Using the Virginia Stormwater Management Handbook

Department of Environmental Quality
Office of Training Services

Continuing Education Units (6)

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Your Instructor

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  Ryn.Kennedy@deq.virginia.gov
- Need help?
  certification@deq.virginia.gov

Reminder:
This is a Continuing Education Course
(not a Certification Course)

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Ground Rules

1. Keep cell phones muted during the training
2. Questions and comments are encouraged
3. Be supportive of all participants

3

Continuing Education

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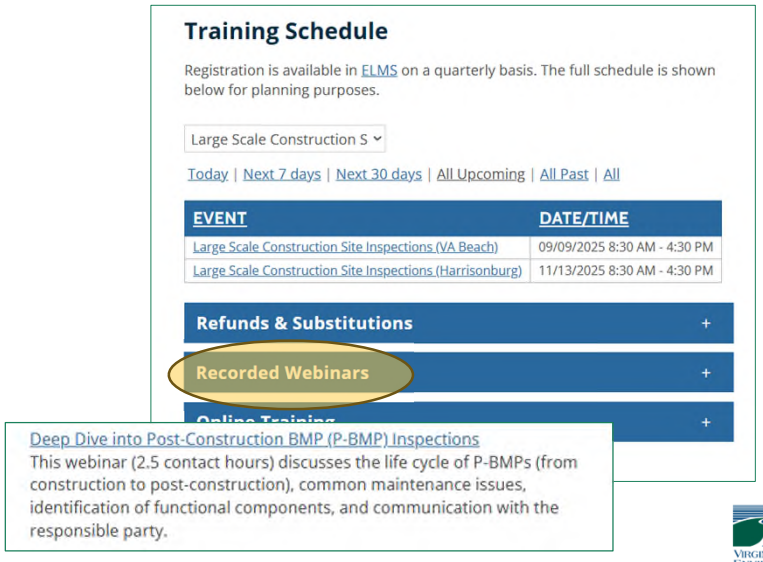
Continuing Education



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Course Goals:

- Utilize the New Virginia Stormwater Management Handbook (VSMH)
- Confirm the location of the VSMH on Encode
- Assess the condition and use of BMPs
- Operate the VSMH during an inspection
- Compose a planting plan utilizing the Appendixes

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Today's Agenda

- 8:30 – 9:00 Introduction
- 9:00 – 9:30 **Activity 1**: Accessing the Handbook
- 9:30 – 10:00 Chapter 7 and PCM-04
- ***10:00 – 10:15*** ***Break***
- 10:15 – 11:30 **Activity 2:** Evaluating C-BMPs
- 11:30 – 12:00 Chapter 8, and P-BAS-03
- ***12:00 – 1:00*** ***Lunch***
- 1:00 – 1:45 **Activity 3:** Evaluating P-BMPs
- 1:45 – 2:30 P-FIL-05 and Appendix G
- ***2:30 – 2:45*** ***Break***
- 2:45 – 3:45 **Activity 4: Creating a Planting Plan**
- 3:45 – 4:30 Handbook Updates and Revisions

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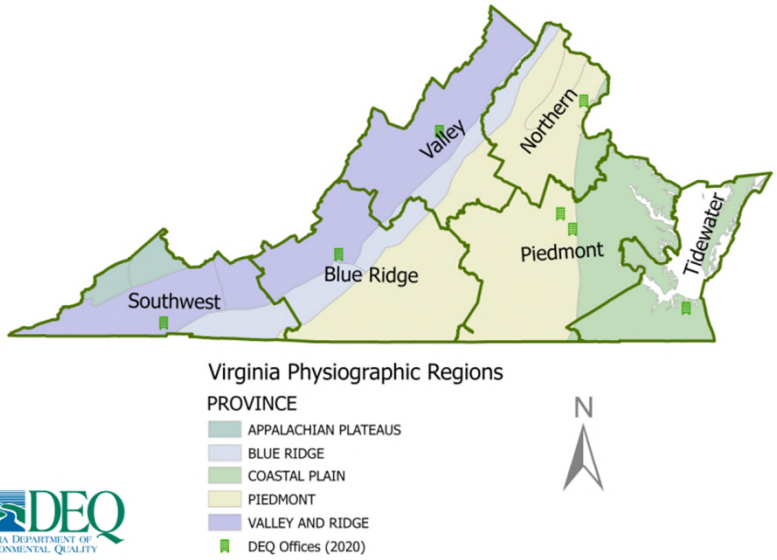
A regional look at Virginia



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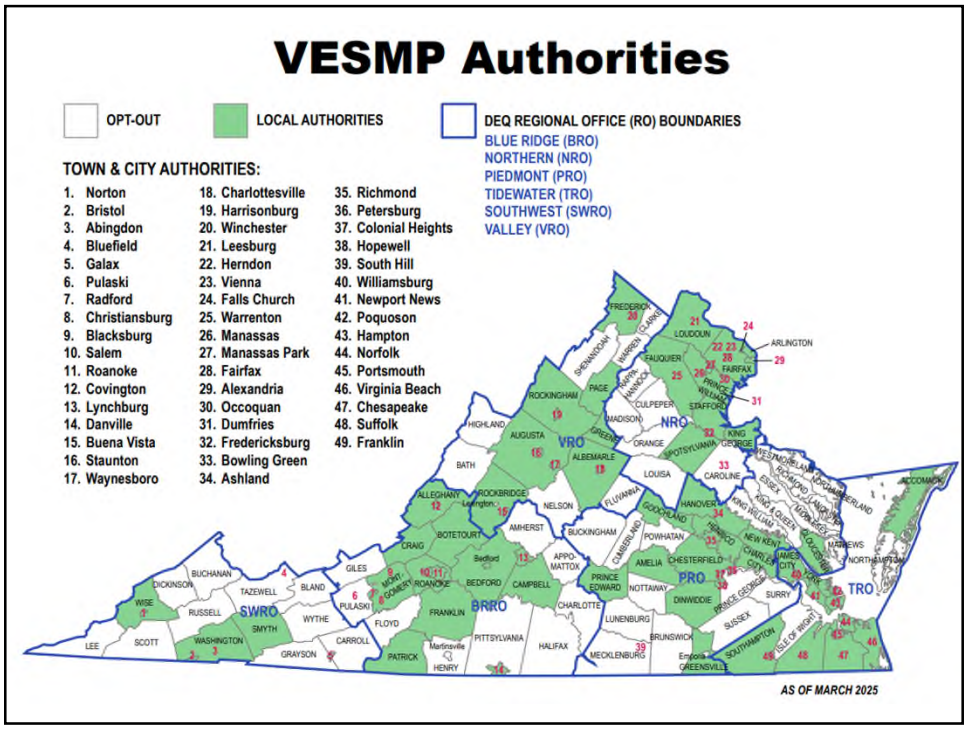
VESMP Authorities
OPT-OUT
LOCAL AUTHORITIES
DEQ REGIONAL OFFICE (RO) BOUNDARIES
BLUE RIDGE (BRO)
NORTHERN (NRO)
PIEDMONT (PRO)
TIDEWATER (TRO)
SOUTHWEST (SWRO)
VALLEY (VRO)
TOWN & CITY AUTHORITIES:
1. Norton
2. Bristol
3. Abingdon
4. Bluefield
5. Galax
6. Pulaski
7. Radford
8. Christiansburg
9. Blacksburg
10. Salem
11. Roanoke
12. Covington
13. Lynchburg
14. Danville
15. Buena Vista
16. Staunton
17. Waynesboro
18. Charlottesville
19. Harrisonburg
20. Winchester
21. Leesburg
22. Herndon
23. Vienna
24. Falls Church
25. Warrenton
26. Manassas
27. Manassas Park
28. Fairfax
29. Alexandria
30. Occoquan
31. Dumfries
32. Fredericksburg
33. Bowling Green
34. Ashland
35. Richmond
36. Petersburg
37. Colonial Heights
38. Hopewell
39. South Hill
40. Williamsburg
41. Newport News
42. Poquoson
43. Hampton
44. Norfolk
45. Portsmouth
46. Virginia Beach
47. Chesapeake
48. Suffolk
49. Franklin
VRO
NRO
PRO
TRO
BRRO
SWRO
AS OF MARCH 2025

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VIRGINIA STORMWATER MANAGEMENT HANDBOOK
FEATURED TOPICS
Introduction
Design Specifications for Construction BMPs
DEQ
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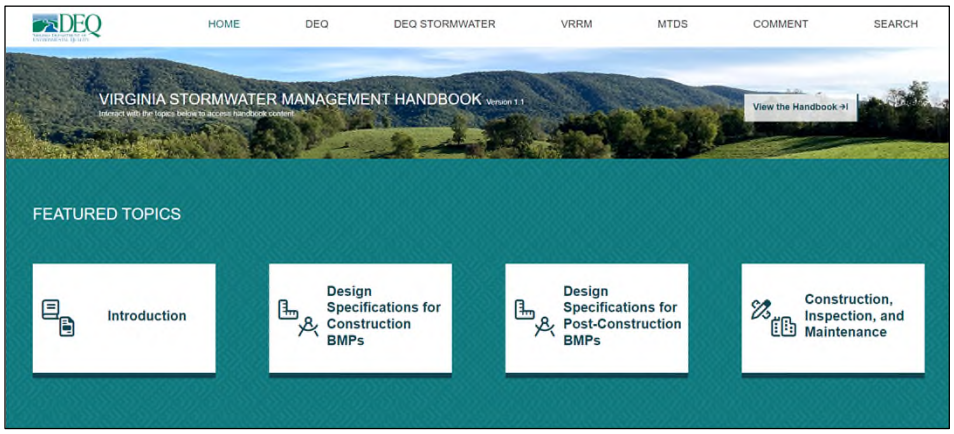
The Virginia Stormwater Management Handbook – Online



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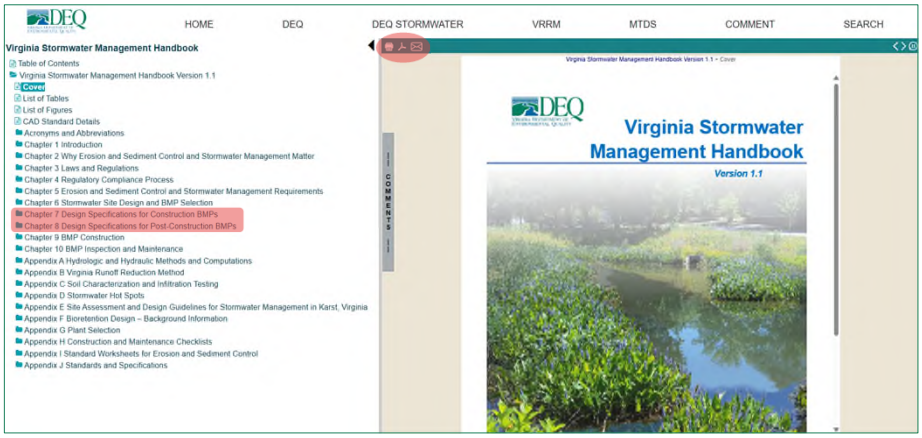

CAUTION: DOWNLOADING THE FULL HANDBOOK ALL AT ONCE MAY CRASH YOUR COMPUTER

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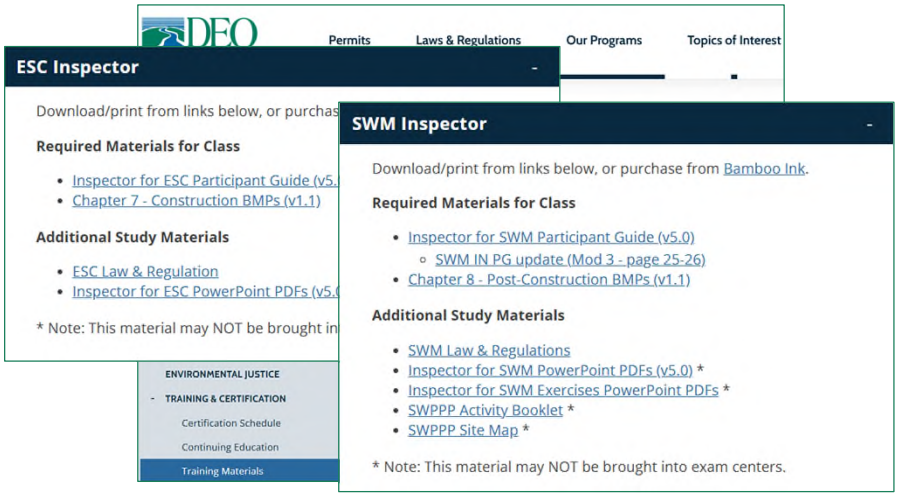
Accessing the Specs



https://www.deq.virginia.gov/our-programs/training-certification/training-materials

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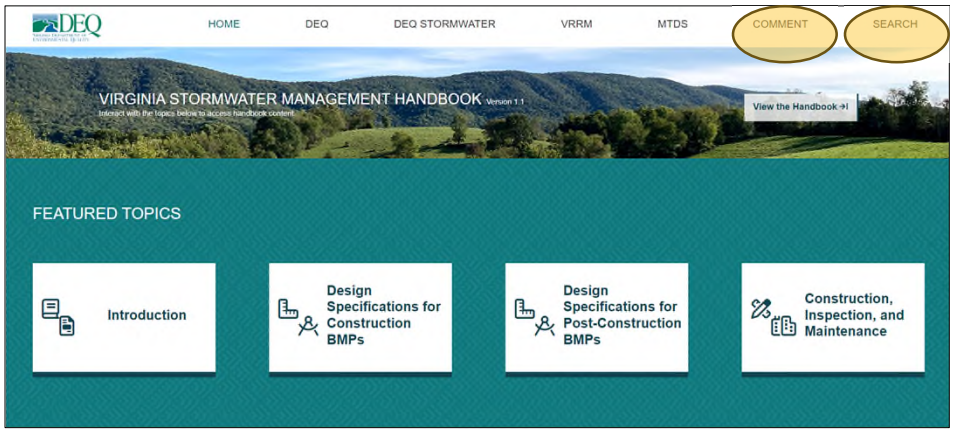

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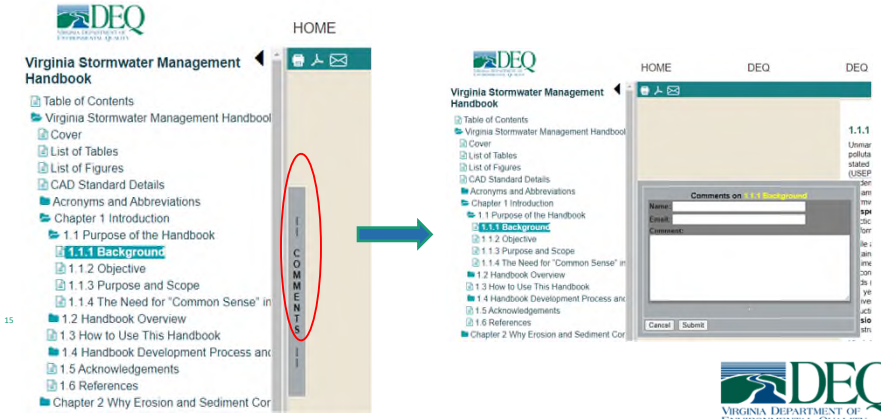
The Handbook is a Living Document

- Updated as regulation and interpretation changes
- Comments may be entered on the enCode Plus Platform



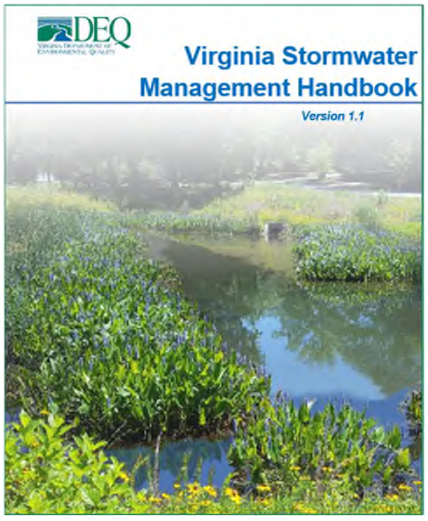
Written Comments

Directly into Encode

For SWM Program Guidance

swmguidance@deq.virginia.gov

How to Use the Handbook



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Handbook Chapters

- **Chapter 1:** Introduction
- **Chapter 2:** Why Erosion and Sediment Control and Stormwater Management Matter
- **Chapter 3:** Laws and Regulations
- **Chapter 4:** Regulatory Compliance Process
- **Chapter 5:** Erosion and Sediment Control and Stormwater Management Requirements

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Handbook Chapters Cont.

- **Chapter 6:** Site Design and BMP Selection
- **Chapter 7:** Design Specifications for Construction BMPs (ESC)
- **Chapter 8:** Design Specifications for Post-Construction BMPs (SWM)
- **Chapter 9:** BMP Construction
- **Chapter 10:** BMP Inspection and Maintenance
- **Appendices**

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Handbook Appendices

A. Hydrologic & Hydraulic Methods & Computations

B. Virginia Runoff Reduction Method

C. Soil Characterizations and Infiltration Testing

D. Stormwater Hot Spots

E. Site Assessment & Design Guidelines for SWM in Karst

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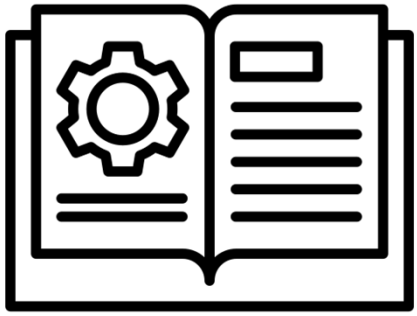
Handbook Appendices Cont.



F. Bioretention Design – Background Information

G. Plant Selection

H. Construction and Maintenance Checklists

I. Standard Worksheets for Erosion & Sediment Control

J. Standards and Specifications

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Chapter 1:

Introduction

"A healthy environment, and healthy state and local economies of Virginia are intrinsically related; balanced economic development and the protection of our environment are not mutually exclusive."

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1.1 Purpose of the Handbook

- Background
- Objective
- Purpose and Scope
- The Need for "Common Sense" in the Implementation of BMPs

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The Need for "Common Sense" in the Implementation of BMPs

- Consider Space Limitations in the Selection of BMPs
- Provide Inspection and Maintenance Access
- Provide Setbacks from Ponds in Residential Development

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The Need for "Common Sense" in the Implementation of BMPs Cont.

- Wet Ponds in Infill Development
- Consider Topography in the Selection and Design of BMPs
- Consider Soils, Underlying Geology, and Groundwater

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1.3 How to Use This Handbook

Audience and Intent. This Handbook is targeted to designers of BMPs, plan reviewers, and operations and maintenance staff. The Handbook's intent is to assist designers by providing information and support components that facilitate design and construction of BMPs while keeping maintenance in mind.

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Implementation & Next Steps

Handbook effective on July 1, 2024

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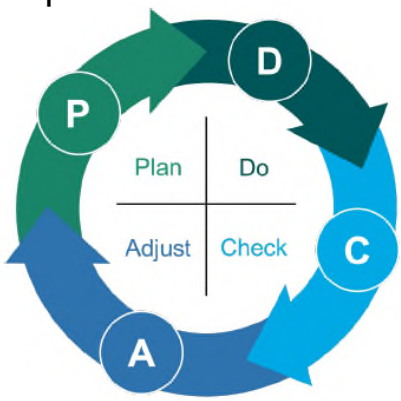
1.4.1 Handbook Development Process

Stakeholder Advisory Group

1. Handbook Outline and Chapters
2. Calculations
3. Erosion & Sediment Control and Stormwater Management BMPs
4. Handbook Planning, Production, and Outreach



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Other Handbook Enhancements

Specifications	60 Construction BMPs 23 Post Construction BMPs + MTDs CAD Details
Chapters	10 Chapters 10 Appendices
Incorporating S&S	Facilitate implementation, reduce DEQ review
Handbook Update Process	Chapter 1

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Significant Updates: Chapters 7 and 8

Design Specifications for Construction BMPs (ESC) & Post-Construction BMPs (SWM)

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Organization of BMP Specifications

- 1.0 Definition
- 2.0 Purpose and Applicability
- 3.0 Planning and Considerations
- 4.0 Stormwater Performance Summary
- 5.0 Design Criteria
- 6.0 Construction Specifications
- 7.0 Operations and Maintenance Considerations
- 8.0 References
- Note: Some BMPs have additional sections

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Numbering and Nomenclature

First letter represents the type of BMP:

- Construction (C)
- Post-Construction (P)

Number represents the specific BMP

C-PCM-04

Three letters represent the primary function of the BMP:

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Construction BMPs – VSMH Ch.7

- Structural practices
  - **C-ECM** – Erosion Control Measures
  - **C-ENV** – Environmentally Sensitive Area Protection
  - **C-PCM** – Perimeter Control Measures
  - **C-SCM** – Sediment Control Measures
- Vegetative practices
  - **C-SSM** – Surface Stabilization Measures

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Post-Construction BMPs – VSMH Ch.8

- **P-BAS** – Basins
- **P-CNV** – Conveyance
- **P-FIL** – Filtration and Infiltration
- **P-SUP** – Support Components

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QUESTIONS?

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Activity 1:

Accessing the VSMH

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Activity 1

Accessing the VSMH

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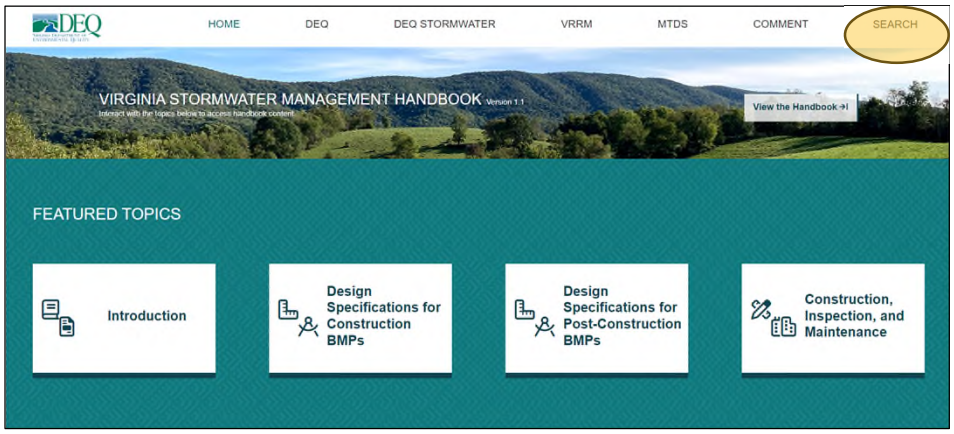
Handbook Digital Access

https://online.encodeplus.com/regs/deq-va/index.aspx

stormwater/stormwater-construction/handbooks

2

The Virginia Stormwater Management Handbook - Online



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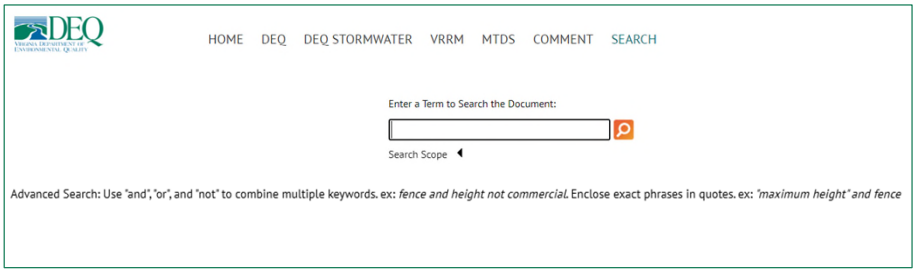

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Search Example #1:

Secondary Containment

Type this in the search box and generate the result

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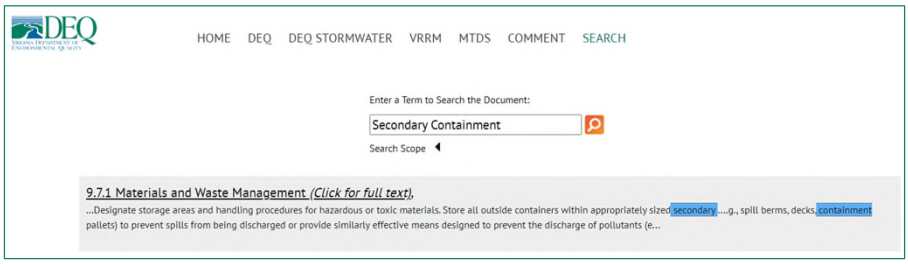
Enter Secondary Containment into the search bar



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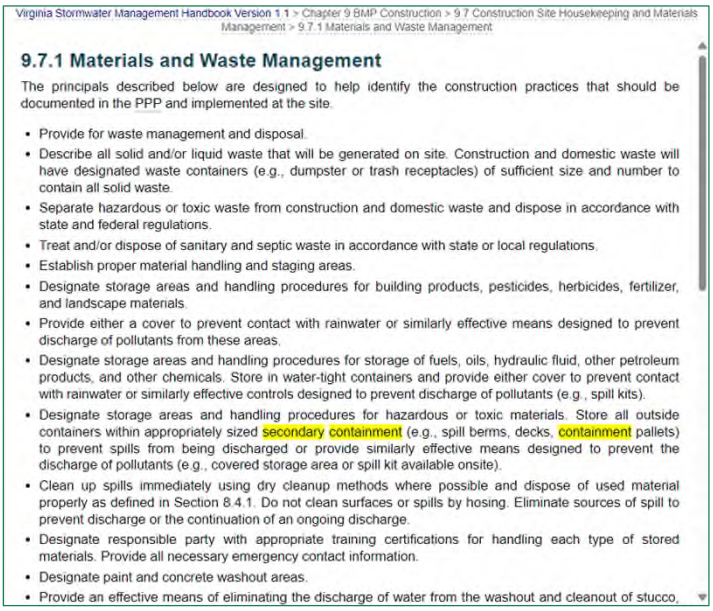

Virginia Stormwater Management Handbook Version 1.1 > Chapter 9 BMP Construction > 9.7 Construction Site Housekeeping and Materials Management > 9.7.1 Materials and Waste Management

9.7.1 Materials and Waste Management

The principals described below are designed to help identify the construction practices that should be documented in the PPP and implemented at the site.

