Course Purpose

To provide general knowledge of the requirements for inspecting, implementing and maintaining erosion, sediment, & stormwater management practices on construction projects covered under the Virginia Construction General Permit. The course focuses on concepts applicable to person(s) responsible for demonstrating compliance with regulations and specifications of Best Management Practices (BMP'S) required on land disturbing activities in the Commonwealth of Virginia and those who are operators or conducting self-inspections required by the Construction General Permit. The target group is onsite contractors or private inspectors hired by the Permit operator or project owner.

Module 1: Stormwater Overview (8:30-9:30)

Stormwater Runoff Overview
Five Stages of Erosion
Principles of Erosion Control
Four Factors Influencing Erosion
Soil Compaction & Impervious Surfaces
New Approach to SWM

Module 2: Regulatory Overview (9:45-11:30)

Brief History of the ESC & SWM Laws
The Construction General Permit (CGP) and how it applies to Construction Projects
SWPPP Requirements
CGP Conditions – Authorization to Discharge Stormwater
Pollution Prevention – Implementing & Inspecting
ESC Program
Enforcement and Penalties

Lunch Break (11:30-12:30)

Module 3: Onsite Practices (12:30-1:30; 1:40-2:50)

ESC Practices & Minimum Standards

- ESC Structures
- Comparative Reference Guide

SWM Best Management Practices Overview

Module 4: Stormwater Inspections during Construction (3:00-3:30)

SWPPP Inspections (880; Part II)
Prohibited Discharges
Documentation –Sample Inspection Report

Runoff

Soil erosion is defined as the removal of the land surface by erosive forces such as water, wind, ice, and gravity.

While the first three factors are considered to be climatic, gravity is a physical factor responsible for the movement of soil particles to the lowest elevations on a landscape. In a general sense, **climate is the most significant agent in the erosion process.**

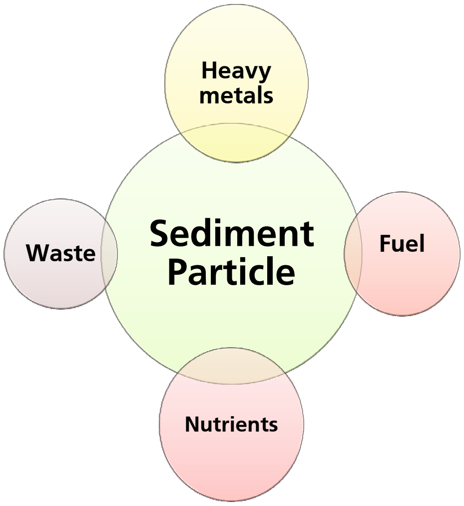
Non-Point Source Pollution Overview

Rainfall can create stormwater runoff during construction and even post construction which ends up either onto adjacent property or in a stream, river or other natural resource.

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.

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).

Construction Site Erosion
Source: Chesapeake Bay Stormwater Training Partnership



Erosion from construction sites and other disturbed areas can potentially contribute large amounts of sediment to streams. In addition to sediment, as stormwater runoff moves across the land surface, it picks up many natural and human-made pollutants, before depositing them into Virginia's waters.

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

Pollutants of particular interest in stormwater are excess nutrients for the following reasons:

- Nutrients are a major source of degradation in many of Virginia's water bodies.
- Elevated nutrient concentrations in stormwater runoff can stimulate excessive growth of vegetation or algae in streams, lakes, reservoirs, and estuaries (see figure below), which can diminish the quality of drinking water, recreation, and fisheries.

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

Stormwater Runoff

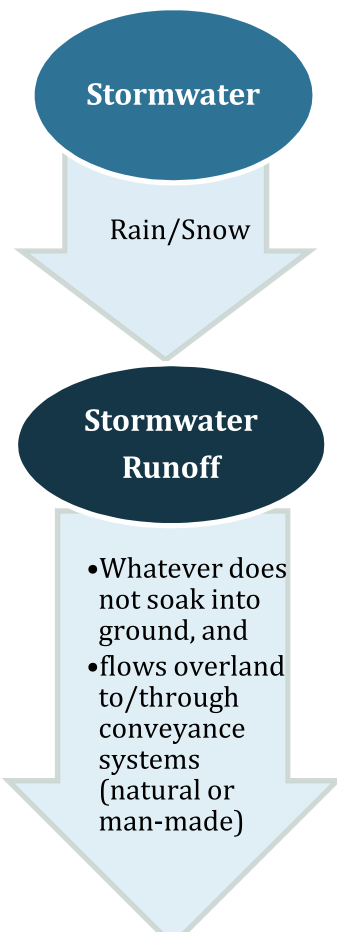
Raindrops hit the exposed soil like tiny bombs

Rainfall is not evenly distributed throughout the year

Most erosive rainfall is during the months of June – Sept.

