications)*.

[2]NRCS TR-55 Runoff Equations 2-1 thru 2-5 and Figure 2-1 can be used to compute a curve number adjustment for larger storm events based on the retention storage provided by the practice(s).

Sources: CWP and CSN (2008) and CWP (2007)

Design Specification No. 9: Bioretention Basins

Individual bioretention areas can serve highly impervious drainage areas less than two acres in size. Surface runoff is directed into a shallow landscaped depression that incorporates many of the pollutant removal mechanisms that operate in forested ecosystems. The primary component of a bioretention practice is the filter bed, which has a mixture of sand, soil, and organic material as the filtering media with a surface mulch layer. During storms, runoff temporarily ponds 6 to 12 inches above the mulch layer and then rapidly filters through the bed. Normally, the filtered runoff is collected in an underdrain and returned to the storm drain system. The underdrain consists of a perforated pipe in a gravel layer installed along the bottom of the filter bed. A bioretention facility with an underdrain system is commonly referred to as a *bioretention filter*. A bioretention facility without an underdrain system or with a storage sump in the bottom is commonly referred to as a b*ioretention basin*. Small-scale or micro-bioretention used on an individual residential lot is commonly referred to as a r*ain garden*.

Summary of Stormwater Functions Provided by Bioretention Basins

vwrrc.vt.edu/swc

Table 6-10

	Level 1 Design	Level 2 Design
Annual runoff volume reduction (RR)	40%	80%
Total phosphorus EMC reduction[1] by BMP treatment process	25%	50%
Total phosphorus mass load removal	55%	90%
Total nitrogen EMC reduction[1] by BMP treatment process	40%	60%
Total nitrogen mass load removal	64%	90%
Channel and flood protection	• Use the RRM spreadsheet to calculate the cover number (CN); or • Design extra storage (optional, as needed) on the surface, in the engineer soil matrix, and in the stone/underdrain layer to accommodate a larger storm, and use NRCS TR-55 Runoff Equations[2] to compute the CN adjustment	

[1]Change in event mean concentration (EMC) through the practice. Actual nutrient mass load removal is the product of the removal rate and the runoff reduction rate (see Table 1 in the *Introduction to the New Virginia Stormwater Design Specifications)*.

[2]NRCS TR-55 Runoff Equations 2-1 thru 2-5 and Figure 2-1 can be used to compute a curve number adjustment for larger storm events based on the retention storage provided by the practice(s).

Sources: CWP and CSN (2008) and CWP (2007)

Design Specification No. 10: Dry swales

Dry swales are essentially bioretention cells that are shallower, configured as linear channels, and covered with turf or other surface material (other than mulch and ornamental plants). They are a soil filter system that temporarily stores and then filters the desired treatment volume (Tv). Dry swales rely on a pre-mixed soil media filter below the channel that is similar to that used for bioretention. If soils are extremely permeable, runoff infiltrates into underlying soils. In most cases, however, the runoff treated by the soil media flows into an underdrain, which conveys treated runoff back to the conveyance system further downstream. The underdrain system consists of a perforated pipe within a gravel layer on the bottom of the swale, beneath the filter media. Dry swales may appear as simple grass channels with the same shape and turf cover, while others may have more elaborate landscaping. Swales can be planted with turf grass, tall meadow grasses, decorative herbaceous cover, or trees.

Summary of Stormwater Functions Provided by Dry Swales
vwrrc.vt.edu/swc
Table 6-11

	Level 1 Design	Level 2 Design
Annual runoff volume reduction (RR)	40%	60%
Total phosphorus EMC reduction[1] by BMP treatment process	20%	40%
Total phosphorus mass load removal	52%	76%
Total nitrogen EMC reduction[1] by BMP treatment process	25%	35%
Total nitrogen mass load removal	55%	74%
Channel protection	• Use the RRM spreadsheet to calculate the cover number (CN); or • Design extra storage (optional, as needed) on the surface, and in the stone/underdrain layer to accommodate a larger storm, and use NRCS TR-55 Runoff Equations[2] to compute the CN adjustment	
Flood mitigation	Partial: Reduced curve numbers and time of conentration	