- Provide for waste management and disposal.
- Describe all solid and/or liquid waste that will be generated on site. Construction and domestic waste will have designated waste containers (e.g., dumpster or trash receptacles) of sufficient size and number to contain all solid waste.
- Separate hazardous or toxic waste from construction and domestic waste and dispose in accordance with state and federal regulations.
- Treat and/or dispose of sanitary and septic waste in accordance with state or local regulations.
- Establish proper material handling and staging areas.
- Designate storage areas and handling procedures for building products, pesticides, herbicides, fertilizer, and landscape materials.
- Provide either a cover to prevent contact with rainwater or similarly effective means designed to prevent discharge of pollutants from these areas.
- Designate storage areas and handling procedures for storage of fuels, oils, hydraulic fluid, other petroleum products, and other chemicals. Store in water-tight containers and provide either cover to prevent contact with rainwater or similarly effective controls designed to prevent discharge of pollutants (e.g., spill kits).
- Designate storage areas and handling procedures for hazardous or toxic materials. Store all outside containers within appropriately sized secondary containment (e.g., spill berms, decks, containment pallets) to prevent spills from being discharged or provide similarly effective means designed to prevent the discharge of pollutants (e.g., covered storage area or spill kit available onsite).
- Clean up spills immediately using dry cleanup methods where possible and dispose of used material properly as defined in Section 8.4.1. Do not clean surfaces or spills by hosing. Eliminate sources of spill to prevent discharge or the continuation of an ongoing discharge.
- Designate responsible party with appropriate training certifications for handling each type of stored materials. Provide all necessary emergency contact information.
- Designate paint and concrete washout areas.
- Provide an effective means of eliminating the discharge of water from the washout and cleanout of stucco,

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9.7.1 Materials and Waste Management

The principals described below are designed to help identify the construction practices that should be documented in the PPP and implemented at the site.

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

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Secondary Containment

Store all outside containers within appropriately sized secondary containment (e.g., spill berms, decks, containment pallets) to prevent spills from being discharged or provide similarly effective means designed to prevent the discharge of pollutants (e.g., covered storage area or spill kit available onsite).

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Do you have any concern(s) about this fuel containment?

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What would you communicate to the Operator of this site about this fuel containment and storage? How would you go about that?

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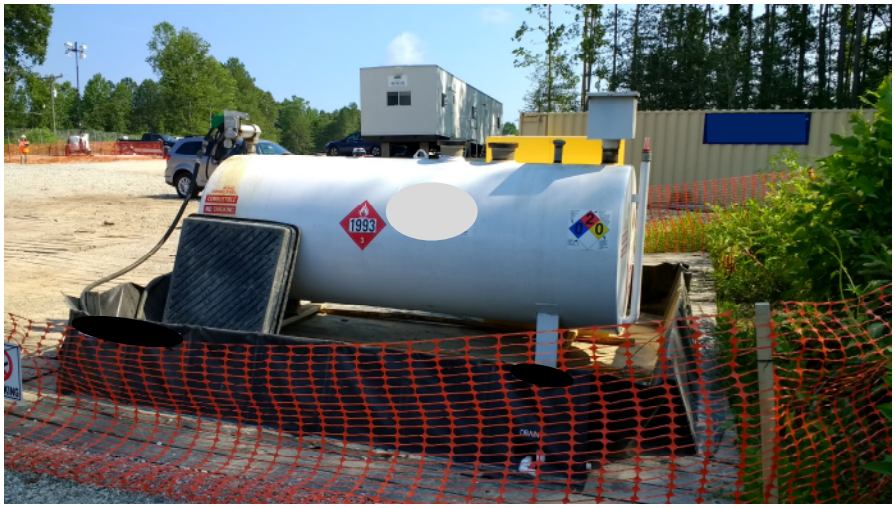
What features do you like about this fuel containment and storage area?



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What are some of your concern(s) about these fuel storage practices?

13

Where is the most likely place for a spill kit to be found on a construction site?

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You notice a few spill kits on site, what's your next course of action? What are you looking for?

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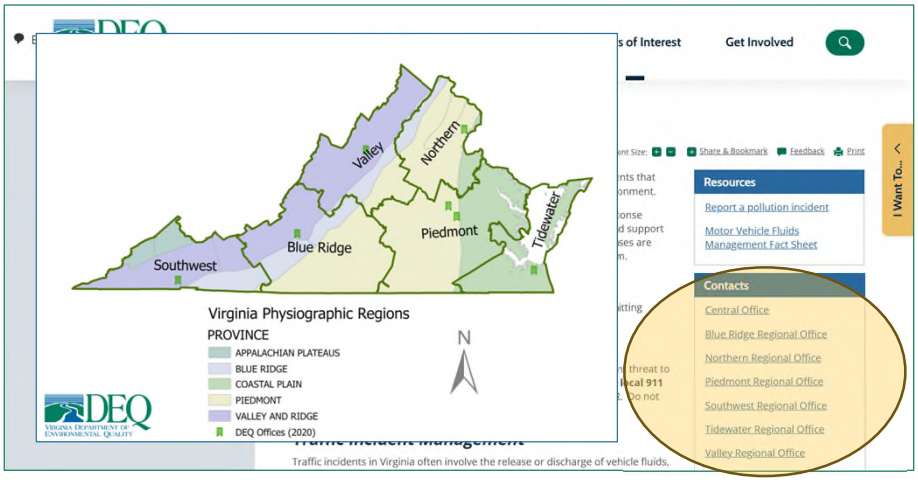
DEQ's Pollution Response Program (PREP) Website:



www.deq.virginia.gov/our-programs/pollution-response

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DEQ's Pollution Response Program (PREP)

Emergencies

If you observe a significant pollution incident that presents an imminent threat to human health or the environment, report the pollution incident to your **local 911** and to the **Virginia Emergency Operations Center at 1-800-468-8892**.

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Motor Vehicle Fluids Management Fact Sheet: Reporting Requirements

≥25 gallons	• Virginia Emergency Operations Center (VEOC) • (800) 468 - 8892
If any amount of oil/fuel has been released to surface water or a storm drain system or has the reasonable potential to reach surface water	• National Response Center (NRC) • (800) 424 – 8802 • Virginia Emergency Operations Center (VEOC) • (800) 468 - 8892

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CLEANUP REQUIREMENTS

- **Containment and recovery may include but are not be limited to:** use of granular absorbents; pads and booms; brooms and shovels; use of plastic sheeting; 55-gallon drums constructed of compatible materials; vacuum trucks; construction of soil berms and use of fuel transfer pumps.

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Motor Vehicle Fluids Management **Fact Sheet**: Clean up Considerations

Discharge of oil/fuel to asphalt or concrete

- Remove all free liquids to the extent practicable.
- Remove all oil/fuel contaminated cleanup debris.

Discharge of oil/fuel to stormwater systems and/or surface water

- For larger spills or spills that threaten sensitive receptors and/or surface water, additional response resources may be needed such as an emergency environmental response contractor. Contact the VEOC and request state assistance.

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Motor Vehicle Fluids Management Fact Sheet: Clean up Considerations

Discharge of oil/fuel to soils

- Remove all free liquids to the extent practicable.
- Remove all saturated soils.
- For small spills, may use a visual or olfactory standard for cleanup (i.e., remove all visibly contaminated soils).
- Document cleanup actions (e.g., take photos to document removal actions).
- Where incident was reported to VEOC (i.e., over 25 gallons), email photo documentation to DEQ.
- For larger spills or for spills near sensitive receptors, DEQ may require confirmation sampling to demonstrate that all saturated soils have been removed. Contact the VEOC and request state assistance.

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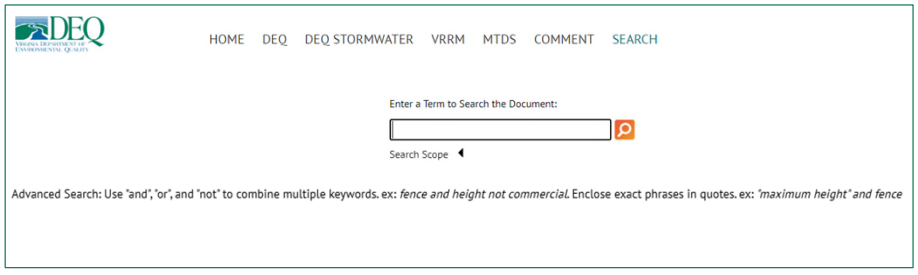

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Search Example #2:

Warm Season Grasses

Type this in the search box and generate the results

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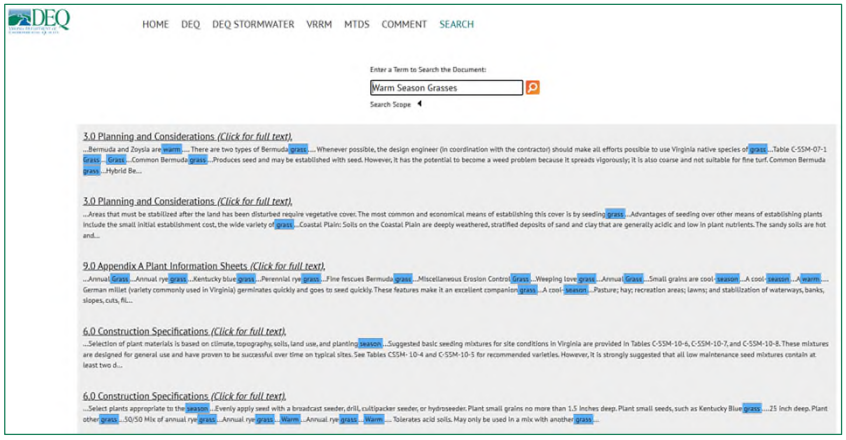
Enter Warm Season Grasses into the search bar



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Search Results: "Warm Season Grasses"

- 3.0 Planning Considerations
- 9.0 Appendix A Plant Information
- 6.0 Construction Specifications
- 7.0 Operations and Maintenance Considerations



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C-SSM-07: Bermuda and Zoysia Grasses

3.0 Planning and Considerations

Bermuda and Zoysia are warm-season, permanent grasses that are well-suited to erosion control, as the grasses have vigorous rhizomes and stolons (runners). There are two types of Bermudagrass grown in Virginia: common and hybrid. Whenever possible, the design engineer (in coordination with the contractor) should make all efforts possible to use Virginia native species of grass for all applicable erosion and sediment control measures.

Table C-SSM-07-1 Grass Types

Grass Types	
Common Bermudagrass	Produces seed and may be established with seed. However, it has the potential to become a weed problem because it spreads vigorously; it is also coarse and not suitable for fine turf. Common Bermudagrass has little cold tolerance and winterkills frequently.
Hybrid Bermudagrasses and Zoysiagrass	Established mainly by sodding, sprigging, or plugging. Recent developments in the turf industry have allowed hybrid Bermudagrass stands to establish from seed; however, the technology is relatively new. These grasses produce a fine, tight turf; do not spread as vigorously as common Bermudagrass; exhibit good cold tolerance; and can withstand many adverse conditions. For these reasons, hybrid Bermudagrass and Zoysiagrass are the warm-season permanent turf grasses of choice for Virginia.
Sprigging	A sprig is a small section of rhizome (underground stem) 3 to 5 inches long, with at least one node or joint. Leaves should be present at the nodes. Stolons (runners) are aboveground stems that spread by creeping on the soil surface. A mixture of sprigs and stolons is usually used in "sprigging." Sprigs may be planted by machine or hand.
Plugging	Plugs are small sections of sod pressed into precut holes in the soil so that top growth is flush to the surface and leaves are exposed. Plugs are usually planted by hand; however, plugging machines are also available.

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C-SSM-07: Bermuda and Zoysia Grasses

Figure 1. A patch of dormant bermudagrass is an eyesore in a cool-season lawn.

PICTURE: VIRGINIA COOPERATIVE EXTENSION

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9.0 Appendix A Plant Information Sheets

- C-SSM-10 Permanent Seeding
  - 1.0 Definition
  - 2.0 Purpose and Applicability of Best Management Practice
  - 3.0 Planning and Considerations
  - 4.0 Stormwater Performance Summary
  - 5.0 Design Criteria
  - 6.0 Construction Specifications
  - 7.0 Operations and Maintenance Considerations
  - 8.0 References
  - **9.0 Appendix A Plant Information Sheets**

Contents:

- Annual Grasses and Grains
- Perennials
- Miscellaneous Erosion Control Grasses
- Legumes

Foxtail Millet (Setaria italica)

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Foxtail millet

A warm-seaso
millet (variety
quickly. These
seedlings. It d
rary cover. Us

Bermudagrass (*Cynodon dactylion*)

Uses	Soil and water conservation, pasture, hay, silage, lawns, both high-maintenance and general-purpose turf, and stabilization of grassed waterways.
Description	A long-lived, warm-season perennial that spreads by stolons and rhizomes (runners and underground stems). Height of stems of common Bermudagrass may be 12 inches. The stems are short-jointed and the leaves flat and spreading. Common Bermudagrass may be established vegetatively with sprigs (sections of stems) or from seeds; however, this grass has the potential to develop into a weed problem because it spreads vigorously. Cold-tolerant hybrids are usually specified. These are traditionally established from sprigs or sod, but seed is now available.
Adaptation	Southern Piedmont and Coastal Plain in Virginia and some southern Appalachian ridges and valleys. Refer to Bermudagrass and Zoysiagrass Establishment (C-SSM-07) for regional adaptations of varieties. Makes its best growth when average daily temperatures are above 75 degrees Fahrenheit. Grows on a wide range of soils from heavy clays to deep sands. Optimum pH is 6.0 to 6.5. It is drought- resistant and salt-tolerant. Tolerates floods of short duration but will not thrive on waterlogged soils; does not persist under heavy shade. For rough areas, the varieties Midland (a forage hybrid) and Coastal are recommended. For fine-turf areas, Tufcote (a fine-leaved turf hybrid), Midiron, Tifway, and Vamont are used in Virginia.
Establishment	By sodding or planting sprigs. Plant sprigs (by hand or machine) when soil is warm in a well- prepared, moist seedbed. Extend one end of the sprig above-ground, and cover the other end with firmly packed soil.
Sources	Readily available as seed, sprigs, and sod.

Bermudagrass (Cynodon dactylon)

illet (Setaria italica)

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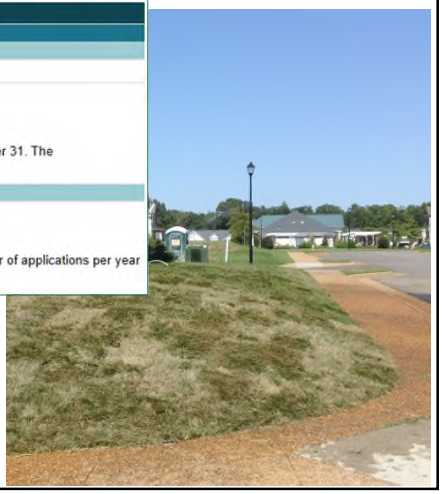
C-SSM-06: Sodding

7.0 Operations and Maintenance Considerations

1. During the 2- to 3-week establishment stage, sod should be watered as necessary to maintain adequate moisture in the root zone and prevent dormancy of sod.
2. No more than one third of the shoot (grass leaf) should be removed in any mowing. Grass height should be maintained between 2 and 3 inches unless otherwise specified.
3. After the first growing season, established sod will require fertilization and may require lime. Follow soil test recommendations when possible or apply maintenance levels as outlined in Table C-SSM-06-3.

Table C-SSM-06-3 Sodding Maintenance

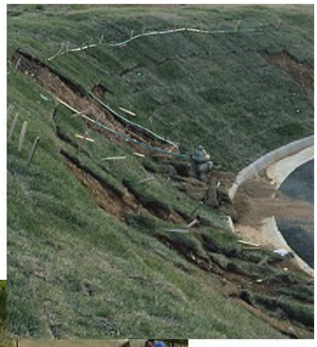
Maintenance Fertilization of Established Sod
Cool-Season Grasses
4 lbs. nitrogen per 1,000 ft^2/year
1 lb. phosphorus per 1,000 ft^2/year
2 lbs. potash per 1,000 ft^2/year
75% of the total requirements should be applied between September 1 and December 31. The balance should be applied during the remainder of the year.
Warm-Season Grasses
Apply 4 to 5 lbs. nitrogen per 1,000 ft^2 per year (between May 1 and August 15).
Phosphorus and potash should only be applied according to soil test results.
Maintenance fertilization should use slow-release fertilizers, which reduce the number of applications per year and subsequently reduce adverse impacts on groundwater.



30

C-SSM-06: 5.0 Design Criteria

- Consider site location and intended purpose when selecting type of sod to use
- **Table C-SSM-06-2:** Virginia Grasses for Sodding



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C-SSM-09: Temporary Seeding

6.0 Construction Specifications

Prior to seeding, complete grading and install necessary erosion control practices such as dikes, waterways, and basins.

Table C-SSM-09-1 Construction Specifications for Temporary Seeding

Plant Selecti

SURFACE STABILIZATION MEASURES		
C-SSM-01 TREE PRESERVATION AND PROTECTION	TP	TP
C-SSM-02 TOPSOILING	TO	TO
C-SSM-03 SURFACE ROUGHENING	SR	SR
C-SSM-04 COMPOST BLANKETS	CB	CB
C-SSM-05 SOIL STABILIZATION BLANKETS AND MATTING	B/M	
C-SSM-06 SODDING	SO	SO
C-SSM-07 BERMUDAGRASS AND ZOYSIAGRASS ESTABLISHMENT	BE/ZE	BE ZE
C-SSM-08 TREES, SHRUBS, VINES, AND GROUND COVER	VEG	VEG
C-SSM-09 TEMPORARY SEEDING	TS	TS
C-SSM-10 PERMANENT SEEDING	PS	PS
C-SSM-11 MULCHING	MU	MU

lications
, and Dates
ant Characteristics
ing varieties (e.g., Noble).
e fall seedings, winter cover.
es cold and low moisture.
annual. Dies at first frost. May
dded to summer mixes.
ded in mixes. Will mow out of most stands.

Korean Lespedeza[c] (*Lespedeza stipulacea*)	25	1.5	X	X	-	X	X	-	Warm-season annual legume. Tolerates acid soils. May only be used in a mix with another grass (e.g., annual or cereal rye); it is not suitable as a pure seeding for this purpose.

32

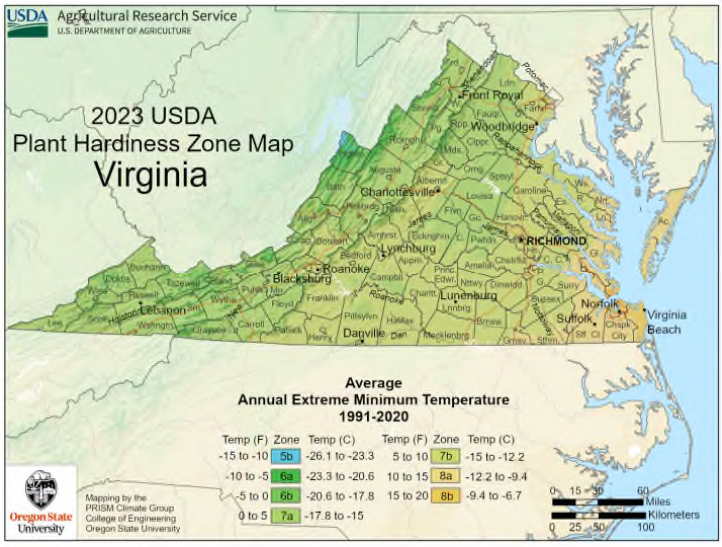
The action of falling rain on disturbed or denuded soil is responsible for 90% or more of total soil erosion.

NOTE

Soil loss rates from construction sites can be 1,000 times the average of natural soil erosion rates and 20 times that from agricultural lands (Keener et al. 2007).

33

C-SSM-10: Permanent Seeding



eeding

n grasses 90
n fertilization of
ys after

est. In the ab-

ber 1 and
year. Do not
one time.

y 1 and August

itenance of turf
impact on
olications may
when at least
r should be
d. Soil testing
, but not for N

API

PHYS

recommendations. Maintenance of pH > 5.5 is essential for both grass and legume persistence in permanent seedings.

34

Questions?

35

Chapter 7

Design Specifications for Construction BMPs (C-BMPs)

37

Chapter 7 - Contents

- 7.1 Introduction to the New Virginia Construction Best Management Practices
- 7.2 Significant Updates
- 7.3 Overview of BMPs
- 7.4 Standards and Specifications for Construction BMPS

38

7.3 Overview of Best Management Practices

39 E&S devices from the 1992 VESCH + 21 NEW Construction BMPs = 60 Construction BMPs total

C-ECM-01	Straw Wattle
C-ECM-02	Impermeable Diversion Fence
C-ECM-03	Slope Interruption Device
C-ECM-08	Waterbars and Sheet Flow Breakers
C-ECM-16	Flexible Transition Mat
C-ENV-05	Cofferdam Crossing
C-ENV-06	Stable Wetland Crossing
C-ENV-07	Gabions
C-ENV-08	Pump Around Diversion
C-ENV-09	Overnight Channel Protection

C-ENV-10	Trenchless Silt Fence
C-ENV-11	Wetland Berm
C-ENV-12	Wetland Weir Outlet
C-ENV-13	Wetland Cell Sediment Trap
C-ENV-14	Modified Turbitity Curtain for Streams
C-ENV-15	Seeding, Mulching, and Soil Stabilization (Wetlands/Streams)
C-PCM-05	Compost Filter Sock
C-SCM-06	Wood Chip Filter Berm
C-SCM-08	Rock Filter Outlet
C-SCM-13	Concrete Washout Pit
C-SSM-04	Compost Blankets

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Construction BMP Categorization and Numbering

Erosion Control Measures: C-ECM-(01-16)

1. Temporary Diversion Dike
2. Temporary Fill Diversion
3. Temporary Right-of-Way Diversion
4. Diversion
5. Temporary Slope Drain
6. Paved Flume
7. Stormwater Conveyance Channel
8. Outlet Protection
9. Rip Rap
10. Temporary Level Spreader
11. Subsurface Drain
12. Straw Wattles
13. Impermeable Diversion Fence
14. Slope Interruption Device
15. Waterbars and Sheet Flow Breakers
16. Flexible Transition Mat

New BMPs in Blue

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40

Construction BMP Categorization and Numbering

Sediment Control Measures: C-SCM-(01-13)

1. Temporary Stone Construction Entrance
2. Construction Road Stabilization
3. Storm Drain Inlet Protection
4. Culvert Inlet Protection
5. Temporary Sediment Trap
6. Temporary Sediment Basin
7. Rock Check Dams
8. Turbidity Curtain
9. Dewatering Structure
10. Dust Control
11. Wood Chip Filter Berm
12. Rock Filter Outlet
13. Concrete Washout Pit

New BMPs in Blue

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41

Construction BMP Categorization and Numbering

Surface Stabilization Measures: C-SSM-(01-11)

1. Surface Roughening
2. Temporary Seeding
3. Permanent Seeding
4. Sodding
5. Bermudagrass and Zoysiagrass Establishment
6. Mulching
7. Soil Stabilization Blankets and Matting
8. Trees, Shrubs, Vines, and Ground Cover
9. Topsoiling
10. Tree Preservation and Protection
11. Compost Blankets

New BMP in Blue

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Construction BMP Categorization and Numbering

Perimeter Control Measures: C-PCM-(01-05)

1. Safety Fence
2. Straw Bale Barrier
3. Silt Fence
4. Brush Barrier
5. Compost Filter Sock

New BMP in Blue

43

Construction BMP Categorization and Numbering

Environmentally Sensitive Area Protection: C-ENV-(01-15)

1. Vegetative Streambank Stabilization
2. Structural Streambank Stabilization
3. Temporary Vehicular Stream Crossing
4. Utility Stream Crossing
5. Cofferdam Crossing
6. Stable Wetland Crossing
7. Gabions
8. Pump Around Diversions
9. Overnight Channel Protection
10. Trenchless Silt Fence
11. Wetland Berm
12. Wetland Weir Outlet
13. Wetland Cell Sediment Trap
14. Modified Turbidity Curtain for Streams
15. Seeding, Mulching and Soil Stabilization

New BMPs in Blue

44

Structural C-BMPs

Designed to filter sediment out of sediment-laden water

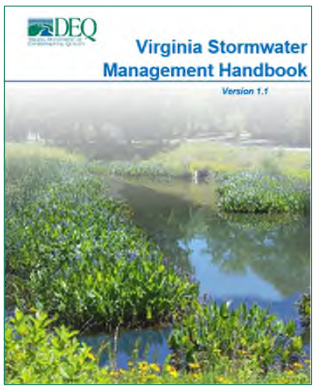
Usually 60 –75% effective

Will not filter out small or suspended particles

More expensive than vegetative controls

45

ESC Certification Course



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C-BMP Symbology

PERIMETER CONTROL MEASURES		
C-PCM-01 SAFETY FENCE	SAF	
C-PCM-02 STRAW BALE BARRIER	STB	
C-PCM-03 BRUSH BARRIER	BB	
C-PCM-04 SILT FENCE	SF	SF SF
C-PCM-05 COMPOST FILTER SOCK	CFS	CFS CFS

47

C-PCM-04 Silt Fence

1.0 Definition

C-PCM-04 Definition

Silt fence (and its derivatives ***wire-supported (reinforced) and super silt fence***) is a temporary sediment barrier consisting of a synthetic filter fabric entrenched and stretched across and attached to supporting posts.

Download File – CAD and PDF for C-PCM-04 Silt Fence

48

8.0 References

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Sherwood, W.C. and D.C. Wyant. 1979. Installation of Straw and Fabric Filter Barriers for Sediment Control. 58th Annual Meeting of Transportation Research Board. Washington, D.C.