Once precipitation reaches the ground, the water will:

(1) evaporate;
(2) be absorbed by the ground and/or taken up by plant roots; or
(3) move into (infiltrate) soil and through soil (percolate) to groundwater



Runoff occurs when the rate of rainfall exceeds the infiltration capacity of the soil. Runoff on unprotected soil begins a few minutes after the start of rainfall. Runoff initially presents itself as **sheet flow**, a shallow layer of water flowing more or less uniformly over the land. Water on the soil gains energy as it begins to run down slopes as runoff.

In this early stage, the major potential for damage caused by stormwater runoff is the ability to transport loose soil particles. This is why it is so important to maintain the vegetation on a construction site as long as possible and incorporate phasing in each project. This is also why it is important to establish temporary or permanent cover (mulch or vegetation) on a site as soon as possible.

MS 1 addresses stabilization

The amount of runoff depends upon:

- The amount and intensity of the rainfall, and
- The character of the soil surface impacted by rainfall.

The TAKE AWAY

- It's more than just a little dirt
- Sediment can have many harmful substances attached to it

Raindrops impact the soil as little bombs.

Raindrop impact is the first effect of a rainstorm on the soil dislodging soil particles and splashing them into the air. The detached particles can be easily picked up by water flowing over a site and become sheet erosion

Raindrop Impact

Of the five types of erosion, raindrop erosion is the most significant in the erosion process. **The action of falling rain on disturbed or denuded soil is responsible for 90% or more of total soil erosion.**

Raindrop impact produces two damaging effects:

- The detachment of soil particles
- Sealing of the soil's surface

Preventing these two effects is the first and most important part of erosion control.

The erosive capacity of rainfall comes from the energy of its motion, or *kinetic energy*.

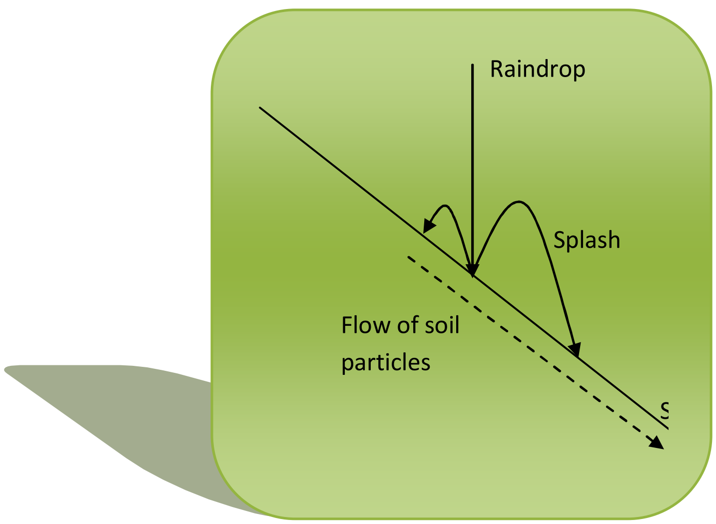
The magnitude of this energy is dependent on the amount and intensity of rainfall, raindrop diameter, and raindrop velocity.

All rain events contain drops of various sizes. An intense rain has a much higher proportion of large drops than a light rain. The damaging effects from rain falling as large drops in an intense thunderstorm has many times more erosive energy than rain falling as a fine drizzle over a longer period of time. In Virginia, the most erosive rains are concentrated during the months of June through September (see Table 1 below) when rainfall events occur as thunderstorms and tropical systems. ***This is also the period when land-disturbance is most active.*** Precipitation in the winter generally falls as a finer mist.

TABLE 1
Precipitation Characteristics by Seasons

Characteristics	Sept. through April	May through Aug.
Form	Rain and/or Snow	Rain
Intensity	Low	High
Drop Size	Small	Large
Duration of Storm	Long	Short
Area of Storm	Large	Large or Small

On level surfaces, the horizontal and vertical effect of splashed soil is self- cancelling. However, on sloping land, the net movement is downhill.



On exposed slopes, the impact of raindrops moves ~ 75% of the soil down the slope.