[1]Change in event mean concentration (EMC) through the practice. Actual nutrient mass load removal is the product of the removal rate and the runoff reduction rate (see Table 1 in the *Introduction to the New Virginia Stormwater Design Specifications)*.
[2]NRCS TR-55 Runoff Equations 2-1 thru 2-5 and Figure 2-1 can be used to compute a curve number adjustment for larger storm events based on the retention storage provided by the practice(s).
Sources: CWP and CSN (2008) and CWP (2007)

Design Specification No. 11: Wet swales

Wet swales can provide runoff filtering and treatment within the conveyance system and are a cross between a wetland and a swale. These linear wetland cells often intercept shallow groundwater to maintain a wetland plant community. The saturated soil and wetland vegetation provide an ideal environment for gravitational settling, biological uptake, and microbial activity. On-line or off-line cells are formed within the channel to create saturated soil or shallow standing water conditions (typically less than 6 inches deep).

Summary of Stormwater Functions Provided by Wet Swales

vwrrc.vt.edu/swc

Table 6-11

	Level 1 Design	Level 2 Design
Annual runoff volume reduction (RR)	0%	0%
Total phosphorus EMC reduction[1] by BMP treatment process	20%	40%
Total phosphorus mass load removal	20%	40%
Total nitrogen EMC reduction[1] by BMP treatment process	25%	35%
Total nitrogen mass load removal	25%	35%
Channel protection	Limited – Reduced time of concentration (TOC); and partial channel protection volume (CPv) can be provided above the treatment volume (Tv), within the allowable maximum ponding depth	
Flood mitigation	Limited – reduced TOC	

[1]Change in event mean concentration (EMC) through the practice.
Sources: CWP and CSN (2008) and CWP (2007)

Design Specification No. 12: Filtering practices

Stormwater filters are a useful practice to treat stormwater runoff from small, highly impervious sites. Stormwater filters capture, temporarily store, and treat stormwater runoff by passing it through an engineered filter media, collecting the filtered water in an underdrain, and then returning it back to the storm drainage system. The filter consists of two chambers: the first is devoted to settling, and the second serves as a filter bed consisting of sand or organic filter media.

Summary of Stormwater Functions Provided by Filtering Practices

vwrrc.vt.edu/swc

Table 6-13

	Level 1 Design	Level 2 Design
Annual runoff volume reduction (RR)	0%	0%
Total phosphorus EMC reduction[1] by BMP treatment process	60%	65%
Total phosphorus mass load removal	60%	65%
Total nitrogen EMC reduction[1] by BMP treatment process	30%	45%
Total nitrogen mass load removal	30%	45%
Channel protection	Limited – The treatment volume diverted off-line into a storage facility for treatment can be used to calculate a curve number (CN) adjustment	
Flood mitigation	None – Most filtering practices are off-line and do not materially change peak discharges	

[1]Change in event mean concentration (EMC) through the practice.

Sources: CWP and CSN (2008) and CWP (2007)

Design Specification No. 13: Constructed wetlands

Constructed wetlands, sometimes called stormwater wetlands, are shallow depressions that receive stormwater inputs for water quality treatment. Wetlands are typically less than one-foot deep (although they have greater depths at the forebay and in micropools) and possess variable microtopography to promote dense and diverse wetland cover. Runoff from each new storm displaces runoff from previous storms, and the long residence time allows multiple pollutant removal processes to operate. The wetland environment provides an ideal environment for gravitational settling, biological uptake, and microbial activity. Constructed wetlands are the final element in the roof-to-stream runoff reduction sequence. They should only be considered for use after all other upland runoff reduction opportunities have been exhausted and there is still a remaining water quality or channel protection volume to manage.

Summary of Stormwater Functions Provided by Constructed Wetlands
vwrrc.vt.edu/swc
Table 6-14

	Level 1 Design	Level 2 Design
Annual runoff volume reduction (RR)	0%	0%
Total phosphorus EMC reduction[1] by BMP treatment process	50%	75%
Total phosphorus mass load removal	50%	75%
Total nitrogen EMC reduction[1] by BMP treatment process	25%	55%
Total nitrogen mass load removal	25%	55%
Channel protection	Yes – Up to one foot of detention storage volume can be provided above the normal pool	
Flood mitigation	Yes – Flood control storage can be provided above the normal pool	