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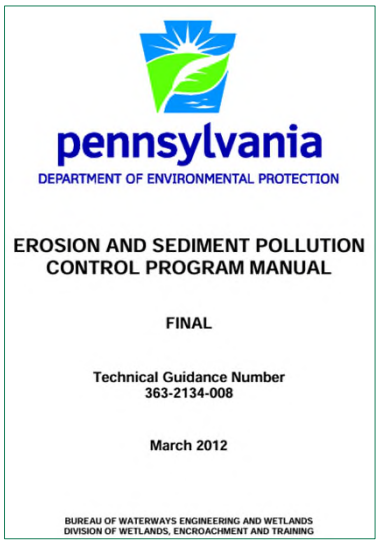
Reference Example:

- Pennsylvania Department of Environmental Protection
- Erosion and Sediment Pollution Control Program Manual
- Technical Guidance Number 363-2134-008
- March 2012



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Example 1:

51

Example 2:

52

Example 3:

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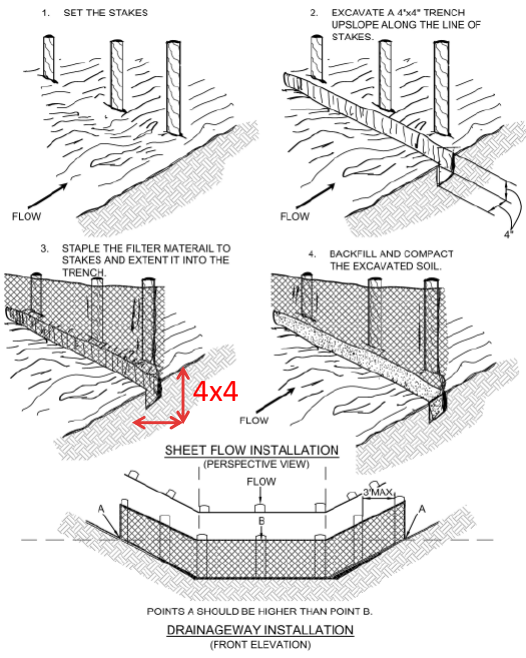

Figure C-PCM-04-4 Construction of Silt Fence without Wire Support Installation

54

PHOTO EXAMPLES

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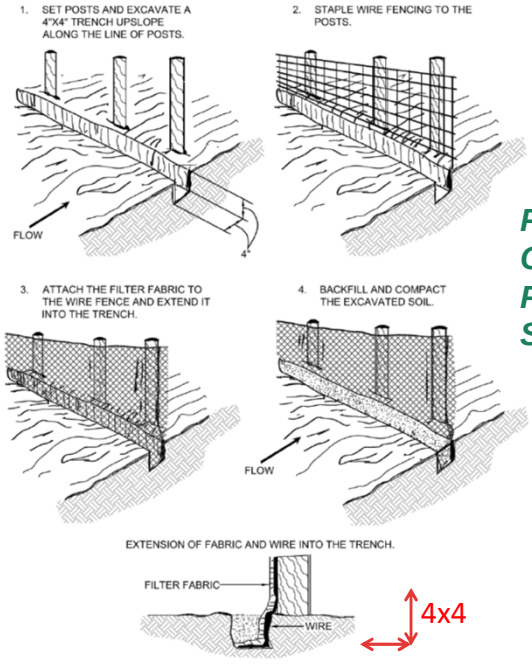

Figure C-PCM-04-3 Construction of Silt Fence with Wire Support Installation

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56

PHOTO EXAMPLE

57

3.0 Planning Considerations

Do not use silt fence where rock or other hard surface prevents the full and uniform depth anchoring of the barrier.

- **Q:** If silt fence won't work due to the site constraints, then what is an alternative C-BMP option for perimeter control?
- **A:** Compost Filter Socks!

58

4.0 Stormwater Performance Summary

Table C-PCM-04-1 Typical Flow Rates and Filtering Efficiencies of Perimeter Controls

Material	Flow Rate (gallon/minute/foot)	Total Solids Removal Efficiency (%)	Total Suspended Solids Removal Efficiency (%)	Turbidity Reduction (%)
Mulch Filter Berm[a]	0.47	54.8	51.3	8.1
Straw Bale[a]	0.46	65.1	53.8	11.8
8-inch Compost Filter Sock[a]	0.37	84.3	75.9	28.6
12-inch Compost Filter Sock[a]	0.37	85.0	84.9	19.1
Silt Fence	0.11	89.0	87.0	76.0

Footnote:

a. Runoff of 2.9 inches on a 2,500-square-foot watershed to replicate maximum spacing requirements for silt fence typically used for sediment control on disturbed soils for 10% slope (Faucette et al. 2008.).

Source for Mulch Filter Berm, Straw Bale, and Compost Filter Sock: Faucette et al. 2009.

Source for Silt Fence: Faucette et al. 2008.

C-PCM-04 Erosion Control Efficiency: LOW

C-PCM-04 Sediment Removal Efficiency: MEDIUM

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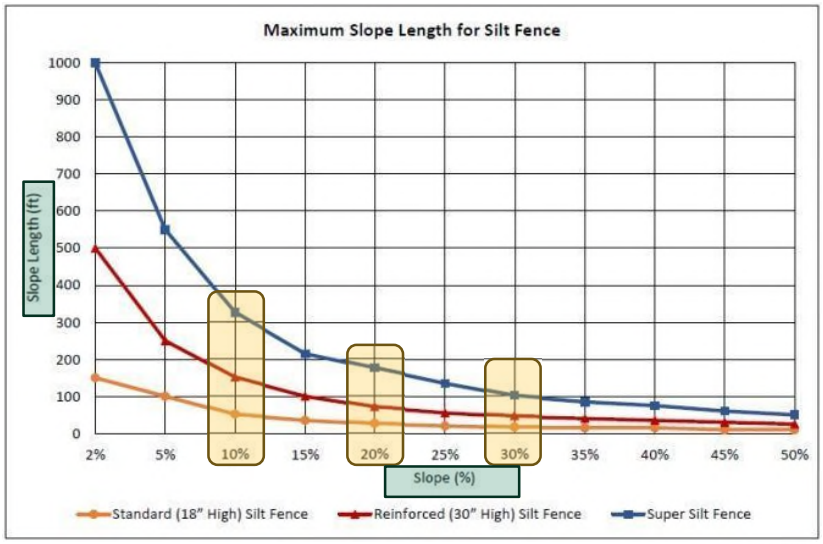
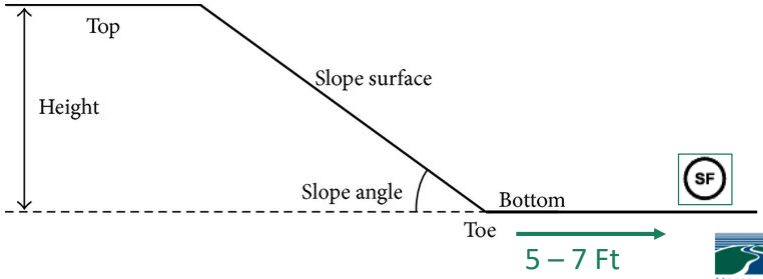
5.0 Design Criteria



60

How far back, beyond the base of a disturbed slope, should Silt Fence be located?

- 5 – 7 Ft



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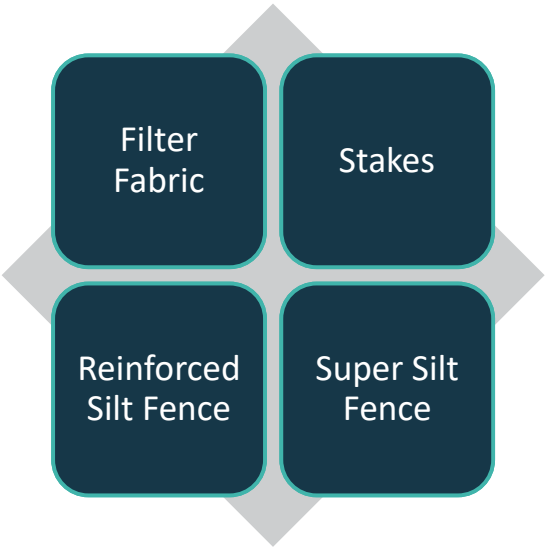
5.0 Design Criteria

Table C-PCM-04-2 Maximum Slope Length (feet) Above Fence			
Slope (%)	Standard (18 inches High) Silt Fence	Reinforced (30 inches High) Silt Fence	Super (33 inches High) Silt Fence
2 (or less)	100	500	1000
5	100	250	550
10	50	150	325
15	35	100	215
20	25	70	175
25	20	55	135
30	15	45	100
35	15	40	85
40	15	35	75
45	10	30	60
50	10	25	50

Source: Pennsylvania Department of Environmental Protection (PADEP) 2012.

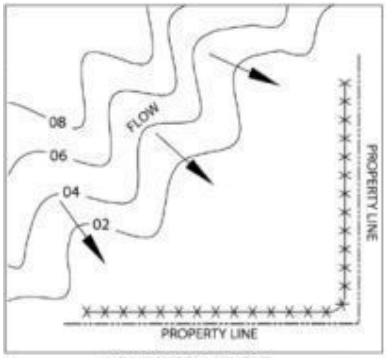
62

6.0 Construction Specifications

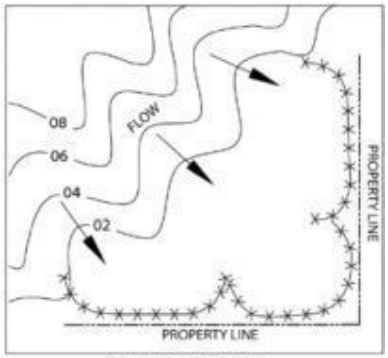


63

7.0 Operation and Maintenance Considerations



INCORRECT PLACEMENT
DO NOT LAYOUT PERIMETER CONTROL SILT FENCES ALONG PROPERTY LINES. ALL SEDIMENT-LADEN RUNOFF WILL CONCENTRATE AND OVERWHELM THE SYSTEM.



CORRECT PLACEMENT
BREAK-UP SILT FENCE INTO SECTIONS TO PREVENT SEDIMENT-LADEN RUNOFF FROM CONCENTRATING AND OVERWHELMING THE SYSTEM.

64

Activity 2:

Evaluating C-BMPs

65

Morning Break

15-Mins

66

Activity 2

Evaluating C-BMPs with the VSMH

1

Outline

- Plan Reading Skills
- Slopes and Angles
- **Activity**: Evaluating Perimeter Controls
  - New Development
  - Re-Development
  - Environmentally Sensitive Areas

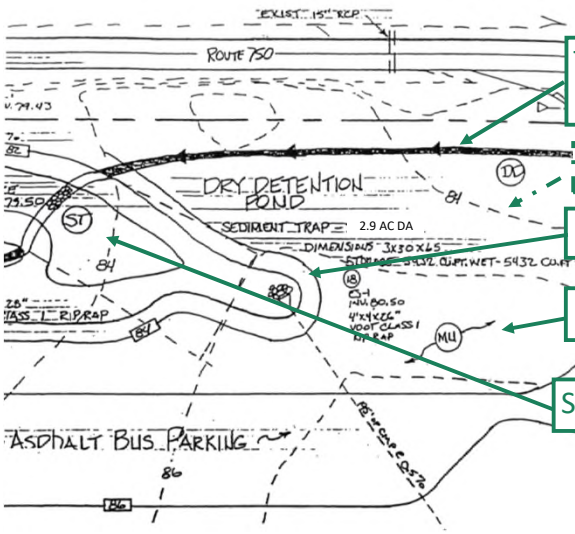
2

Plan Reading Skills

- Illustrative Portion of ESC plans
- Reading Contour Lines
- Cut & Fill Slopes

3

Illustrative Portion of ESC Plan



Temporary Diversion Dike (DD)

Existing contour

Proposed contour

Mulch (MU)

Sediment Trap (ST)

4

C-BMP Symbology

PERIMETER CONTROL MEASURES		
C-PCM-01 SAFETY FENCE	SAF	
C-PCM-02 STRAW BALE BARRIER	STB	
C-PCM-03 BRUSH BARRIER	BB	
C-PCM-04 SILT FENCE	SF	SF SF
C-PCM-05 COMPOST FILTER SOCK	CFS	CFS CFS

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5

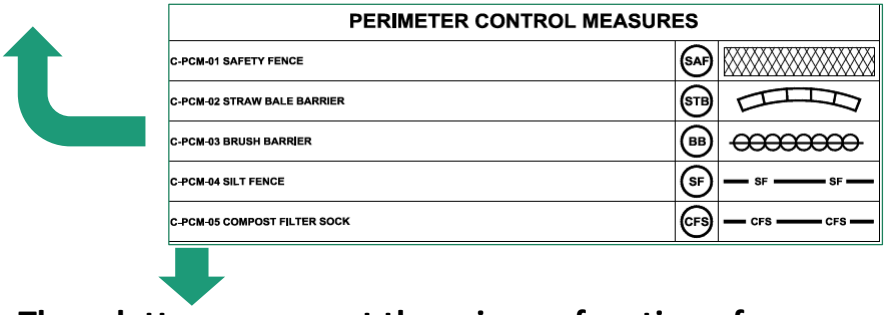
Numbering and Nomenclature

First letter represents the type of BMP:

- Construction (C)
- Post-Construction (P)

Number represents the specific BMP:

01-05



Three letters represent the primary function of the BMP: C-PCM → Perimeter Control Measures

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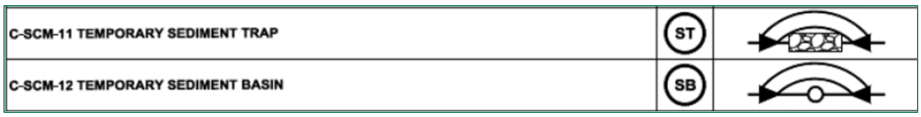
6

C-BMP Symbology and Function

- What is the primary function of a sediment trap or sediment basin?

  C-SCM → Sediment Control Measure



- What is the primary function of a trenchless silt fence?

  C-ENV → Environmentally Sensitive Area Protection

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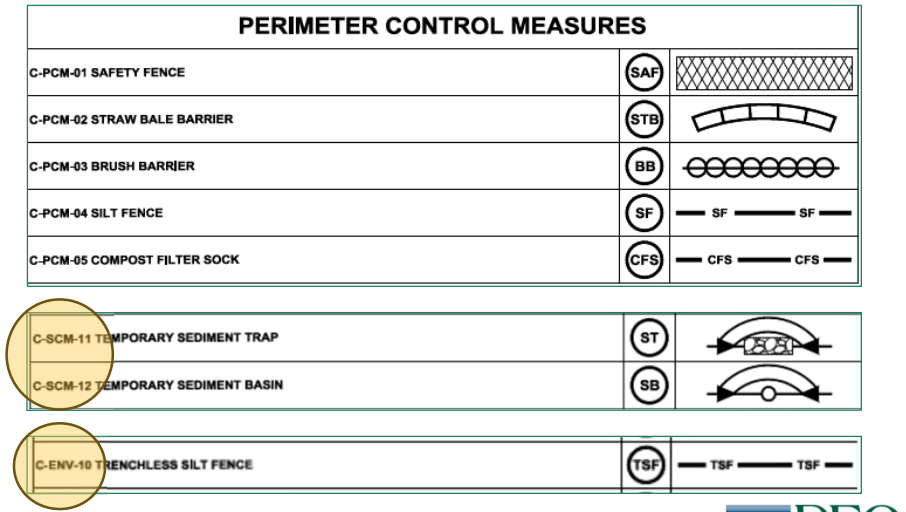
7

C-BMP Symbology



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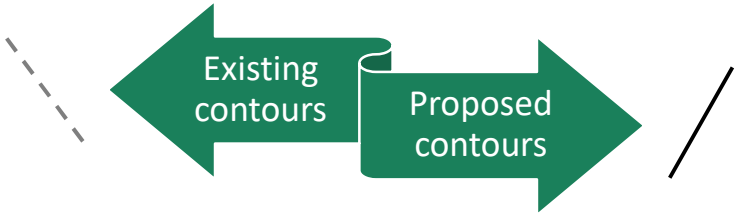
8

Reading Contour Lines

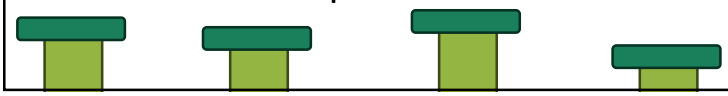
- Existing contours are usually shown as lighter gray or dashed lines
- Proposed contours are usually shown as solid black lines



9

Reading Contour Lines

- **Contour line** – a line on a map connecting points of equal elevation (height relative to sea level)
- **Contour interval** – the difference in elevation between two adjacent contour lines
- **Index contour** – contour lines that are labeled to help you find the contour interval, usually bolded
- **Benchmark** – point of known elevation

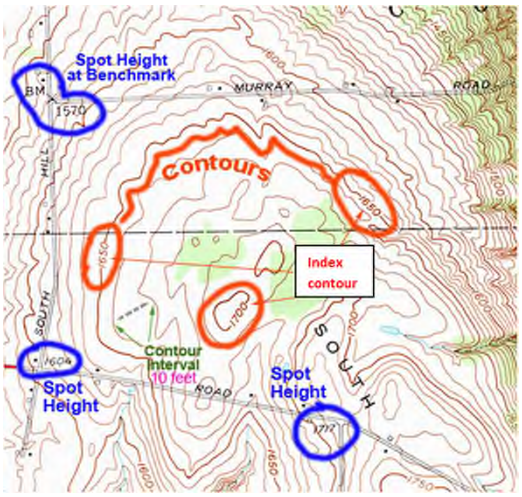


10

Reading Contour Lines

- Contour lines indicate the steepness of the terrain
- The closer the lines are together = steeper terrain
- Further apart

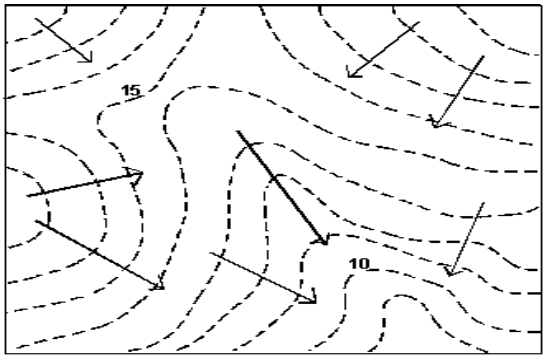
  means less steep



11

Reading Contours

Water always flows perpendicular to contour lines.



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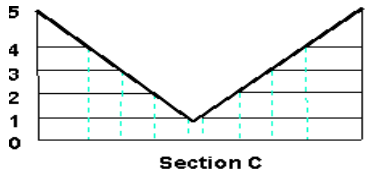
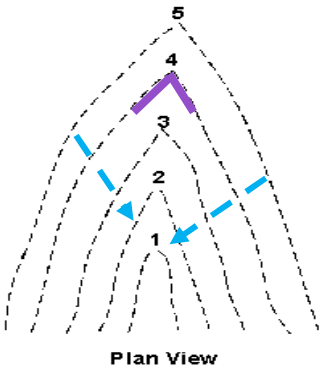
Valley or Swale

- Represented by contours which point toward the **higher** numbers.
- Inverted V – points to higher numbers.



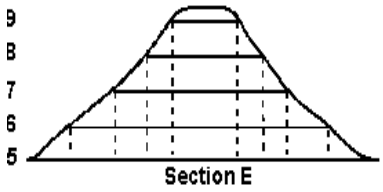


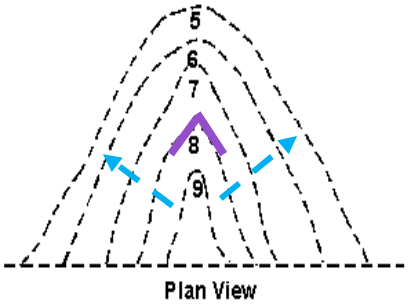
Water always flows perpendicular to contour lines.

13

Ridge

- Appears similar to a valley, but represented by contours which point toward the **lower** numbers.
- Denotes drainage divides.

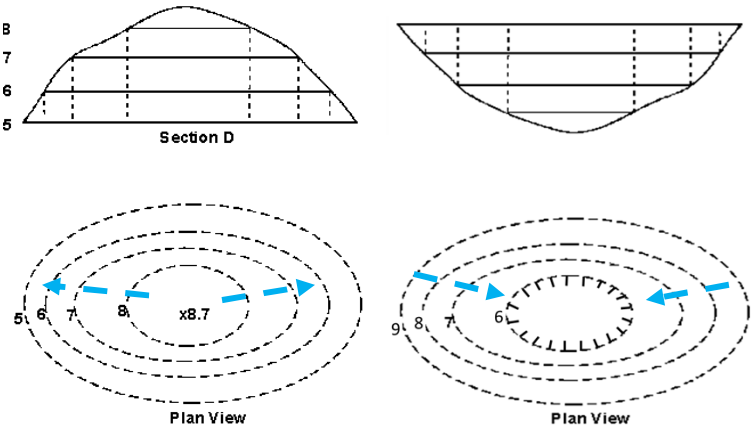




Water always flows perpendicular to contour lines.

14

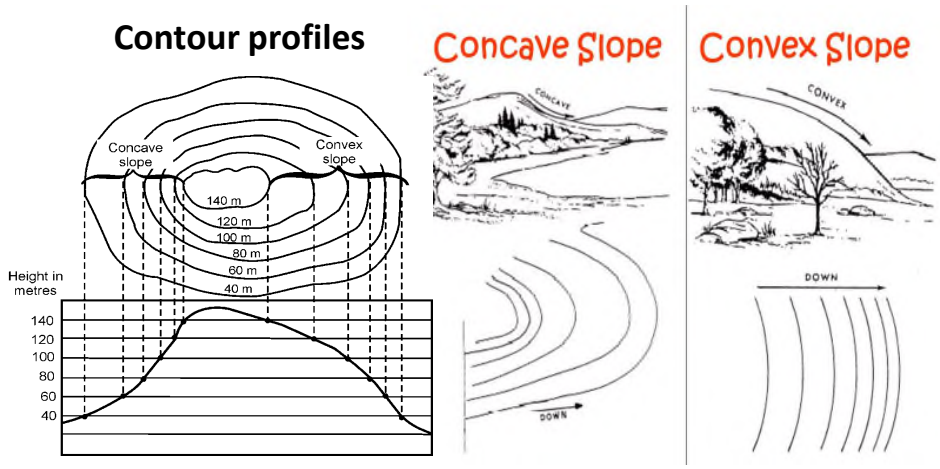
Summit vs. Depression



Water always flows perpendicular to contour lines.

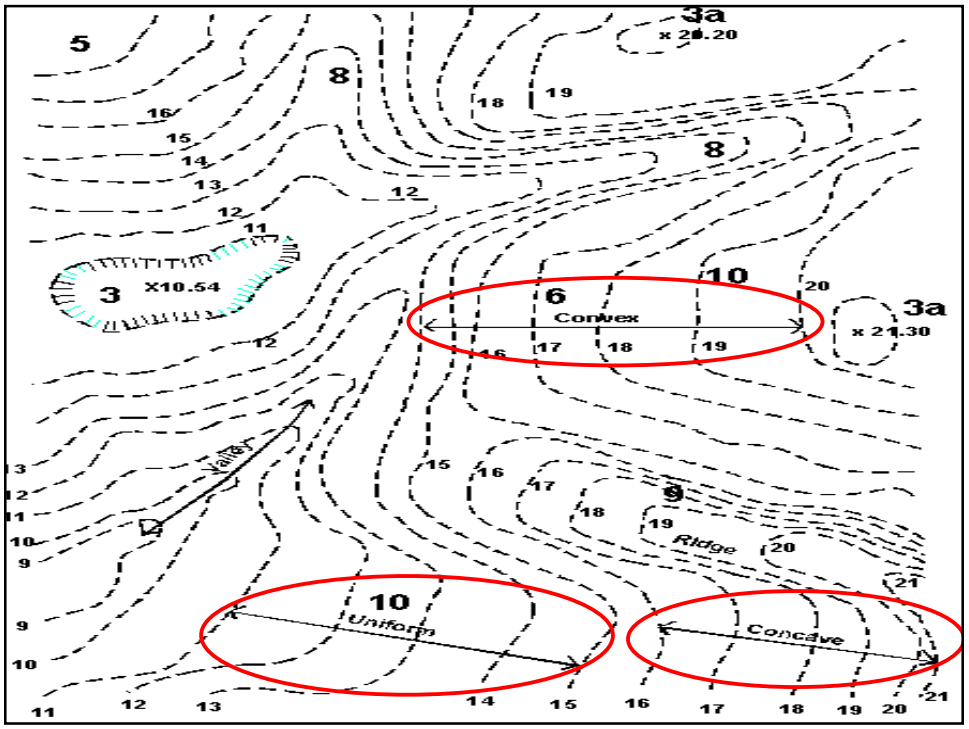
15

Concave vs. Convex



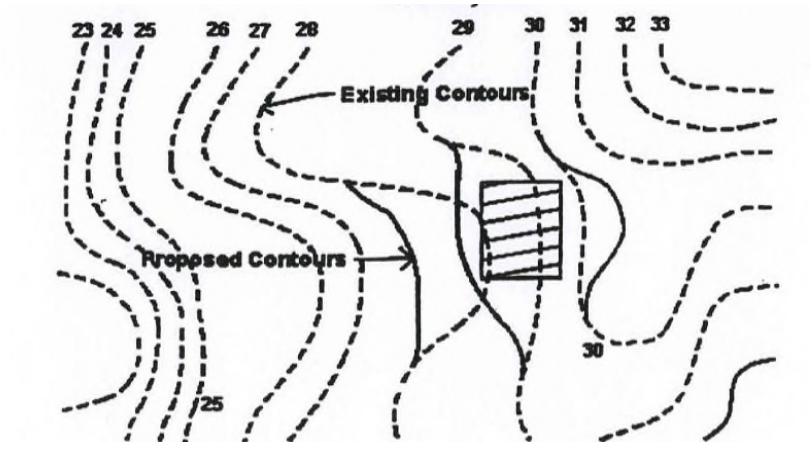
The closer the lines are together = steeper terrain
Further apart lines are = less steep

16



17

Cut & Fill Slopes



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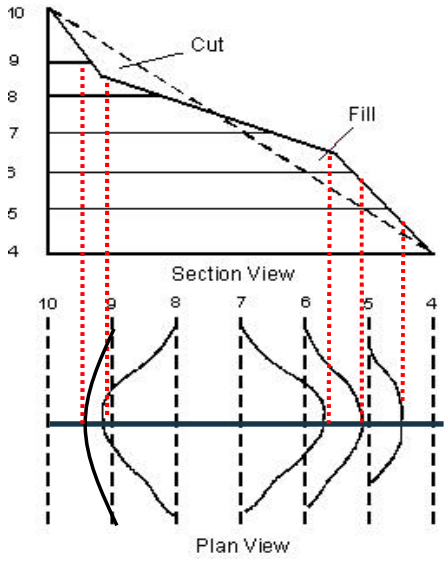
18