Another damaging effect of raindrops is the compacting, puddling, and sealing of the soil surface. Repeated strikes churn the surface into a slurry, which seals the pore spaces in the soil preventing water infiltration. As they continue to pound the land, raindrops will also compact the bare soil, forming an almost complete seal. Even on coarse sandy soil, this action reduces the infiltration of water into the soil and leads to increased erosion and runoff.

Sediment-laden water and raindrop impact are slowly sealing the soil in this agricultural field

Sheet erosion

Sheet erosion is the second stage of erosion. The soil's ability to infiltrate water is exceeded & water starts to run across the surface of the soil (sheet flow). The dislodged soil particles are transported by sheet flow.

Rill erosion

Rill erosion begins when shallow sheet flow begins to concentrate in low spots. As the flow changes from sheet flow to deeper flow in these low areas, the velocity and turbulence increases. The energy of this concentrated flow detaches and transports soil material, cutting tiny channels or rills that are only a few inches deep. At this stage, hand tools or other surface treatments will easily repair erosion damage.

Gully erosion

Gully erosion occurs when rills converge to form larger channels or gullies. The major difference between gully and rill erosion is size. Gullies are too large to be restored with conventional tillage equipment and usually require heavy

Channel erosion

Channel erosion can occur in two ways.

1 - When gullies are not repaired in time and large volumes of water increase the size of the gully,

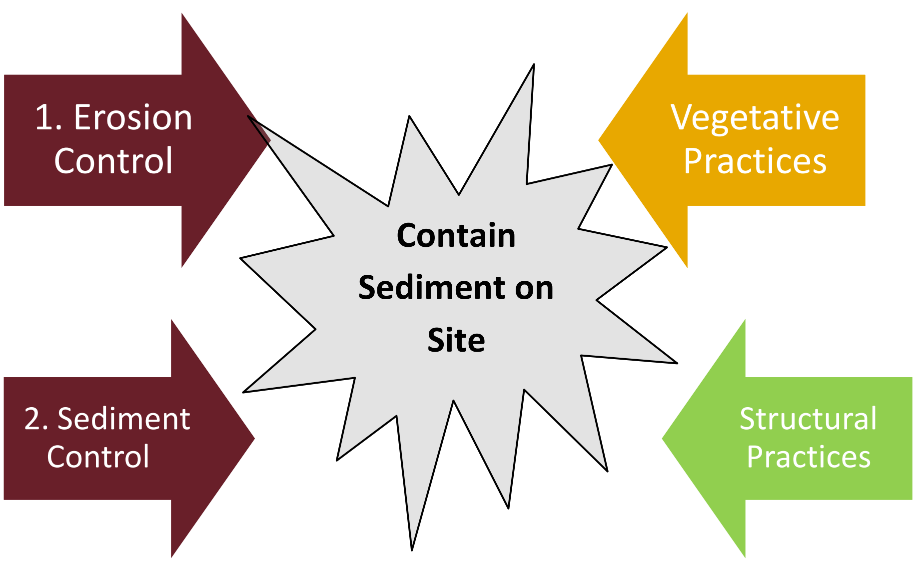
2 - In existing streams or drainage ways when the volume and velocity of flow destroys the structural integrity of stream beds and banks

Erosion and sediment control is essential to protect:

- Down gradient properties and waterways
- The environment
- Recreation resources
- The economy
- The livelihood of our fellow citizens

If there is no erosion then there is no sediment!

The TAKEAWAY



Four Factors Influencing Erosion

The phases of erosion discussed above can all be correlated back to the four factors that influence erosion:

(1) Climate
(2) Ground Cover
(3) Soil properties
(4) Topography

While these factors are often interrelated, they need to be discussed individually.

(1) Climatic Factors influencing erosion include precipitation type (rain, snow, etc.); rainfall intensity and raindrop size; snow melt; and temperature extremes (freezing, excessive heat, etc.). On page 7, we discussed that raindrops are responsible for 90% of the erosion that occurs on a site and that summer storms are generally more intense and more erosive (Table 1; page 8).

In discussing precipitation, we often refer to: amount and intensity. A two inch precipitation event in the winter is very different than a two inch precipitation event in the summer.

Summer rains are often associated with thunderstorms with higher intensity and shorter duration

(2) Ground cover is perhaps the most important factors influencing erosion. As discussed earlier in this chapter, the size of raindrops and the speed by which they hit the soil are among the most important factors influencing erosion. Ground cover such as vegetation or mulches slow down the speed of raindrops by intercepting them on leaves, branches, and stalks.