[1]Change in event mean concentration (EMC) through the practice.
Sources: CWP and CSN (2008) and CWP (2007)

Design Specification No. 14: Wet pond

Wet ponds consist of a permanent pool of standing water that promotes a better environment for gravitational settling, biological uptake, and microbial activity. Runoff from each new storm enters the pond and partially displaces pool water from previous storms. The pool also acts as a barrier to re-suspension of sediments and other pollutants deposited during prior storms. When sized properly, wet ponds have a residence time that ranges from many days to several weeks, which allows numerous pollutant removal mechanisms to operate. Wet ponds can also provide extended detention above the permanent pool to help meet channel protection requirements.

Summary of Stormwater Functions Provided by Wet Ponds

vwrrc.vt.edu/swc

Table 6-15

Level 1 Design (RR:0[1]; TP:50[5]; TN:30[5])	Level 2 Design (RR:0[1]; TP:75[5]; TN:40[5])
Tv = [(1.0)(Rv)(A)/12]-volume reduced by upstream BMP	Tv = [1.5 (Rv)(A)/12]-volume reduced by upstream BMP
Single pond cell (with forebay)	Wet ED[2] (24 hr) and/or a multiple cell design[3]
Length/width ration or flow path = 2:1 or more	Length of shortest flow path/overall length[4] = 0.8 or more
Standard aquatic benches	Wetlands more than 10% of pond area
Turf in pond buffers	Pond landscaping to discourage geese
No internal pond mechanisms	Aeration (preferably bubblers that extend to or near the bottom of floating islands)
Flood mitigation	Yes – Flood control storage can be provided above the permanent pool

[1]Runoff reduction rates can be computed for wet ponds designed for water reuse and upland irrigation.
[2]Extended detention may be provided to meet a maximum of 50% of the treatment volume; refer to design specification 15 for extended detention design.
[3]At least three internal cells must be included, including the forebay.
[4]In the case of multiple inflows, the flow path is measured from the dominant inflows (that comprise 80% or more of the total pond inflow).
[5]Due to groundwater influence, slightly lower TP and TN removal rates in coastal plain (section 7.2) and CSN Technical Bulletin No.2. (2009)
Sources: CSN (2009), CWP and CSN (2008), and CWP (2007)

Design Specification No. 15: Extended detention (ED) pond

An Extended Detention (ED) Pond relies on 12 to 24 hour detention of stormwater runoff after each rain event. An under-sized outlet structure restricts stormwater flow so it backs up and is stored within the basin. The temporary ponding enables particulate pollutants to settle out and reduces the maximum peak discharge to the downstream channel, thereby reducing the effective shear stress on banks of the receiving stream.

ED is normally combined with wet ponds (Design Specification No 14) or constructed wetlands (Design Specification No 15) to maximize pollutant removal rates. Designers should note that an ED pond is the final element in the roof to stream runoff reduction sequence, so one should be considered *only* if there is remaining treatment volume or channel protection volume to manage after all other upland runoff reduction practices have been considered and properly credited. Designers may need to submit documentation to the local plan review authority showing that all other runoff reduction opportunities have been exhausted and were found to be insufficient, leaving additional water quality or channel protection volume to manage.

Summary of Stormwater Functions Provided by Extended Detention Ponds
vwrrc.vt.edu/swc
Table 6-16

	Level 1 Design	Level 2 Design
Annual runoff volume reduction (RR)	0%	15%
Total phosphorus EMC reduction[1] by BMP treatment process	15%	15%
Total phosphorus mass load removal	15%	31%
Total nitrogen EMC reduction[1] by BMP treatment process	10%	10%
Total nitrogen mass load removal	10%	24%
Channel protection	Yes – Storage volume can be provided to accommodate the full channel protection volume (CPv)	
Flood mitigation	Yes – Flood control storage can be provided above the maximum extended detention volume	

[1]Change in event mean concentration (EMC) through the practice. The actual nutrient mass load removed is the product of the removal rate and the runoff reduction rate (see Table 1 in the *Introduction to the New Virginia Stormwater Design Specifications)*.
Sources: CWP and CSN (2008) and CWP (2007)

Resources

Draft Virginia Stormwater Management Handbook

DEQ Training FAQs -
http://www.deq.virginia.gov/ConnectWithDEQ/TrainingCertification.aspx