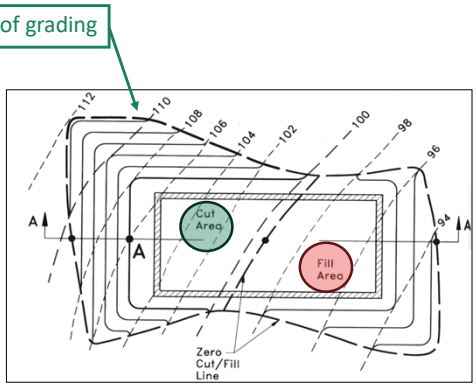
Cut & Fill Slopes



19

Cut & Fill Slopes

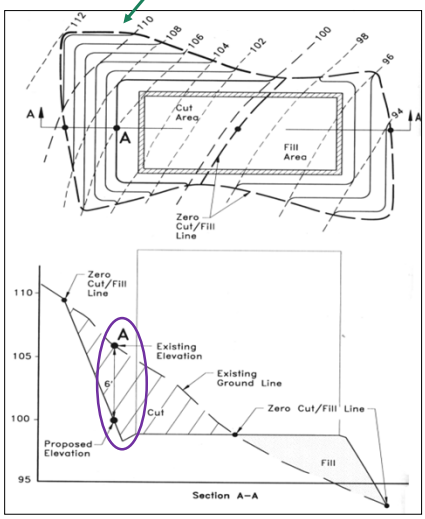
- Which way does the **existing** site drain?
- They want to put a building in the flow path, so a cut on the uphill side and a fill on the downhill side is required to create the flat building pad



20

Cut & Fill Slopes

- Which way will the site drain with the proposed grading?
  - They want to put a building in the flow path, so a cut on the uphill side and a fill on the downhill side is required to create the flat building pad
- Water will be sent around the building to the downhill side



21

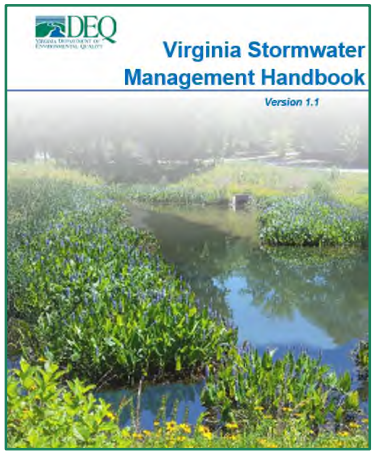
Slopes and Angles

22

Chapter 9: BMP Construction

9.5 Key Construction Topics

- Minimize Limits of Disturbance
- Perimeter Controls
- Construction Haul Roads
- Steep Slopes
- Anti-Compaction Protocols



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Critical Slope Length

Slope Gradient	Slope Length
0 - 7%	300 feet (100 meters)
7 - 15%	150 feet (50 meters)
15% and higher	75 feet (25 meters)

Common Sense Approach

Approximately 0.5 – 1% internal slope is recommended in a **P-BAS-03 (Extended Detention Basin)**
(Table P-BAS-03-8 Conveyance and Overflow Design)

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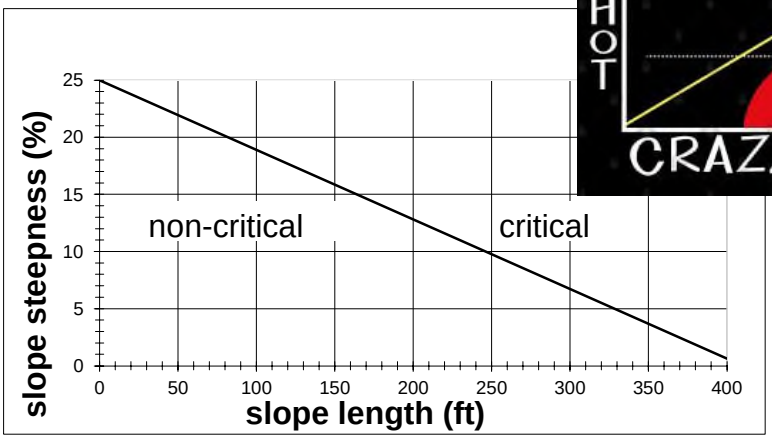
Critical Slope for Erosion Potential



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VDOT's Manual of Instructions (MOI)

Chapter 3: Geotechnical Engineering Chapter states:

A critical slope is defined as any slope that is steeper than 2H:1V; that is greater than twenty-five (25) feet in height; that affects or supports a structure; that impounds water or whose failure would result in significant cost for repair or damage to property.

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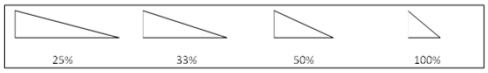
Slopes and Angles

Presented as:

- ratios (2:1, 3:1) or
- percentages (50%, 33%)



The closer the first number is to 0 or the higher the percentage, the steeper the slope.

27

Slopes and Angles

Presented as:

- ratios (2:1, 3:1) or
- percentages (50%, 33%)

The closer the first number is to 0 or the higher the percentage, the steeper the slope.

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Slopes and Angles

- Slope = rise/run
- But ratios flip those two numbers, so it's run:rise

- Ratio Example: **3:1** = For every three horizontal feet, there is one foot of vertical rise

29

Calculating Slope Percentage:

- Divide the vertical distance by the horizontal distance
- Then multiplies by 100

30

Calculating Slope Percentage:

- **What is a 4:1 slope as a percentage?**
  - Divide the vertical distance by the horizontal distance
  - Then multiplies by 100.

$$\frac{1}{4} \times 100 = 25\% \text{ slope}$$

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Calculating Slope Percentage:

- This math can also be simplified:
  - **Calculating a 5:1 slope is the same as asking how many times does 5 go into 100?**
    - 20 times
    - $\frac{1}{5} \times 100 = 20\%$ slope
  - **How many times does 2 go into 100?**
    - 50 times = 50% slope
    - $\frac{1}{2} \times 100 = 50\%$ slope

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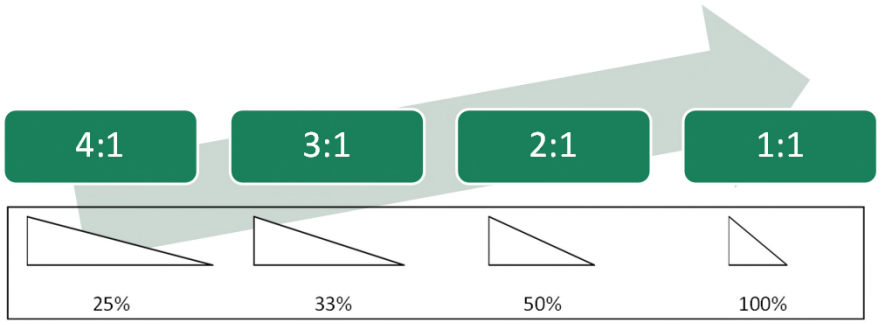
Slope Steepness



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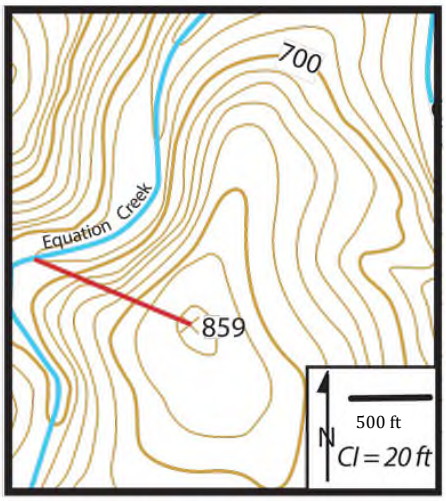
Calculating Slope Steepness

- Choose two points of interest
- Find the elevation change (rise)
  - Subtract the two points of interest
- Measure the slope length (run)
- Divide rise/run
- Multiply by 100

$$\frac{(125 - 110)}{40} \times 100 = 37.5\% \text{ slope}$$

34

How do I calculate slope in real life?



Topographic Map of part Math State Park

- Rise over run
- Rise?
  - 680 -> 859
  - 859 - 680 = 179
- Run?
  - 1,000ft
- 179ft / 1,000ft = 0.179
- 0.179 x 100 = 17.9% or 18%
- Critical?

35

Activity:

Evaluating the use of Perimeter Controls

36

Evaluating the use of Perimeter Controls

- 3 distinct types of Development:
  - New Development
  - Re-Development
  - Development in an Environmentally Sensitive Area

37

Evaluating the use of Perimeter Controls

- Review site conditions
- Calculate the slope %
- Determine best use of C-BMPs for site's condition

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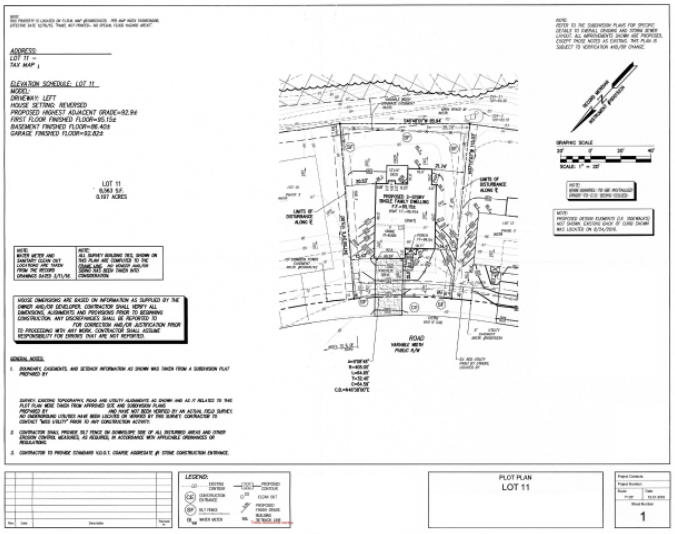
Scenario 1:

New Development – SFH

Example 1: Lot 11

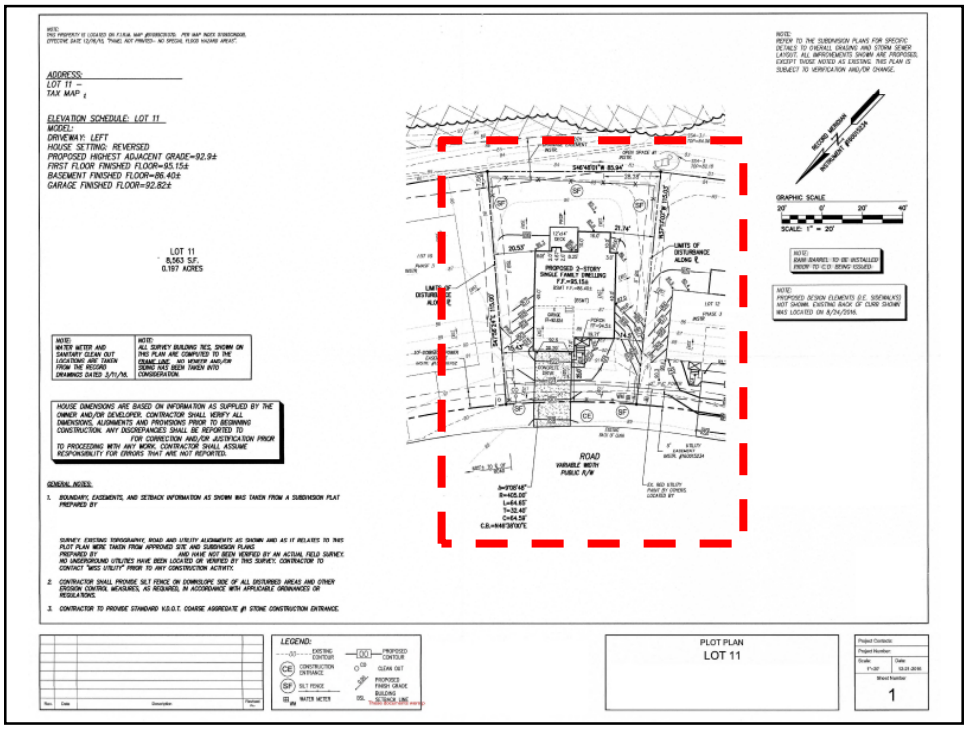
39



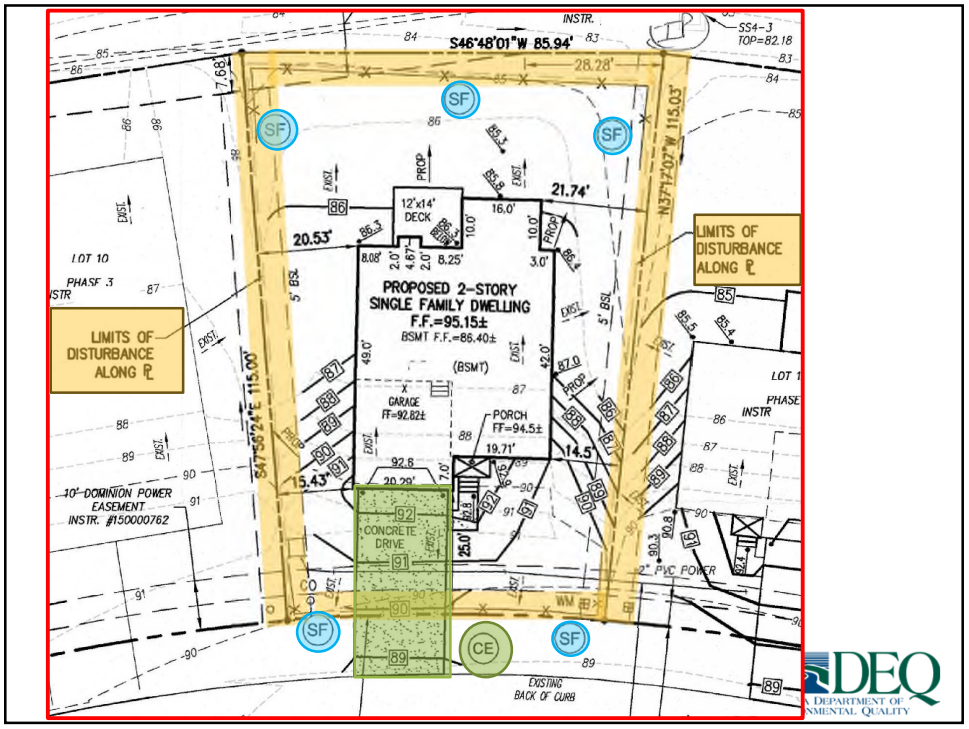
New Development, Single Family Home.

Lot 11

40


ADDRESS:
LOT 11 –
TAX MAP 1
ELEVATION SCHEDULE: LOT 11
MODEL:
DRIVEWAY: LEFT
HOUSE SETTING: REVERSED
PROPOSED HIGHEST ADJACENT GRADE=92.9±
FIRST FLOOR FINISHED FLOOR=95.15±
BASEMENT FINISHED FLOOR=86.40±
GARAGE FINISHED FLOOR=92.82±
LOT 11
8,563 S.F.
0.197 ACRES
HOUSE DIMENSIONS ARE BASED ON INFORMATION AS SUPPLIED BY THE OWNER AND/OR DEVELOPER. CONTRACTOR SHALL VERIFY ALL DIMENSIONS, ALIGNMENTS AND PROVISIONS PRIOR TO BEGINNING CONSTRUCTION. ANY DISCREPANCIES SHALL BE REPORTED TO FOR CORRECTION AND/OR JUSTIFICATION PRIOR TO PROCEEDING WITH ANY WORK. CONTRACTOR SHALL ASSUME RESPONSIBILITY FOR ERRORS THAT ARE NOT REPORTED.
GENERAL NOTES:
1. BOUNDARY, EASEMENTS, AND SETBACK INFORMATION AS SHOWN WAS TAKEN FROM A SUBDIVISION PLAT PREPARED BY
SURVEY, EXISTING TOPOGRAPHY, ROAD AND UTILITY ALIGNMENTS AS SHOWN AND AS IT RELATES TO THIS PLOT PLAN WERE TAKEN FROM APPROVED SITE AND SUBDIVISION PLANS PREPARED BY AND HAVE NOT BEEN VERIFIED BY AN ACTUAL FIELD SURVEY. NO UNDERGROUND UTILITIES HAVE BEEN LOCATED OR VERIFIED BY THIS SURVEY. CONTRACTOR TO CONTACT "MISS UTILITY" PRIOR TO ANY CONSTRUCTION ACTIVITY.
2. CONTRACTOR SHALL PROVIDE SILT FENCE ON DOWNSLOPE SIDE OF ALL DISTURBED AREAS AND OTHER EROSION CONTROL MEASURES, AS REQUIRED, IN ACCORDANCE WITH APPLICABLE ORDINANCES OR REGULATIONS.
3. CONTRACTOR TO PROVIDE STANDARD V.D.O.T. COARSE AGGREGATE #1 STONE CONSTRUCTION ENTRANCE.
ROAD
VARIABLE WIDTH
PUBLIC R/W
LIMITS OF DISTURBANCE ALONG ℄
PROPOSED 2-STORY SINGLE FAMILY DWELLING F.F.=95.15±
LEGEND:
PROPOSED CONTOUR
CONSTRUCTION ENTRANCE
CLEAN OUT
SILT FENCE
PROPOSED FINISH GRADE
BUILDING
WATER METER
PLOT PLAN
LOT 11
1

41


INSTR.
S46°48'01"W 85.94'
28.28'
SS4-J
TOP=82.18
N37°12'07"W 115.03'
S47°36'24"E 115.00'
7.68'
21.74'
20.53'
16.0'
12'x14' DECK
8.08'
8.25'
PROPOSED 2-STORY SINGLE FAMILY DWELLING
F.F.=95.15±
BSMT F.F.=86.40±
(BSMT)
GARAGE FF=92.82±
PORCH FF=94.5±
19.71'
14.5'
15.43'
92.6
20.29'
42.0'
49.0'
3.0'
5' BSL
LIMITS OF DISTURBANCE ALONG ℄
LOT 10
PHASE 3
INSTR
LOT 1
PHASE
INSTR
10' DOMINION POWER EASEMENT INSTR. #150000762
CONCRETE DRIVE
25.0'
2" PVC POWER
EXISTING BACK OF CURB
DEQ
A DEPARTMENT OF ENVIRONMENTAL QUALITY

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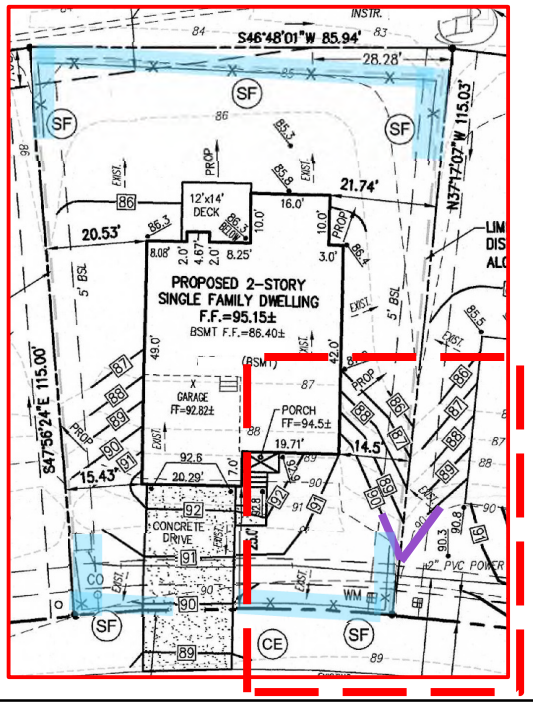
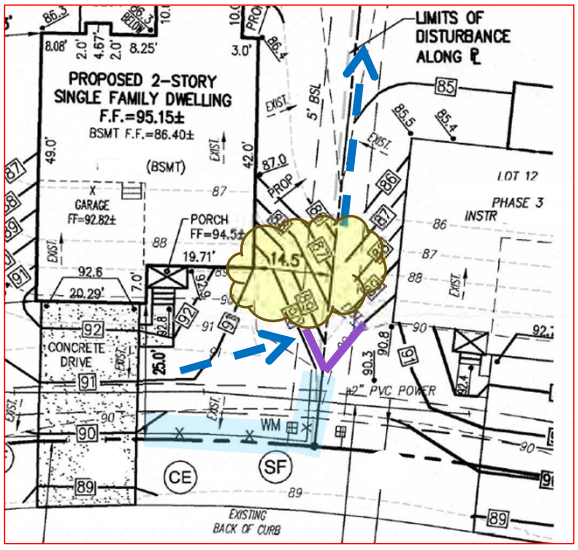
During a runoff producing event, what direction will water flow on this lot?



43



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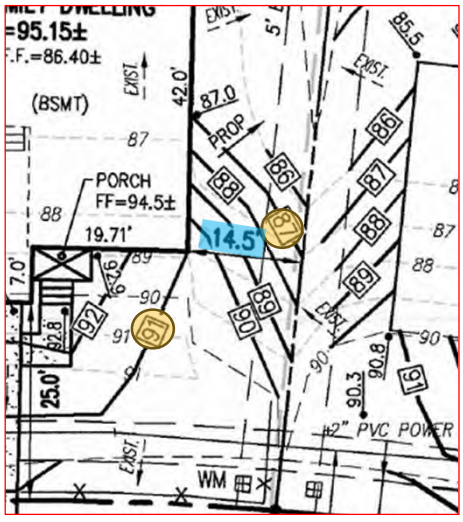
Calculating Slope Steepness:

$$\frac{(Point\ A - PointB)}{Slope\ Length} \times 100$$

$$= \%\ \text{slope}$$

CHECK OUT YOUR HANDOUT!

45



$$\frac{(Point\ A - PointB)}{Slope\ Length} \times 100$$

$$= \%\ \text{slope}$$

$$\frac{(91) - (87)}{14.5} \times 100$$

$$= \%\ \text{slope}$$

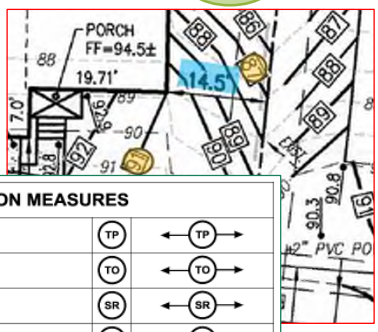
$$= 27.58\%\ \text{slope}$$

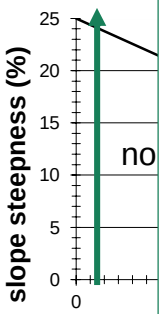
46

Critical or Non-Critical Slope?

= 27.58% slope

Any drainage concerns?
Other possible C-BMPs we could use in this area?





SURFACE STABILIZATION MEASURES	
C-SSM-01 TREE PRESERVATION AND PROTECTION	TP
C-SSM-02 TOPSOILING	TO
C-SSM-03 SURFACE ROUGHENING	SR
C-SSM-04 COMPOST BLANKETS	CB
C-SSM-05 SOIL STABILIZATION BLANKETS AND MATTING	B/M
C-SSM-06 SODDING	SO
C-SSM-07 BERMUDAGRASS AND ZOYSIAGRASS ESTABLISHMENT	BE/ZE
C-SSM-08 TREES, SHRUBS, VINES, AND GROUND COVER	VEG
C-SSM-09 TEMPORARY SEEDING	TS
C-SSM-10 PERMANENT SEEDING	PS
C-SSM-11 MULCHING	MU

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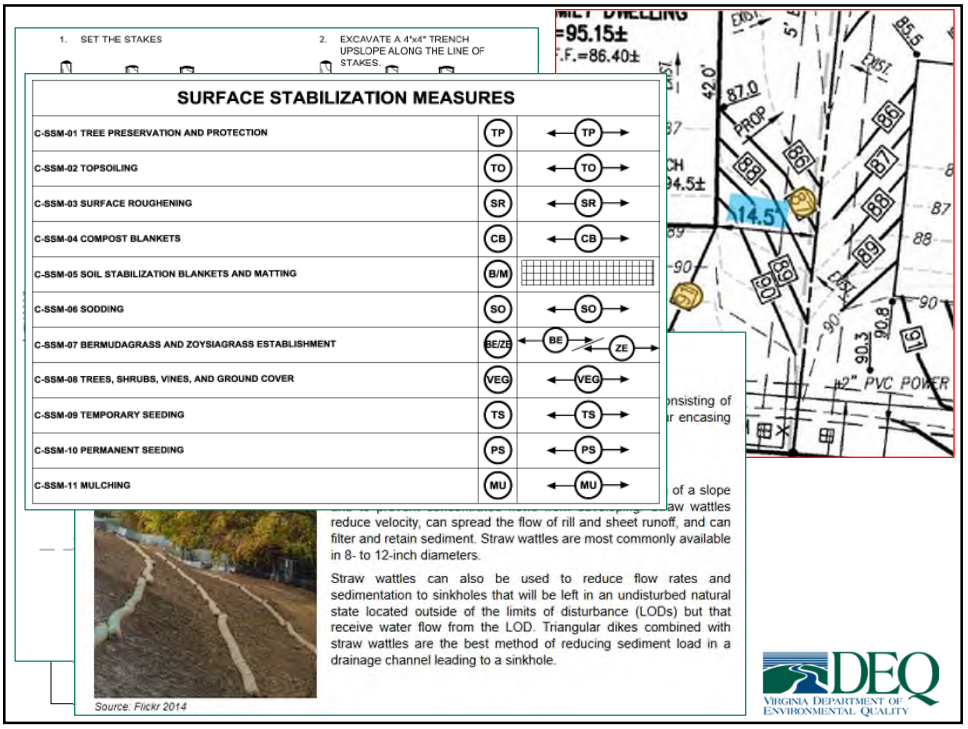

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Scenario 1:

New Development – SFH

Example 2: Lot 108

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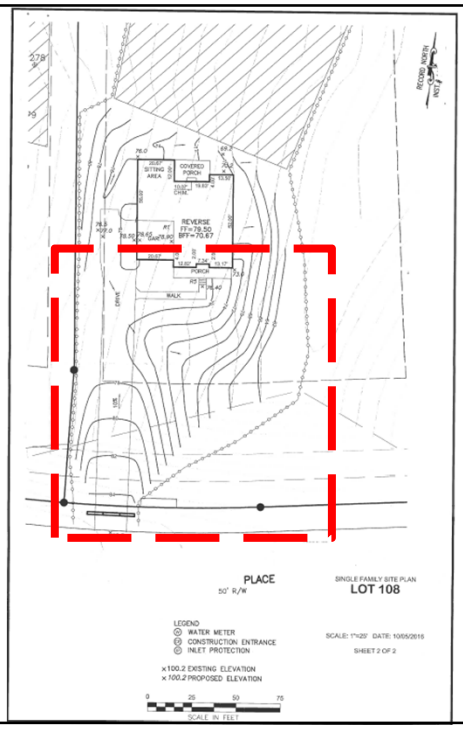
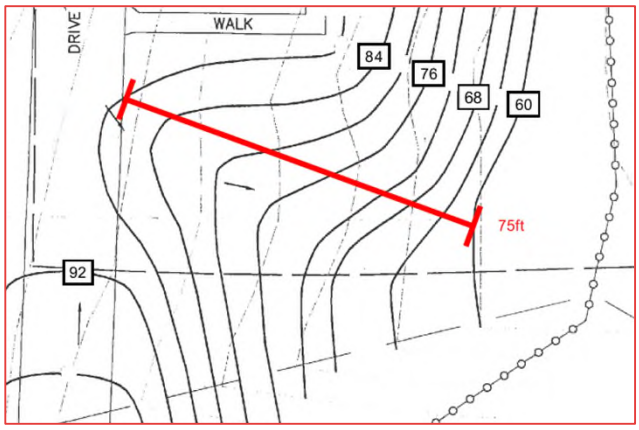


New Development, Single Family Home.