Research has shown that erosion potential is directly proportional to the amount of bare soil exposed to raindrop impact. Therefore, surface cover is the most important factor for controlling erosion. ***While vegetative cover provides the best protection, the use of any surface cover material can reduce soil erosion by 90-99%!***

(3) Also important factors when looking at the erodibility of a site are **soil properties**, which include:

- soil texture (or the size of the particles in the soil),
- bulk density (or how tightly those particles are packed together),
- the percent organic matter,
- infiltration rate (the speed by which water enters the soil) and
- permeability rate (the speed by which water moves through the soil).

(4) Topographic features that influence site erodibility include *slope grade, slope length, slope shape and slope orientation.*

Slope steepness or grade influences erosion in several ways. First water will flow faster as the length and angle of a slope increase. Second, there is more "splash effect" on steeper slopes. These principles are the reason for the grouping of slope gradient into three general ranges of soil erodibility (Table 2).

Table 2
Relation between Slope Gradient and Erosion Hazard

Slope gradient	Erosion hazard
0-7%	Low
7-15%	Moderate
15% & over	High

With respect to ESC, slope length is defined as the distance from the point where overland flow begins to the point where it enters a well-defined channel, waterway or the point where deposition may occur because of a decrease in slope gradient.

The primary topographic considerations for erosion potential of a slope are its length and steepness. Table 3 provides the critical slope length for different slope gradient ranges.

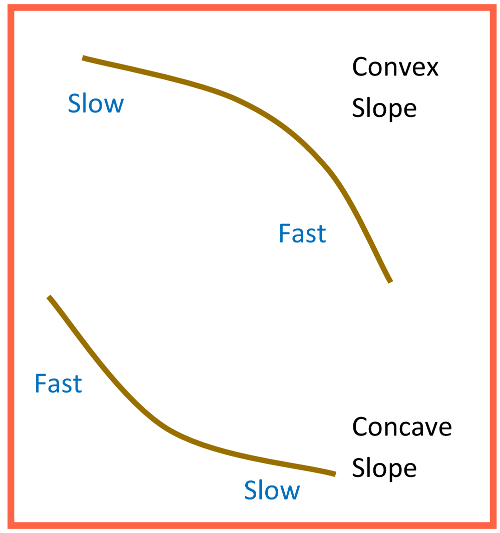
Table 3
Slope Gradient and Length Combinations at Which the Erosion Hazard Will Become Critical

Slope gradient	Slope length
0-7%	300 feet (100 meters)
7-15%	150 feet (50 meters)
15% & over	75 feet (25 meters)

The TAKE AWAY

- Increasing slope length will increase the volume of water in the runoff.
- This effect will create a point on the slope where water volume and velocity will begin to form rill and gullies without adequate ESC practices!

Slope shape also impacts erosion potential



- *Convex slopes (are slopes that are steeper at the lower end).*
- *Concave slopes (are slopes which flatten at the lower end).*

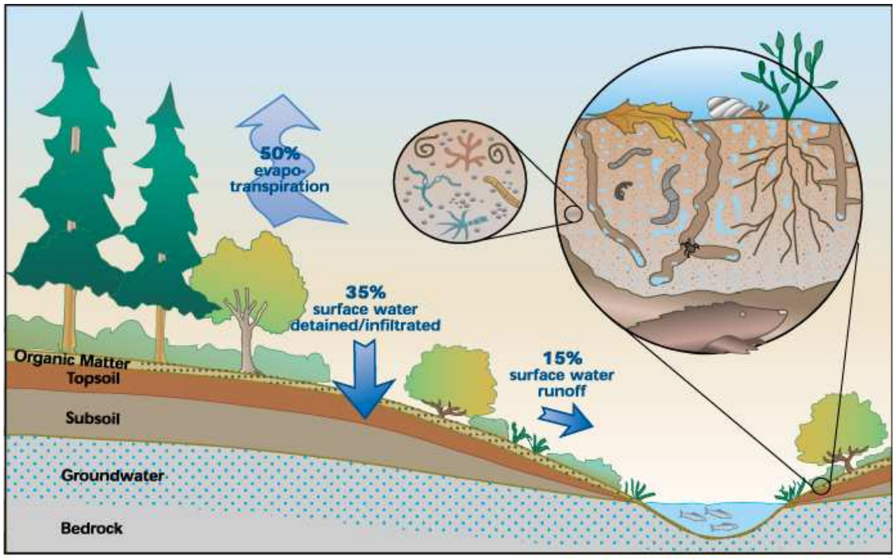
Erosion will be more on convex and less on concave slopes than what would be expected if the effect is calculated on the basis of an average grade.