US EPA (General stormwater information):
http://water.epa.gov/action/weatherchannel/stormwater.cfm

USGS Water Cycle and Stream Flow:
http://ga.water.usgs.gov/edu/watercyclestreamflow.html

USGS National Water-Quality Assessment Program: http://water.usgs.gov/nawqa/

USGS NAWQAP - Ecological Health in the Nation's Streams:
http://water.usgs.gov/nawqa/ecology/pubs/cir-1391/index.html

US EPA SWPPP Guidance and Resources:
http://cfpub.epa.gov/npdes/stormwater/swppp.cfm

References

This participant guide provides an overview of the information and concepts in the Draft Virginia Stormwater Handbook and the Virginia Stormwater Management Program (including overviews of federal and Virginia stormwater legislations and BMP Clearinghouse information). Fully cited information and references can be found in these sources. Sources for non-original figures in Module 2 (Why Stormwater Management Matters) that do not appear in the Handbook are listed within figure captions.

Regional Staff Assigned to Local VSMP Program Review & Development			
Stormwater Compliance & Planning Staff	**Supervisor**	**Program Manager**	**Regional Office**
Elizabeth Abe	Cody Boggs	Robert Weld	Blue Ridge Regional Office
Ian Edwards		Robert Weld	Blue Ridge Regional Office
Tim Ott	Cody Boggs	Robert Weld	Blue Ridge Regional Office
Don Packard	Cody Boggs	Robert Weld	Blue Ridge Regional Office
Marian Carroll	Kelly Vanover	Trisha Beasley	Northern Regional Office
Troy Smith	Kelly Vanover	Trisha Beasley	Northern Regional Office
Debbie Switzer	Kelly Vanover	Trisha Beasley	Northern Regional Office
Nancy Miller	Marc Alling	Kyle Winter	Piedmont Regional Office
May Sligh	Marc Alling	Kyle Winter	Piedmont Regional Office
Shawn Smith	Marc Alling	Kyle Winter	Piedmont Regional Office
David Aho	John McCutcheon	Allison Dunaway	Piedmont Regional Office
Matt Grant	John McCutcheon	Allison Dunaway	Piedmont Regional Office
Kevin Landry	John McCutcheon	Allison Dunaway	Piedmont Regional Office
Mike Lee	John McCutcheon	Allison Dunaway	Piedmont Regional Office
Xing Lin	John McCutcheon	Allison Dunaway	Piedmont Regional Office
Matt Stafford	John McCutcheon	Allison Dunaway	Piedmont Regional Office
Mike Vanlandingham	John McCutcheon	Allison Dunaway	Piedmont Regional Office
Shawn Fluharty	Noah Hill	Bert Parolari	Tidewater Regional Office
Ved Malhotra	Noah Hill	Bert Parolari	Tidewater Regional Office
Phyllis Hinch	Kelly Miller	Allen Newman	Southwest Regional Office
John Mlinarcik	Gary Flory	Keith Fowler	Valley Regional Office
Paul DeMarsh	Gary Flory	Keith Fowler	Valley Regional Office
V'lent Lassiter	Joan Salvati		Central Office
Daniel Moore	Joan Salvati		Central Office
Jay Carter	Joan Salvati		Central Office

Knowledge Check Answers

Module 2

1. Rainfall in Virginia averages between _____ and _____ per year?
   42-48 inches per year

2. Which of the following represent human influences on the natural water cycle (circle all that apply):

   A. Groundwater withdrawal.

   B. Rainfall capture in cisterns for dry period usage.

   C. Diverting stormwater runoff from steep slopes.

   D. Evaporation of water from ocean surfaces to the atmosphere.

   E. None of the above.

   Correct answer is A, B, C

3. The frequency of extreme precipitation events in Virginia since 1948 has increased by what percent?
   25 *percent*

4. Traditionally, Virginia has used what design storm for discharges into a natural channel or stream?
   A. 2 Year / 24 hour
   B. 2 Year / 12 hour
   C. 10 Year / 24 hour
   D. 10 year / 12 hour
   Correct answer is A. 2 Year / 24 hour