Lot 108

50

What is the contour interval on this lot?



- 4 ft. elevation change between each contour line

OR

- 8 ft. elevation change between each index contour.

51

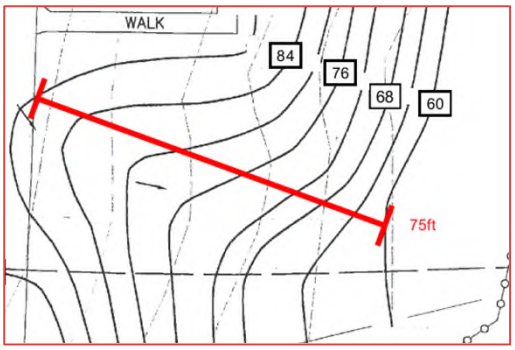


Table C-PCM-04-2 Maximum Slope Length (feet) Above Fence			
Slope (%)	Standard (18 inches High) Silt Fence	Reinforced (30 inches High) Silt Fence	Super (33 inches High) Silt Fence
2 (or less)	100	500	1000
5	100	250	550
10	50	150	325
15	35	100	215
20	25	70	175
25	20	55	135
30	15	45	100
35	15	40	85
40	15	35	75
45	10	30	60
50	10	25	50

Source: Pennsylvania Department of Environmental Protection (PADEP) 2012.

$$\frac{(Point\ A - PointB)}{Slope\ Length} \times 100$$

$= \%$ slope

$$\frac{(88 - 60)}{75} \times 100$$

$= \%$ slope

$= 37.33\%$ slope

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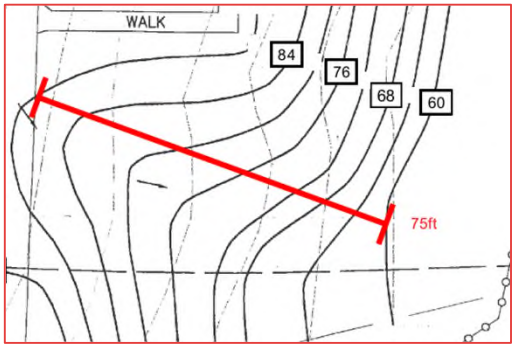
What other C-BMPs could help stabilize this area?



= 37.33% slope

- **C-SSM-02**: Topsoiling
- **C-SSM-03**: Surface Roughening
- **C-SSM-05**: Soil Stabilization Blankets
- **C-SSM-06**: Sodding
- **C-SSM-09**: Temporary Seeding
- **C-SSM-10**: Permanent Seeding
- **C-SSM-11:** Mulching

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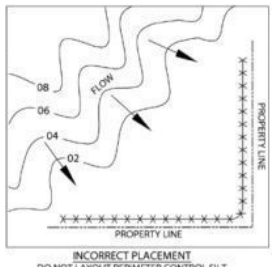
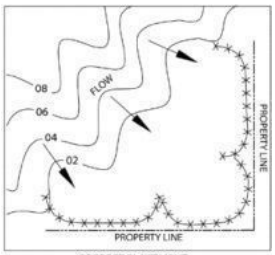
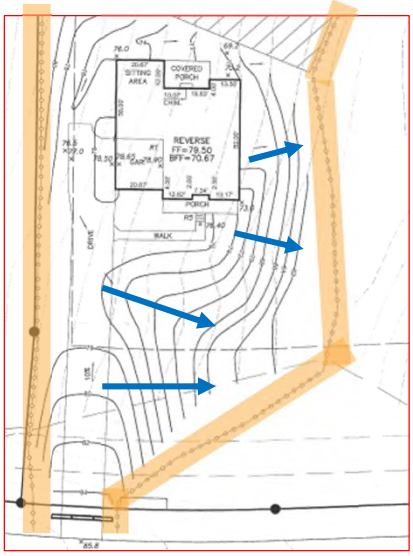
Consider the Placement:



INCORRECT PLACEMENT
DO NOT LAYOUT PERIMETER CONTROL SILT FENCES ALONG PROPERTY LINES. ALL SEDIMENT-LADEN RUNOFF WILL CONCENTRATE AND OVERWHELM THE SYSTEM.



CORRECT PLACEMENT
BREAK-UP SILT FENCE INTO SECTIONS TO PREVENT SEDIMENT-LADEN RUNOFF FROM CONCENTRATING AND OVERWHELMING THE SYSTEM.



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Scenario 2:

New Development – POD for a Subdivision

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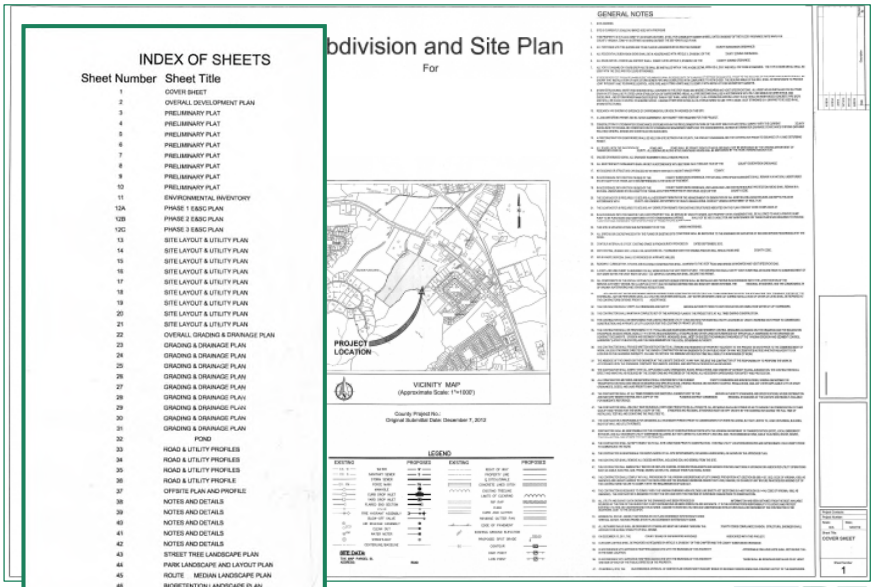
New Development: POD for a Subdivision.



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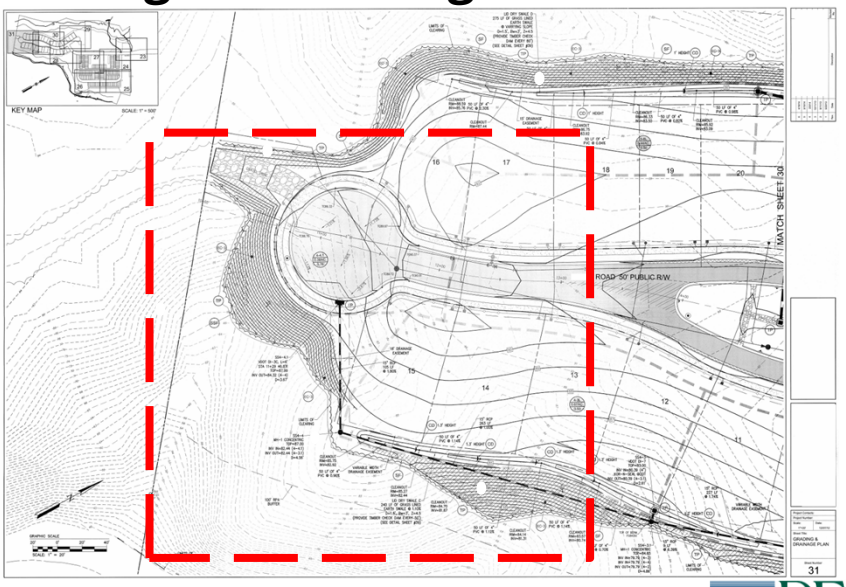
Grading and Drainage Plan – Sheet 31



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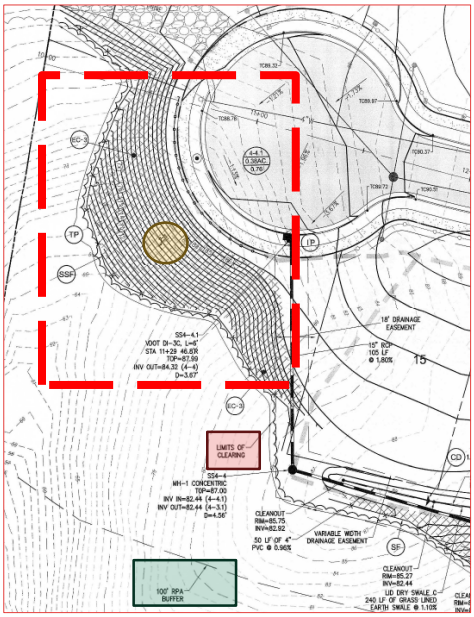
Grading and Drainage Plan



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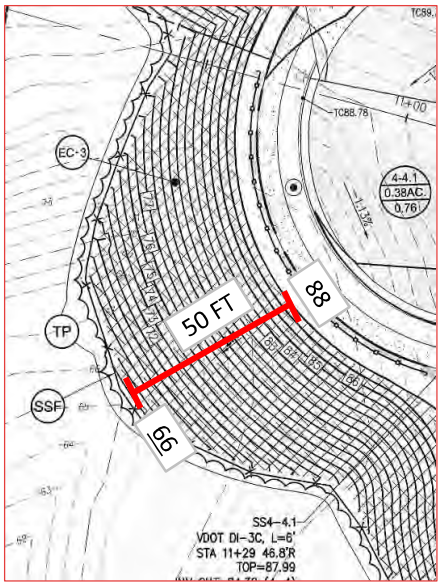
Calculate the Slope Percentage



$$\frac{(Point\ A - PointB)}{Slope\ Length} \times 100$$

$= \%$ slope

$$\frac{(88 - 66)}{50} \times 100$$

$= \%$ slope

$= 44\%$ slope

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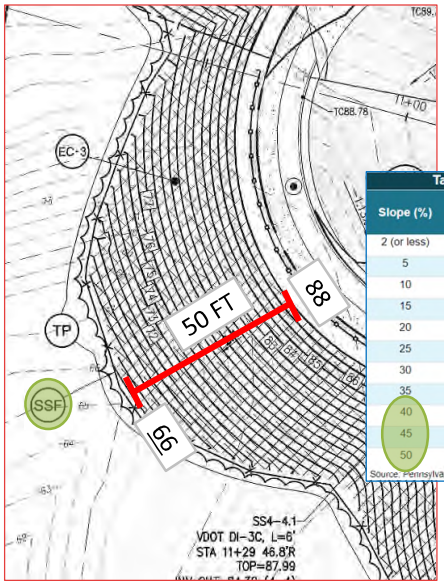
Slope Percentage



$= 44\%$ slope

Table C-PCM-04-2 Maximum Slope Length (feet) Above Fence

Slope (%)	Standard (18 inches High) Silt Fence	Reinforced (30 inches High) Silt Fence	Super (33 inches High) Silt Fence
2 (or less)	100	500	1000
5	100	250	550
10	50	150	325
15	35	100	215
20	25	70	175
25	20	55	135
30	15	45	100
35	15	40	85
40	15	35	75
45	10	30	60
50	10	25	50

Source: Pennsylvania Department of Environmental Protection (PADEP) 2012.

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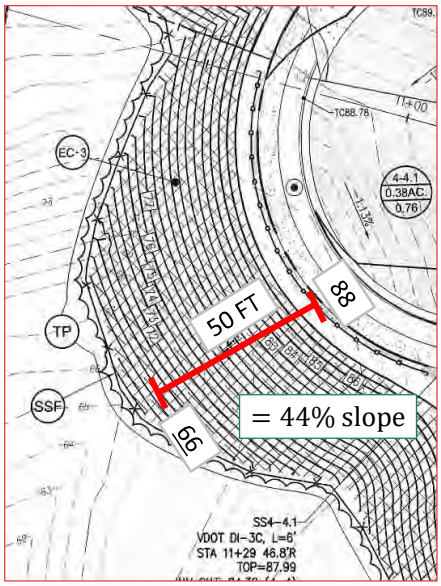
Grading and Drainage Plan



What C-BMPs are being called out for this slope?

- **C-SSM-01:** Tree Protection
- **C-SSM-05:** Soil Stabilization Blankets
- **C-PCM-04:** Super Silt Fence

What Minimum Standards are of major concern here?

- **MS-1:** Stabilization
- **MS-3:** Permanent Vegetation
- **MS-7:** Cut and Fill Slopes

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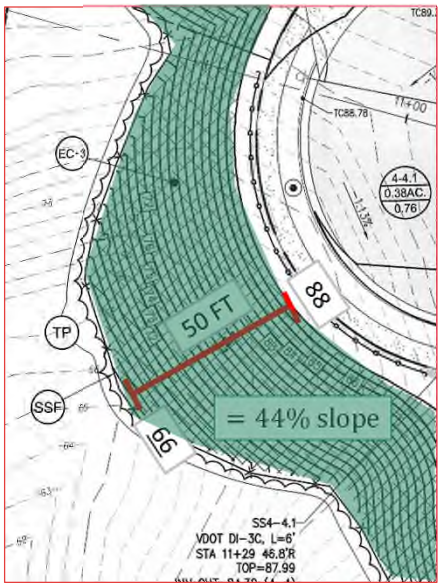
Grading and Drainage Plan



What other C-BMPs should be utilized on this area?

- C-SSM-09: Temporary Seeding
- C-SSM-10: Permanent Seeding

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Scenario 3:

Re-Development

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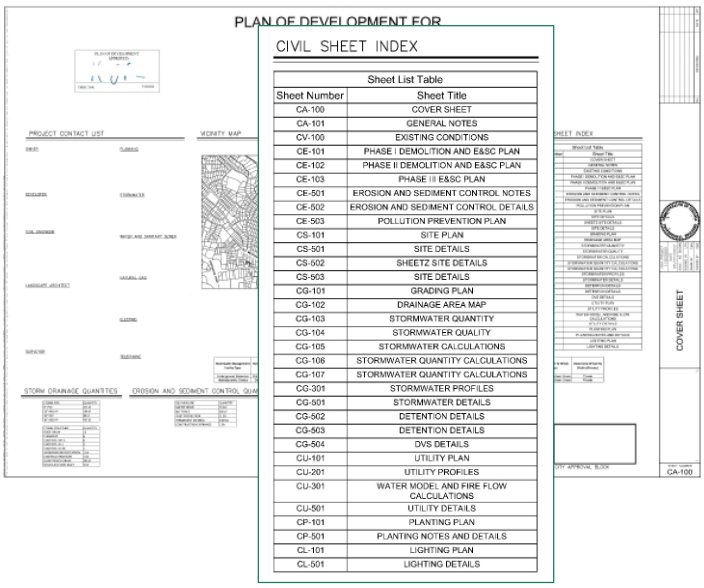
PLAN OF DEVELOPMENT FOR

CIVIL SHEET INDEX

Sheet List Table	
Sheet Number	Sheet Title
CA-100	COVER SHEET
CA-101	GENERAL NOTES
CV-100	EXISTING CONDITIONS
CE-101	PHASE I DEMOLITION AND E&SC PLAN
CE-102	PHASE II DEMOLITION AND E&SC PLAN
CE-103	PHASE III E&SC PLAN
CE-501	EROSION AND SEDIMENT CONTROL NOTES
CE-502	EROSION AND SEDIMENT CONTROL DETAILS
CE-503	POLLUTION PREVENTION PLAN
CS-101	SITE PLAN
CS-501	SITE DETAILS
CS-502	SHEETZ SITE DETAILS
CS-503	SITE DETAILS
CG-101	GRADING PLAN
CG-102	DRAINAGE AREA MAP
CG-103	STORMWATER QUANTITY
CG-104	STORMWATER QUALITY
CG-105	STORMWATER CALCULATIONS
CG-106	STORMWATER QUANTITY CALCULATIONS
CG-107	STORMWATER QUANTITY CALCULATIONS
CG-301	STORMWATER PROFILES
CG-501	STORMWATER DETAILS
CG-502	DETENTION DETAILS
CG-503	DETENTION DETAILS
CG-504	OVS DETAILS
CU-101	UTILITY PLAN
CU-201	UTILITY PROFILES
CU-301	WATER MODEL AND FIRE FLOW CALCULATIONS
CU-501	UTILITY DETAILS
CP-101	PLANTING PLAN
CP-501	PLANTING NOTES AND DETAILS
CL-101	LIGHTING PLAN
CL-501	LIGHTING DETAILS

PROJECT CONTACT LIST

VICINITY MAP

SHEET INDEX

STORM DRAINAGE QUANTITIES

EROSION AND SEDIMENT CONTROL QUA

COVER SHEET

CA-100

Re-Development.

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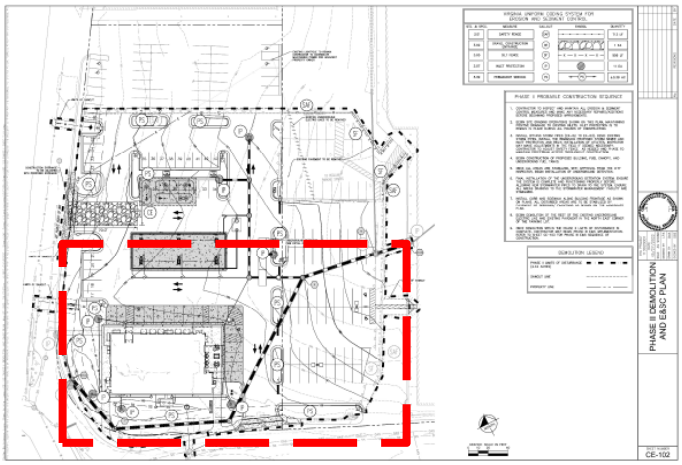

Phase II Demolition and ESC Plan

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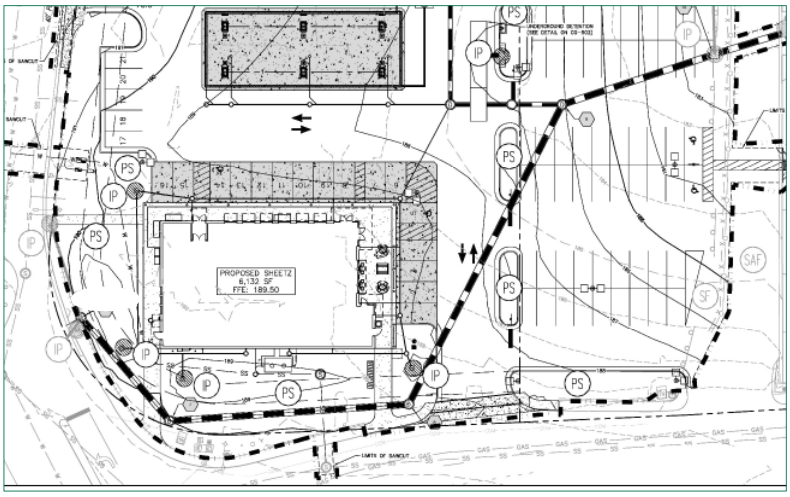

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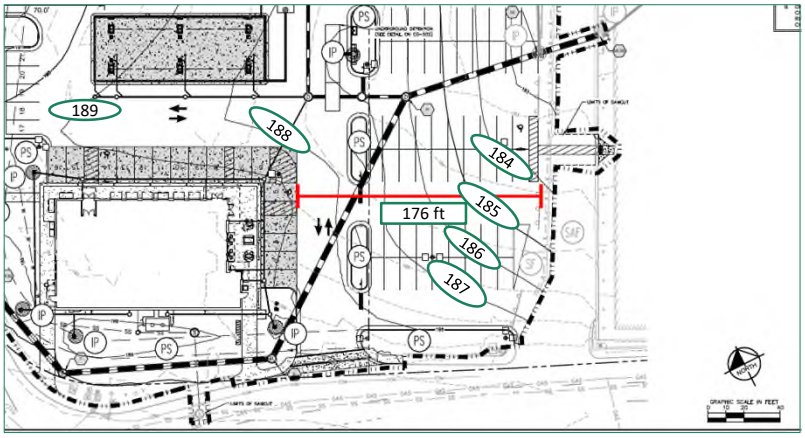
Calculate the Slope Percentage

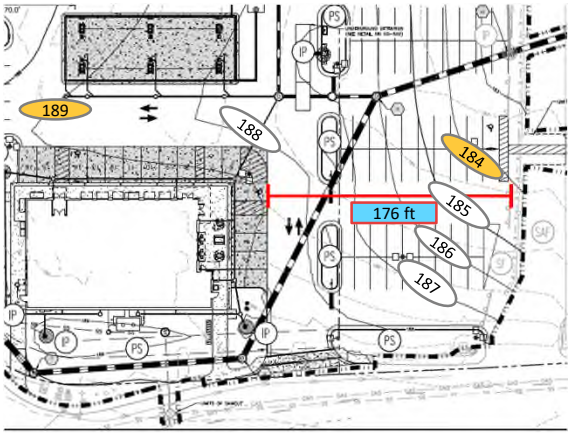


$$\frac{(Point\ A - Point B)}{Slope\ Length} \times 100$$

$$= \%\ slope$$

67

Calculate the Slope Percentage



$$\frac{(Point\ A - Point B)}{Slope\ Length} \times 100$$

$$= \%\ slope$$

$$\frac{A - B}{L} \times 100$$

$$= \%\ slope$$

$$= 2.84\%\ slope$$

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Re-Development Scenario

- Will standard silt fence be sufficient?
  - **Slope Length:** 178 ft
  - **Slope (%):** 2.84

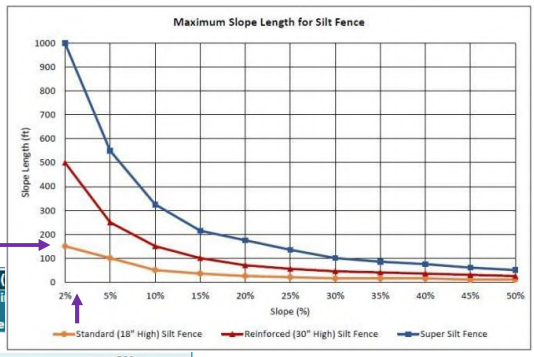

Table C-PCM-04-2 Maximum Slope Length (			
Slope (%)	Standard (18 inches High) Silt Fence	Reinforced (30 i High) Silt Fence	
2 (or less)	100	500	
5	100	250	550
10	50	150	325
15	35	100	215
20	25	70	175
25	20	55	135
30	15	45	100
35	15	40	85
40	15	35	75
45	10	30	60
50	10	25	50

Source: Pennsylvania Department of Environmental Protection (PADEP) 2012.

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Re-Development Scenario

- Are there other perimeter controls that might function with these site conditions?
  - **Slope Length:** 178 ft
  - **Slope (%):** 2.84

C-PCM-01 SAFETY FENCE
C-PCM-02 STRAW BALE BARRIER
C-PCM-03 BRUSH BARRIER
C-PCM-04 SILT FENCE
C-PCM-05 COMPOST FILTER SOCK

CFS — CFS — CFS

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C-PCM-05 Compost Filter Sock

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C-PCM-05 Compost Filter Sock – 5.0 Design Criteria

Slope Length: 178 ft
Slope (%): 2.84

7.0 Operations and Maintenance Considerations
- Do not permit traffic to cross compost filter socks.

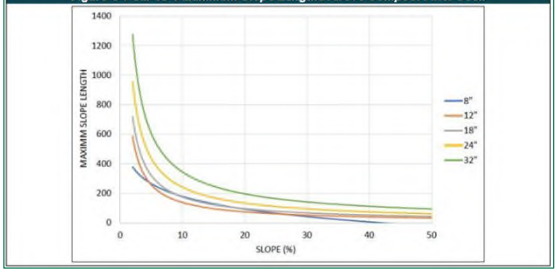
Table C-PCM-05-1 Design Parameter of Sock Thickness

Maximum Slope Lengths Above Compost Filter Sock

Diameter (inches)	Slope (%) 2	5	10	20	25	33	50
	Length (feet)						
8	378	264	177	91	64	29	--
12	586	256	137	73	60	47	32
18	718	321	174	95	78	61	42
24	956	436	240	133	110	86	60
32	1,277	605	344	195	163	130	93

Source: Adapted from Florida Erosion and Control Designer and Reviewer Manual, Pennsylvania Department of Environmental Protection Erosion and Sediment Control Pollution Control Program Manual, North Carolina Erosion and Sediment Control Planning and Design Manual, Filtrexx: Federal Specifications for Compost Filter Socks for Sediment & Erosion Control, and the United States Department of Agriculture.