Slope orientation or aspect also affects erosion. South and southwest facing slopes are usually warmer and drier because of sun exposure and exposure to warmer winds. Therefore, the vegetation on these slopes may be sparser, and establishment of new vegetation on south and southwest facing slopes is generally more difficult than northern slopes. Conversely, northern slopes are cooler, less exposed to the sun, and usually moister; therefore, it has different challenges in establishing vegetation on northern slopes.

The TAKE AWAY

Slope shape impacts runoff speed and erodibility of the slope

Before land disturbing activity



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

After land disturbing activity

Construction equipment can cause compaction of the top & subsoil such that the bulk density approaches that of concrete; becoming functionally impervious

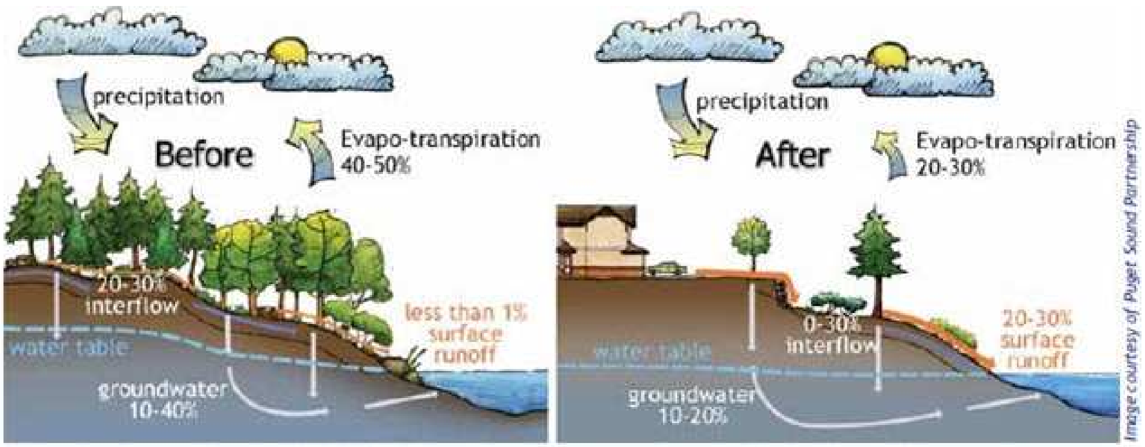
Compacted Soil
(Source: Center for Watershed Protection)

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

Hydrology & How LDA Changes the Water Cycle & Channel

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

- Clearing removes the vegetation
- Construction grading flattens hilly terrain and fills in natural depressions that would normally slow runoff
- Rainfall that once seeped into the ground now runs over the surface



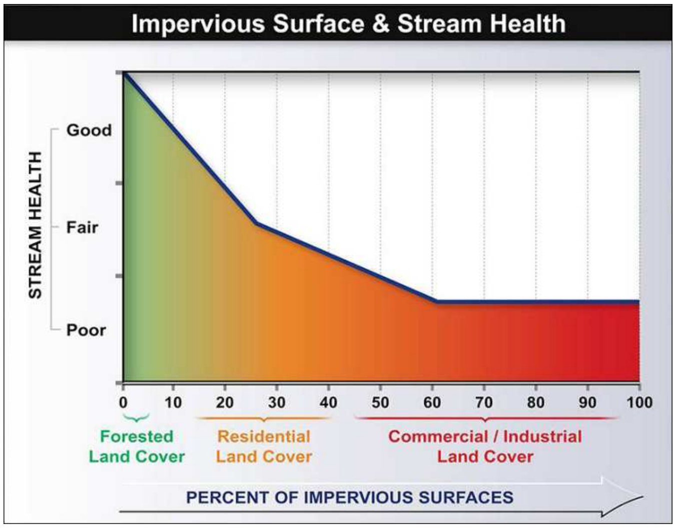
Changes in hydrology and land cover before (left) and after (right) development.
(Source: Puget Sound Partnership, 2013)

The addition of buildings, roadways, parking lots and other impervious surfaces further reduce infiltration and increase runoff.

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

The stream channel's physical shape, character, and health becomes altered by these higher velocity post runoff flows



- Higher flows occur more often and 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 (see figure below).

Stream Down Cutting
(Source: Center for Watershed Protection)

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.

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

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

New Approach to SWM

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. .

As precipitation patterns change and construction increases alter the hydrologic cycle, it is more important than ever to make smart and conscientious use of water supplies. Recycling or reusing stormwater presents a tremendous opportunity to do just that.

What do we do? **Answer =**

How has our approach changed over time?