5. True or False? When stormwater runoff is allowed to drain away instead of being used to recharge the groundwater it alters the hydrologic balance of a watershed.
   A. True
   B. False
   Correct answer is A. True

6. Nationwide, significant flow alterations have occurred in what proportion of assessed waters?
   A. 50%
   B. 60%
   C. 75%
   D. 90%
   Correct answer is D. 90%

7. Ecological stress becomes apparent when impervious cover in a watershed reaches between:
   A. 40-50%
   B. 30-40%
   C. 20-30 acres
   D. 10-25%
   Correct answer is D. 10-25%

8. Increased peak discharges for a developed watershed can be how many times higher than an undisturbed watershed?
   2 to 5 times

9. Beneficial uses for the Chesapeake Bay include:
   A. Swimming and sport fishing
   B. Human consumption of fish or shellfish
   C. A depository for excess nutrients
   D. A. and B.
   E. All of the above

   Correct answer is D. (A. Swimming and sport fishing, and B. Human consumption of fish or shellfish)

10. Rainwater harvesting presents an option that could alleviate pressures on water supplies in Virginia. What are some of these pressures?

    Possible correct answers include: Water treatment plant capacity (struggle to keep up with demands); groundwater sources becoming increasingly depleted (more runoff); decreased stream base flow (clean water supply)

11. How does increasing surface runoff change groundwater recharge rates?

    Correct answer: increases in surface runoff ***decrease*** *groundwater recharge*

Module 3

1. A _____ is a good example of a "common plan of development."

   Subdivision

2. With respect to stormwater runoff, the Code of Virginia requires the Board to:
   A. Permit
   B. Regulate
   C. Control
   D. All of the above

   Correct answer is D. All of the above

3. Which of the following statements is false with respect to technical criteria and administrative procedures for VSMPs?
   A. Establish a permit fee schedule
   B. Provide for the evaluation of innovative technologies
   C. Discourage the use of LID design
   D. Establish provisions for the long term maintenance of SWM control devices

   Correct answer is C. Discourage the use of LID design

4. True or False. Localities may adopt more stringent ordinances if they are necessary to address TMDL requirements or depleted ground water resources.
   A. True
   B. False

   Correct answer is A. True

5. The VSMP authority must act on any permit application within what time frame?
   A. 30 days after it has determined the final application is complete
   B. Before the first snowfall
   C. 45 days before the bond is posted
   D. 60 days after it has determined the final application is complete

   Correct answer is D. 60 days after it has determined the final application is complete

6. Absent an imminent threat, documentation of a problem is done throughout an onsite inspection and enforcement consists of the following steps?
   A. Don't ask, don't tell
   B. Stop, drop, and roll
   C. Report, notice, stop work order

   Correct answer is C. Report, notice, stop work order

7. The Department may invoke civil penalties not to exceed:
   A. $25,00/day
   B. $32,500/violation
   C. $100,000/annually

   Correct answer is B. $32,500/violation

8. True or false. Professional engineers licensed in VA do not need to complete a Board administered training program to qualify for the initial certificate of competency?
   A. True
   B. False

   Correct answer is B. False

Module 4

Part II

2. Are state and federal agencies or local governments able to impose more stringent technical criteria or other requirements than included in the Regulation?
   Yes, as stated in 4VAC50-60-47.

3. A two-acre LDA received a Construction GP on March 14, 2013. What technical criteria must be met and for how long?
   The project's site design must meet the Part II C technical criteria for two additional five-year permit cycles.

4. What are the exceptions to the question above?
   If state permit coverage is not be maintained, the portions of the project not under construction shall become subject to any new technical criteria adopted since original state permit coverage was issued.

   Government projects where bonding or public debt financing has been issued for a project prior to July 1, 2012. Those projects are subject to the technical criteria of Part II C and have no specified time for completion.

5. What date must grandfathered projects be completed by?
   Grandfathered projects must be completed by June 30, 2019 unless they are government projects where bonding or public debt financing has been issued prior to July 1, 2012.

6. If a portion of the grandfathered project is not complete by the above date, what happens?
   Portions of the project not under construction shall become subject to the technical criteria of Part II B.