Figure C-PCM-05-1 Maximum Slope Lengths Above Compost Filter Sock



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Scenario 4:

Environmentally Sensitive Area

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Environmentally Sensitive Area Protection: C-ENV

ENVIRONMENTAL SENSITIVE AREA PROTECTION		
C-ENV-01 VEGETATIVE STREAMBANK STABILIZATION	VSS	
C-ENV-02 STRUCTURAL STREAMBANK STABILIZATION	SSS	
C-ENV-03 TEMPORARY VEHICULAR STREAM CROSSING	SC	
C-ENV-04 UTILITY STREAM CROSSING	USC	
C-ENV-05 COFFERDAM CROSSING	CDC	CDC CDC
C-ENV-06 STABLE WETLAND CROSSING	WC	
C-ENV-07 GABIONS/GABION DEFLECTORS	GAB	
C-ENV-08 PUMP AROUND DIVERSION	PD	PD PD
C-ENV-09 OVERNIGHT CHANNEL PROTECTION	CP	
C-ENV-10 TRENCHLESS SILT FENCE	TSF	TSF TSF
C-ENV-11 WETLAND BERM	WB	WB WB
C-ENV-12 WETLAND WEIR OUTLET	WO	
C-ENV-13 WETLAND CELL SEDIMENT TRAP	WST	
C-ENV-14 MODIFIED TURBIDITY CURTAIN FOR STREAMS	TCS	
C-ENV-15 SEEDING, MULCHING, AND SOIL STABILIZATION WETLANDS STREAMS	SWS	SWS

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C-ENV-10 Trenchless Silt Fence

Purpose and Applicability:

- …where typical silt fence (trenched) would adversely impact the surrounding woody vegetation to be preserved

Planning Considerations:

- Drainage area is no more than 0.25 acre per 100 feet of silt fence length.

Erosion Control Efficiency: **LOW**

Sediment Removal Efficiency: **MEDIUM**

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C-ENV-10: Design Criteria

- Locate trenchless silt fence at least **5 to 7 feet beyond** the base of disturbed slopes with grades **greater than 7%.**
- Use trenchless silt fence only where the size of the drainage area is no more than **0.25 acre per 100 feet** of standard silt fence length.

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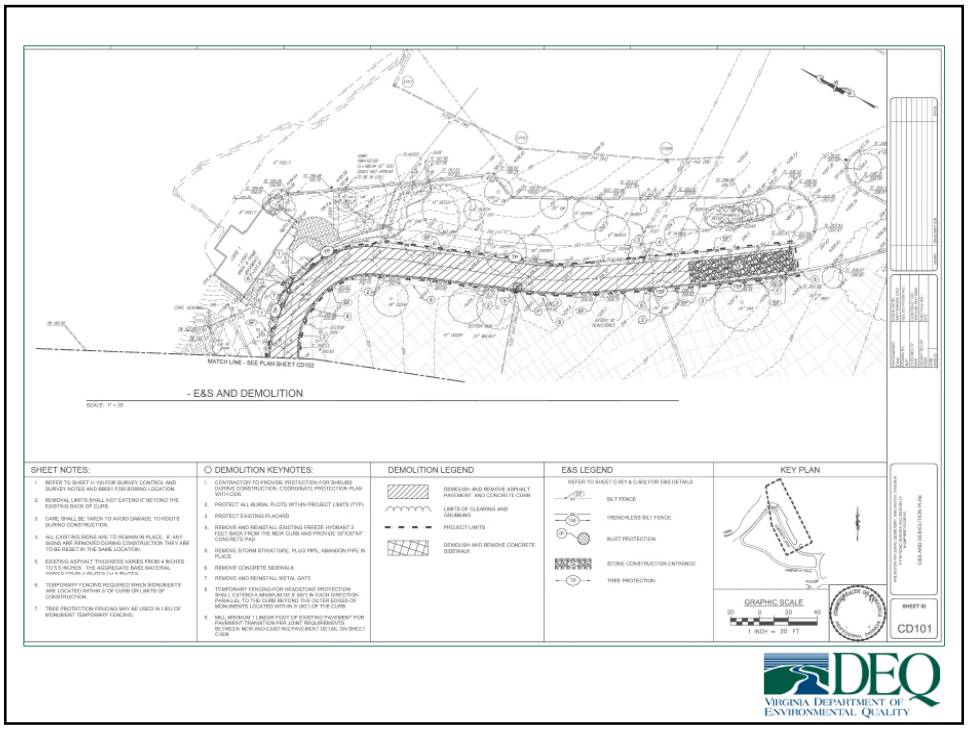
- E&S AND DEMOLITION
SHEET NOTES:
DEMOLITION KEYNOTES:
DEMOLITION LEGEND
E&S LEGEND
KEY PLAN
GRAPHIC SCALE
1 INCH = 20 FT
SHEET ID
CD101
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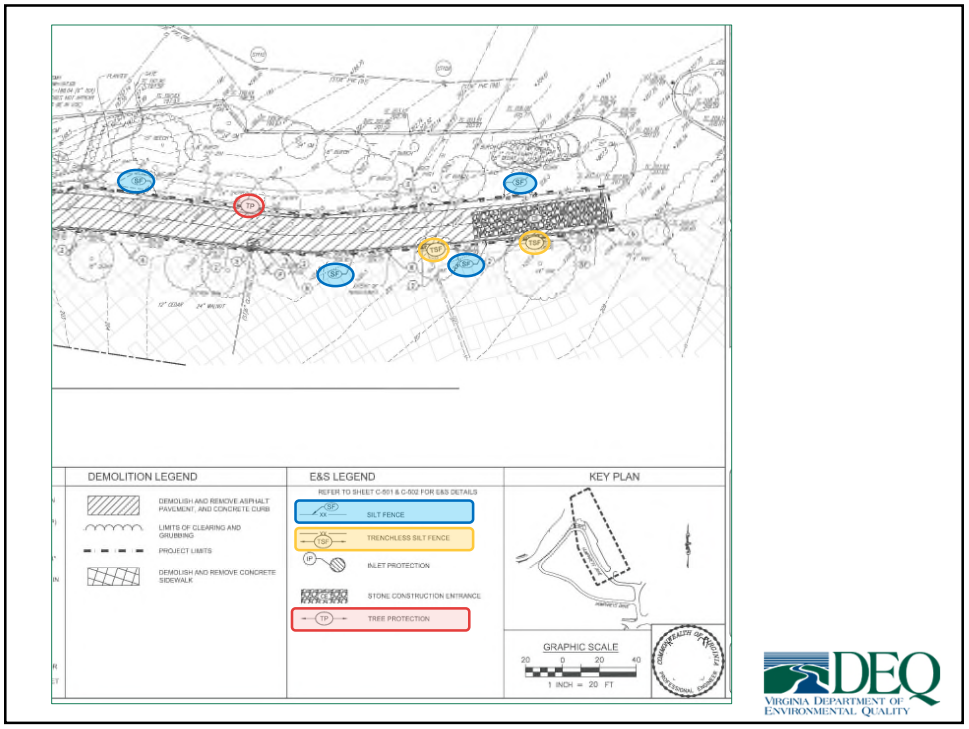
DEMOLITION LEGEND
E&S LEGEND
KEY PLAN
GRAPHIC SCALE
1 INCH = 20 FT
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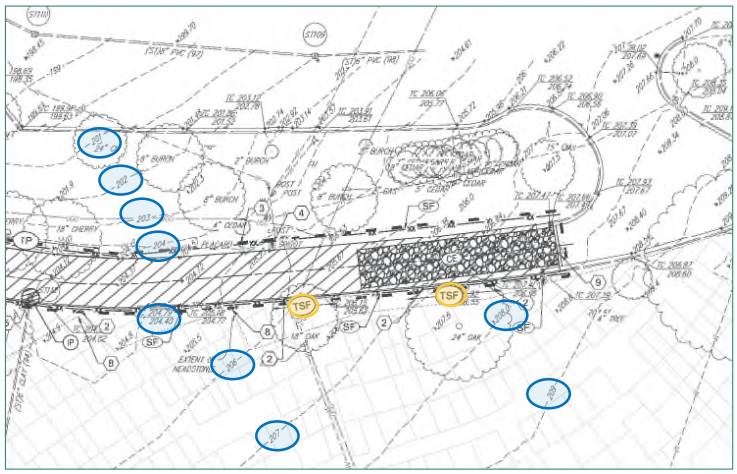
Based on the site conditions, do you think this is an adequate use of trenchless silt fence?



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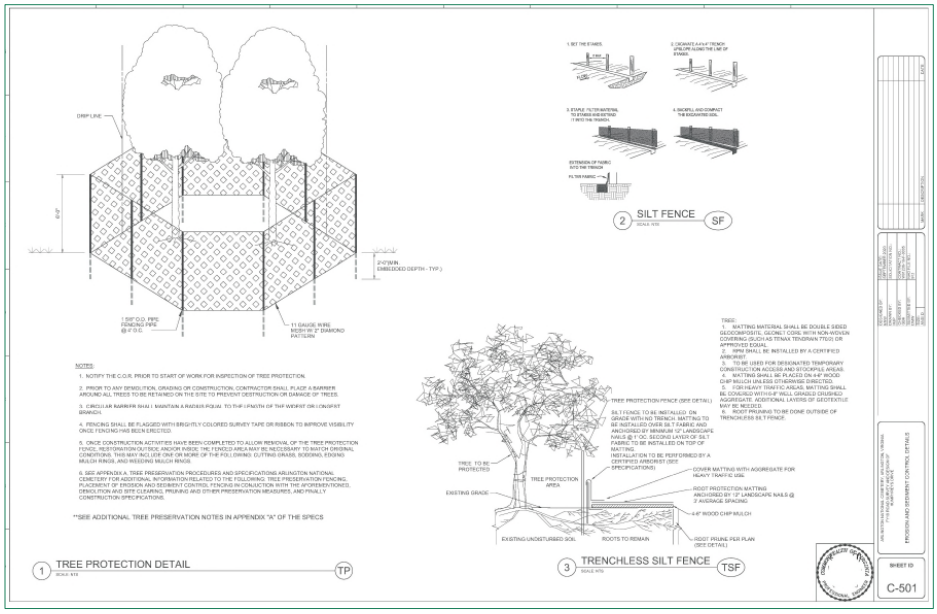

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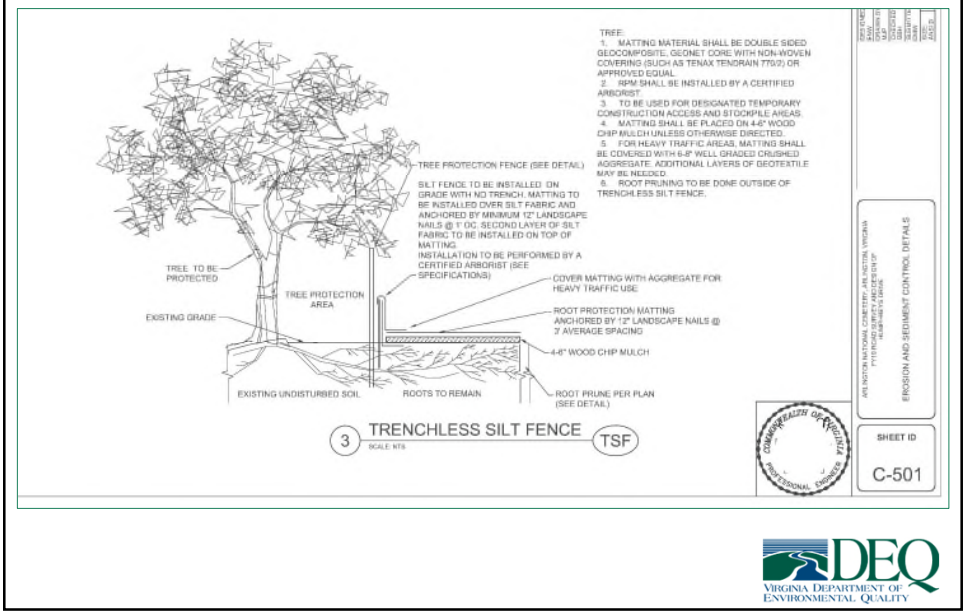

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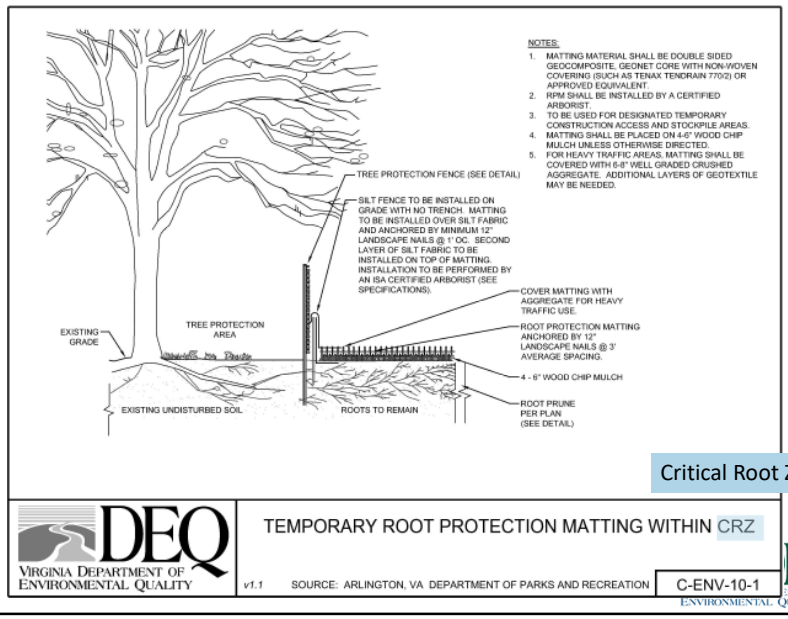
Figure C-ENV-10-1
Trenchless Silt Fence



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Trenchless Super Silt Fence

Figures from CAD Files linked in the Handbook

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Figure C-ENV-10-4
Trenchless Super Silt Fence

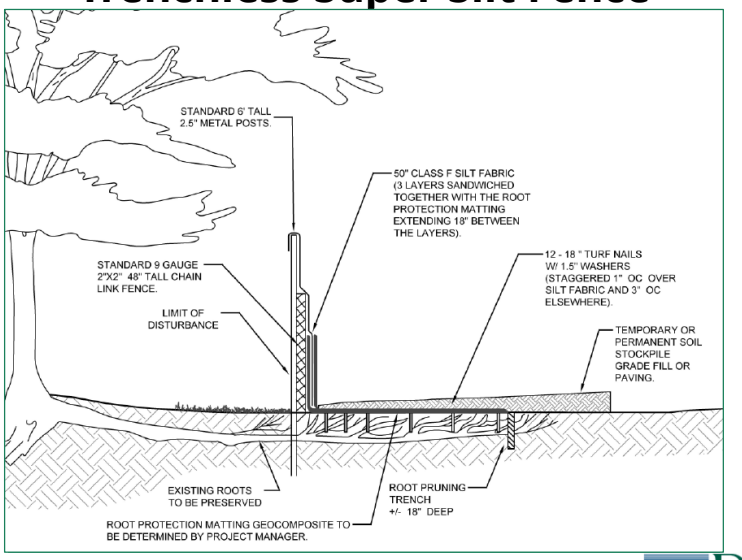

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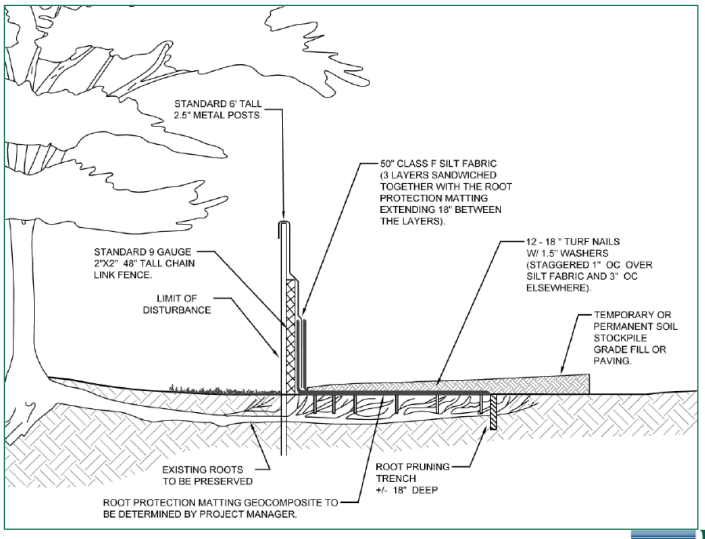
Figure C-ENV-10-4
Trenchless Super Silt Fence



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Chapter 8

Design Specifications for Post-Construction BMPs (P-BMPs)

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Chapter 8 - Contents

1. Introduction to the New Virginia Post-Construction Best Management Practices
2. Significant Updates
3. Overview of BMPs
4. Overview of Manufactured Treatment Devices (MTDs)
5. Standards and Specifications for Post-Construction BMPS

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8.3 Overview of Best Management Practices

15 Non-proprietary BMPs + 5 Appendices + 2 New P-BMPs + 2 Support Components = 24 Post-Construction BMPs included in the Handbook

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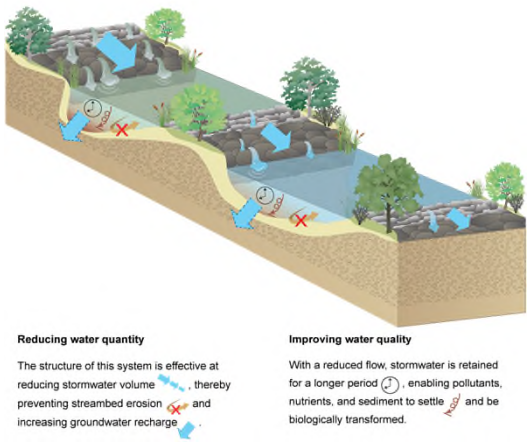
Two New P-BMPs

P-FIL-09 Tree Planting

P-CNV-04 Regenerative Stormwater Conveyance



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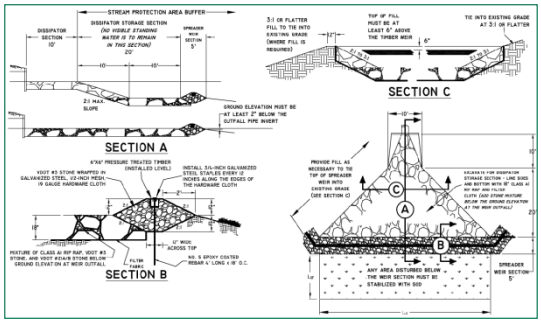
Two New Support Components

P-SUP-07:
Quantity-Only Approach

P-SUP-08:
Permanent Level Spreader



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8.4 Overview of Manufactured Treatment Devices

- 8.4.1 Hydrodynamic Devices
- 8.4.2 Filtering Devices
- 8.4.3 Biofilter Devices
- 8.4.4 MTD Approval Process

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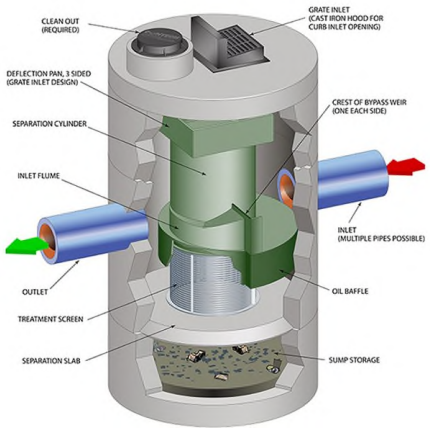
MTD-H: Hydrodynamic Devices



- Flow-through structures with a settling or separation unit to remove sediments and other pollutants.
- Primary treatment mechanisms are gravity separation and spill capture.

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8.4.1.2 Hydrodynamic Devices in Virginia

MTD Name	BMP #
Aqua-Swirl	MTD-H-01
Xcelerator	MTD-H-02
Barracuda Max Hydrodynamic Separator	MTD-H-03
Downstream Defender	MTD-H-04
First Defense Optimum	MTD-H-05
Continuous Deflective Separator (CDS)	MTD-H-06
Debris Separating Baffle Box (DSSB)	MTD-H-07
Cascade Separator Hydrodynamic System (HDS)	MTD-H-08
SciCloneX HDS	MTD-H-09
Dual Vortex Separator (DVS)	MTD-H-10
Nutrient Separating Baffle Box (NSBB)	MTD-H-11
HydroStorm Hydrodynamic Separator	MTD-H-12
HydroDome Stormwater Separator	MTD-H-13
SiteSaver	MTD-H-14
StormSettler	MTD-H-15

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MTD-H: Maintenance – General Underground Systems

WARNING: Entering confined spaces is dangerous, check out OSHA's Confided Space Certification and Training for more info.

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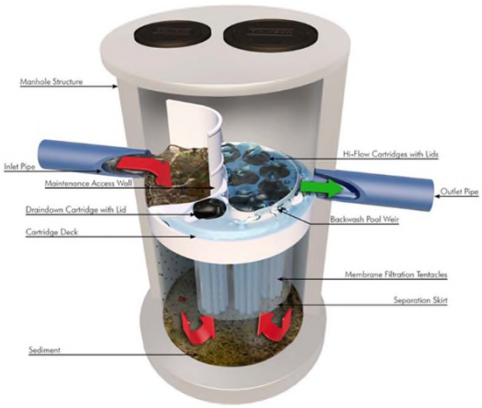
MTD-F: Filtering Devices



- Flow enters the system and passes through the media, where solids are filtered from the flow and soluble pollutants attach to specialized media.
- Filter treatment is provided by straining pollutants and providing a potential platform for microbial breakdown of pollutants

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8.4.2.2 Filtering Devices in Virginia

MTD Name	BMP #
Aqua-Filter	MTD-F-01
BayFilter using Enhanced Media Cartridges (EMC)	MTD-F-02
StormTech Isolator Row Plus	MTD-F-03
HydroFilter	MTD-F-04
HydroChain Vortex Filter (HCVF)	MTD-F-05
Jellyfish Filter	MTD-F-06
Kraken Filter	MTD-F-07
StormFilter Phosphorb ZPG	MTD-F-08
PerkFilter	MTD-F-09
StormKleener Filter Cartridge System	MTD-F-10
StormKeeper Sediment Strip	MTD-F-11
Up-Flo Filter Using Filter Ribbons	MTD-F-12
Up-Flo Filter Extended Maintenance Cartridge (EMC)	MTD-F-13

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Filtering Media

Expanded perlite

Zeolite

Sand

Other specialized media

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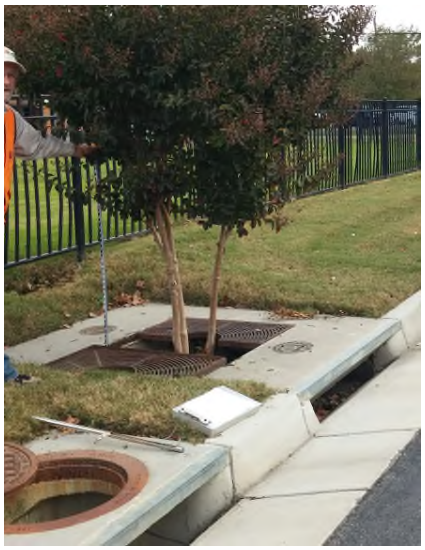
MTD-B: Biofilter Devices



- Treat stormwater runoff through filtration by soil media or vegetation.
- Offers an enhanced treatment of pollutants like nutrients and metals, due to the integration of biological components or elements into the device.

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8.4.3.2 Biofilter Devices in Virginia

MTD Name	BMP #
Aqua-Ponic	MTD-B-01
Biopod	MTD-B-02
EcoPure Biofilter	MTD-B-03
FocalPoint High- Performance Media Biofiltration System	MTD-B-04
Filterra HC Biofiltration	MTD-B-05
Filterra Biofiltration	MTD-B-06
Filterra Bioscape Biofiltration	MTD-B-07
Modular Wetlands Biofiltration	MTD-B-08
StormGarden	MTD-B-09
StormTree Biofiltration Practice	MTD-B-10
StormScape Filter	MTD-B-11

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MTD Maintenance

- Always check and refer to the appropriate manufacture's maintenance guidance and owner's manual
- Manufacture may have a certified maintenance vendors list

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8.4.4 MTD Approval Process

Complete the Proprietary BMP Registration Statement

Submit registration and support documents

DEQ reviews submission:

Assign applicable TP removal efficiency

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For each approved MTD, the following information is provided:

- VDEQ APPROVAL LETTER
- WEB LINK TO VIEW SPECIFICATIONS AND OTHER PRODUCT INFORMATION
- VENDOR CONTACT INFORMATION
- INFORMATION REVIEWED BY VDEQ

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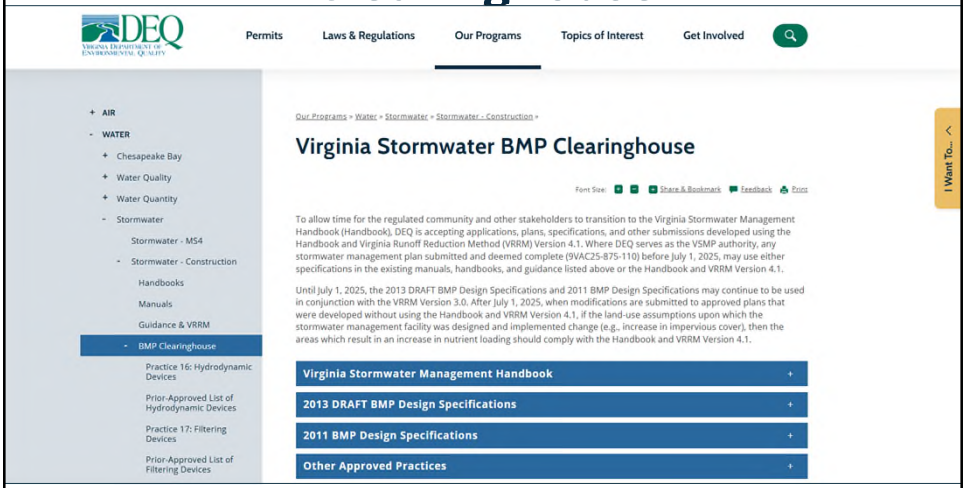
Virginia Stormwater BMP Clearinghouse



https://www.deq.virginia.gov/our-programs/water/stormwater/stormwater-construction/bmp-clearinghouse

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8.5 Standards and Specifications for Post-Construction BMPs

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P-BAS-03

Extended Detention Pond

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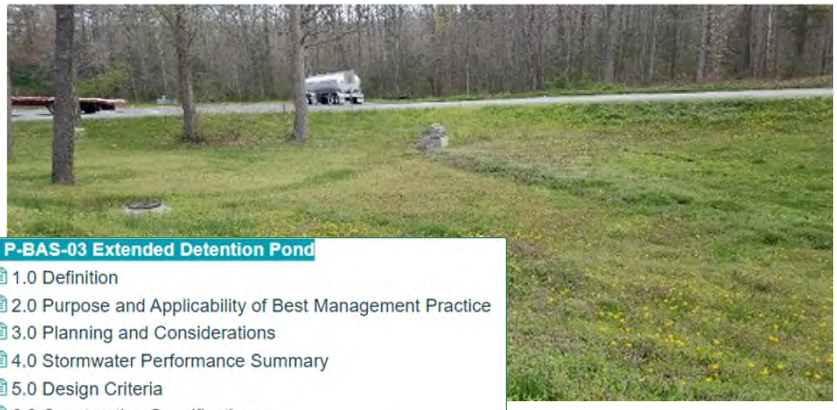
P-BAS-03: Extended Detention Pond



- P-BAS-03 Extended Detention Pond
  - 1.0 Definition
  - 2.0 Purpose and Applicability of Best Management Practice
  - 3.0 Planning and Considerations
  - 4.0 Stormwater Performance Summary
  - 5.0 Design Criteria
  - 6.0 Construction Specifications
  - 7.0 Operations and Maintenance Considerations
  - 8.0 References

Dry Detention Basin at the Ladysmith (Caroline Co.) Northbound VDOT Safety Rest Area
Photo credit: Scott Crafton

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P-BAS-03: 2.0 Purpose and Applicability

- The primary pollutant removal mechanism is gravitational settling.
- Provides fair to good removal of particulate pollutants.
- Provides low or negligible removal of soluble pollutants such as nitrate and soluble phosphorus.