Part II A

1. What are the four components of a SWPPP?
   Approved erosion and sediment control plan
   Approved stormwater management plan
   Pollution prevention plan
   A plan specifying any additional control measures to meet the requirements of a TMDL

2. Who approves the erosion and sediment control plan?
   Virginia Erosion and Sediment Control authority

3. Which two plans have to be approved before the Department can issue a Construction General permit?
   Erosion and sediment control plan and stormwater management plan.

4. Which plan within the SWPPP describes the pollution prevention measures that will take place during construction activities to protect waterways?
   Pollution prevention plan

Part II B

1. What nutrient is measured to control the quality of stormwater discharge from a site after construction?
   Phosphorous

2. Why is it important to control the quantity of stormwater leaving a site after construction?
   Protect channels from concentrated stormwater flow, prevent flooding, and minimize erosion and sedimentation

3. What are the three conditions that offsite options can be used under to meet required phosphorous reductions?
   1. Less than 5 acres of land will be disturbed
   2. Post construction P load is less than 10 pounds per year
   3. At least 75% of the required P reductions are achieved onsite

Part II C

The following questions all pertain to grandfathered projects.

1. What is the assumed percentage of impervious surface in a watershed?
   16%

2. If the percentage of proposed impervious cover for a project is less than the average land cover condition and the existing percentage of impervious cover on the site is less than or equal to the average land cover condition, what is the pollutant discharge requirement?
   No pollutant discharge reduction required

3. When utilizing technology based criteria, is the appropriate BMP selected based on the predevelopment condition or the post development condition?
   Post-development condition

4. If utilizing a comprehensive stormwater management plan, what is the requirement for offsite reductions?
   Ensure offsite reductions equal to or greater than those that would be required on each contributing site are achieved within the same HUC or within another locally designated watershed.

Part III A

1. What part of the Regulations explains the administrative and technical criteria VSMP authorities must require land-disturbing activities to comply with?
   Part II
2. A locality's VSMP authority must adopt ordinances, and other VSMP authorities must provide program documentation, that ensure compliance with what?
   State permit conditions of subsection L in 4VAC50-60-460 and are at least as stringent as the provisions of the CG Permit (4VAC50-60-1100 et. seq.)

3. How long does the VSMP authority have to determine the completeness of a stormwater management plan?
   15 days

4. If a plan is determined complete, and notification has been given within 15 days of submission, how long does the authority have to review the plan?
   60 days from the time of notification

Part III B & III C

1. How often does the Department review each Board approved VSMP?
   At least once every 5 years

2. If the Board determines that the deficiencies noted in the Department's review of a VSMP and its ordinances will cause the VSMP to be out of compliance of the Act and Regulations, what are the next steps for the VSMP authority?
   If the VSMP authority agrees to the corrective action approved by the Board, the VSMP will be considered conditionally compliant with the Act and Regulations until a subsequent finding of compliance is issued by the Board. If the VSMP authority fails to implement the necessary compliance action identified by the Board within the specified time, the Board may take action pursuant to § 62.1-44.15:38 of the Code of Virginia.

Part IV

1. What technical criteria do state projects have to comply with?
   Technical criteria in Part II

2. What is the purpose of state stormwater management annual standards?
   State agencies, such as VDOT, conduct multiple land-disturbing activities a year. Annual standards allow state agencies to follow the Regulations while saving time by not having to submit an application for each project.

3. How often should stormwater management facilities by inspected by the responsible state agency?
   Inspection of a stormwater management facility must occur at least annually and after any storm which causes the capacity of the facility's principal spillway to be exceeded.

Module 5

1. By signing the Construction General Permit registration statement, the operator is verifying what plan has been prepared?
   By signing the registration statement, the operator certifies the SWPPP has been prepared.

2. A long-term maintenance agreement for permanent stormwater management facilities has to be approved before approving what plan?
   Before approving a stormwater management plan, the plan reviewer must approve any long-term maintenance agreements for permanent stormwater management facilities.

3. What five things must the VSMP administrator verify before permit coverage can be issued by the department?
   1) *Operator's registration statement has been accepted by the Department*
   2) *Stormwater management plan has been approved by the VSMP authority*
   3) *Long-term maintenance agreement for permanent stormwater management facilities has been approved by the VSMP authority*
   4) *Erosion and sediment control plan has been approved by the VESCP authority*
   5) *All fees have been paid*