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P-BAS-03: 2.1
Feasibility/Limitations

- **Tailwater Conditions:** The flow depth in the receiving channel should be considered when determining outlet elevations and discharge rates from the ED pond
- **Soils**: Seldom a design constraint
- **Perennial Streams**: Typically, not allowed and/or requires state/federal permit(s)

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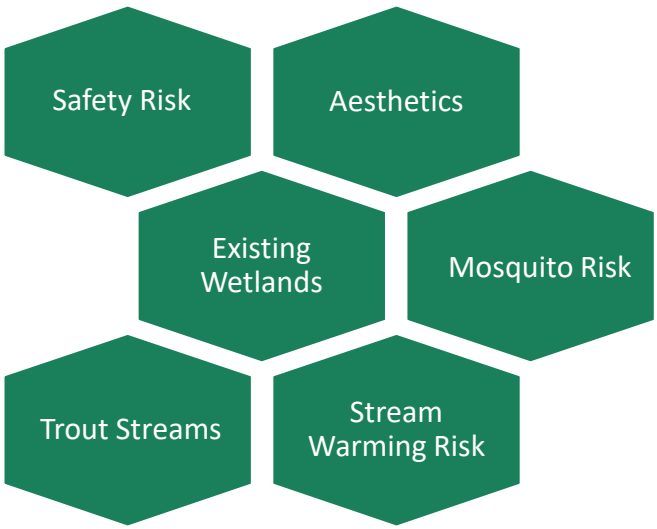
3.0 Planning and Considerations



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4.0 Stormwater Performance Summary

Table P-BAS-03-4 Summary of Stormwater Functions Provided by ED Ponds

Stormwater Function	Level 1 Design	Level 2 Design
Annual Runoff Volume Reduction (RR)	0%	15%
Total Phosphorus (TP) event mean concentration (EMC) Reduction[1] by BMP Treatment Process	15%	15%
TP Mass Load Removal	**15%**	31%
Total Nitrogen (TN) EMC Reduction[1] by BMP Treatment Process	10%	10%
TN Mass Load Removal	10%	24%
Channel Protection	Yes; storage volume can be provided to accommodate the full CPv	
Flood Mitigation	Yes; flood protection storage can be provided beyond the maximum extended detention volume	

1. Change in EMC through the practice. The actual nutrient mass load removed is the product of the removal rate and the runoff reduction rate.

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P-BAS-03: 5.0 Design Criteria – Conveyance and Overflow

No pilot channels	Internal slope ★	Principal spillway
Non-clogging low flow orifice ★	Emergency spillway	Adequate outfall protection
On-Line ED Ponds	Dam Safety Permits	Inlet protection

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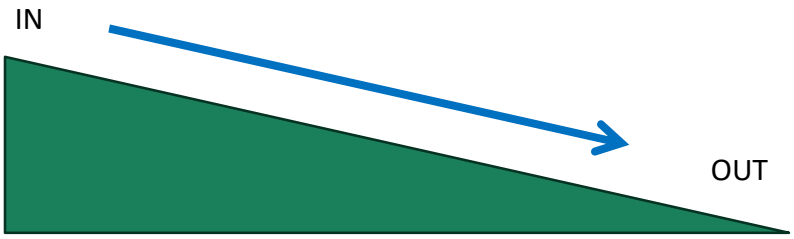
Internal slope

- The maximum longitudinal slope through the pond must be approximately 0.5 to 1 percent to promote positive flow through the ED pond.



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Non-Clogging Low Flow Orifice

- ED ponds with drainage areas of 10 acres or less are prone to chronic clogging by organic debris and sediment.

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Non-Clogging Low Flow Orifice

- Conventional trash racks need to have spacings that are half the diameter of the orifice;
  - This is not practical for 3-inch or smaller orifices.
  - Orifices less than 3 inches in diameter should be avoided, unless otherwise approved by the VESMP authority.

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5.7 Maintenance Features

- Maintenance access
- Riser or outfall device
- Access roads
- Steeper grades can be allowed
- A maintenance right-of-way or easement
- Can sediments be spoiled (deposited) onsite?

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5.8 Additional Design Guidance

- Karst terrain
- Coastal plain terrain
- Steep terrain
- Cold climate and winter performance
- Linear highway site
- Linear utility sites

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7.2 Maintenance Inspections

Sediment accumulation levels in forebay	Growth of wetlands, trees, and shrubs planted	Condition of stormwater inlets to the pond
The banks of upstream and downstream channels	Outfall channel	Principal spillway and riser
Trash racks, reverse sloped pipes, or flashboard risers	Maintenance access	Internal and external side slopes of the pond

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7.3 Common Ongoing Maintenance Tasks

- Prone to clogging
- Maintenance plan should outline vegetation management
- Recommend remove trash at least once a year
- Sediment removal from the forebay is essential.
  - Anticipate every 5 - 7 years, or when 50% of the forebay capacity has been filled.

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Activity 3:

Evaluating P-BMPs

Break for Lunch: 1-Hour
12PM – 1PM

100

Activity 3

Evaluating P-BMPs with the SWMH

1

Outline

- **Evaluating P-BMPs:**
  - **Case Study:** Review Construction Record Drawing Materials
  - **Activity**: Timeline of conversion from temporary basin to P-BMP
  - **Chapter 10:** BMP Inspection and Maintenance

2

Evaluating P-BMPs

Case Study

3

Case Study: Redevelopment of a High School

- Your locality has recently completed a re-design and construction of a High School.
- You receive a construction record drawing (CRD) for one of the permanent stormwater management facilities (P-BMP) to review.
- This CRD will serve as the record for what was built on site for future post-construction inspections.

4

Major Site Changes

2018

2024

5

Construction Completed in 2021

6

Construction Record Drawings

"Record drawings are prepared by the architect and reflect on-site changes the contractor noted in the as-built drawings.

They are often compiled as a set of on-site changes made for the owner per the owner-architect contract."

American Institute of Architects

DEQ

7

Construction Record Drawings

Might include
Documented revisions to approved construction plans or approved amendments to plans ("Red Line Drawings")
Shop drawings
As-built survey
Special inspections
Other

DEQ

8

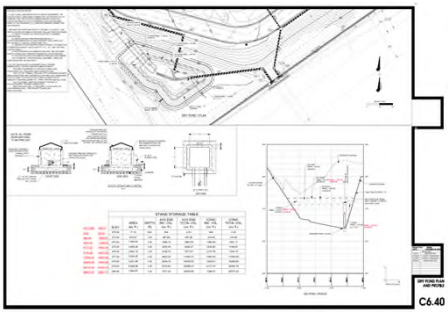
Reviewing a Construction Record Drawing

- Take 10-Mins to review the construction record drawing
- Be prepared to discuss!
- **Materials:**
  - As-Built Plan Sheet A or B
  - Magnify glasses available

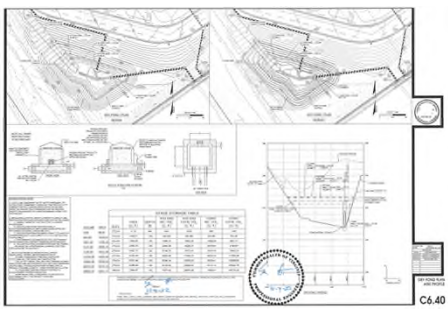
9

Reviewing a Construction Record Drawing

CRD: A



CRD: B



10

Reviewing a Construction Record Drawing (CRD) – Pt 1

- What is featured on the CRD? Is there anything missing?
  - Documented revisions or amendments to approved construction plans ("Red Line Drawings")
  - Shop drawings
  - As-built survey
  - Special inspections
- Could you accept this CRD as is?
  - Would you require any changes before accepting?

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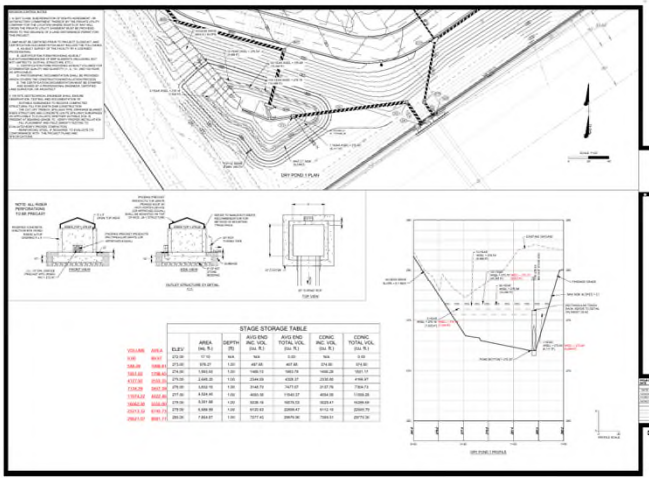
What improvements (if any) would you request for this CRD before acceptance?



CRD-A

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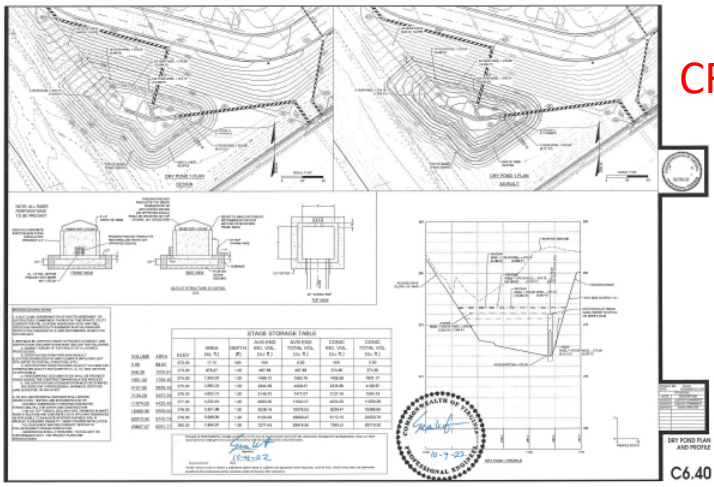
What improvements (if any) would you request for this CRD before acceptance?



CRD-B

13

Reviewing a Construction Record Drawing (CRD)

WHAT ELSE WOULD RYN REQUEST FOR A CRD:

- One sheet plan document with all the pertinent design information
- Color coded for approved design and as-built
- Helpful title of the single sheet for easy reference
- Suggested maintenance timeline (Short and long term)

14

Reviewing a Construction Record Drawing (CRD) – Pt 2

- What P-BMP is featured in this CRD?
  - What is the basic function of the facility?
  - Where and how does water get in and out?
- Was the design changed during construction?
  - Where and how?
- Did the builder meet the designer's intent?
- What improvements (if any) would you request for this CRD before acceptance?

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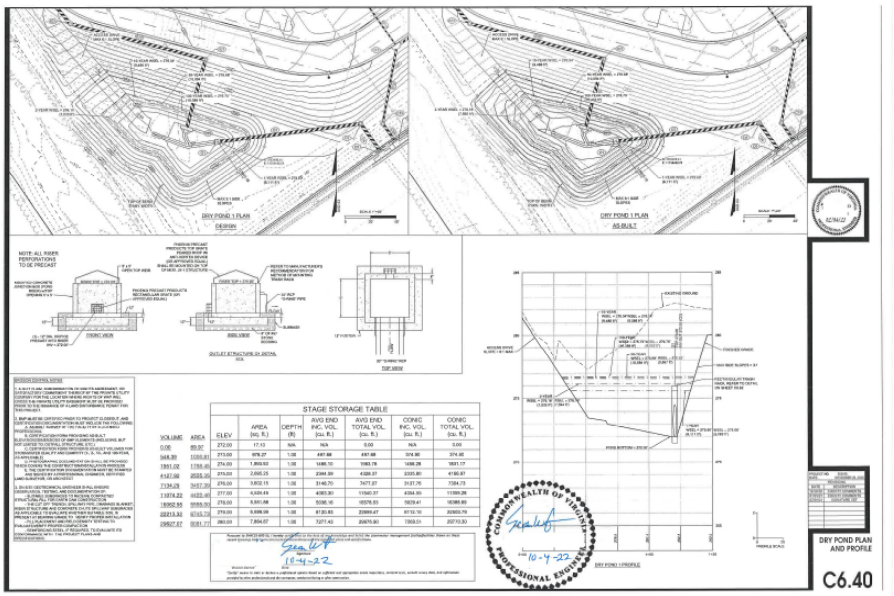
What P-BMP is featured in this CRD?



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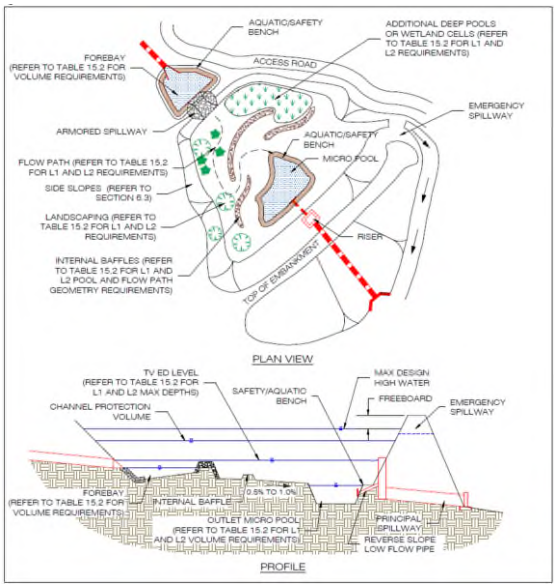
P-BAS-03 Extended Detention Pond



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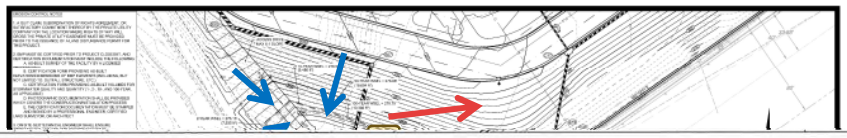
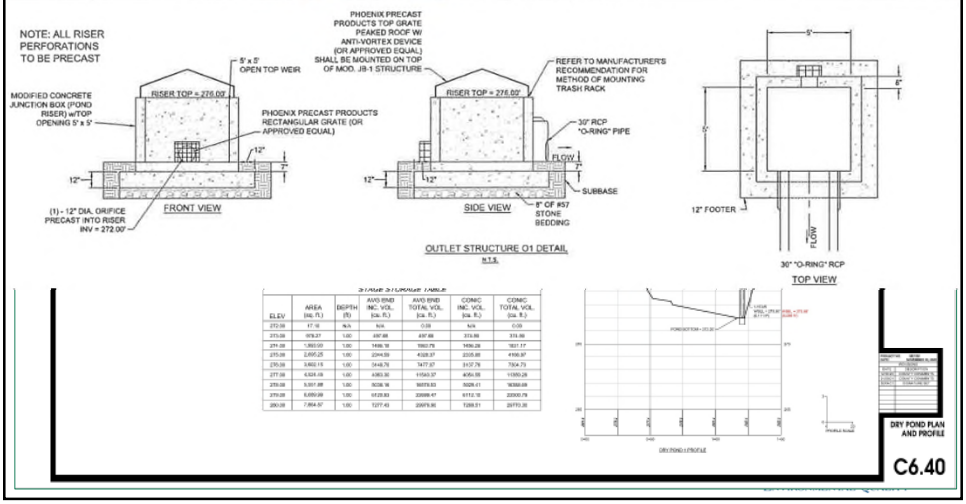
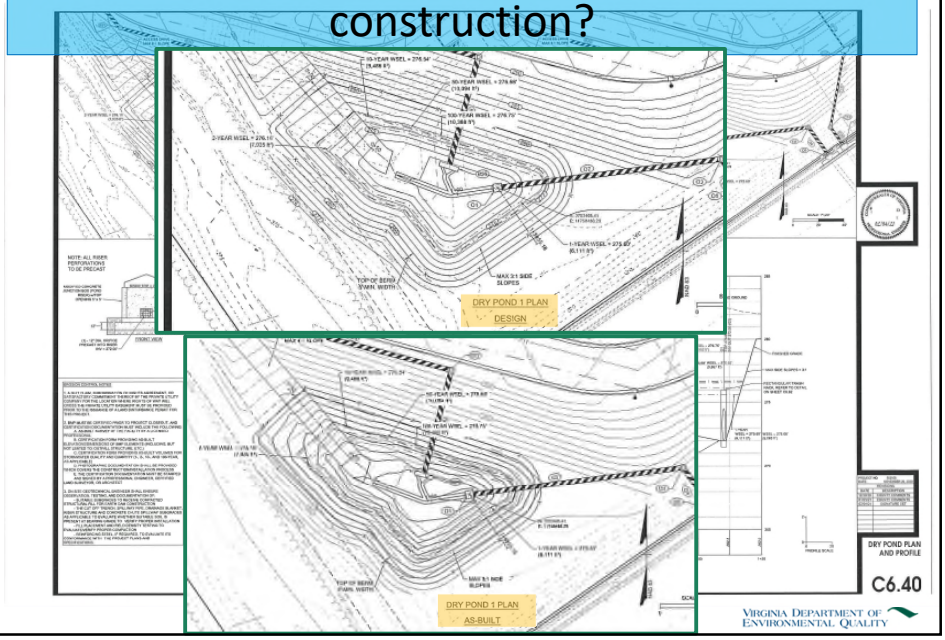
What is the basic function of the facility?





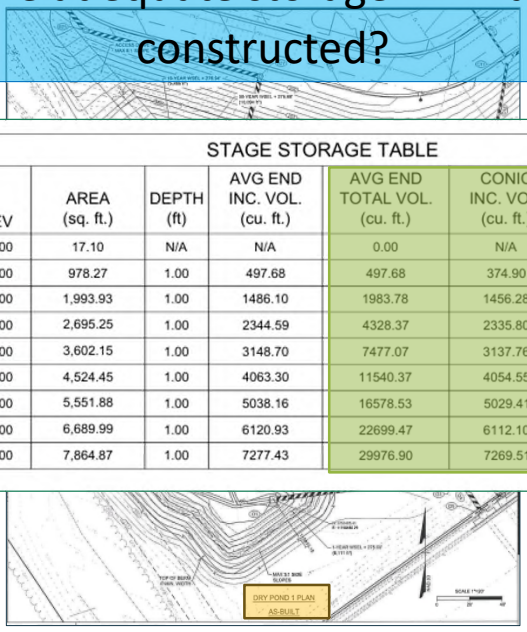
18

Did the design change drastically during construction?



19

Is there adequate storage in what was constructed?

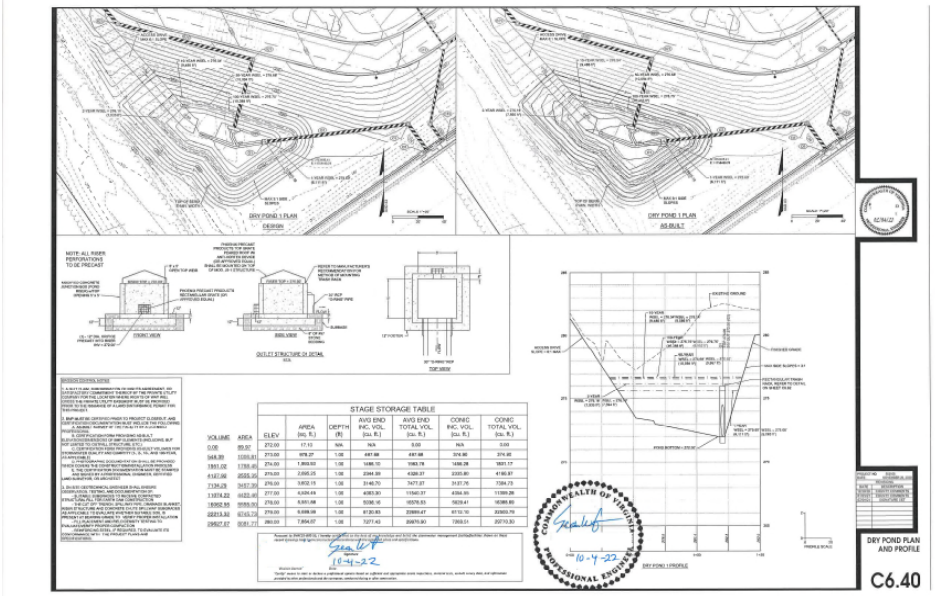


STAGE STORAGE TABLE

VOLUME	AREA	ELEV	AREA (sq. ft.)	DEPTH (ft)	AVG END INC. VOL. (cu. ft.)	AVG END TOTAL VOL. (cu. ft.)	CONIC INC. VOL. (cu. ft.)	CONIC TOTAL VOL. (cu. ft.)
0.00	89.97	272.00	17.10	N/A	N/A	0.00	N/A	0.00
548.39	1006.81	273.00	978.27	1.00	497.68	497.68	374.90	374.90
1951.02	1798.45	274.00	1,993.93	1.00	1486.10	1983.78	1456.28	1831.17
4127.92	2555.35	275.00	2,695.25	1.00	2344.59	4328.37	2335.80	4166.97
7134.29	3457.39	276.00	3,602.15	1.00	3148.70	7477.07	3137.76	7304.73
11074.22	4422.46	277.00	4,524.45	1.00	4063.30	11540.37	4054.55	11359.28
16062.95	5555.00	278.00	5,551.88	1.00	5038.16	16578.53	5029.41	16388.69
22213.32	6745.73	279.00	6,689.99	1.00	6120.93	22699.47	6112.10	22500.79
29627.07	8081.77	280.00	7,864.87	1.00	7277.43	29976.90	7269.51	29770.30

20

Did the builder meet the designer's intent?



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Evaluating P-BMPs

Activity

22

Activity: Conversion Timeline

Review the photo-timeline documenting inspections as the operator converts the temporary sediment basin/trap to the P-BMP

23

P-BAS-03: Extended Detention

6.0 Construction Specifications

6.1 Construction Sequence

24

Step 1:
Use of ED pond as an E&S control.

- An ED pond may serve as a sediment basin during project construction.
- The bottom elevation of the ED pond should be lower than the bottom elevation of the temporary sediment basin.
- The construction notes should clearly indicate that the facility will be dewatered, dredged, re-graded, and stabilized to design dimensions after the original site construction is complete.

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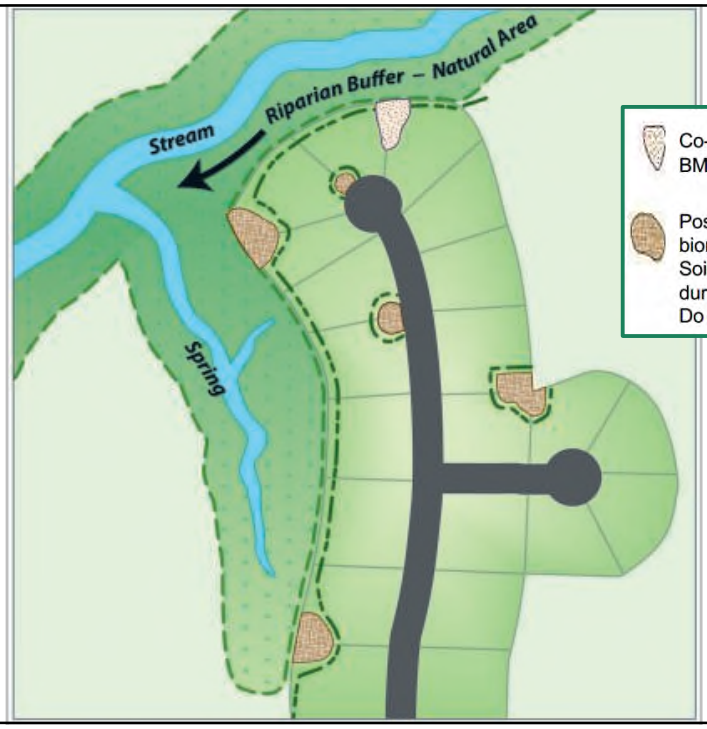

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What should the operator receive prior to the conversion of a temporary basin to a permanent stormwater facility?

Bonus Question: Is this an appropriate use of straw bales?

27

What is being constructed? What material is going to be used?

Bonus Question: What pollution prevention practices should be available on site?

28

What's the most likely next step(s) the contractor is going to take?

29

What's being installed, and or what purpose?

30

Is this P-BMP permanently stabilized?

31

Final Inspection Thoughts

32

Chapter 10

BMP Inspection and Maintenance

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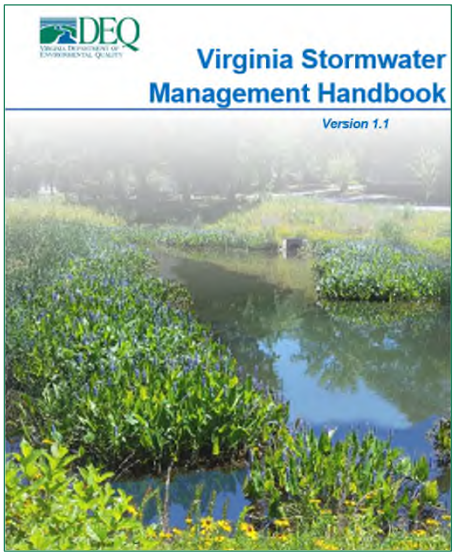
Chapter 10 Contents

1. Introduction
2. Inspection and Maintenance Requirements
3. Best Practices for Developers and Designers
4. Summary of BMP Operations and Maintenance Tasks and Activities
5. References



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Program Responsibility Includes:

1. Assigning maintenance responsibility through legally binding agreements
2. Providing adequate access to BMPs
3. Enforcing compliance with maintenance agreements

Photo of Taskinas Creek in Virginia

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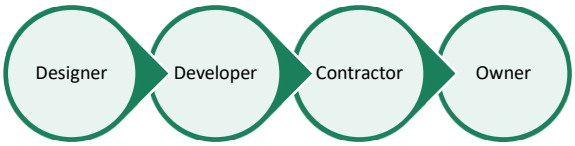
Transfer of Authority:



- **Chapter 4:**
  - Regulatory framework and requirements for the transition of facility ownership
- **Chapter 9:**
  - Construction phase requirements for stormwater facility maintenance programs

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Transition of facility ownership discussion items:

- Facility-specific features
- Access during maintenance
- Reporting Responsibility
- O&M issues
- Design issues
- Non-standard or proprietary features

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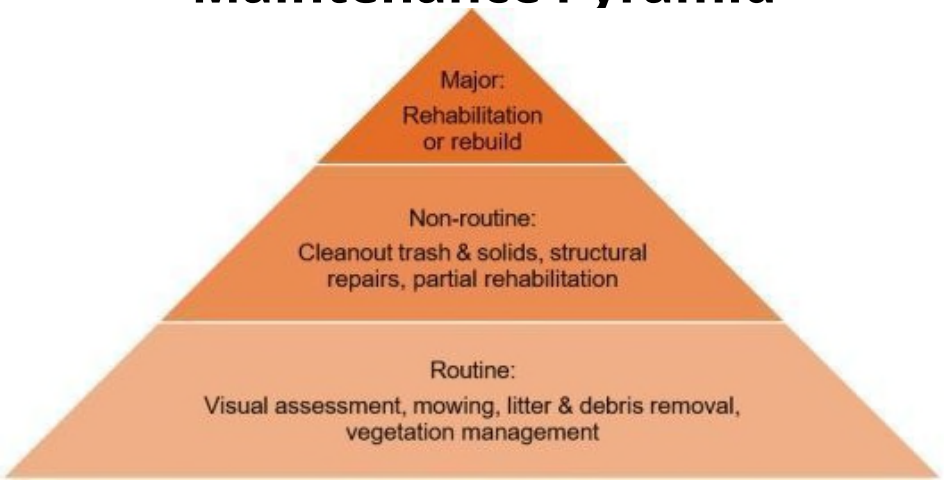
Figure 10-3 BMP Operation and Maintenance Pyramid



38

Table 10-1 Examples of Non-Routine and Routine Maintenance

Structural Maintenance Items (Non-routine)	Routine Maintenance Items
• Clogged or broken pipes	• Mowing
• Missing or broken parts (e.g., valves, seals, manhole)	• Removal of small amounts of sediment
• Cracked concrete	• Removal of vegetative overgrowth and woody plants
• Dam repairs	• Removal of trash and yard debris
• Erosion at outfall or on banks	• Replacing dead or diseased landscaping
• Sinkhole formation or subsidence within the BMP footprint	• Control of invasive plants
• Regrading or dredging	• Vegetation and media maintenance
• Mechanical equipment repairs	• Nuisance control (e.g., animals, undesirable plan communities, etc.)
• Landscaping needs complete refurbishment	• Minor cleaning of pretreatment devices, inlets, outlet structures, chambers, etc.

Sources: CWP 2008; Water Environment Federation et al. 2022

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Routine or Non-Routine Maintenance?

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Routine or Non-Routine Maintenance?

41

Routine or Non-Routine Maintenance?

42

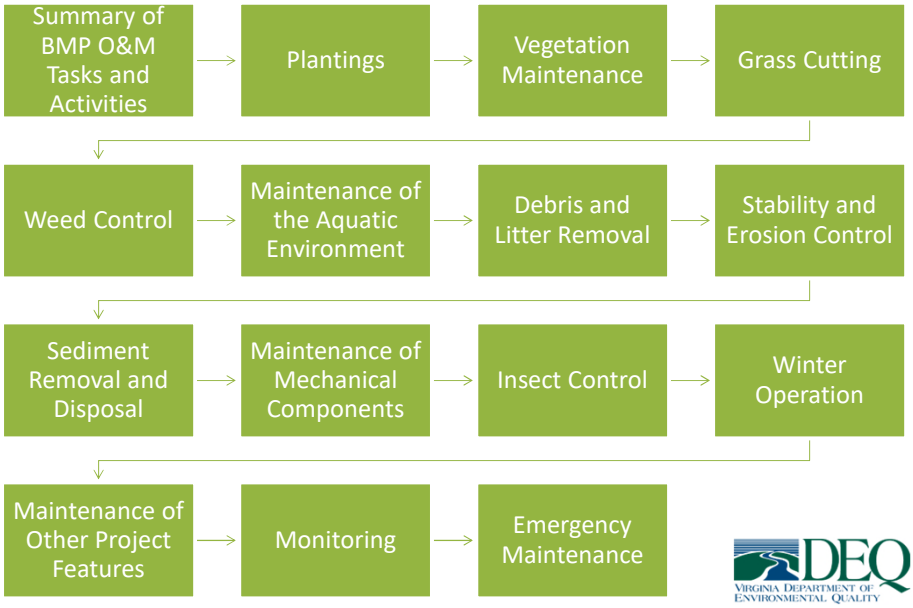
Routine or Non-Routine Maintenance?

43

Routine or Non-Routine Maintenance?

44

10.4 Summary of BMP Operation and Maintenance Tasks and Activities



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Sediment Removal and Disposal

- Frequency Factors
- Wet Vs Dry removal
- Underground or proprietary BMPs
- On-Site Disposal
- Off-Site Disposal
- Hazardous Waste Disposal

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Seasonal Maintenance Tasks

- **Insect Control:**
  - Reduce stagnant water
  - Remove trash and debris
  - Fish
  - Aeration

- **Winter Operation:**
  - Road maintenance influence (salt and sand)
  - Groundwater contamination → Clean more frequently

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P-FIL-05

Bioretention

- P-FIL-05 Bioretention
  - 1.0 Definition
  - 2.0 Purpose and Applicability of Best Managemen
  - 3.0 Planning and Considerations
  - 4.0 Stormwater Performance Summary
  - 5.0 Design Criteria
  - 6.0 Construction Specifications
  - 7.0 Operations and Maintenance Considerations
  - 8.0 References
  - 9.0 Appendix A Micro-bioretention
  - 10.0 Appendix B Ultra-Urban Bioretention

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Table P-FIL-05-1 Summary of the Three Main Types of Bioretention

Table P-FIL-05-1 Summary of the Three Main Types of Bioretention

Type	Details
Bioretention	Focuses on general bioretention practices that are used to treat parking lots and/or commercial rooftops, usually in commercial or institutional areas. Inflow can be either sheet flow or concentrated flow. Bioretention practices may also be distributed throughout a residential subdivision, but ideally, they should be in a common area or within drainage easements to treat a combination of roadway and lot runoff (Figure P-FIL-05-3).
Micro-bioretention (a.k.a. Rain Gardens)	Small, distributed practices designed to treat runoff from small areas, such as individual rooftops, driveways, and other on-lot features in detached, single-family residential developments. Inflow is typically sheet flow or can be concentrated flow with energy dissipation when located at downspouts. Please refer to Appendix A Micro-bioretention for design criteria for Micro-bioretention (Figure P-FIL-05-4).
Ultra Urban Bioretention	Structures such as expanded tree pit planters, curb extensions, and foundation planters located in ultra-urban developed areas such as city streetscapes. Please refer to Appendix B Ultra-Urban Bioretention for design criteria for Urban Bioretention (Figure P-FIL-05-5).

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Typical locations:

- Parking lot islands
- Parking lot edges
- Road medians, roundabouts, interchanges, and cul-de-sacs
- Right-of-way or commercial setback
- Courtyards
- Dry extended detention basin
- Tree planter and other local landscaping planting structures

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Table P-FIL-05-2 Summary of Stormwater Treatment Functions Provided by Bioretention

Stormwater Function	Level 1 Design	Level 2 Design
Annual Runoff Reduction Volume	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%

Notes:

Source: Hirschman et al 2009.

1. Change in event mean concentration (EMC) through the best management practice (BMP).

4.2 Performance

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P-FIL-05: Design Criteria – 5.2 Surface Ponding Area

- **5.2.1 Depth:** 6-12 in ponding depth
- **5.2.2 Side Slopes:** 3H:1V or flatter
- **5.2.3 Surface Cover:**
  - Mulch
  - Managed grass or non-leguminous herbaceous cover
  - Alternative Vegetative Covers and/or Zones

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P-FIL-05: 5.2.4 Planting Plan

A planting plan must be developed for the intended vegetated zones in each bioretention area.

The **primary objective** of the planting plan is to cover as much of the surface area of the filter bed as quickly as possible to provide some level of vegetative resistance to water flow and enhance evapotranspiration and nutrient.

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Table P-FIL-05-6 Bioretention Vegetation Options and Templates

Vegetation Component	Options
Managed Grass	This option serves as both vegetation and surface cover (see Section 5.2.3). For Level 1 practices, managed grass is all that is needed. For Level 2 practices, managed grass must be combined with shrubs and/or trees. Use grass species that have dense cover, are relatively slow growing, and require limited mowing (see Table P-FIL-05-7).
Perennial Garden	This option uses herbaceous plants and native grasses to create a garden effect with seasonal cover. This option is attractive, but it requires diligent maintenance in the form of weeding. Use of pollinator friendly mixes is encouraged.
Perennial garden with shrubs	This option mixes native shrubs and perennials together in the bioretention area. This option is frequently used when the soil filter media is too shallow to support tree roots (which have a minimum effective rooting depth of 36 inches).
Tree, shrub and herbaceous plants	This template is the traditional landscaping option for bioretention and is highly recommended. The landscape goal is to simulate the structure and function of a native early successional forest plant community.
Managed grassland and trees	This option is a lower maintenance version of the tree-shrub-herbaceous option. Trees are planted within larger mulched islands to prevent damage during mowing operations.
Herbaceous meadow	This approach focuses on the herbaceous layer and may resemble a wildflower meadow or roadside vegetated area (e.g., with Joe-Pye weed, New York ironweed, sedges, grasses, etc.). The goal is to establish a natural look that may be appropriate if the practice is located in a lower maintenance area (e.g., further from buildings and parking lots). Shrubs and trees may be incorporated around the perimeter.

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P-FIL-05: Vegetation Plan Considerations:

- **Native plant species**
- Pollinator friendly species
- **Specified zone of hydric tolerance** and must be capable of surviving both wet and dry conditions
- **Shallow filter beds:** Use turfgrass, perennials or shrubs
- **Trees**: plant shade-tolerant ground covers within the drip line
  - **Tree species**: tolerate expected non-pristine air and water inputs from the urban landscape
- **Maintenance**
- Snow storage or is to accept snowmelt runoff

5.3 Links for Stormwater BMP and Native Plant Publications

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Appendix G

Plant Selection

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G.2 Plant Information

1. Plant Type
2. Plant Name
3. Virginia Native Range
4. Hardiness Zones
5. Size
6. Recommended Plant Spacing
7. Stormwater Impoundment Zone Suitability
8. Sun Requirements
9. Moisture Requirements
10. Additional Features/Notes
11. Pruning Time
12. Bloom Times
13. Fruit Time
14. Seasonal Photos

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P-FIL-05: 5.4 Installation and Maintenance Plan

Common Sense Approach

- Plant “wet tolerant” species near the center of the practice.
- Plant woody vegetation away from points of inflow.
- Trees should not be planted directly above underdrains but instead should be located closer to the perimeter.
- Planting holes for trees should be at least 3 feet deep to provide enough soil volume for the root structure of mature trees.
- Temporary or supplemental irrigation may be needed for bioretention plantings for plant material survival.

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Table P-FIL-05-12 Summary of Essential First-Year Maintenance Operations

Activity	Timing
Initial Inspections	For the first 6 months following construction, the site should be inspected at least twice after storm events that exceed 0.5 inch of rainfall.
Spot Reseeding	Inspectors should look for bare or eroding areas in the contributing drainage area or around the bioretention area, and make sure they are immediately stabilized with grass cover.
Fertilization	One-time, spot fertilization may be needed for initial plantings. Slow-release nitrogen sources should be utilized whenever possible.
Watering	Watering is needed once a week during the first 2 months, and then as needed during the first growing season (March/April-October), depending on rainfall.
Remove and replace dead plants	Since significant amounts of the initial planting stock may not survive in the first year, construction contracts should include a care-and-replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction. The typical thresholds below which replacement is required are 85% survival of intended/seeded herbaceous plant material and 100% survival of shrubs and trees.

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Table P-FIL-05-13 Routine Maintenance Tasks

Maintenance Tasks	Frequency
Mow grass filter strips and bioretention turfgrass cover.	At least 4 times per year
Perform spot weeding, erosion repair, trash removal, and mulch raking.	Monthly
Add reinforcement planting to maintain desired vegetation density. Remove invasive plants using recommended control methods. Stabilize the contributing drainage area to prevent erosion.	As needed
Perform spring inspection and cleanup. Supplement mulch to maintain a 2 to 3-inch layer. Prune trees and shrubs.	Annually as/if needed
Remove sediment in pretreatment cells and inflow points.	At least 4 times per year
Replace the mulch layer.	Every 2-3 years or if in poor condition
Revaluate Ksat via appropriate method for both primary media filter layer and underlying and/or lateral soil infiltration zone (if utilized).	Every 5 years

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Activity 4:

Creating a planting plant for a P-FiIL-05 using Appendix G

Afternoon Break: 15-Mins

2:30PM – 2:45PM

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Activity 4

Creating a Proposal for a P-FIL-05 Bioretention

1

Scenario:

- A new library has been approved for construction by the community!
- Due to the LDA activity associated with the new library's construction, a **P-FIL-05 Bioretention** is necessary to treat the post-construction stormwater runoff generated from the site.
- You are going to create a planting plan utilizing Appendix G from the VSMH

2

Quick Review

P-FIL-05 Bioretention

3

Figure P-FIL-05-3

- Image of bioretention cell receiving stormwater runoff from multiple input points (3) in a mixed-use development in Blacksburg, VA

4

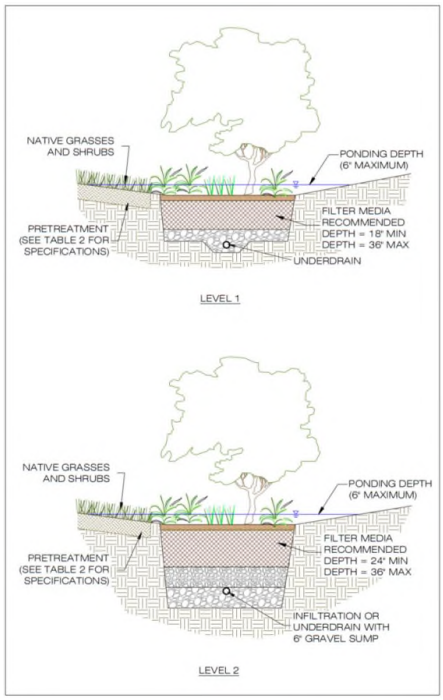

Figure P-FIL-05 A-2

- Typical Micro-bioretention basis with Level 1 vs. Level 2 design

5

Plant Information

1. Plant Type
2. Plant Name
3. Virginia Native Range
4. Hardiness Zones
5. Size
6. Recommended Plant Spacing
7. Stormwater Impoundment Zone Suitability
8. Sun Requirements
9. Moisture Requirements
10. Additional Features/Notes
11. Pruning Time
12. Bloom Times
13. Fruit Time
14. Seasonal Photos

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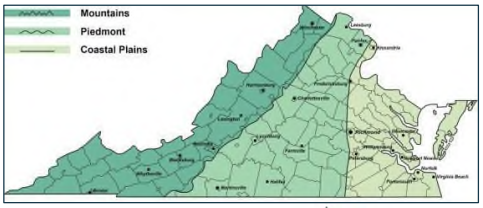
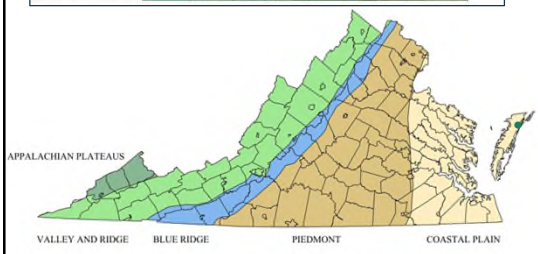
3. Virginia Native Range





PHYSIOGRAPHIC PROVINCES IN VIRGINIA

- **Mountains** - The Mountain region includes the Valley and Ridge, Blue Ridge, and Appalachian Plateau provinces and covers much of western Virginia.
- **Piedmont** - The Piedmont encompasses central Virginia and serves as a transitional zone between the lower coastal lands and the Appalachian Mountains.
- **Coastal Plains** - The Coastal Plains run along the Atlantic Ocean and feature flatter topography, sandy soils, and well-developed ravines and tidal river systems.

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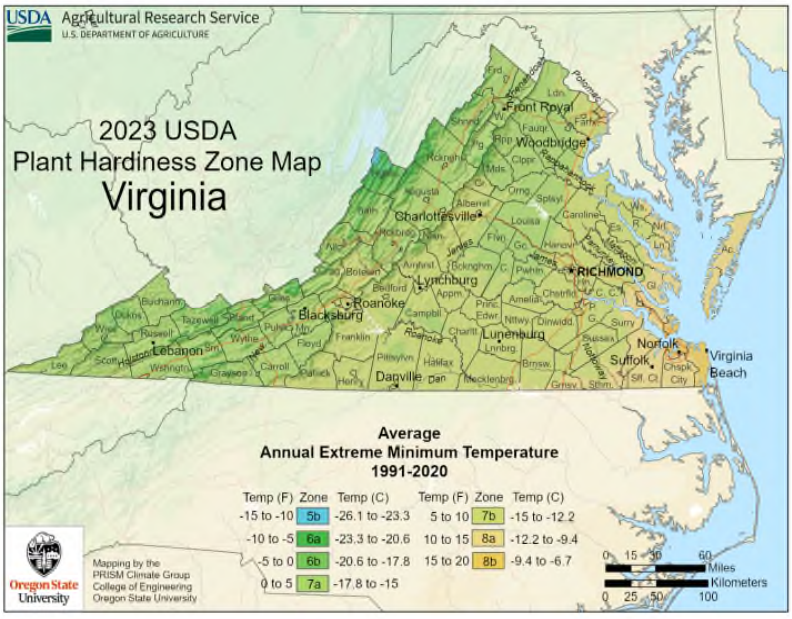
4. Hardiness Zones



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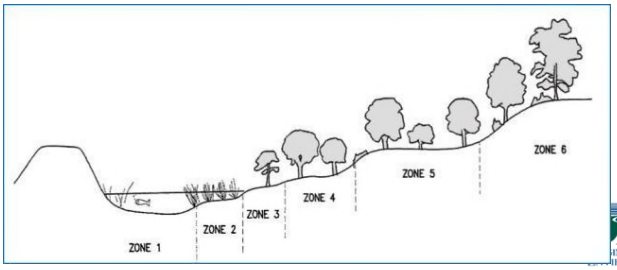
7. Stormwater Impoundment Zone Suitability

- Zone 1: Deep Water Area
- Zone 2: Shallow Water Area
- Zone 3: Shoreline Fringe
- Zone 4: Riparian Fringe Area
- Zone 5: Floodplain Terrace
- Zone 6: Upland Areas



9

10. Additional Features

Water Tolerant

Drought Tolerant

Wildlife/Pollinator

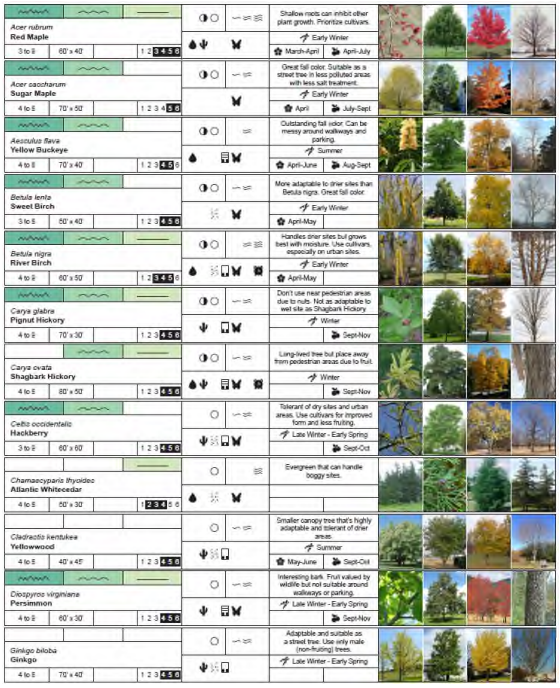
Phytoremediation

Salt Tolerant

Urban/Pollution Tolerant

Year-Round Interest

10

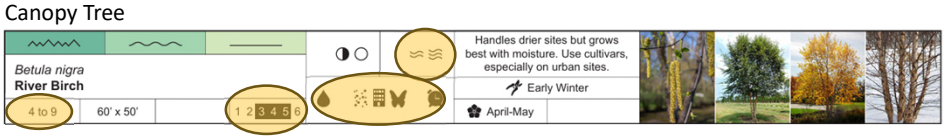


G.3.1
Canopy Trees

Example: River Birch

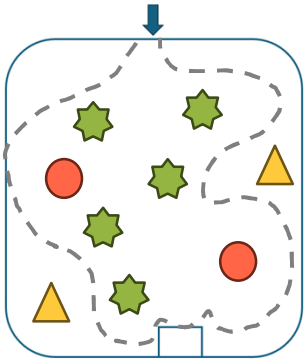
Plant Type [1]

Canopy Tree



Hardiness Zones: 4-9 (all of Virginia)
Stormwater Impoundment Zone Suitability: 3 (Shoreline Fringe), 4 (Riparian Fringe), and 5 (Flood Plain terrace)
Moisture Requirements: Medium to High
Additional Features: Water tolerance, salt tolerance, urban/pollution tolerance, wildlife/pollinator, and year-round interest

Create a Basic Planting Plan for a P-FIL-05



Instructions:

- **Time Allotment**: 20-Minutes
- Choose **LOCATION of CHOICE** for this Bioretention (i.e. Williamsburg, Richmond, Roanoke, Lynchburg, etc.)
- **Select 3+ plants** (tree, shrub, flowering perennials, grasses) from the appropriate Native Range and Hardiness Zone
- Designate an icon for each planting and be prepared to discuss!

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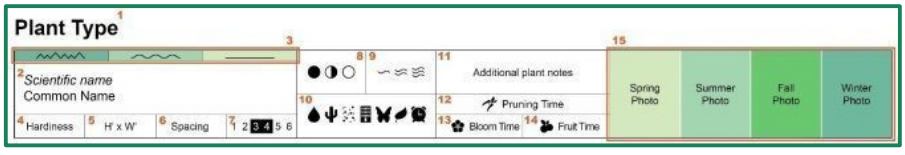
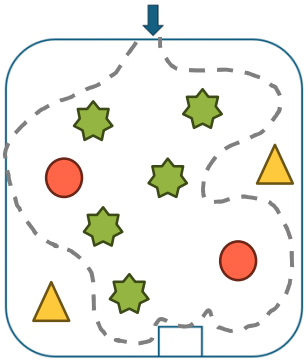
Create a Basic Planting Plan for a P-FIL-05





- Choose **LOCATION of CHOICE** for this Bioretention (i.e. Williamsburg, Richmond, Roanoke, Lynchburg, etc.)
- **Select 3+ plants** (tree, shrub, flowering perennials, grasses) from the appropriate Native Range and Hardiness Zone

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What Plants did you choose?

Bioretention					
Location:					
Planting Plan					
Plant Type	Plant Name	Va Native Range	Hardiness Zone	SWM Zone	Additional Features
Canopy Trees					
Understory Trees					
Flowering Perennials					
Grasses and Groundcovers					
Other Considerations:	Native plants and pollinators Inlet flow energy reduction (Pre-treatment?) Flow path Emergency/Overflow outlet				

DEQ
Virginia Department of Environmental Quality

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Handbook Updates and Revision Process

Version 1.1 and beyond…

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Technical Review Committee (TRC)

- Building Industry
- Virginia Colleges and Universities
- Engineering and Architecture Community
- Environmental Community
- Local Governments and Regional Agencies
- Manufacturers of Stormwater Products
- Virginia Agencies
- Virginia Utilities

TRC composition – broad representation (Section 1.4.2)

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Handbook Update Process

- Identify problems and track comments
- Review and prioritize problems and comments
- Convene technical review committee meetings
- Revise handbook sections and inform users

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VSMH V1.1

- **Technical corrections:**
  - Typos and errors
  - Add statutory references
  - Add CAD and PDF files for design specs
  - Full list of update on website

COMMONWEALTH OF VIRGINIA
Department of Environmental Quality

Subject: Guidance Memo No. GM24-2001 – **Virginia Stormwater Management Handbook, Version 1.1**

To: Regional Directors, Central Office, Office of Stormwater Management

From: Mike Rolband, Director

Date: June 25, 2024

https://www.deq.virginia.gov/our-programs/water/stormwater/stormwater-construction/handbooks

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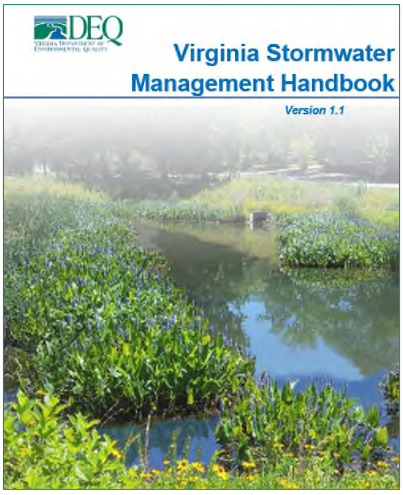
Written Comments

- Directly into Encode
- For SWM Program Guidance: swmguidance@deq.virginia.gov



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